ADMINISTRATIVE DRAFT

YOLO REGIONAL CONSERVATION INVESTMENT STRATEGY/LOCAL CONSERVATION PLAN

STEERING COMMITTEE:

Yolo Habitat Conservancy
California Department of Water Resources
California Natural Resources Agency
Yolo County
American Rivers
Environmental Defense Fund

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Acronyms and Abbreviations

°F	Fahrenheit
AB 2087	Assembly Bill 2087
AIS	Aerial Information Systems
BANS-TAC	Bank Swallow Technical Advisory Committee
BWFS	Basin-Wide Feasibility Studies
BWFS	Basin-Wide Feasibility Studies
Caltrans	California Department of Transportation
CCAH	Center for Companion Animal Health
CCAP	Cache Creek Area Plan
CCIP	Cache Creek Improvement Program
CCRMP	Cache Creek Resource Management Plan
CDFW	California Department of Fish and Wildlife
now CDFW	California Department of Fish and Game
CEC	California Energy Commission
CFGC	California Fish and Game Code
CFGC	California Fish and Game Code
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
CIP	Capital Improvement Plan
Conservancy	Yolo Habitat Conservancy
CROS	California Roadkill Observation System
CVFPP	Central Valley Flood Protection Plan
CVJV	Central Valley Joint Venture
CVP	Central Valley Project
CWHR	California Wildlife Habitat Relationships Program
Delta	Sacramento–San Joaquin Delta
DPS	Distinct Population Segment
DWR	Department of Water Resources
ESUs	Evolutionarily Significant Units
FESA	Federal Endangered Species Act
FRPA	Fish Restoration Agreement
GIS	geographic information system
HCP/NCCP	Yolo Habitat Conservation Plan/Natural Communities Conservation Plan

I-	Interstate
IWMP	Integrated Water Management Plan
LCP	Local Conservation Plan
Legislature	California State Legislature
LMA	local maintaining agencies
LMAs	Local Maintaining Agencies
LPCCC	Lower Putah Creek Coordinating Committee
MCA	mitigation credit agreement
MCV	Manual of California Vegetation
NAIP	National Agriculture Imagery Program
NCCPA	Natural Community Conservation Planning Act
NCVM	Napa County Vegetation Map
NFD	not formally defined
NMFS	National Marine Fisheries Service
NPS	National Park Service
OHV	off-highway vehicle
PCS	Potential Conservation Sites
PG&E	Pacific Gas & Electric
RCD	Resource Conservation District
RCIS	regional conservation investment strategy
RCIS/LCP	Regional Conservation Investment Strategy and Local Conservation Plan
REC	Road Ecology Center
Reclamation	U.S. Bureau of Reclamation
Region	Lower Sacramento/Delta North Region
RFMP	Regional Flood Management Plan
RPA	Reasonable and Prudent Alternative
RWQCB	Central Valley Regional Water Quality Control Board
SMUD	Sacramento Municipal Utility District
Solano HCP	Solano Multispecies Habitat Conservation Plan
SPFC	State Plan of Flood Control
SSIA	State Systemwide Investment Approach
STAC	Scientific and Technical Advisory Committee
STATSGO	State Soil Geographic
SWAP	State Wildlife Action Plan
SWP	State Water Project
TMDL	Total Maximum Daily Load

UC Davis	University of California, Davis
USDA	U.S. Department of Agriculture
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	and the U.S. Geologic Survey
WRA	Water Resources Association of Yolo County
WSAFCA	West Sacramento Area Flood Control Agency

Chapter 1
Introduction

1.1 Overview

The County of Yolo includes approximately 653,549 acres and its 215,802 residents (as of 2016) live primarily within the four incorporated cities of Davis, West Sacramento, Winters, and Woodland. Agriculture is a major component of the county economy. Through coordinated efforts over the course of decades, the governing bodies of the County and its cities have successfully preserved the agricultural working landscape and many natural features of the area through decades of rapid change in surrounding counties. The County and cities also partnered in 2002 to form a joint powers agency (known today as the Yolo Habitat Conservancy, and referred to herein as Conservancy) to develop a countywide Habitat Conservation Plan/Natural Communities Conservation Plan and, among other things, better align local development with continued preservation of the agricultural landscape and other natural communities.

The Yolo Regional Conservation Investment Strategy and Local Conservation Plan (RCIS/LCP) is a collaborative conservation planning effort of the County, Yolo Habitat Conservancy, California Natural Resources Agency, and California Department of Water Resources. The RCIS/LCP is intended to provide a complementary framework for future conservation efforts that includes stewardship-driven conservation, in addition to mitigation-driven conservation, to enhance the conservation benefits in Yolo County. The joint RCIS and LCP describes the existing condition for the amount, location, and type of natural communities and focal species habitat in the strategy area (see Chapter 2). Based on this, the RCIS/LCP recommends conservation actions to address land cover types and focal species that can be the focus of project planning and conservation efforts. The RCIS/LCP can help assure the land area allocated to conservation purposes does not decline and can be increased in coordination with willing landowners on the basis of stewardship-driven conservation goals.

The RCIS/LCP may guide voluntary stewardship-driven conservation efforts that support the protection and enhancement of focal species habitat across a variety of natural communities and compatible agricultural lands, assist in obtaining grants for these efforts, and promote the protection of wildlife corridors. The preparers of this plan (Section 1.3) intend various entities to use the RCIS/LCP to guide such stewardship-driven efforts, including but not limited to landowners, land trusts, nonprofit organizations, and municipalities developing their regional planning documents.

This RCIS/LCP also provides a framework within which mitigation-driven conservation can be considered in ways that augment the habitat values in the landscape in association with public infrastructure needs within the RCIS/LCP area. The RCIS/LCP may streamline and simplify negotiations on the adequacy of mitigation and the issuance of permits for state projects, including critical state infrastructure projects in Yolo County, or other projects not covered by the Yolo HCP/NCCP by establishing priorities for mitigation beyond what the Yolo HCP/NCCP provides. The RCIS/LCP will not specify mitigation requirements, but it can provide a framework from which mitigation can be designed within a context of desired conservation in the region. This project streamlining could be enhanced further if entities develop an MCA under the RCIS. The RCIS/LCP, however, is not creating any new regulations in Yolo County, nor is it changing the process by which a project applicant would obtain permits for impacts to biological resources.

1.1.1 Regional Conservation Investment Strategy

In 2016, the California State Legislature (Legislature) passed, and Governor Brown signed, Assembly Bill 2087 (AB 2087), a new law to guide voluntary conservation and mitigation actions for the state's most vulnerable species and resources and to help streamline the mitigation process for state and local projects, such as infrastructure and forest management. AB 2087 amends the California Fish and Game Code, Division 2, Chapter 9, to add Sections 1850–1861. It creates a program to identify and prioritize the conservation needs of vulnerable species and resources at a regional scale, including actions to address the impacts of climate change and other stressors that influence the resiliency of those species and natural resources. AB 2087 ensures the new program complements Habitat Conservation Plans and Natural Community Conservation Plans.

The program allows the California Department of Fish and Wildlife (CDFW) or any local or state public agency to develop a Regional Conservation Investment Strategy (RCIS) to guide voluntary conservation actions and mitigation actions for a suite of species. The RCIS must include specific information about conservation actions and conservation priorities necessary to eliminate or reduce stressors and negative pressures on those species. Once CDFW approves an RCIS, public agencies or conservation organizations can use it to identify conservation priorities that will help guide their conservation investments. Public infrastructure agencies or private developers can voluntarily use an approved RCIS to inform their selection of appropriate mitigation sites or actions.

CDFW published guidelines for the RCIS Program, called *Program Guidelines*, in April 2017. They later revised these Program Guidelines slightly in June 2017. This RCIS complies with the June 2017 Program Guidelines. The newest set of Program Guidelines released by CDFW in March 2018 do not apply to the Yolo RCIS[1].

A person or entity, including a state or local agency, can sponsor the development of a mitigation credit agreement (MCA) for a region within an RCIS area (e.g. a watershed or conservation zone in which mitigation credits may be purchased) and request approval of the agreement from CDFW. An MCA allows project proponents to negotiate compensatory mitigation with CDFW before project impacts occur. An MCA identifies conservation actions or habitat enhancement actions and explains how, and to what extent, they will measurably advance the RCIS conservation objectives. Once CDFW approves the MCA, the MCA sponsor submits mitigation project proposals to CDFW to establish and release the credits consistent with the MCA's mitigation framework. Mitigation credits created pursuant to a MCA may be used to satisfy the mitigation requirements of any State or federal law, if the respective entity administering that law agrees. Once approved, this RCIS will enable MCAs to be developed and executed in the strategy area. More details on how the RCIS can be used, including preparation of MCAs, are discussed in Section 4.4, How to Use This RCIS/LCP.

Adoption of this RCIS by CDFW is consistent with the California Fish and Game Code 1850(e) and 1852(c)(7). By authorizing CDFW to approve RCISs, it is not the intent of the California State Legislature to regulate the use of land, establish land use designations, or to affect, limit, or restrict the land use authority of any public agency. Nothing in the Yolo RCIS (or LCP) is intended to, nor

[1] Because the Conservancy submitted the agency draft RCIS/LCP to CDFW for their first review in February 2018, prior to release of the newest Program Guidelines, CDFW exempted this RCIS from those Guidelines.

should it be interpreted to conflict with state law or local ordinances. Therefore, voluntary actions guided by this RCIS must comply with all applicable state and local requirements.

1.1.2 Local Conservation Plan

The Yolo Habitat Conservancy prepared the Local Conservation Plan (LCP) component of this joint RCIS/LCP in parallel with the preparation of the present version of the Yolo Habitat Conservation Plan/Natural Community Conservation Plan (HCP/NCCP). The LCP recognizes there are many more species of conservation interest in Yolo County which would benefit from a similar conservation framework. To meet that need, the LCP provides a voluntary, non-regulatory framework for additional conservation, beyond what the Conservancy will achieve through the Yolo HCP/NCCP.

The development of the LCP began in 2013, when the Yolo Habitat Conservancy revised the Yolo HCP/NCCP to: (1) cover only 12 of the 32 species covered by the First Administrative Draft Yolo HCP/NCCP; (2) focus conservation in the eastern portion of the Yolo HCP/NCCP Plan Area where the 12 covered species occur; and (3) remove discussion of other species of local concern. Because the HCP/NCCP is a regulatory document with financial and conservation commitments that the permittees must meet, the HCP/NCCP focuses on 12 species that are either listed now or are expected to become listed during the 50-year permit term. The Yolo Habitat Conservancy's Advisory Committee concurred with this approach, provided that the Conservancy simultaneously prepared a Local Conservation Plan (LCP) to address the 20 species dropped from the Yolo HCP/NCCP and other countywide conservation opportunities for additional species and natural communities, including the western portion of the County. The Yolo Habitat Conservancy prepared an administrative draft of the LCP in early 2016. The LCP is a compatible but separate plan from the Yolo HCP/NCCP that establishes conservation priorities to help focus implementation efforts to conserve biological resources not addressed in the Yolo HCP/NCCP. The LCP is not a part of the Yolo HCP/NCCP, is non-regulatory, and implementation of the LCP conservation strategy is voluntary.

After the inception of the RCIS program in late 2016, the California Natural Resources Agency and the California Department of Water Resources asked the Yolo Habitat Conservancy to consider expanding the LCP into an RCIS. Since many components of the LCP were consistent with the requirements of an RCIS, the Yolo Habitat Conservancy agreed to this approach. Details on the uses of the LCP appear in Section 4.4, How to Use This RCIS/LCP.

1.2 Purpose

1.2.1 Regional Conservation Investment Strategy

As stated in the California Fish and Game Code Section 1852 (b), the purpose of an RCIS is to provide voluntary guidance for one or more of the following components, in ways that will enhance the long-term viability of native species, habitat, and other natural resources.

1. Identification of wildlife and habitat conservation priorities, including actions to address the impacts of climate change and other wildlife stressors.
2. Investments in natural resource conservation.

3. Infrastructure planning, including but not limited to public infrastructure and forest management (e.g., regional flood control, including potential expansion and/or other changes to the Yolo Bypass).
4. Identification of areas that can provide compensatory mitigation for impacts to species and natural resources.

Yolo County and the Conservancy share these goals and believe investments in conservation, infrastructure, and compensatory mitigation should occur in a manner that avoids or minimizes conflicts with other local priorities. The continued preservation of farmland and a sustainable agricultural industry—in particular, high-value crops such as rice and processing tomatoes—are foremost among such priorities. Other local priorities include improving local flood protection, enhancing agricultural drainage and water supply infrastructure, supporting implementation of the Yolo HCP/NCCP, and protecting the wetland, recreational, educational, and other amenities of the Yolo Bypass Wildlife Area. The County envisions the RCIS and the LCP as a means to align habitat conservation and similar efforts contemplated in AB 2087 with these longstanding local priorities.

The State of California has tremendous and varied interests in the vitality of Central Valley communities, economies, and ecological landscapes. Only through innovative and integrated planning will the people of California achieve our collective goals, especially in the face of a changing climate. State-driven infrastructure investments—whether related to transportation, flood management, or other purposes—are a principal means by which to protect and enhance these interests. The State envisions this RCIS as an important step towards maximizing the value of these kinds of infrastructure investments within Yolo County.

The State envisions this RCIS as a vehicle to support implementation of multi-benefit flood system projects. The 2012 Central Valley Flood Protection Plan (CVFPP), prepared by the California Department of Water Resources (DWR) and adopted by the Central Valley Flood Protection Board (CVFPB), recommends a State Systemwide Investment Approach (SSIA) for improvements to the Central Valley flood management system (DWR 2012). The 2017 CVFPP Update incorporates new information and provides greater specificity to help guide both short-term and long-term investments. This new information is documented in a series of detailed studies, including two Basin-Wide Feasibility Studies (BWFS) for the Sacramento River Basin and the San Joaquin River Basin, respectively, six Regional Flood Management Plan studies (RFMP), a CVFPP Investment Strategy, and a CVFPP Conservation Strategy (DWR 2016).

The CVFPP Conservation Strategy (DWR 2016) provides a comprehensive, long-term approach to the improvement of ecosystem functions through the integration of ecological restoration with flood risk reduction and management projects. DWR envisions the RCIS as a potential vehicle to support implementation of multi-benefit flood system projects that contribute to environmental and biological goals and objectives through actions by DWR and its partners in flood management and conservation in the strategy area. These partners include federal and State agencies, Local Maintaining Agencies (LMAs), local communities, and nongovernmental organizations.

This RCIS/LCP formulates conservation goals and objectives for the strategy area, as well as conservation priorities for land acquisition and habitat management, enhancement, and restoration. (see Chapter 3, *Conservation Strategy,* for details).

1.2.2 Local Conservation Plan

The LCP component of the Yolo RCIS/LCP is a countywide plan for Yolo County, California, designed to meet the following purposes.

- Provide a voluntary, nonregulatory framework for landscape-based conservation planning in Yolo County in partnership with landowners, resource managers, local agencies, and other regional conservation plans.
- Provide a voluntary, nonregulatory framework for permanently sustaining natural ecosystem process dynamics in all natural communities in Yolo County, thereby maintaining habitat conditions and dynamics that sustain the viability of all native and desired non-native species in Yolo County.
- Provide a voluntary, nonregulatory conservation framework for species and habitat types identified as of local concern in Yolo County and adjacent areas that allows local, state, and federal agencies and concerned citizens to evaluate conservation opportunities for these species and habitats in the county and adjacent areas.
- Allow private landowners to benefit from and better understand the conservation value of their lands in a regional context.
- Justify fundraising (e.g., grants, federal assistance) for financial assistance to landowners for voluntary conservation projects (e.g., pond maintenance, planting hedgerows).

Many of the components of the LCP overlap with those of the RCIS. The LCP has some unique elements that are not required in an RCIS, however, such as addressing additional sensitive species beyond the focal species identified for the RCIS, and prioritizing conservation of the rarest natural communities.

1.3 Planning Process

1.3.1 Sponsoring State Agency and Local Approval

An organization developing an RCIS must have a state agency sponsor at the time it submits the RCIS to CDFW for approval. For CDFW to approve a final RCIS, a state agency must request the approval of the RCIS by sending a letter to the director of CDFW stating the RCIS will aid in meeting the state's goals, in (1) conservation and (2) public infrastructure or forestry management. The state agency sponsor of this RCIS is the California Department of Water Resources (DWR). See Appendix A for the letter to CDFW submitted by the state agency sponsor.

Additionally, the Yolo RCIS/LCP is subject to approval by the Yolo Habitat Conservancy Board of Directors and Yolo County Board of Supervisors. The Yolo Habitat Conservancy approved the draft Yolo RCIS/LCP on January 22, 2018, for submittal to CDFW. Similarly, the Yolo County Board of Supervisors approved the draft Yolo RCIS/LCP on January 23, 2018, for submittal to CDFW. The Yolo RCIS/LCP will go before these boards for approval again after the public review period and prior to submitting the final RCIS/LCP to CDFW.

1.3.2 Steering Committee

A Steering Committee, comprised of key public agencies and stakeholders likely to utilize the RCIS/LCP, guided its development. The Steering Committee reviewed early drafts of RCIS/LCP chapters and made decisions regarding the course of the strategy. The Steering Committee included representatives from the following organizations and government entities.

- California Natural Resources Agency
- California Department of Water Resources
- Yolo County
- Yolo Habitat Conservancy
- Environmental Defense Fund
- American Rivers
- Yolo Habitat Conservancy Advisory Committee (described below)

1.3.3 Advisory Committee

In 2004, the Conservancy appointed an Advisory Committee[2] to provide input and advice during the development of the Yolo HCP/NCCP. The Advisory Committee consists of individuals active in different sectors relevant to development of the HCP/NCCP and the RCIS/LCP, such as conservation, development, and agriculture. Members represent a range of stakeholders with an interest in the HCP/NCCP (the stakeholders) and the LCP. The Conservancy board appointed Advisory Committee members according to their expertise, interest in the program, and capacity to represent the interests of their particular stakeholders. Advisory Committee members participate as individuals, and do not represent their respective agencies and organizations.

The Advisory Committee held open meetings on a regular basis (generally monthly) to review relevant materials and documents; evaluate and synthesize ideas, data, and information; and discuss and resolve complex issues associated with the Yolo HCP/NCCP and LCP. The Advisory Committee sought to reach a consensus when possible and provide recommendations to the Conservancy Board of Directors on a range of matters. When the Conservancy expanded the LCP to include the RCIS in early 2017, the Conservancy expanded the role of the Advisory Committee to provide advice and contribute to the development of the joint RCIS/LCP.

Through 2016, the Advisory Committee participated in the preparation and review of the First Administrative Draft LCP. In 2017, the Advisory Committee met regularly and provided valuable input in the development of the public draft RCIS/LCP.

1.3.4 Public Outreach

Public outreach has been an important element of the RCIS/LCP. As described above, public outreach has been achieved primarily through the open meetings of the Advisory Committee, which met regularly for 13 years (2004 to the present, beginning as a component of the Yolo HCP/NCCP)

[2] The Advisory Committee was formerly known as the Steering Advisory Committee, or SAC; the name was changed to Advisory Committee in 2012.

on the LCP component of the document, and for almost a year (since early 2017) on the RCIS component of this RCIS/LCP.

Specific types of public outreach are required for CDFW to approve an RCIS. California Fish and Game Code Section 1854(c)(1) requires an RCIS sponsor to publish a notice of its intent to create an RCIS. The Conservancy published this notice of intent on August 15, 2017 (see Appendix B).

California Fish and Game Code Section 1854(c)(3)(A) requires the public agency preparing an RCIS to hold a public meeting to allow interested persons and entities to receive information about the RCIS early in the preparation process and provide written and oral comments. The Conservancy held a public meeting on September 14, 2017 at the Yolo County Department of Community Services in Woodland, California. The Conservancy posted the notice of intent to prepare this RCIS and notice of this public meeting with the Governor's Office of Planning and Research, with the Yolo County Clerk Recorder, and on the Conservancy's web site on August 15, 2017 (at least 30 days prior to the public meeting). The Conservancy provided the notice to CDFW, each city, county, and city and county within or adjacent to the regional conservation investment strategy area, and to the Conservancy's general Listserv. The Conservancy and other Steering Committee representatives invited interested persons to provide oral and written comments. Conservancy received a single written comment during the public meeting from Dan Schatzel of the West Sac Trail Riders and a letter from Eric Vink of the Delta Protection Commission during the 60 days after the public meeting. Written public comments, and responses to those comments, are included in Appendix B, *Public Outreach*.

1.4 Approach

To approve the RCIS component of the Yolo RCIS/LCP, CDFW must determine that it meets all of the requirements in the California Fish and Game Code for an RCIS. To assist CDFW with these findings, Table 1-1 lists the requirements in the order they appear in the Code and where they are found in this RCIS/LCP.

To develop the RCIS/LCP, the consultant preparing the plan completed the following tasks with direction from Steering Committee.

- Selected focal species for the RCIS described in Section 1.5.4.
- Mapped 13 natural community types as the basis for habitat distribution models for key focal species. These maps are based on information developed by the Conservancy, the Advisory Committee, and other local, state and federal entities for the Yolo HCP/NCCP. Chapter 2, *Environmental Setting*, provides maps and descriptions of the natural communities.
- Developed species accounts for focal species, provided in Appendix C, *Species Accounts.*
- Incorporated appropriate elements of the Yolo HCP/NCCP into the LCP.
- Conducted a gap analysis to evaluate how much of each natural community and modeled habitat of each key focal species is protected, and will be protected under the Yolo HCP/NCCP. This analysis provides information about remaining conservation needs in Yolo County, including natural community and focal species' habitat conservation priorities beyond the conservation the Yolo HCP/NCCP will provide.

- Evaluated existing conservation, development, and State infrastructure plans to assess ways the RCIS/LCP could provide conservation that complements and does not conflict with existing plans.
- Developed conservation goals and objectives at the landscape, natural community, and focal species scales and identified conservation actions to achieve these goals and objectives and address the conservation gaps identified in the gap analysis. The conservation goals and objectives, and associated conservation actions, are provided in Chapter 3, Section 3.4, *Conservation Goals and Objectives.* The methods used in the conservation gap analysis are provided in Chapter 3, Section 3.3.1, *Methods*, and Section 3.3.2, *Results*, provides the results.
- Integrated the goals and objectives of local plans, as appropriate.
- Described the process by which the implementation sponsor will implement, monitor, and adaptively manage the LCP (Chapter 3, Section 3.6, *Monitoring and Adaptive Management Framework*). This includes additional steps needed to refine the conservation framework provided by the LCP.

Table 1-1. Required Elements in an RCIS and Location of Elements in this RCIS

Fish and Game Code	Required Element	Relevant RCIS Section(s)
1852(a)	The department may approve a regional conservation investment strategy pursuant to this chapter. A regional conservation investment strategy may be proposed by the department or any other public agency, and shall be developed in consultation with local agencies that have land use authority within the geographic area of the regional conservation investment strategy. The department may only approve a regional conservation investment strategy if one or more state agencies request approval of the regional conservation investment strategy through a letter sent to the director indicating that the proposed regional conservation investment strategy would contribute to meeting both f the following state goals: 1. Conservation. 2. Public infrastructure or forest management.	Section 1.3.1, *Sponsoring State Agency*
1852(c)(2)	An explanation of the conservation purpose of and need for the strategy.	Section 1.2
1852(c)(2)	The geographic area of the strategy and rationale for the selection of the area, together with a description of the surrounding ecoregions and any adjacent protected habitat areas or linkages that provide relevant context for the development of the strategy.	Section 1.5.1 and Chapter 2
1852(c)(3)	The focal species included in, and their current known or estimated status within, the strategy.	Sections 1.5.4 and 2.1.3 and Appendix C

Fish and Game Code	Required Element	Relevant RCIS Section(s)
1852(c)(4)	Important resource conservation elements within the strategy area, including, but not limited to: 1. Important ecological resources and processes 2. Natural communities 3. Habitat 4. Habitat connectivity 5. Existing protected areas, and 6. An explanation of the criteria, and methods used to identify those important conservation elements.	1. Chapter 2 2. Section 2.1 through 2.10 3. Section 2.6 4. Section 2.9 5. Section 2.4 6. Integrated into above sections
1852(c)(5)	A summary of historic, current, and projected future stressors and pressures in the strategy area, including climate change vulnerability, on the focal species, habitat, and other natural resources, as identified in the best available scientific information, including, but not limited to, the State Wildlife Action Plan.	Section 2.10
1852(c)(6)	Consideration of major water, transportation and transmission infrastructure facilities, urban development areas, and city, county, and city and county general plan designations that accounts for reasonably foreseeable development of major infrastructure facilities, including, but not limited to, renewable energy and housing in the strategy area.	Section 2.12
1852(c)(7)	Provisions ensuring that the strategy will be in compliance with all applicable state and local requirements and does not preempt the authority of local agencies to implement infrastructure and urban development in local general plans.	Sections 1.1.1 and 1.5.3
1852(c)(8)	Conservation goals and measurable objectives for the focal species and important conservation elements identified in the strategy that address or respond to the identified stressors and pressures on focal species.	Section 3.4
1852(c)(9)	Conservation actions, including a description of the general amounts and types of habitat that, if preserved or restored and permanently protected, could achieve the conservation goals and objectives, and a description of how the conservation actions and habitat enhancement actions were prioritized and selected in relation to the conservation goals and objectives.	Tables 3-2 and 3-3, Section 3.4
1852(c)(10)	Provisions ensuring that the strategy is consistent with and complements any administrative draft natural community conservation plan, approved natural community conservation plan, or federal habitat conservation plan that overlaps with the strategy area.	Sections 2.1.2 and 3.2.3.3
1852(c)(11)	An explanation of whether and to what extent the strategy is consistent with any previously approved strategy or amended strategy, state or federal recovery plan, or other state or federal approved conservation strategy that overlaps with the strategy area.	Section 3.2.3.3

Fish and Game Code	Required Element	Relevant RCIS Section(s)
1852(c)(12)	A summary of mitigation banks and conservation banks approved by the department or the U.S. Fish and Wildlife Service that are located within the strategy area or whose service area overlaps with the strategy area.	Section 2.12.6
1852(c)(13)	A description of how the strategy's conservation goals and objectives provide for adaptation opportunities against the effects of climate change for the strategy's focal species.	Section 3.4.1
1852(c)(14)	Incorporation and reliance on, and citation of, the best available scientific information regarding the strategy area and the surrounding ecoregion, including a brief description of gaps in relevant scientific information, and use of standard or prevalent vegetation classifications and standard ecoregional classifications for terrestrial and aquatic data to enable and promote consistency among regional conservation investment strategies throughout California.	Chapter 2 and Section 3.6
1852(d)	A regional conservation investment strategy shall compile input and summary priority data in a consistent format that could be uploaded for interactive use in an Internet Web portal and that would allow stakeholders to generate queries of regional conservation values within the strategy area.	Table 3-3
1852(e)	In addition to considering the potential to advance the conservation of focal species, regional conservation investment strategies shall consider all of the following: 1. The conservation benefits of preserving working lands for agricultural uses. 2. Reasonably foreseeable development of infrastructure facilities. 3. Reasonably foreseeable projects in the strategy area, including, but not limited to, housing. 4. Reasonably foreseeable development for the production of renewable energy. 5. Draft natural community conservation plans within the area of the applicable regional conservation investment strategy.	1. Section 3.4 2. Section 2.13 3. Section 2.13 4. Section 2.13 5. Sections 2.12, 3.2.3.3
1854(a)	The department may prepare or approve a regional conservation investment strategy, or approve an amended strategy, for an initial period of up to 10 years after finding that the strategy meets the requirements of Section 1852.	Section 1.5.2

Fish and Game Code	Required Element	Relevant RCIS Section(s)
1854(c)(1)	A public agency shall publish notice of its intent to create a regional conservation investment strategy. This notice shall be filed with the Governor's Office of Planning and Research and the county clerk of each county in which the regional conservation investment strategy is found in part or in whole. If preparation of a regional conservation investment strategy was initiated before January 1, 2017, this notice shall not be required.	Section 1.3.4 and Appendix B
1854(c)(3) (*A*)	A public agency proposing a strategy or amended strategy shall hold a public meeting to allow interested persons and entities to receive information about the draft regional conservation investment strategy or amended strategy early in the process of preparing it and to have an adequate opportunity to provide written and oral comments. The public meeting shall be held at a location within or near the strategy area.	Section 1.3.4
1854(c)(3) (*B*)	In a draft regional conservation investment strategy or amended strategy submitted to the department for approval, the public agency shall include responses to written public comments submitted during the public comment period.	Section 1.3.4 and Appendix B
1854(c)(3)(*C*)	If preparation of a regional conservation investment strategy was initiated before January 1, 2017, and a public meeting regarding the strategy or amended strategy that is consistent with the requirements of this section was held before January 1, 2017, an additional public meeting shall not be required.	Section 1.3.4
1854(c)(4)	At least 30 days before holding a public meeting to distribute information about the development of a draft regional conservation investment strategy or amended strategy, a public agency proposing a strategy shall provide notice of a regional conservation investment strategy or amended strategy public meeting as follows: A. On the public agency's Internet website and any relevant LISTSERV. B. To each city, county, and city and county within or adjacent to the regional conservation investment strategy area. C. To the implementation sponsor for each natural community conservation plan or federal regional habitat conservation plan that overlaps with the strategy area. D. To each public agency, organization, or individual who has filed a written request for the notice, including any agency, organization, or individual who has filed a written request to the department for notices of all regional conservation investment strategy public meetings.	Section 1.3.4 and Appendix B

Fish and Game Code	Required Element	Relevant RCIS Section(s)
1854(c) (5)	At least 60 days before submitting a final regional conservation investment strategy or amended strategy to the department for approval, the public agency proposing the investment strategy or amended strategy shall notify the board of supervisors and the city councils in each county within the geographical scope of the strategy and provide the board of supervisors and the city councils with an opportunity to submit written comments for a period of at least 30 days.	Section 1.3.4
1854 (e)	The department shall require the use of consistent metrics that incorporate both the area and quality of habitat and other natural resources in relation to a regional conservation investment strategy's conservation objectives to measure the net change resulting from the implementation of conservation actions and habitat enhancement actions.	Sections 3.3 and 3.4
1856(b)	For a conservation action or habitat enhancement action identified in a regional conservation investment strategy to be used to create mitigation credits pursuant to this section, the regional conservation investment strategy shall include, in addition to the requirements of Section 1852, all of the following: 1. An adaptive management and monitoring strategy for conserved habitat and other conserved natural resources. 2. A process for updating the scientific information used in the strategy, and for tracking the progress of, and evaluating the effectiveness of, conservation actions and habitat enhancement actions identified in the strategy, in offsetting identified threats to focal species and in achieving the strategy's biological goals and objectives, at least once every 10 years, until all mitigation credits are used. 3. Identification of a public or private entity that will be responsible for the updates and evaluation required pursuant to paragraph (2).	Section 3.6 and Chapter 4

1.5 Scope of the Strategy

1.5.1 Strategy Area

The strategy area encompasses all areas within Yolo County, totaling an estimated 653,549 acres (Figure 1-1). The RCIS/LCP strategy area is entirely within the plan area for the Yolo HCP/NCCP.

Figure 1-1. Yolo RCIS/LCP Strategy Area

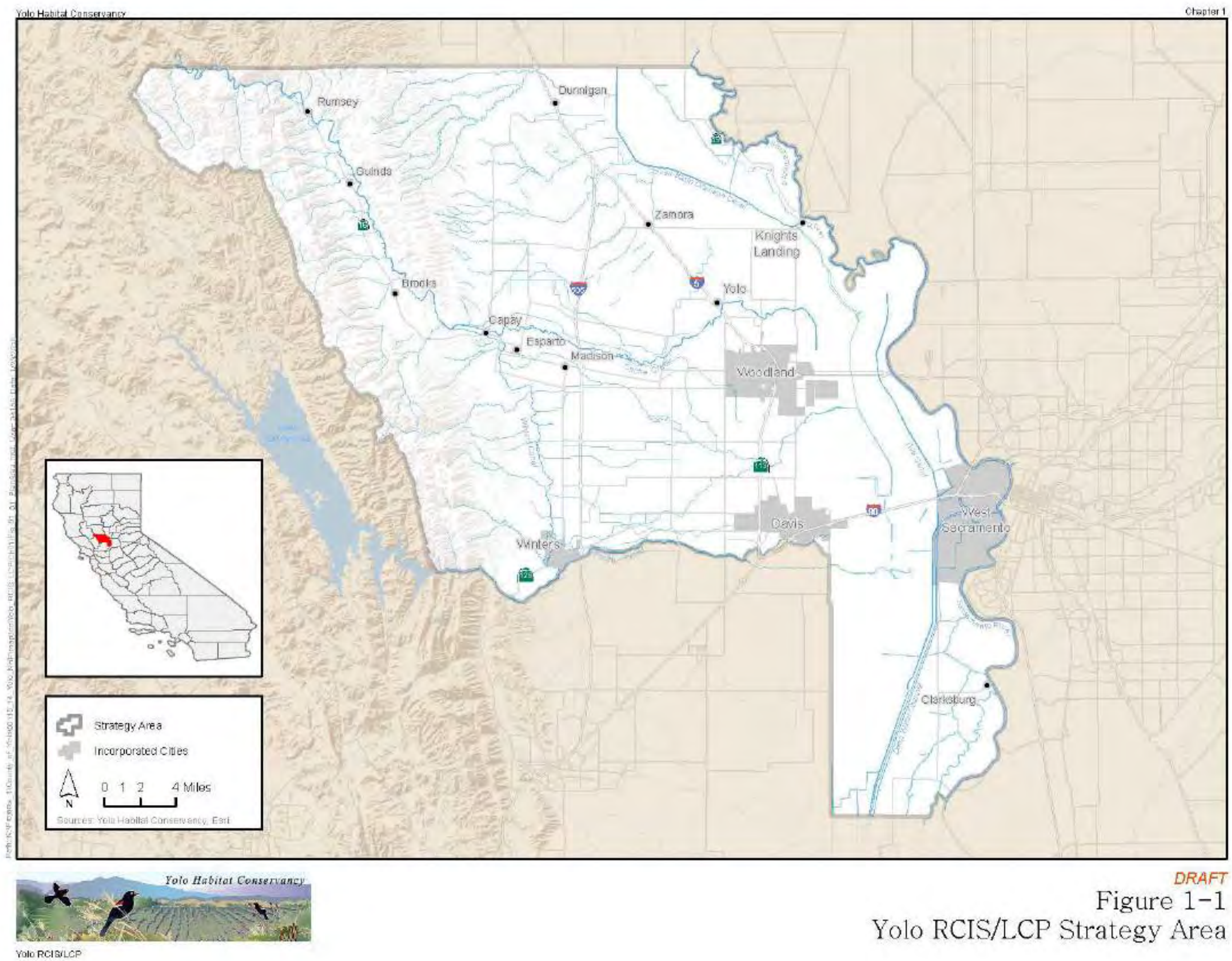
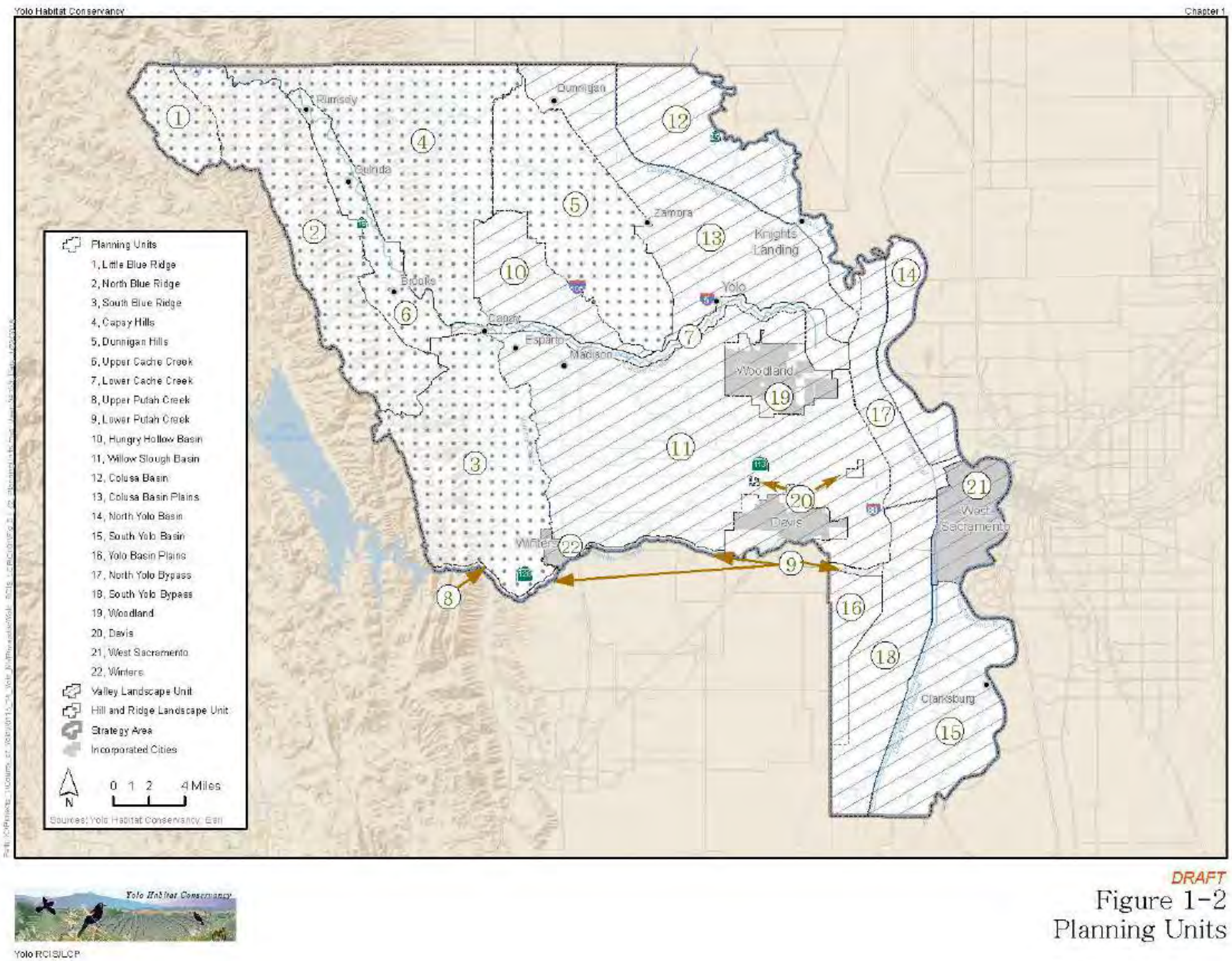


Figure 1-2. Planning Units



1.5.2 Term of the Strategy

CDFW may approve an RCIS for an initial period of up to 10 years after finding the RCIS meets the requirements of California Fish and Game Code Section 1852. CDFW may extend the duration of an approved or amended RCIS for additional periods of up to 10 years after updating the RCIS with new scientific information and a new finding that the RCIS continues to meet the requirements of Section 1852. The proposed term of this RCIS is 10 years, from 2018 to 2028.

The LCP component of the plan has no defined term or expiration date. The LCP component of the plan is expected to continue guiding conservation in Yolo County even after the RCIS has expired.

The proposed term of the Yolo HCP/NCCP is 50 years, from 2018 to 2068. Since the LCP and RCIS are intended to work in concert with the Yolo HCP/NCCP, the Implementation Sponsor or other entity may amend the RCIS/LCP periodically so that it remains active for the duration of the HCP/NCCP.

1.5.3 Voluntary Strategy

This RCIS/LCP is a nonbinding and voluntary strategy. This RCIS/LCP does not do the following (California Fish and Game Code Sections 1852(c)(7) and 1855 (b)).

- Establish a presumption under the California Environmental Quality Act that any project's impacts are, or are not, potentially significant.
- Prohibit or authorize any project or project impacts.
- Create a presumption or guarantee that any proposed project will be approved or permitted, or that any proposed impact will be authorized, by any state or local agency.
- Create a presumption that any proposed project will be disapproved or prohibited, or that any proposed impact will be prohibited, by any state or local agency.
- Alter or affect, or create additional requirements for, the general plan of the city, county, or city and county, in which it is located.
- Have a binding or mandatory regulatory effect on private landowners or project proponents.
- Preempt the authority of local agencies to implement infrastructure and urban development in local general plans.

1.5.4 Natural Communities

The RCIS/LCP addresses conservation of the following natural communities. Although cultivated lands are not a *natural* community, crop types that provide habitat for species of local concern are included within the scope of this RCIS/LCP as a *seminatural* community.

- Cultivated lands
- California prairie
- Serpentine
- Chamise chaparral

- Mixed chaparral
- Oak-foothill pine
- Blue oak woodland
- Closed-cone pine-cypress
- Montane hardwood
- Valley oak woodland
- Alkali prairie
- Vernal pool complex
- Fresh emergent wetland
- Riparian
- Lacustrine and riverine

Chapter 2, *Existing Ecological Conditions,* provides definitions and descriptions for each of these natural communities.

1.5.5 Focal Species and Conservation Species

This strategy categorizes 133 species into three groups based on the amount of information available for these species and whether they are included in the LCP or both the RCIS and the LCP based on the criteria listed below. The focal species are the species whose conservation needs the RCIS addresses, consistent with RCIS requirements. This RCIS includes 40 focal species as part of Group 1 (Table 1-2). All RCIS focal species are also a component of the LCP.

The remaining 97 species are part of Groups 2 and 3 and are called "conservation species" (Table 1-2). These conservation species are specific to the LCP and are not part of the RCIS[3]. The following subsections provide more details on each of these three groups and describe how the species were selected for each group.

1.5.5.1 Focal Species (Group 1 Species) Selection

Group 1 species include all species that are focal species for the RCIS. There are 40 Group 1 species (Table 1-2). They include the 32 species that the Conservancy proposed for covering in the first administrative draft of the Yolo HCP/NCCP, 2 additional special-status bird and 8 additional special-status fish species.. Species models and species accounts are available for all focal species (Appendix C). The plan includes conservation objectives for these species, either as groups of species with shared objectives, or, for some species, as individual objectives.

The focal species were chosen based on four criteria.

1. They were likely to occur in Yolo County.
2. They were state or federally listed or likely to become listed in the foreseeable future.
3. They could be adversely affected by activities in Yolo County.

[3] CDFW will be reviewing and approving this RCIS/LCP only for the focal species, not the conservation species.

4. Sufficient information was available to adequately evaluate effects on the species and develop appropriate conservation measures.

1.5.5.2 Selection of Group 2 Conservation Species

Group 2 species are conservation species for the LCP. This includes 39 species the Conservancy addressed as species of local concern in the first administrative draft of the Yolo HCP/NCCP with the addition of 3 special-status bird species. These species are rare, declining, or potentially threatened by land use changes and are of concern to local organizations. While many of these species have special-status designations, they do not meet the criteria used to select as focal species in Group 1. Species accounts are provided for these species in Appendix C. Habitat models were not developed for Group 2 conservation species because of a lack of available data or resources.

The plan does not include conservation goals and objectives for Group 2 conservation species. Instead, the LCP provides conservation priorities that will support the viability of these species in the Yolo County landscape.

1.5.5.3 Selection of Group 3 Conservation Species

Group 3 species are conservation species for the LCP. This group is 32 additional species that the Advisory Committee, including local plant and wildlife experts, identified as rare or declining, and important to local conservation. Neither species accounts nor habitat models were prepared for these species because of a lack of available data.

The plan does not include conservation goals and objectives for the Group 3 conservation species. Instead, the LCP prioritizes conservation that will support the viability of these species in the Yolo County landscape.

Table 1-2. Focal Species (RCIS) and Conservation Species (LCP)

Common Name	Scientific Name	Status (Federal/State/CNPS)[a]
FOCAL SPECIES FOR RCIS and LCP (GROUP 1 SPECIES)		
Plants		
alkali milk-vetch	*Astragalus tener var. tener*	-/-/1B
brittlescale	*Atriplex depressa*	-/-/1B
San Joaquin spearscale	*Atriplex joaquiniana*	-/-/1B
Palmate-bracted bird’s-beak	*Chloropyron palmatum*	E/E/1B
Heckard’s pepper-grass	*Lepidium latipes var. heckardii*	-/-/1B
Baker’s navarretia	*Navarretia leucocephala ssp. bakeri*	-/-/1B
Colusa grass	*Neostapfia colusana*	T/E/1B
Solano grass	*Tuctoria mucronata*	E/E/1B
Invertebrates		
Conservancy fairy shrimp	*Branchinecta conservatio*	E/-/-
vernal pool fairy shrimp	*Branchinecta lynchi*	T/-/-
midvalley fairy shrimp	*Branchinecta mesovallensis*	-/-/-
California linderiella	*Linderiella occidentalis*	-/-/-
Vernal pool tadpole shrimp	*Lepidurus packardi*	E/-/-

Common Name	Scientific Name	Status (Federal/State/CNPS)[a]
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	T/-/-
Fish		
white sturgeon	*Acipenser transmontanus*	-/-/-
green sturgeon	*Acipenser medirostris*	T/CSC/-
delta smelt	*Hypomesus transpacificus*	T/E/-
Central Valley steelhead	*Oncorhynchus mykiss*	T/CSC/-
Sacramento River winter-run Chinook salmon	*Oncorhynchus tshawytscha*	E/T/-
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	T/T/-
Central Valley fall- and late fall-run Chinook salmon	*Oncorhynchus tshawytscha*	-/CSC/-
Sacramento splittail	*Pogonichthys macrolepidotus*	-/CSC/-
Amphibians		
California tiger salamander	*Ambystoma californiense*	T/T/-
foothill yellow-legged frog	*Rana boylii*	-/CSC/-
western spadefoot	*Spea hammondii*	-/CSC/-
Reptiles		
western pond turtle	*Actinemys marmorata*	-/CSC/-
giant garter snake	*Thamnophis gigas*	T/T/-
Birds		
tricolored blackbird	*Agelaius tricolor*	-/T/-
grasshopper sparrow	*Ammodramus savannarum*	-/CSC/-
western burrowing owl	*Athene cunicularia hypugaea*	-/CSC/-
Swainson's hawk	*Buteo swaisonii*	-/T/-
greater sandhill crane	*Grus canadensis tabida*	-/T, FP/-
northern harrier	*Circus cyaneus*	-/CSC/-
black tern	*Chlidonias niger*	-/CSC/-
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	T/E/-
white-tailed kite	*Elanus leucurus*	-/FP/-
California black rail	*Laterallus jamaicensis coturniculus*	-/T, FP/-
loggerhead shrike	*Lanius ludovicianus*	-/CSC/-
yellow-breasted chat	*Icteria virens*	-/CSC/-
bank swallow	*Riparia riparia*	-/T/-
least Bell's vireo	*Vireo bellii pusillus*	E/E/-
Mammals		
Townsend's big-eared bat	*Corynorhinus townsendii*	-/CSC/-
CONSERVATION SPECIES FOR LCP (GROUP 2 SPECIES)		
Plants		
bent-flowered fiddleneck	*Amsinckia lunaris*	-/-/1B
Jepson's milk-vetch	*Astragalus rattanii var. jepsonianus*	-/-/1B
Ferris' milk-vetch	*Astragalus tener var. ferrisiae*	-/-/1B

Common Name	Scientific Name	Status (Federal/State/CNPS)[a]
heartscale	*Atriplex cordulata*	-/-/1B
vernal pool smallscale	*Atriplex persistens*	-/-/1B
round-leaved fillaree	*California macrophylla*	-/-/1B
Snow Mountain buckwheat	*Eriogonum nervulosum*	-/-/1B
adobe-lily	*Fritillaria pluriflora*	-/-/1B
Hall's harmonia	*Harmonia hallii*	-/-/1B
drymaria-like western flax	*Hesperolinon drymarioides*	-/-/1B
rose mallow	*Hibiscus lasiocarpus*	-/-/2.2
delta tule pea	*Lathyrus jepsonii var. jepsonii*	-/-/1B
Colusa layia	*Layia septentrionalis*	-/-/1B
Mason's lilaeopsis	*Lilaeopsis masonii*	-/-/R/1B
Bearded popcorn flower	*Plagiobothrys hystriculus*	-/-/1B
Morrison's jewelflower	*Streptanthus morrisonii ssp. Morrisonii*	-/-/1B
saline clover	*Trifolium depauperatum var. hydrophilum*	-/-/1B
Invertebrates		
molestan beetle	*Lytta molesta*	-/CSC/-
ancient ant	*Pyramica reliquia*	-/-/-
Birds		
golden eagle	*Aquila chrysaetos*	-/FP/-
Bell's sparrow	*Artemisiospiza belli*	-/-/-
short-eared owl	*Asio flammeus*	-/CSC/-
redhead	*Aythya americana*	-/CSC/-
oak titmouse	*Baeolophus inornatus*	-/-/-
western snowy plover	*Charadrius alexandrinus nivosus*	T/CSC/-
mountain plover	*Charadrius montanus*	PT/CSC/-
lesser nighthawk	*Chordeiles acutipennis*	-/-/-
Pacific-slope flycatcher	*Empidonax difficilis*	-/-/-
American peregrine falcon	*Falco peregrinus anatum*	D/E, FP/-
prairie falcon	*Falco mexicanus*	-/-/WL
long-billed curlew	*Numenius americanus*	-/-/WL
yellow-billed magpie	*Pica nuttalli*	-/-/-
purple martin	*Progne subis*	-/CSC/-
bald eagle	*Haliaeetus leucocephalus*	D/E, FP/-
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	-/CSC/-
Mammals		
pallid bat	*Antrozous pallidus*	-/CSC/-
ringtail	*Bassariscus astutus*	-/FP/-
western red bat	*Lasiurus blossevillii*	-/CSC/-
San Joaquin pocket mouse	*Perognathus inornatus inornatus*	-/-/-
American badger	*Taxidea taxus*	-/CSC/-

Common Name	Scientific Name	Status (Federal/State/CNPS)[a]
Sacramento Valley red fox	*Vulpes vulpes ssp. patwin*	-/-/-
CONSERVATION SPECIES FOR LCP (GROUP 3 SPECIES)		
Plants		
Purdy's onion	*Allium fimbriatum var. purdyi*	-/-/4.3
twig-like snapdragon	*Antirrhinum virga*	-/-/4.3
modest rockcress	*Arabis modesta*	-/-/4.3
serpentine milkweed	*Asclepias solanoana*	-/-/4.2
Brewer's milk-vetch	*Astragalus breweri*	-/-/4.2
Cleveland's milk-vetch	*Astragalus clevelandii*	-/-/4.3
lagoon sedge	*Carex lenticularis var. limnophila*	-/-/2.2
Parry's rough tarplant	*Centromadia parryi ssp. rudis*	-/-/4.2
serpentine collomia	*Collomia diversifolia*	-/-/4.3
deep-scarred cryptantha	*Cryptantha excavata*	-/-/1B.3
dwarf downingia	*Downingia pusilla*	-/-/1B.2
Purdy's fritillary	*Fritillaria purdyi*	-/-/4.3
nodding harmonia	*Harmonia nutans*	-/-/4.3
hogwallow starfish	*Hesperevax caulescens*	-/-/4.2
Northern California black walnut	*Juglans hindsii*	-/-/1B.1
Ferris' goldfields	*Lasthenia ferrisiae*	-/-/4.2
Coulter's goldfields	*Lasthenia glabrata ssp. coulteri*	-/-/1B.1
Jepson's leptosiphon	*Leptosiphon jepsonii*	-/-/1B.2
woolly-headed lessingia	*Lessingia hololeuca*	-/-/3
Hoover's lomatium	*Lomatium hooveri*	-/-/4.3
Heller's bush-mallow	*Malacothamnus helleri*	-/-/4.3
sylvan microseris	*Microseris sylvatica*	-/-/4.2
little mousetail	*Myosurus minimus ssp. apus*	-/-/3.1
cotula navarretia	*Navarretia cotulifolia*	-/-/4.2
Jepson's navarretia	*Navarretia jepsonii*	-/-/4.3
Delta woolly-marbles	*Psilocarphus brevissimus var. multiflorus*	-/-/4.2
Keck's checkerbloom	*Sidalcea keckii*	-/-/1B.1
sticky sandspurry	*Spergularia macrotheca var. longistyla*	-/-/1B.2
green jewel-flower	*Streptanthus hesperidis*	-/-/1B.2
Suisun Marsh aster	*Symphyotrichum lentum*	-/-/1B.2
Fish		
Sacramento perch	*Archoplites interruptus*	-/CSC/-
Pacific lamprey	*Entosphenus tridentatus*	-/CSC/-
river lamprey	*Lampetra ayresii*	-/CSC/-
hardhead	*Mylopharodon conocephalus*	-/CSC/-
longfin smelt	*Spirinchus thaleichthys*	-/CSC/-
Reptiles		

Common Name	Scientific Name	Status (Federal/State/CNPS)[a]
San Joaquin whipsnake	*Masticophis flagellum ruddocki*	-/-/-
Birds		
lark sparrow	*Chondestes grammacus*	-/-/-
Snowy egret	*Egretta thula*	-/-/-
Cooper's hawk	*Accipiter cooperii*	-/CSC/-
long-eared owl	*Asio otus*	-/CSC/-
Least bittern	*Ixobrychus exilis*	-/CSC/-
Ferruginous hawk	*Buteo regalis*	-/WL/-
merlin	*Falco columbarius*	-/WL/-
Lewis' woodpecker	*Melanerpes lewis*	-/-/-
osprey	*Pandion haliaetus*	-/WL/-
double-crested cormorant	*Phalacrocorax auritus*	-/-/-
White-faced ibis	*Plegadis chihi*	-/WL/-
yellow warbler	*Setophaga petechia*	-/CSC/-
Modesto song sparrow	*Melospiza melodia*	-/-/-
California thrasher	*Toxostoma redivivum*	-/-/-
Mammals		
tule elk	*Cervus elaphus nannodes*	-/-/-
western red bat	*Lasiurus blossevillii*	-/CSC/-
river otter	*Lontra canadensis*	-/-/-
mink	*Mustela vison*	-/-/-
long-eared myotis	*Myotis evotis*	-/-/-
fringed myotis	*Myotis thysanodes*	-/-/-
long-legged myotis	*Myotis volans*	-/-/-
Yuma myotis	*Myotis yumanensis*	-/-/-
mountain lion	*Puma concolor*	-/-/-
American black bear	*Urusus americanus*	-/-/-

Notes:
a. Status:
C = Candidate for listing under the FESA
E = Listed as endangered under the FESA or CESA
PT = Proposed as threatened under the FESA
T = Listed as threatened under the FESA or CESA
FP = Fully Protected under California Fish and Game Code
CSC = California Species of Special Concern
WL = CDFW Watch List
- = No designation
CESA = California Endangered Species Act
FESA = Federal Endangered Species Act
1B: Plants Rare, Threatened, or Endangered in California and Elsewhere
2B: Plants Rare, Threatened, or Endangered in California, But More Common Elsewhere
3: Plants About Which More Information is Needed - A Review List
4: Plants of Limited Distribution - A Watch List

1.5.6 Planning Species

The LCP component (not the RCIS) also includes four *planning species,* which are species that are not necessarily rare or threatened but that may help inform the conservation actions and priorities in ways the focal species may be unable to do. The four planning species are American badger, black-tailed deer, tule elk, and California ground squirrel. These planning species may include area-dependent species, umbrella species, indicator species, or keystone species.

- **Area-dependent species.** The species requires large, contiguous blocks of habitat and may therefore inform the placement of protected areas on the landscape.
- **Umbrella species.** Conservation of an umbrella species would indirectly conserve multiple other species that are dependent on the same ecological conditions.
- **Indicator species.** The species' abundance in a given area is believed to indicate certain environmental or ecological conditions or suitable conditions for a group of other species. This type may include species that are particularly sensitive to climate change.
- **Keystone species.** The species' impacts on the community or ecosystem are much larger than would be expected based on the species' abundance.

The following provides rationale for including each of the four planning species.

- **American badger.** This species requires large blocks of California prairie and is therefore an area-dependent species. Conservation of American badger would indirectly conserve the diversity of other native California prairie species, and therefore it can also be considered an umbrella species. The American badger is a California species of special concern; therefore it is both a conservation species (Group 2) and a planning species under the LCP.
- **Black-tailed deer.** This species requires large blocks of land and large-scale landscape connectivity to accommodate migration, therefore black-tailed deer is considered an area-dependent species.
- **Tule elk.** Although tule elk and black-tailed deer habitat needs overlap somewhat, their preferred feeding styles cause them to differ significantly. Elk are primarily grazers preferring prairie habitat in valleys and foothills lacking woody vegetation except along streams, while mule deer are mainly browsers and prefer woody habitats like oak woodland and chaparral. When California prairies were dominated by wildflowers before their massive invasion by non-native grasses, tule elk occupied a niche much like domestic cattle do today. The tule elk is a California species of special concern; therefore it is both a focal species (Group 3) and a planning species under the LCP.
- **California ground squirrel.** The California ground squirrel is a keystone species in the California prairie natural community. This species is prey for numerous raptor species and provides burrows for native wildlife such as western burrowing owls and northern Pacific rattlesnakes. Additionally, ground squirrels till and churn the soil, enhancing its ability to support a greater vegetative diversity. Nitrogen-rich mixtures of grasses and forbs in turn support grazers and browsers that use these food resources (Seaver 2004).

1.6 Organization of this Document

This section provides a brief overview of the contents of the chapters and appendices of this RCIS/LCP. The document consists of four chapters.

- Chapter 1, *Introduction*, sets the context for the development of the RCIS/LCP, including the purpose and scope; describes the process that guided the development of the conservation strategy; and provides an overview of the RCIS/LCP document contents and organization.
- Chapter 2, *Environmental Setting*, describes the existing environmental conditions, built environment, and relevant plans and programs within the strategy area, providing the context for the proposed conservation actions.
- Chapter 3, *Conservation Strategy*, describes the conservation goals and objectives, priority conservation actions for each focal species and natural community, and the adaptive management and monitoring framework of the strategy.
- Chapter 4, *Plan Implementation*, addresses implementation tasks and responsibilities for the RCIS/LCP.

The document also includes the following six appendices.

- Appendix A, *Letter to CDFW from the State Agency Sponsor*
- Appendix B, *Public Outreach*
- Appendix C, *Species Accounts*
- Appendix D, *Pollinator Strategy*
- Appendix E, *Consistency with Other Plans* (This appendix describes consistency with the Yolo HCP/NCCP, species recovery plans, and other conservation plans relevant to Yolo County.)
- Appendix F, *Conservation Strategy Rationale* (This appendix include rationale for the conservation goals and objectives, and a description of how the conservation strategy addresses climate change for focal species.)
- Appendix G, *Invasive Species Strategy*

Chapter 2
Environmental Setting and Regional Planning Environment

2.1 Introduction

Sections 2.2 through 2.11 of this chapter describe the physical and biological conditions in the Yolo RCIS/LCP strategy area, including conditions related to the agricultural landscape, local ecological communities and focal/conservation species. Section 2.2, *Physical Characteristics*, describes the characteristics of the climate, hydrology, topography, geology, and soils of the strategy area. Section 2.3, *Land Cover Mapping*, describes the methods, data sources, and classification system for mapping natural communities and habitats for focal/conservation species. Section 2.4., *Protected Areas,* describes the publicly owned lands and lands protected under conservation easements in the strategy area. Section 2.5, *Ecoregions,* describes ecoregions found in the strategy area in two ways, as defined by the U.S. Department of Agriculture (USDA) and the U.S. Geologic Survey (USGS). Section 2.6, *Natural Communities and Associated Plant and Wildlife Species*, describes the composition and extent of natural communities in the strategy area. Section 2.7, *Other Land Cover Types*, describes the composition and extent of other land covers in the strategy area that may or may not provide habitat for focal/conservation species. Section 2.8 is supported by Appendix C, *Species Accounts*, which provides summaries of the status and attributes of the Group 1 focal species and Group 2 conservation species.

Section 2.12, *Regional Conservation Planning Environment*, summarizes other plans (existing or in preparation) related to conservation or development within the strategy area. Section 2.13, *Development and Major Infrastructure*, describes reasonably foreseeable infrastructure development in the strategy area.

2.2 Physical Characteristics

Climate, topography, hydrology, geology, and soils determine the conditions that support plant and wildlife species and the potential for protection, restoration, and enhancement of habitat for focal species. The following data sources were used to describe the physical environment of the strategy area.

- Soil Survey of Yolo County, California (Natural Resources Conservation Service [USDA-NRCS] 2007)
- PRISM climate data (PRISM Climate Group 2004)
- State Soil Geographic (STATSGO) database for California (U.S. Department of Agriculture Soil Conservation Service [USDA-SCS] 1994)
- National Hydrographic Dataset (U.S. Geological Survey 2011)
- Other relevant technical reports and literature

2.2.1 Climate

The strategy area has a Mediterranean-type climate, with cool, wet winters and warm, dry summers. Cyclical climatic events can cause large annual fluctuations in precipitation levels (Minnich 2007; Reever-Morghan et al. 2007). Precipitation primarily occurs in the form of rain from October through April, with very little precipitation during the summers. Figure 2-3 shows average annual distribution of precipitation for the strategy area.

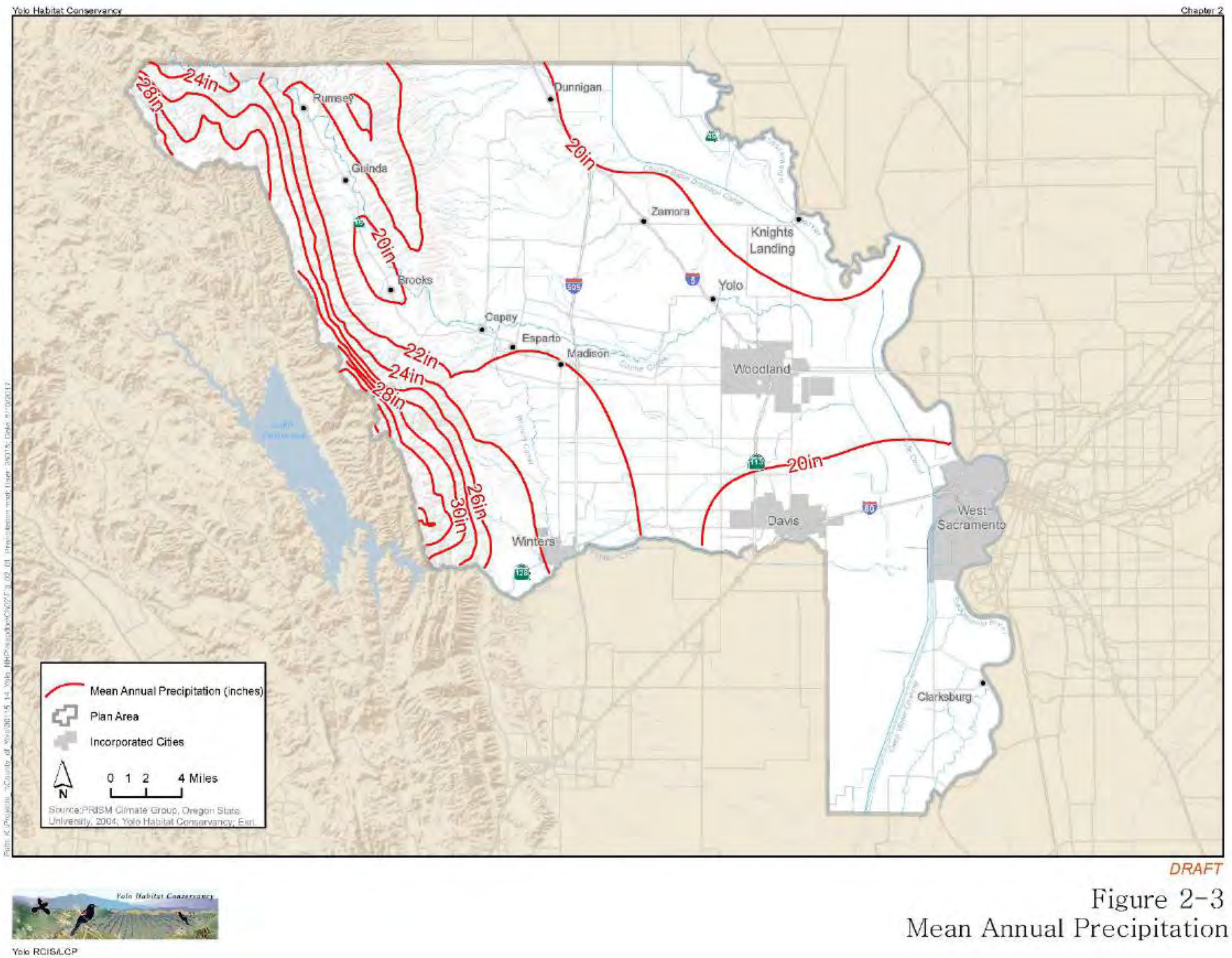
Average annual precipitation is lowest in the areas near the Sacramento River (18 inches annually) and greatest in the Little Blue Ridge and Blue Ridge mountains (21 to 30 inches annually)(Rantz 1969). These mountains are in the inner Coast Range, which elsewhere in California is in a rain shadow and consequently has quite low rainfall. The inner Coast Range in Yolo County, however, is exposed to storms moving through a gap in the Coast Range provided by the San Francisco Bay estuary. Consequently, the inner Coast Range in Yolo County has ecological conditions resembling those found in the outer Coast Range. Average daily temperatures in the strategy area range from a high and low of 59 degrees Fahrenheit (°F) and 35°F in January to a high and low of 96°F and 59°F in July.

2.2.2 Topography

The strategy area lies within the California's Great Central Valley and Coast Ranges geomorphic provinces (Norris and Webb 1990) and its topography is characterized by valley, foothill, and mountain range components. The Little Blue Ridge and Blue Ridge occupy the west side of the strategy area, with the highest elevations in the county (approximately 3,100 feet above mean sea level) in the northwestern corner. The eastern side of the strategy area is located on the valley floor, with elevation typically less than 100 feet above mean sea level. The Capay Hills, a parallel satellite range of the Coast Range, lie east of the northern half of the Blue Ridge and are separated from it by the Capay Valley. The Capay Hills connect with the Blue Ridge at the Capay Valley's closed northern end. East of the Capay Hills a much lower and more subdued Coast Range satellite, the Dunnigan Hills/Plainfield Ridge, connects to the Capay Hills at its northern end.

The uplifting of the Coast Ranges by tectonic processes created north-northwest trending faults such as those underlying the eastern edge of Capay Valley, and folds such as the Dunnigan Hills/Plainfield Ridge anticline that runs from the Capay Hills to Putah Creek and extend superficially into Solano County. Tectonic processes also created the companion Madison syncline, forming the Hungry Hollow Basin between the Capay Hills and the Dunnigan Hills north of Cache Creek and the Cache/Putah Basin at the base of the Blue Ridge between Cache and Putah Creeks (State of California 1987; Jones & Stokes 1996; Graymer et al. 2002; Luhdorff & Scalmanini 2004; WRIME 2006). The low-lying areas of the strategy area consist of a broad, flat alluvial plain on the Central Valley floor that slopes downward from the Coast Range east to the Colusa and Yolo Basins, which parallel the Sacramento River (WRIME 2006). This alluvial plain consists of two elements: a bajada formed by sediments derived from the Cache Creek and Putah Creek basins (the area from the foothills to approximately Davis and Woodland); and the Colusa and American basins, which are associated with Sacramento River fluvial geomorphology (east of Woodland and Davis) (Kelley 1985; Mount 1995). The elevations in the southern end of the Yolo Basin are slightly below sea level.

Figure 2-3. Mean Annual Precipitation



2.2.3 Watersheds

The strategy area is within the Sacramento River hydrologic region and includes four subbasins (HUC 8) with one or more watersheds (HUC-10), described below. Table 2-1 includes the full acreage of each subbasin and watershed, as well as the acres of each in the strategy area. Subbasins and watersheds that overlap small portions of the strategy area (i.e., approximately 1,000 acres or less) were not counted as occurring in the strategy area.

Table 2-1. Subbasins (HUC-8) and Watersheds (HUC-10) in the Yolo County Strategy Area

Name	Entire Area (acres)	Area (acres) and Percent in Strategy Area
Sacramento-Stone Corral Subbasin (HUC 18020104)	**1,205,675**	**159,787 (24.4%)**
Colusa Basin Drainage Canal(1802010410)	155,100	125,505 (21.9%)
Colusa Trough (1802010408)	254,164	2525 (0.4%)
Sacramento River (1802010412)	61,446	1630 (0.3%)
Sycamore Slough (1802010409)	86,333	30,137 (5.2%)
Upper Cache Subbasin (HUC 18020116)	**745,517**	**158,750 (24.3%)**
Upper Cache Creek (1802011606)	79,148	14,150 (2.5%)
Lower Cache Creek (1802011607)	145,244	144,600 (25.2%)
Upper Putah Subbasin (HUC 18020162)	**418,663**	**29,552 (4.5%)**
Lower Putah Creek (1802016205)	55,539	29,473 (5.1%)
Lower Sacramento Subbasin (HUC 18020163)	**786,245**	**304,382 (46.6%)**
Cache Slough (1802016306)	268,589	86,253 (15%)
Knights Landing Ridge Cut-Tule Canal (1802016303)	106,927	106,927 (18.6%)
Sherman Lake-Sacramento River (1802016307)	125,619	1468 (0.3%)
South Fork Willow Slough (1802016301)	30,091	30,086 (5.2%)
Willow Slough (1802016302)	79,651	1467 (0.3%)
Subbasin Total	**3,156,100**	**652,471**
Watershed Total	**1,447,851**	**574,221**

2.2.4 Hydrology

The surface hydrologic features in the strategy area are dominated by the Sacramento River and Cache and Putah Creeks (Figure 2-4), which originate upstream of Yolo County (WRIME 2006). Both Cache Creek and Putah Creek are antecedent streams that are older than the Coast Range and have maintained a relatively constant elevation as the Coast Range was tectonically uplifted during the last several million years. Consequently, both streams have eroded deep canyons through Blue Ridge. Other surface waters, originating from local precipitation, springs, and irrigation tailwater, contribute to the numerous smaller creeks that drain the Blue Ridge, Capay Hills, Dunnigan Hills/Plainfield Ridge, and the Central Valley floor. Irrigation water is distributed through a network of natural and modified sloughs and constructed drainages that ultimately drain to the Colusa and Yolo Basins, which run along the west bank of the Sacramento River. Figure 2-4 shows the watersheds in the strategy area. Cache Creek flows are regulated in Lake County by the Cache Creek

Dam at the outlet of Clear Lake and the Indian Valley Dam on the North Fork of Cache Creek, and in Yolo County by the Capay Diversion Dam. Flows in Putah Creek are regulated by the Monticello Dam, situated at the Blue Ridge, at the western edge of Yolo County, and by the Putah Diversion Dam, located west of the City of Winters (WRIME 2006). The flows in the Sacramento River and in the adjacent Colusa and Yolo Basins are controlled by the State Water Project (SWP) and Central Valley Project, and are contained by levees constructed by the Sacramento River Flood Control Project. As part of the Sacramento River Flood Control Project, high flows that pass over Fremont and Sacramento Weirs are diverted through the Yolo Bypass located in the Yolo Basin. The four main drainages in the strategy area are described below.

2.2.4.1 Sacramento River, Colusa Basin, and Yolo Basin

The Sacramento River forms the eastern edge of the strategy area. Prior to 1850, the Sacramento River periodically overflowed its natural levees, filling the adjacent lowland Colusa and Yolo Basins (Kelley 1985; Mount 1995). These two major lowlands were separated by a large deposit of alluvium known as the Knights Landing Ridge. Overflows in both basins eventually drained back into the Sacramento River at the southern end of the strategy area. Gold mining in the Sierra Nevada significantly altered the hydrologic function of the Sacramento River during the hydraulic mining period (1850 to 1884), producing large amounts of sediment that choked the channels of the Sacramento River. This sediment influx raised portions of the riverbed that run along the Yolo County boundary, and the sediments were flushed into the Yolo and Colusa Basins during flood events. The sediments were gradually purged from the lower sections of the Sacramento River in the early 1900s, by the time the Sacramento River Flood Control Project began (Kelley 1985). The lower Sacramento River is now largely sediment-starved as a result of sediment retention behind dams and the leveeing of the historical Sacramento River floodplain.

The Yolo Bypass was constructed in the 1930s as part of the Sacramento River Flood Control Project to shunt floodwaters out of the Sacramento River to reduce the potential for large-scale flooding in urban areas. Under normal conditions, water flows from the Colusa Basin into the Yolo Basin through a cut in the Knights Landing Ridge, known as the Knights Landing Ridge Cut Canal. During flood conditions, flows from the Sacramento River enter the 57,000-acre Yolo Bypass over the fixed Fremont Weir at its northern end. Flood flows also enter the Yolo Bypass through the gated Sacramento Weir, which is just upstream of the confluence with the American River. The Yolo Bypass can convey up to 80 percent of the system's floodwaters, which drain back into the Sacramento River a few miles upstream of Rio Vista in Solano County. During summer, the Toe Drain/Tule Canal on the east side of the Yolo Bypass carries perennial flows southward (Schemel et al. 2002). Numerous tidal sloughs dominate the southern end of the Yolo Basin. The Sacramento Deep Water Ship Channel, a navigation canal, was constructed in the early 1960s adjacent to the east side of the lower Yolo Basin to provide access for larger ships to the Port of Sacramento (now the Port of West Sacramento) in West Sacramento.

Figure 2-4 Watersheds and Major Streams

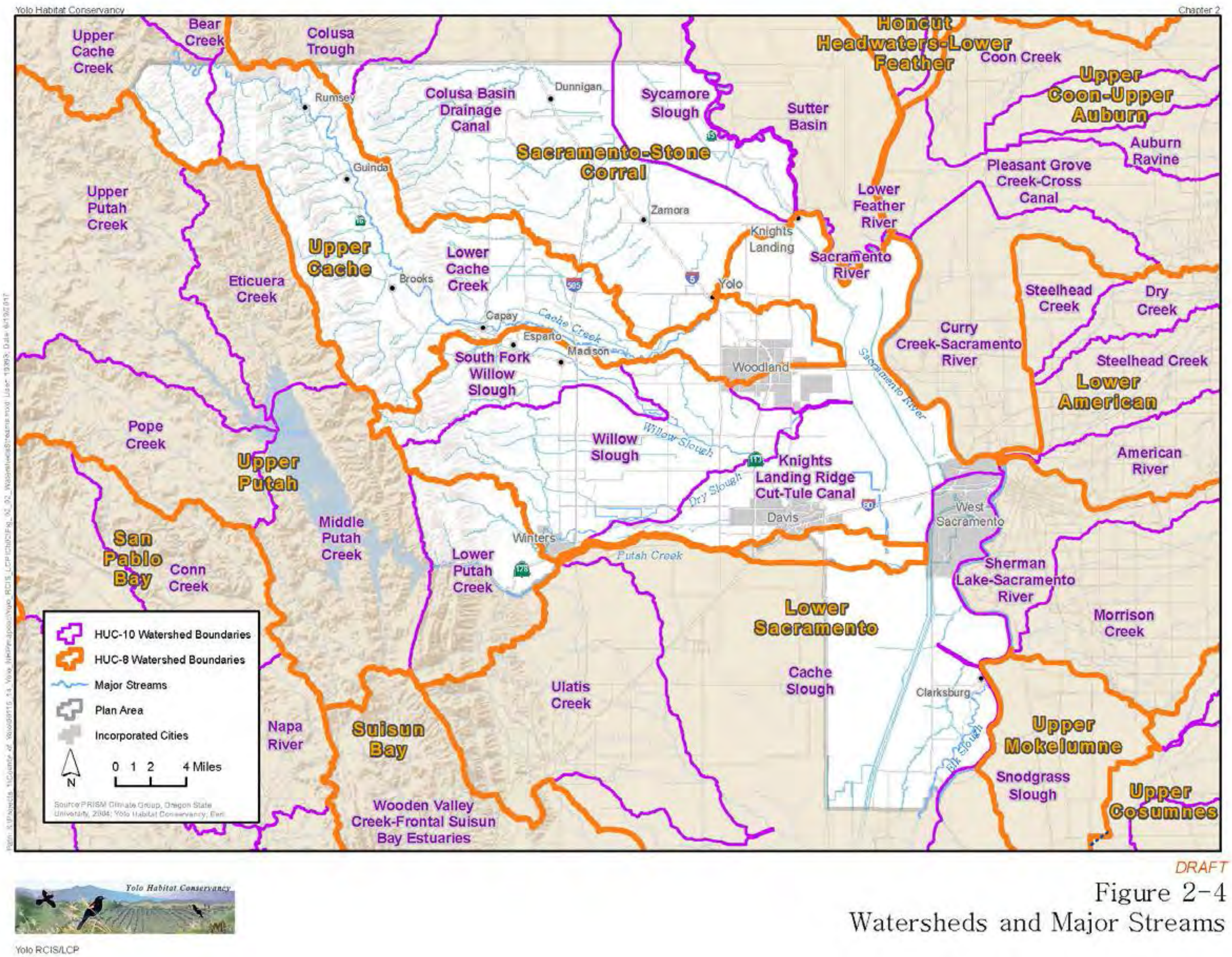


Figure 2-4
Watersheds and Major Streams

2.2.4.2 Cache Creek

Cache Creek enters northwestern Yolo County through deep gorges in the Coast Range and then flows southeastward down the narrow Capay Valley. Near that valley's southern end it flows through the Capay Hills in another deep gorge and then eastward across the Central Valley floor to the Yolo Bypass. Flows are diverted at the Capay Diversion Dam, just west of Capay, to the Winters and West Adams irrigation canals. The reach below this dam, known as Lower Cache Creek, historically flowed between raised natural levees, and overflows would drain away from the creek into the Hungry Hollow and Cache/Putah Basin. Lower Cache Creek between the Capay Hills and Dunnigan Hills/Plainfield Ridge is characterized as a "losing reach" because it loses a substantial amount of its flow to groundwater recharge where it flows across coarse sediments deposited in the Madison syncline basin (WRIME 2006). Since this reach loses so much water, it does not support extensive stands of woody vegetation, but some areas support shrubby vegetation such as sandbar willow, typical of riparian scrub (Holstein 2013). The section of Lower Cache Creek that crosses the Dunnigan Hills/Plainfield Ridge anticline, however, is a "gaining reach," where flows increase through groundwater contribution from springs in the creek bed. Cache Creek terminates at the Cache Creek Settling Basin, an artificial basin constructed to trap sediment that otherwise would flow into the Yolo Bypass. The Cache Creek Settling Basin is separated from the Yolo Bypass by an outlet weir that overtops at high flows, sending Cache Creek waters through the Yolo Bypass to the Sacramento–San Joaquin River Delta. The "gaining reach" is lined with mature riparian vegetation, and the settling basin contains an extensive area of developing riparian forest.

The Central Valley Regional Water Quality Control Board (RWQCB) has determined that Cache Creek is impaired because fish tissue and water from these water bodies contain elevated levels of mercury. The Central Valley RWQCB developed a Total Maximum Daily Load (TMDL) water quality management plan to lower mercury levels in the Cache Creek watershed and downstream in the Sacramento–San Joaquin Delta. The TMDL encompasses the 81-mile reach of Cache Creek between Clear Lake Dam and the outflow of Cache Creek Settling Basin.

2.2.4.3 Putah Creek

Putah Creek runs along the southern boundary of Yolo County (Figure 2-4). It enters Yolo County at the base of Monticello Dam and runs eastward through a canyon that widens downstream to the Putah Diversion Dam, which supplies the Putah South Canal. Below the dam, Putah Creek flows across its alluvial fan, creating a groundwater basin. Lower Putah Creek historically flowed between raised natural levees, and overflows would drain away from the creek northward into the Cache/Putah Basin and southward through minor channels into Solano County.

The lower section of Putah Creek is a losing reach until it crosses the Dunnigan Hills/Plainfield Ridge anticline, where it briefly becomes a gaining reach (Thomasson et al. 1960; California Department of Water Resources 1955). The creek continues eastward until it reaches Davis and eventually drains into the Yolo Basin. Beginning in 1870, a series of flood-control projects deepened a minor fork of Putah Creek that ran south of Davis. A levee system was constructed across the North Fork of Putah Creek that directed most flows into the South Fork and dewatered the North Fork downstream of the levees (Anonymous 1870). Putah Creek terminates at the Putah Sinks within the Yolo Bypass. Drainage modifications and agricultural conversion in the sinks beginning in the late 1800s have completely modified the Putah Sinks from historical conditions (Vaught 2006).

2.2.4.4 Willow Slough

Willow Slough drains a 164 square mile watershed between Cache Creek and Putah Creek (Water Resources Association of Yolo County 2005). The Willow Slough watershed, which includes numerous small drainages that flow into Willow Slough, is divided into five major landform units: the eastern slope of the Inner Coast Range, the low hills at the foot of the range, the alluvial plains of the Madison syncline, a band of undulating hills known as the Plainfield Ridge, and the low-lying basin east of the ridge. Historically, after floodwaters receded each year, several large alkaline playa-type pools would remain on the edges of alluvial deposits in the plains around Willow Slough.

In the late 1800s, Willow Slough was generally perennial. Decreases in base flow may have resulted from cattle grazing in the foothills (which tends to increase direct runoff and decrease infiltration and base flow) and groundwater pumping (which tends to lower groundwater levels and shorten or eliminate reaches where groundwater seeps into slough channels). Downcutting of the channel of nearby Cache Creek at Dunnigan Hills/Plainfield Ridge also likely captured groundwater formerly feeding springs that kept Willow Slough perennial.

In the 1960s, the U.S. Army Corps of Engineers constructed the Willow Slough Bypass approximately ¼ mile east of SR 113 to the north of the City of Davis. The bypass diverts all flood flows in downstream Willow Slough to a lower elevation of the Yolo Bypass. Creation of the bypass increased the draining velocity of flood flows through improved gravity flow (Water Resources Association of Yolo County 2005).

Willow Slough has been ditched and modified from its natural conditions into a dense rectilinear network that supplies irrigation water and drains floodwaters (Jones & Stokes 1996). In some localized areas these ditches are lined with narrow bands of riparian vegetation, while in other areas they abut cultivated agricultural fields and their banks are maintained as bare soil. Portions of Willow Slough, however, still retain their natural sinuosity and are lined with dense riparian forests (Holstein 2013). The original remnant of Willow Slough continues northeast and enters the Yolo Bypass at Conaway Ranch (Water Resources Association of Yolo County 2005).

2.2.5 Soils and Geology

The Coast Range in Yolo County is mostly underlain by the Great Valley sequence of marine sediments deposited between 190 and 70 million years ago on a shallow sea floor when the Pacific Ocean's coast was located in various places between what is now western Nevada and what are now the Sierra Nevada foothills. An exception occurs at Little Blue Ridge in the county's northwestern corner. A serpentine deposit in this location, squeezed upward by tectonic forces from deep in the earth's mantle, occurs in association with a small amount of Franciscan Formation, a mélange of sea floor sediments. These sea floor sediments were scraped off an oceanic plate being tectonically subducted into a marine trench at about the same time the Great Valley sequence was forming. Uplift occurring later along faults and resultant accrual of sediments caused Great Valley sequence deposition to end, and the ocean to withdraw from what are now the Coast Range and Central Valley. About 1 million years ago, the Coast Range achieved its present elevation in an uplift that turned beds of the Great Valley sequence sediments on their edge. Putah and Cache Creeks are older than this uplift, however, and they were able to maintain their location and elevation by eroding deep canyons in the Coast Range and Capay Hills as they uplifted.

Meanwhile as the Coast Range was uplifting, what is now the Central Valley was continually subsiding into a vast basin where sediments deposited after eroding from surrounding mountains. Consequently, early marine sediments and even vast volcanic plains were buried beneath thousands of feet of nonmarine sediments that are youngest at the surface and become progressively older at depth. The volcanic plain outcrops as Lovejoy basalt along the base of the Coast Range. The Capay Hills have a Great Valley sequence core but are largely mantled by more recent uplifted nonmarine sediments, while the anticlinal Dunnigan Hills/Plainfield Ridge consists entirely of uplifted and eroded nonmarine sediments similar to those on the Central Valley floor. The majority of these nonmarine sediments were laid down as the 2- to 5-million-year-old Tehama formation.

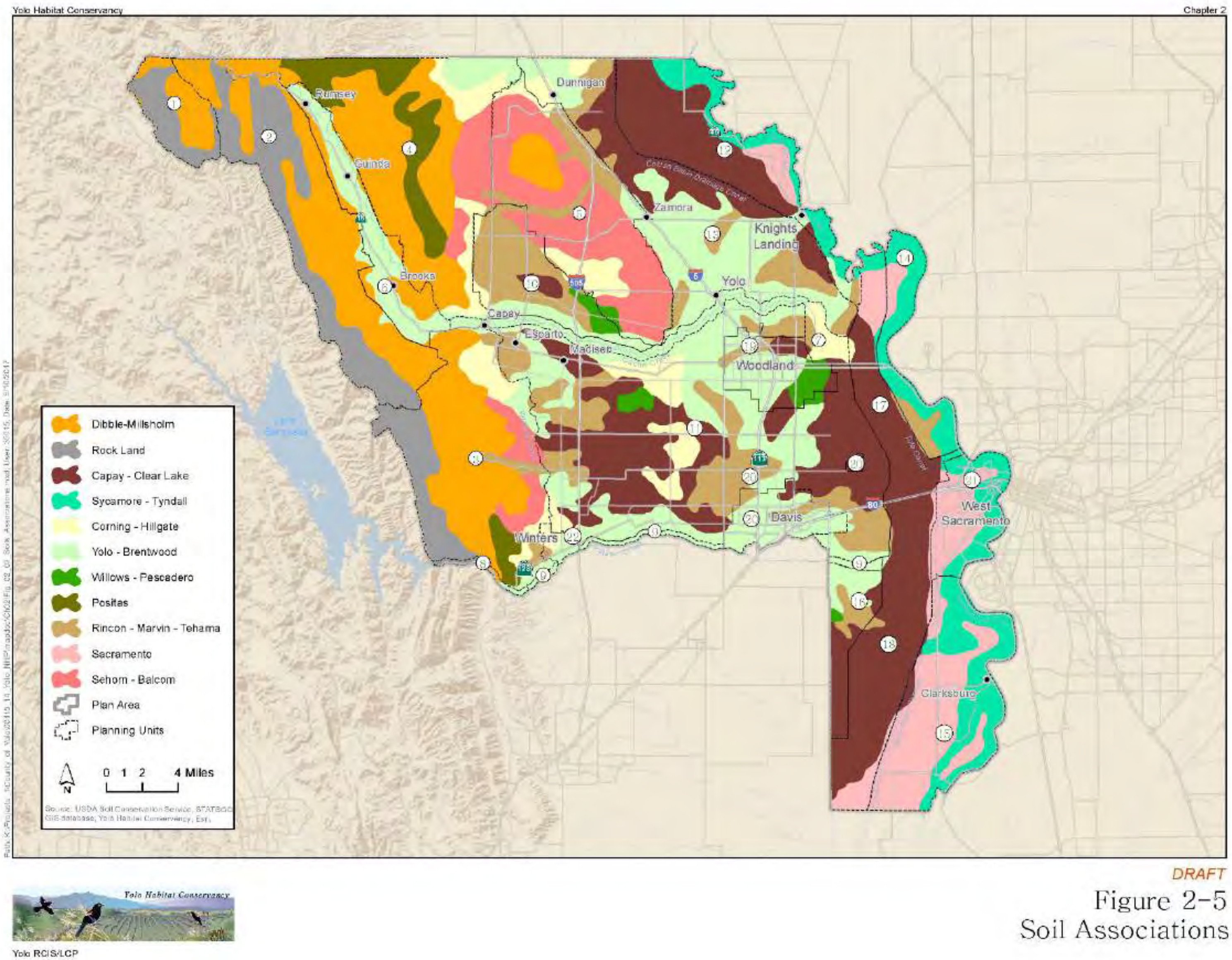
Soils form when parent material (Figure 2-5), either bedrock or alluvium, is altered by physical and chemical processes. In Yolo County's Coast Range, soils closely mirror underlying bedrock of the Great Valley sequence and serpentine, while much more recent nonmarine sediments like the Tehama and Red Bluff formations mantle the base of Blue Ridge, most of the Capay Hills, and all of the Dunnigan Hills/Plainfield Ridge. In lowlands of the Central Valley floor, a diversity of soil types reflects ongoing exposure to the forces of stream flow, persistent drainage overflows, deposition of salts, and uneven rates of particle settling. In many cases, vegetation patterns are closely associated with particular soil types.

Soil associations of the strategy area are shown on Figure 2-6. A soil association is a landscape-level classification system based on the distinctive spatial distributions of combinations of soil series. Soils in each series have similar physical and chemical characteristics. As a result of their broad geographical extent, soil associations represent a relatively persistent historical record of landscape-level physical and chemical processes. In Yolo County, those processes have resulted in 12 soil associations consisting of an uplands group, a lowland alluvial fan group, and a lowland Colusa/Yolo Basin group, as described below.

2.2.5.1 Uplands Soils Group

The uplands soils group consists of five soils associations: Rock Land, Dibble-Millsholm, Positas, Sehorn-Balcorn, and Corning-Hillgate (Figure 2-6. The Rock Land association is located on sandstone of Franciscan complex and Great Valley sequence materials along the highest ridges of the Little Blue Ridge and Blue Ridge (Andrews 1970). Serpentine Ultramafic parent material (Figure 2-5) is the source of soils that cause the unique natural communities and endemic plants in the northwestern corner of the strategy area. Typically, 50 to 90 percent of the land surface of Rock Land is exposed sandstone, shale, or serpentinized bedrock: The remainder is covered by a thin layer of sandy loam (Andrews 1970). The most typical vegetation on Rock Land is chaparral. Immediately below the Rock Land association on Blue Ridge and along the flanks of the Capay Hills is the Dibble-Millsholm association, which formed from Great Valley sequence materials (Andrews 1970). Exposed bedrock covers less than 10 percent of the surface of the Dibble-Millsholm association, which consequently has more soil development. The most typical vegetation of this association is woodland dominated by blue oaks, interior live oaks, and foothill pine. Although it lacks similar parent material, an outlier of this association has been mapped on the highest areas of the northern Dunnigan Hills.

Figure 2-5. Soil Associations



The patchy Positas association formed on terraces over the Red Bluff formations in the southern end of the Blue Ridge and along the western and northern slopes of the Capay Hills. Its soils are gravelly loams. The Sehorn-Balcom association formed over the Tehama formation, along the eastern toes of the Blue Ridge and Capay Hills, and along most of the Dunnigan Hills. The soils of this association consist of silty clays and clays. Adjacent terraces of the Red Bluff and Tehama formations support the Corning-Hillgate association, which also extends along the Plainfield Ridge. The soils of this association are gravelly loams or loams. One outlier of this association has been mapped across the entire Cache Creek Settling Basin. Vegetation in the settling basin is riparian, but vegetation of the Positas, Sehorn-Balcom, and Corning-Hillgate associations is typically California prairie with some blue oak woodland.

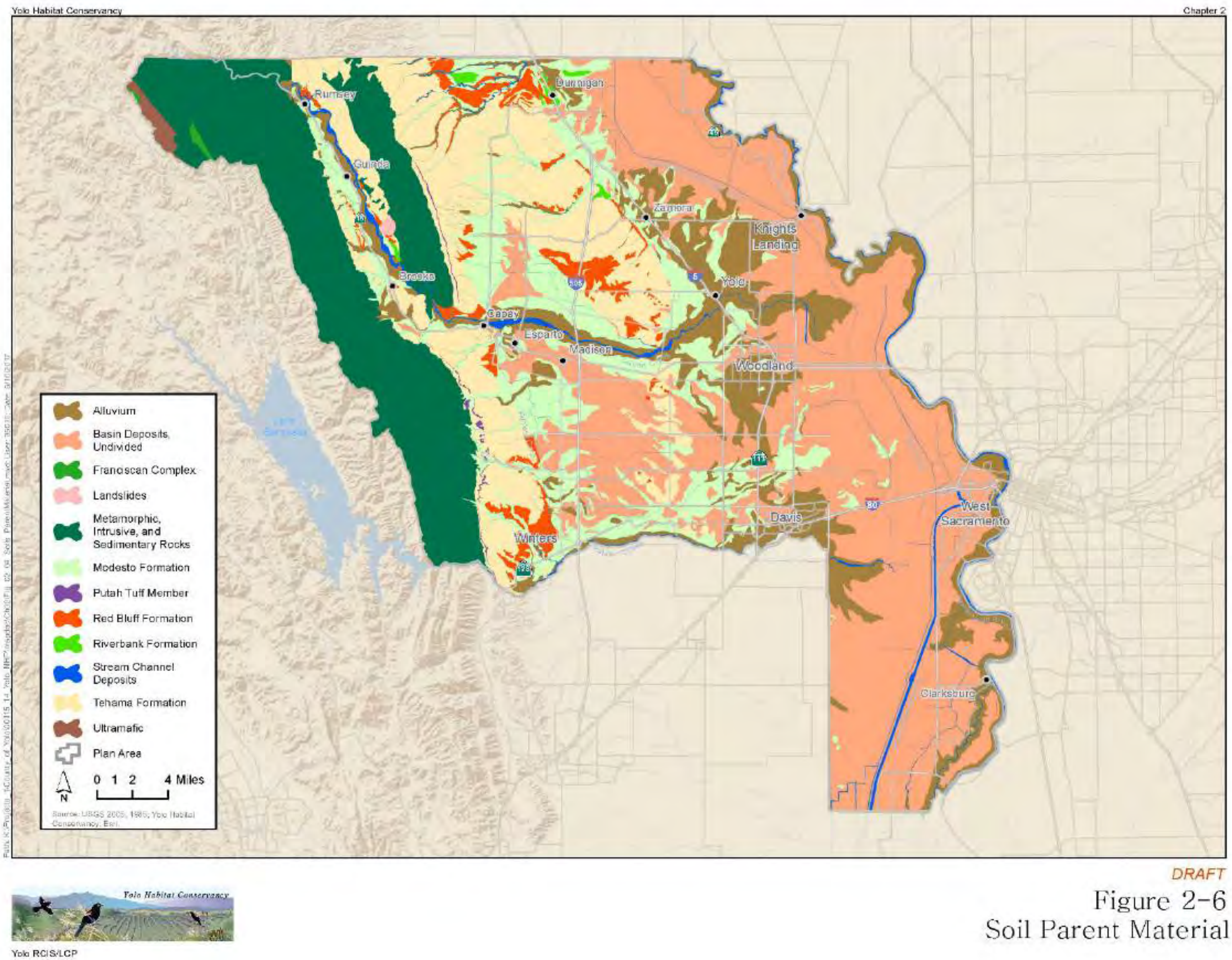
2.2.5.2 Lowland Alluvial Fan Group

The lowland alluvial fan group consists of four soils associations: Yolo-Brentwood, Capay-Clear Lake, Rincon-Marvin-Tehama, and Willows-Pescadero (Figure 2-6). The Yolo-Brentwood association is most closely associated with alluvial floodplains and fans of Cache and Putah Creeks. In the Cache/Putah Basin it forms the highest portions of the basin rim at the mouths of the streams from the Blue Ridge and along the natural levee of Putah Creek. Its soils are deep and well-drained, and their textures range from silty loams to silty clay loams. Its historic vegetation was valley oak forest and woodland. The soils of the Capay-Clear Lake association line the bottoms of the Hungry Hollow and Cache/Putah Basin in the Madison syncline. These soils are generally poorly drained silty clays to clays. Their historic vegetation was primarily California prairie with some localized seasonal fresh emergent wetland. The Rincon-Marvin-Tehama association is found on the rim of the Cache/Putah Basin between the Yolo-Brentwood association and the Capay-Clear Lake association. Its historic vegetation was also California prairie. On the eastern side of the Cache/Putah basin is a patch of the Willows-Pescadero association that has formed where groundwater has been forced to the surface by the Dunnigan Hills/Plainfield anticline. The soils of this association are saline-alkaline silty clay loams to clays. These soil associations are also found east of the Dunnigan Hills/Plainfield Ridge anticline, where salts transported eastward across the Putah/Cache alluvial fans accumulate at the basin rim interface between the fans and the Yolo and Colusa basins. The historic vegetation on Willows-Pescadero soils was alkali prairie.

2.2.5.3 Lowland Colusa/Yolo Basin and Sacramento River Natural Levee Group

The lowland Colusa/Yolo Basin and Sacramento River natural levee group consists of three soil associations: Sycamore-Tyndall, Sacramento, and Capay-Sacramento (Figure 2-6). The Sycamore-Tyndall association is on the natural levees of the Sacramento River. Its soils are somewhat poorly drained, very fine sandy loams to clay loams. Their historic vegetation was valley oak woodland with some riparian vegetation along the Sacramento River. Below the Sycamore-Tyndall association in the rice lands of the Colusa Basin is the Sacramento association. Its soils are poorly drained silty clay loams and clays. Finally, because of their artificial drainage systems, the Yolo Bypass and parts of the Colusa Basin contain the Capay-Sacramento association with its moderately well-drained to poorly drained silty clay loams to clays. The historic vegetation of the Sacramento and Capay-Sacramento associations was perennial fresh emergent wetland dominated by tules.

Figure 2-6. Soil Parent Material



2.3 Land Cover Mapping

A land cover dataset was created for use in developing the conservation strategy. Land cover consists of naturally occurring and anthropogenic vegetation, human-made structures, and other unvegetated land cover types (e.g., barren lands, other lands incidental to agriculture). This section describes the land cover classification system and the methods used to map these land cover types in the strategy area. The land cover dataset was generated at a scale and level of resolution appropriate for regional resources planning; it was not developed for use in project-level planning. That is, land cover will be verified at the project-level during implementation for tracking and compliance purposes. While updates to this dataset have been made at a much finer scale to reflect the smaller areas of essential land covers, much of the data set was digitized at a more coarse scale reflecting an alliance level of vegetation types. A total of 79 land cover types were identified and mapped. As described in the following subsections, the land cover type map represents point-in-time data and was developed at a resolution sufficient for RCIS/LCP planning. The land cover type mapping may be periodically updated during implementation (Section 3.5, *Monitoring and Adaptive Management*) and may continue to be used as a planning tool during implementation.

Land cover mapping was developed using the following data sources.

- Mapping of the Blue Ridge and Little Blue Ridge regions of the strategy area on 1993 USGS digital orthophotographs prepared by UC Davis, CDFW, and Aerial Information Systems (AIS)
- Riparian land cover mapping prepared by Jones & Stokes (1989, 1990)
- Riparian land cover mapping of the Sacramento River (1996), Cache Creek (1996), and Putah Creek (1998) prepared by Chico State University as adjusted in 2004.
- CDFW Bay-Delta vegetation mapping dataset (2005 data)
- DWR 2008 land cover data set
- National Agriculture Imagery Program (NAIP) 2012 aerial imagery
- USFWS wetland easements data
- 2013 Google Earth imagery
- I-Cubed Aerial Imagery Service
- Yolo County Agricultural Commissioner’s Field Level Pesticide data (2011, 2013)

2.3.1 Natural Community, Vegetation, and Other Land Cover Classification

The Conservancy developed a comprehensive, multilevel land cover classification and mapping system for the HCP/NCCP planning process. The RCIS/LCP uses this system, although slightly modified. The land cover classification system achieves the following goals.

- Integrates existing, commonly used and emerging vegetation classification systems.
- Represents the natural and anthropogenic communities, vegetation types, and other land cover types in the strategy area under existing conditions.

- Provides the basis for characterizing current and future wildlife habitat uses through wildlife habitat relationships models (Section 2.10, *Focal and Conservation Species*).
- Provides a foundation for future mapping efforts, where more detailed site-specific mapping could be integrated.

The classification system uses a two-level hierarchy that establishes 13 natural communities and 79 floristic-based vegetation types and other unvegetated land cover types (Table 2-2, *Natural Communities and Other Land Cover Types*). The vegetation types were primarily derived from the hierarchical structure of *A Manual of California Vegetation* (MCV) (Sawyer and Keeler-Wolf 1995), as adopted and modified by the California Vegetation Classification and Mapping Program and the Napa County Vegetation Map (NCVM) (Thorne et al. 2004). Modifications to the MCV vegetation types were applied from the NCVM to describe the relatively unique vegetation in the western part of the strategy area.

Table 2-2. Natural Communities and Other Land Cover Types

Natural Community	Vegetation / Land Cover Detail	Crop Type	Total Extent in Strategy Area (acres)[a]
Natural or Semi-Natural Communities			
Cultivated Lands Seminatural Community	Alfalfa	Alfalfa	48,879
	Rice	Rice	35,724
	Field Crops	Corn	8,017
		Dry Beans	229
		Grain Sorghum	163
		Safflower	15,508
		Sudan	1,536
		Sugar Beets	10
		Sunflowers	11,114
		Undifferentiated Field Crops	5,488
	Truck/Berry Crops	Asparagus	128
		Melons/Squash/Cucumbers	3,049
		Onions/Garlic	815
		Peppers	956
		Strawberries	18
		Tomatoes	36,656
		Undifferentiated Truck and Berry Crops	1,832
	Grain/Hay Crops	Grain and Hay Crops	65,258
Cultivated Lands Seminatural Community, continued	Pasture	Miscellaneous Grasses (grown for seed)	3,855
		Mixed Pasture	11,195
		Native Pasture	138

Natural Community	Vegetation / Land Cover Detail	Crop Type		Total Extent in Strategy Area (acres)[a]
			Total	**250,568**
California Prairie	California Annual Grasslands Alliance			70,934
	Lotus scoparius Alliance (post-burn)			172
	Sparse Bush Lupine / Annual Grasses / Rock Outcrop NFD Alliance			39
	Upland Annual Grasslands & Forbs Formation			8,169
	Urban Ruderal			1,582
			Total	**80,896**
Serpentine	Serpentine Barren			10
	Serpentine Grasslands NFD Super Alliance			237
	California Bay - Leather Oak - Rhamnus Mesic Serpentine NFD Super Alliance			173
	Leather Oak - Chaparral Alliance			1,729
	White Leaf Manzanita - Leather Oak - (Chamise - Ceanothus spp.) Xeric Serpentine NFD Super Alliance			167
	McNab Cypress Alliance			11
			Total	**2,327**
Chamise Chaparral	Chamise - Wedgeleaf Ceanothus Alliance			9,255
	Chamise Alliance			20,881
			Total	**30,137**
Mixed Chaparral	Evergreen Shrubland			403
	Mixed Manzanita - (Interior Live Oak - California Bay - Chamise) NFD Alliance			4
	Scrub Oak Chaparral Alliance			11,396
Mixed Chaparral, continued	Toyon - (Foothill Pine/ Chamise)/Annual Grasses Savanna NFD Alliance			530

Natural Community	Vegetation / Land Cover Detail	Crop Type	Total Extent in Strategy Area (acres)[a]
	Whiteleaf Manzanita Alliance		92
		Total	**12,425**
Oak-Foothill Pine	Foothill Pine Alliance		3,760
	Interior Live Oak-Blue Oak-(Foothill Pine) NFD Association		26,797
	Interior Live Oak Alliance		13,182
		Total	**43,739**

Natural Community	Vegetation / Land Cover Detail	Crop Type		Total Extent in Strategy Area (acres)[a]
Blue Oak Woodland	Blue Oak Alliance		**Total**	**35,944**
Closed-Cone Pine-Cypress	Knobcone Pine Alliance			201
	MacNab Cypress Alliance			11
			Total	**212**
Montane Hardwood	Black Oak Alliance			98
	Canyon Live Oak Alliance			485
	Mixed Oak Alliance			2,442
	Sparse California Juniper-Canyon Live Oak-California Bay-California Buckeye/Steep Rock Outcrop NFD Alliance			62
			Total	**3,087**
Valley Oak Woodland	Valley Oak Alliance		**Total**	**181**
Alkali prairie	Alkali prairie			309
Vernal pool complex	Vernal Pool Complex			299
Fresh emergent wetland	Alkali Bulrush - Bulrush Brackish Marsh NFD Super Alliance			9
	Bulrush - Cattail Wetland Alliance			712
	Bulrush - Cattail Fresh Water Marsh NFD Super Alliance			3,707
Fresh emergent wetland, continued	Carex spp. - Juncus spp. - Wet Meadow Grasses NFD Super Alliance			718
	Crypsis spp. - Wetland Grasses - Wetland Forbs NFD Super Alliance			16,579
	Perennial pepperweed (*Lepidium latifolium*) Alliance			216
	Saltgrass Alliance			3,987
	Undetermined alliance – Managed			371
			Total	**26,299**
Riparian	Blackberry NFD Super Alliance			226
	Coyote Brush			208

Natural Community	Vegetation / Land Cover Detail	Crop Type	Total Extent in Strategy Area (acres)[a]
	Fremont Cottonwood - Valley Oak - Willow (Ash - Sycamore) Riparian Forest NFD Association		3,062
	Giant Reed Series		101
	Great Valley Oak Riparian Association		75
	Mixed Fremont Cottonwood - Willow spp. NFD Alliance		1,721
	Mixed Willow Super Alliance		2,979
	Tamarisk Alliance		507
	Undifferentiated Riparian Bramble and Other		17
	Undifferentiated Riparian Scrub		131
	Undifferentiated Riparian Woodland/Forest		222
	Valley Oak Alliance – Riparian		3,136
Riparian, continued	White Alder (Mixed Willow) Riparian Forest NFD Association		57
		Total	**12,442**
Lacustrine and Riverine	Open Water		13,203
Total Natural and Seminatural Communities			512,002
Other Land Cover Types			
Other Agriculture	Citrus/Subtropical	Dates	6
		Lemon	0
		Miscellaneous Subtropical Fruits	16
		Olives	948
		Oranges	189
	Deciduous Fruits/Nuts	Almonds	22,618
		Apples	409
		Apricots	210
		Figs	41

Natural Community	Vegetation / Land Cover Detail	Crop Type	Total Extent in Strategy Area (acres)[a]
		Peaches/Nectarines	150
		Pears	215
		Pistachios	731
		Prunes	2,071
		Undifferentiated Deciduous Fruits and Nuts	1,335

[a] Numbers may not precisely sum due to rounding.

For the purpose of the Yolo HCP/NCCP, the Conservancy classified natural communities in a manner adapted from the California Wildlife Habitat Relationship classification system (Mayer and Laudenslayer 1988), including land cover categories for characterizing cultivated lands, non-natural areas (including vacant or urban parcels), and open water (see natural community descriptions below). Ecologists on the Advisory Committee recommended modifications to the natural community designations used in the Yolo HCP/NCCP, and the Yolo Habitat Conservancy incorporated these modifications into the RCIS/LCP. Table 2-3 presents the natural communities and corresponding land cover designations from other classification systems, including the Yolo HCP/NCCP. Consistent with RCIS Guidelines, Table 2-3 crosswalks the Yolo RCIS/LCP natural communities with the Second Edition of *A Manual of California Vegetation* (Sawyer et. al 2009), the California standard for vegetation mapping.

The Conservancy used the vegetation and other land cover types to predict the known and potential distribution of Group 1 focal species under existing conditions and under future conditions with HCP/NCCP implementation, as described in Section 2.10, *Focal Species.*

Table 2-3. Comparison of RCIS/LCP Land Cover Types to Other Local and Statewide Classifications Systems

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
California Prairie	Grassland	Wild Oat Grassland Semi-Natural Herbaceous Stands	Wild Oats Grassland Semi-Natural Alliance	Annual Grassland	California Annual Grasslands Alliance	California Annual Grasslands Alliance	Not mapped
		Deer weed Scrub Alliance	Deer Weed Scrub Alliance		Lotus Scoparius Alliance (Post-Burn)	Lotus Scoparius Alliance (Post-Burn)	Not mapped
		Silver Bush Lupine Scrub Alliance	Silver Bush Lupine Scrub Alliance		Sparse Bush Lupine / Annual Grasses / Rock Outcrop NFD Alliance	Sparse Bush Lupine / Annual Grasses / Rock Outcrop NFD Alliance	Not mapped
		Wild Oat Grassland Semi-Natural Herbaceous Stands	Wild Oats Grassland Semi-Natural Alliance		Upland Annual Grasslands & Forbs Formation	Upland Annual Grasslands & Forbs Formation	Not mapped
		No term available	No term available		Urban Ruderal	Not mapped	Urban, Urban Landscape, Industrial, Commercial, Residential, Semiagricultural, and Incidental to Agriculture
Serpentine	Serpentine	No term available		Serpentine	Serpentine Barren	Serpentine Barren	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
		Purple Needle grass Grassland Alliance, California Oat Grass Prairie Alliance, California Goldfields-Dwarf Plantain-Six Weeks Fescue Flower Fields Alliance	Purple Needle grass Grassland Alliance, California Oat Grass Prairie Alliance, California Goldfields-Dwarf Plantain-Six Weeks Fescue Flower Fields Alliance		Serpentine Grasslands NFD Super Alliance	Serpentine Grasslands NFD Super Alliance	Not mapped
Serpentine, continued	Mixed Chaparral	Leather Oak Chaparral Alliance	Leather Oak Chaparral Alliance	Mixed Chaparral	Leather Oak Chaparral Alliance	Leather Oak - California Bay - *Rhamnus* sp.) - Mesic Serpentine NFD Alliance; Leather Oak - Whiteleaf Manzanita - Chamise Xeric Serpentine NFD Super Alliance	Not mapped
		White Leaf Manzanita Chaparral Alliance	White Leaf Manzanita Chaparral	Alliance	Whiteleaf Manzanita - Leather Oak (*Chamise - Ceanothus* spp.) - Xeric Serpentine NFD Super Alliance	Whiteleaf Manzanita - Leather Oak (*Chamise - Ceanothus* spp.) - Xeric Serpentine NFD Super Alliance	Not mapped
		Leather Oak Chaparral Alliance	Leather Oak Chaparral Alliance		California Bay - Leather Oak (*Umbellularia*) - Mesic Serpentine NFD Super Alliance	California Bay - Leather Oak – Rhamnus sp. Mesic Serpentine NFD Super Alliance	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
	Closed-Cone Pine-Cypress	McNab Cypress Woodland Alliance	McNab Cypress Woodland Alliance	Closed-Cone Pine-Cypress	McNab Cypress Alliance	McNab Cypress Alliance	Not mapped
Chamise Chaparral	Chamise Alliance	Chamise Chaparral Alliance	Chamise Chaparral Alliance	Chamise Alliance	Chamise - Wedgeleaf Ceanothus Alliance	Chamise - Wedgeleaf Ceanothus Alliance	Not mapped
		Chamise Chaparral Alliance	Chamise Chaparral Alliance		Chamise Alliance	Chamise Alliance	Not mapped
Mixed Chaparral	Mixed Chaparral	no term available	no term available	Mixed C haparral	Evergreen Shrubland	Evergreen Shrubland	Not mapped
		Interior Live Oak Woodland Alliance	Interior Live Oak Woodland Alliance		Mixed Manzanita (Interior Live Oak - California Bay - Chamise) NFD Alliance	Mixed Manzanita (Interior Live Oak - California Bay - Chamise) NFD Alliance	Not mapped
		Scrub Oak Chaparral Alliance	Scrub Oak Chaparral Alliance		Scrub Oak Chaparral Alliance	Scrub Interior Live Oak - Scrub Oak (California Bay - Flowering Ash)	Not mapped
		Toyon Chaparral Alliance	Toyon Chaparral Alliance		Toyon - (Foothill Pine / Chamise)/ Annual Grasses Savanna NFD Alliance	Toyon - (Foothill Pine / Chamise)/ Annual Grasses Savanna NFD Alliance	Not mapped
		White Leaf Manzanita Chaparral Alliance	White Leaf Manzanita Chaparral Alliance		Whiteleaf Manzanita Alliance	Whiteleaf Manzanita Alliance	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
Oak-Foothill Pine	Oak-Foothill Pine	Ghost Pine Woodland Alliance	Foothill Pine Woodland Alliance	Blue Oak-Foothill Pine	Foothill Pine Alliance	Foothill Pine Alliance; Foothill Pine / Mesic Non-serpentine Chaparral NFD Association	Not mapped
		Interior Live Oak Woodland, Blue Oak Woodland Alliance	Interior Live Oak Woodland, Blue Oak Woodland Alliance		Interior Live Oak - Blue Oak - (Foothill Pine) NFD Association	Interior Live Oak - Blue Oak - (Foothill Pine) NFD Association	Not mapped
					Interior Live Oak Alliance	Interior Live Oak Alliance	Not mapped
Blue Oak Woodland	Blue Oak Woodland	Blue Oak Woodland Alliance	Blue Oak Woodland Alliance	Blue Oak-Foothill Pine	Blue Oak Alliance	Blue Oak Alliance	Not mapped
Montane Hardwood	Montane Hardwood	California Black Oak Forest Alliance	California Black Oak Forest Alliance	Montane Hardwood	Black Oak Alliance	Black Oak Alliance	Not mapped
		Canyon Live Oak Forest Alliance	Canyon Live Oak Forest Alliance		Canyon Live Oak Alliance	Canyon Live Oak Alliance	Not mapped
		Blue Oak Woodland, Valley Oak Woodland Alliance	Blue Oak Woodland, Valley Oak Woodland Alliance		Mixed Oak Alliance	Mixed Oak Alliance	Not mapped
		California Juniper Woodland Alliance	California Juniper Woodland Alliance		Sparse California Juniper-Canyon Live Oak-California Bay-California Buckeye / Steep Rock Outcrop NFD Alliance	Sparse California Juniper-Canyon Live Oak-California Bay-California Buckeye / Steep Rock Outcrop NFD Alliance	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
Valley Oak Woodland	Valley Oak Woodland	Valley Oak Woodland Alliance	Valley Oak Woodland Alliance	Valley Oak Woodland	Valley Oak Alliance (Riparian)	Valley Oak Alliance	Not mapped
		Valley Oak Woodland Alliance	Valley Oak Woodland Alliance		Great Valley Oak Riparian Association	Not mapped	Not mapped
Closed-Cone Pine-Cypress	Closed-Cone Pine-Cypress	Knobcone Pine Forest Alliance	Knobcone Pine Forest Alliance	Knobcone Pine Alliance	Knobcone Pine Alliance	Not mapped	
Eucalyptus	Eucalyptus	Eucalyptus Semi-Natural Stands Alliance	Eucalyptus-Tree-of Heaven-Black Locust Groves, Semi-Natural Alliance	Eucalyptus Alliance	Eucalyptus Alliance	Not mapped	
Alkali Prairie	Alkali prairie			N/A	Alkali prairie	Not mapped	Not mapped
Fresh Emergent Wetland	Fresh Emergent Wetland	Salt Marsh Bulrush Marshes Alliance	Salt Marsh Bulrush Marshes Alliance	Fresh Emergent Wetland	(Alkali Bulrush - Bulrush) Brackish Marsh NFD Super Alliance	(Alkali Bulrush - Bulrush) Brackish Marsh NFD Super Alliance	Not mapped
		Hardstem Bulrush Marsh Alliance, American Bulrush Marsh Alliance, California Bulrush Marsh Alliance	Hardstem Bulrush Marsh Alliance, American Bulrush Marsh Alliance, California Bulrush Marsh Alliance		Bulrush - Cattail Wetland Alliance	(Bulrush - Cattail) Fresh Water Marsh NFD Super Alliance	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
		Hardstem Bulrush Marsh Alliance, American Bulrush Marsh Alliance, California Bulrush Marsh Alliance	Hardstem Bulrush Marsh Alliance, American Bulrush Marsh Alliance, California Bulrush Marsh Alliance		(Bulrush - Cattail) Fresh Water Marsh NFD Super Alliance	(Bulrush - Cattail) Fresh Water Marsh NFD Super Alliance	Not mapped
		Iris-leaved Rush Seeps Alliance	Iris-leaf Rush Seeps Alliance		(*Carex* spp. - *Juncus* spp. - Wet Meadow Grasses) NFD Super Alliance	(*Carex* spp. - *Juncus* spp. - Wet Meadow Grasses) NFD Super Alliance	Not mapped
		No term available	No term available		*Crypsis* spp. - Wetland Grasses - Wetland Forbs NFD Super Alliance	Not mapped	Not mapped
		Perennial Pepper weed Patches Alliance	Perennial Pepper weed Patches Alliance		Perennial pepperweed (*Lepidium latifolium*) Alliance	Not mapped	Not mapped
		Salt grass Flats Alliance	Salt grass Flats Alliance		Saltgrass Alliance	Saltgrass - Pickleweed NFD- Super Alliance	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
		Cattail Marshes Alliance, Saltgrass Flats Alliance, Perennial Pepper weed Patches Alliance, Hardstem Bulrush Marsh Alliance, American Bulrush Marsh Alliance, California Bulrush Marsh Alliance	Cattail Marshes Alliance, Saltgrass Flats Alliance, Perennial Pepper weed Patches Alliance, Hardstem Bulrush Marsh Alliance, American Bulrush Marsh Alliance, California Bulrush Marsh Alliance		Undetermined alliance - Managed	(Alkali Bulrush - Bulrush) Brackish Marsh NFD Super Alliance, Bulrush - Cattail) Fresh Water Marsh NFD Super Alliance, (*Carex* spp. - *Juncus* spp. - Wet Meadow Grasses) NFD Super Alliance	Not mapped
		Giant Reed Breaks, Semi-Natural Alliance	Giant Reed Breaks, Semi-Natural Alliance		Giant Reed Series	Not mapped	Not mapped
Valley Foothill Riparian	Valley Foothill Riparian	Coastal Brambles Alliance, Himalayan Black berry Brambles Semi-Natural Shurbland Stands	Coastal Brambles Alliance, Himalayan Blackberry-Rattlebox-Edible Fig Riparian Scrub Semi-Natural Alliance	Valley Foothill Riparian	Blackberry NFD Super Alliance	Valley Oak - Fremont Cottonwood - (Coast Live Oak) Riparian Forest NFD Association	Not mapped
		Coyote Brush Scrub Alliance	Coyote Brush Scrub Alliance		Coyote Brush	Not mapped	Riparian Vegetation

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
		Fremont Cottonwood Forest Alliance	Fremont Cottonwood Forest Alliance		Mixed Fremont Cottonwood - Willow spp. NFD Alliance	Mixed Fremont Cottonwood - Willow spp. NFD Alliance	Riparian Vegetation
		Black Willow Thickets Alliance, Red Willow Thickets Alliance, Shining Willow Groves Alliance	Black Willow Thickets Alliance, Red Willow Thickets Alliance, Shining Willow Groves Alliance		Mixed Willow Super Alliance	Mixed Willow Super Alliance	Riparian Vegetation
		Tamarisk Thickets Semi-Natural Shrubland Stands	Tamarisk Thickets Semi-Natural Alliance		Tamarisk Alliance	Tamarisk Alliance	Not mapped
		Coastal Brambles Alliance, Himalayan Black berry Brambles Semi-Natural Shurbland Stands	Coastal Brambles, Himalayan Blackberry-Rattlebox-Edible Fig Riparian Scrub		Undifferentiated Riparian Bramble and Other	Valley Oak - Fremont Cottonwood - (Coast Live Oak) Riparian Forest NFD Association, Mixed Fremont Cottonwood - Willow spp. NFD Alliance, Mixed Willow Super Alliance	Riparian Vegetation

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
		Black Willow Thickets Alliance, Red Willow Thickets Alliance, Shining Willow Thickets Alliance Fremont Cottonwood Forest Alliance Valley Oak Woodland Alliance	Black Willow Thickets Alliance, Red Willow Thickets Alliance, Shining Willow Thickets Alliance Fremont Cottonwood Forest Alliance Valley Oak Woodland Alliance		Undifferentiated Riparian Scrub	Valley Oak - Fremont Cottonwood - (Coast Live Oak)[b] Riparian Forest NFD Association, Mixed Fremont Cottonwood - Willow spp. NFD Alliance, Mixed Willow Super Alliance	Riparian Vegetation
Valley Foothill Riparian, continued	Valley Foothill Riparian, continued	Black Willow Thickets Alliance, Red Willow Thickets Alliance, Shining Willow Thickets Alliance Fremont Cottonwood Forest Alliance Valley Oak Woodland Alliance	Black Willow Thickets Alliance, Red Willow Thickets Alliance, Shining Willow Thickets Alliance Fremont Cottonwood Forest Alliance Valley Oak Woodland Alliance	Valley Foothill Riparian, continued	Undifferentiated Riparian Woodland/Forest	Valley Oak - Fremont Cottonwood - (Coast Live Oak)[c] Riparian Forest NFD Association, Mixed Fremont Cottonwood - Willow spp. NFD Alliance, Mixed Willow Super Alliance	Riparian Vegetation
		White Alder Groves	White Alder Groves		White Alder (Mixed Willow) Riparian Forest NFD Association	White Alder Riparian Forest NFD – Association (Mixed Willow-California-Big Leaf Maple)	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
Vernal Pool Complex	Vernal Pool Complex	Fremont's Goldfields-Saltgrass Alkaline Vernal Pools Alliance, Fremont's Goldfields-Downingia Vernal Pools Alliance, Smooth Goldfields Vernal Pool Bottoms Alliance, Fremont's tidy tips-Blow Wives Vernal Pools Alliance	Fremont's Goldfields-Saltgrass Alkaline Vernal Pools Alliance, Fremont's Goldfields-Downingia Vernal Pools Alliance, Smooth Goldfields Vernal Pool Bottoms Alliance, Fremont's tidy tips-Blow Wives Vernal Pools Alliance	Vernal Pool Complex	Vernal Pool Complex	Not mapped	Not mapped
Lacustrine/ Riverine	Lacustrine/ riverine	no term available	no term available	Riverine	Open Water	Water	Water Surface
Agricultural (Seminatural Community)	Agricultural (Seminatural Community)	No term available	no term available	Irrigated Row and Field Crops	Field Crops	Agriculture	Field Crops, Truck, and Berry Crops
				Dryland Grain Crops	Grain and Hay	Agriculture	Grain and Hay Crops
				Pasture	Pasture	Agriculture	Pasture
				Rice	Rice	Agriculture	Rice
				Irrigated Row and Field Crops	Truck, Nursery, and Berry Crops	Agriculture	Field Crops, Truck, and Berry Crops

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
Land Cover Types That Are Not Natural or Seminatural Communities							
Yolo RCIS/LCP Land Cover Type	Yolo HCP/NCCP Land Cover Type			California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	Department of Water Resources Map
Agriculture (not habitat for focal species)	Agriculture (not habitat for focal species)	No term available	no term available	Evergreen orchard	Citrus/Subtropical	Agriculture	Citrus and Subtropical
		No term available	no term available	Deciduous Orchard	Deciduous Fruits and Nuts	Agriculture	Deciduous Fruits and Nuts
				Vineyard	Vineyard	Agriculture	Vineyard
Unvegetated, Vacant, and Developed	Unvegetated, Vacant, and Developed	No term available	no term available	Urban	Semiagricultural/ Incidental to Agriculture	Urban	Urban, Urban Landscape, Industrial, Commercial, Residential, Semiagricultural, and Incidental to Agriculture
				Barren	Barren – Anthropogenic	Not mapped	Barren and Wasteland
				Barren	Barren – Gravel and Sand Bars	Not mapped	Barren and Wasteland
				Barren	Rocky Outcrop	Rock Outcrop	Not mapped

RCIS/LCP	Yolo HCP/NCCP Natural Communities	Manual of California Vegetation, 2nd Edition (Sawyer 2009)	California Department of Fish and Wildlife Natural Communities List	California Wildlife Habitat Relationship Classification System	Yolo HCP/NCCP Vegetation	Napa County Vegetation Map[a]	DWR Map
				Urban	Urban or Built-up	Urban	Urban, Urban Landscape, Industrial, Commercial, Residential
Unvegetated, Vacant, and Developed, continued	Unvegetated, Vacant, and Developed, continued	Wild Oat Grassland Semi-Natural Herbaceous Stands	Wild Oat Grassland Semi-Natural Herbaceous Stands	Urban, Annual Grassland	Vegetated Corridor	Urban, California Annual Grasslands Alliance	Urban, Urban Landscape, Industrial, Commercial, Residential, Semiagricultural, Barren and Wasteland, and Incidental to Agriculture

[a] Land cover in the Blue Ridge and Little Blue Ridge region of the strategy area was identified using University of California, Davis (UC Davis), DFW, and Aerial Information Systems (AIS) jointly mapped habitats in Napa County, which extended into this portion of the Strategy Area.

[b] Although this alliance under the Napa County Vegetation Mapping system corresponds with the valley/foothill riparian vegetation type, coast live oak is not present in Yolo County. The dominant oak in Yolo County is interior live oak.

[c] Although this alliance under the Napa County Vegetation Mapping system corresponds with the valley/foothill riparian vegetation type, coast live oak is not present in Yolo County. The dominant oak in Yolo County is interior live oak.

2.3.2 Mapping Methods

This section describes the methods used to develop the land cover dataset from existing datasets, which were developed for portions of the strategy area at different times using differing land classification systems and mapping methods. These varying datasets were combined to develop a seamless land cover geographic information system (GIS) data layer.

To prepare the land cover database, multiple land cover and vegetation sources were obtained and assessed. Certain important characteristics such as mapping scale, mapping methods, and land cover/vegetation classification varied among these data sources. To minimize mapping inconsistencies that can result from using multiple data sources and classification systems, a crosswalk was developed for the various classification systems used in the mapping efforts, and a single, standardized classification system was developed for the Yolo HCP/NCCP, as described in Section 2.5.1, *Natural Community, Vegetation, and Other Land Cover Classification*, and Table 2-3, *Other Classification Systems*. Supplemental mapping was conducted to minimize inconsistencies as they were identified during the mapping process. This process involved spatial changes and attribute editing where necessary. The mapping units from the various sources were thus combined into a seamless GIS layer covering the extent of the strategy area. Although some inconsistencies remain in the dataset, this process reduced remaining anomalies to a level that provides a reliable basis for developing the conservation strategy.

Land cover in the Blue Ridge and Little Blue Ridge planning units was identified using mapping data developed jointly by the UC Davis, CDFW, and AIS: The data was developed for Napa County but extended into this portion of the strategy area. The Napa County map was created using the now obsolete 1995 MCV classification system, aerial photo interpretation, and limited field verification. Land cover that could be formally assigned to a defined type in the 1995 MCV classification system was classified at the alliance level (floristic-based), although a few associations comprising several vegetation types were also included. All grass types, many shrub types, and low-density stands of foothill pine were not identifiable in the aerial photos; these vegetation types were therefore aggregated into a super alliance. Vegetation types that could not be formally assigned because the type had not been formally defined, or because the type could not be distinguished in the aerial photographs, were assigned a provisional classification consistent with 1995 MCV and were identified as not formally defined (NFD). The minimum mapping unit of most land cover types was 2.5 acres, although units as small as 0.63 acre were delineated around important features such as agricultural ponds.

Riparian features were originally mapped in 1990, augmented in 1996 (Sacramento mainstem) and 1998 (Cache Creek and Putah Creek), and reviewed and adjusted in 2004, with some areas updated as recently as 2014. The Yolo County Community Development Agency's Riparian Zone Mapping Dataset includes mapping of the valley bottoms and lower slopes of Yolo County that occurred during the winter of 1989 and spring of 1990 (Jones & Stokes 1990). Portions of the Sacramento River and major tributaries were mapped by Chico State University to inventory and map riparian lands along these hydrologic features (the Sacramento River and Major Tributaries Riparian Zone Mapping dataset). Chico State University mapped the Sacramento River mainstem in 1996, Cache Creek in 1998, and Putah Creek in 1998. The strategy area was confined to streams in the Sacramento Valley, and mapping ended in the foothill canyons on both sides of the valley. All mapped areas were conducted at a 1:12,000 mapping scale. These data were incorporated into the initial land cover dataset to provide greater resolution of riparian land cover types. The 1989 and 1990 Yolo County Community Development Agency's Riparian Zone Mapping dataset, consisting of printed maps and no digital data layers, was reviewed and compared with the 2004 digital orthophotographs. New polygons were digitized on the 2004 aerial photos to correspond to the printed mapped polygons, and the vegetation classification assigned on the printed maps was correlated with these newly digitized polygons. In the Davis, West Sacramento, Woodland and Winters Planning Units, riparian vegetation was remapped in June 2011. Riparian features existing in the DWR 2008 land cover dataset that fell beyond the riparian features mapped in 1990, 1996, 1998, 2004, and 2011 were also included in the riparian mapping.

The alkali prairie and fresh emergent wetland features in the western portion of the strategy area were mapped in February 2013 using 2012 NAIP and i-Cubed imagery, in conjunction with CDFW biologists' interpretations. Land cover was initially mapped by aerial photo interpretation using 1993 USGS digital orthophotography.

The 2005 Bay-Delta vegetation mapping dataset was created by AIS for CDFW using CDFW's vegetation classification and mapping program to assess existing vegetation and land use conditions in the Delta region. The CDFW Bay-Delta vegetation cover dataset was used to augment vegetation mapping of areas of overlap between the strategy area and the region surveyed by CDFW. The map classification is based on field data collected during the summer and fall of 2005. Vegetation was mapped from the suballiance to super alliance level using the National Vegetation Classification Standard. Maps were at 1:12,000 scale, vegetation was mapped at a 2-acre minimum mapping unit, and critical vegetation types such as wetlands were mapped at a 1-acre minimum mapping unit. Features that were distinct or deemed important were mapped below the minimum mapping unit size.

In the spring of 2008, 2004 orthophotography was used to update the land cover data layer for ponds and new development. The orthophotography was reviewed in detail to identify any ponds, which are a component of some focal species habitat models (Appendix C, *Species Accounts*) that were not captured by the previous mapping efforts. At the same time, areas that were seen as developed on the orthophotography were updated. Orthophotography was used to further update the developed lands layer in 2014.

Cultivated lands and natural land cover types not addressed in other data sources at greater resolution were identified using the DWR Land Use Map 2008 dataset. Where necessary, the classifications of DWR polygons were adjusted to conform to the HCP/NCCP land cover dataset classification hierarchy. NAIP 2012 aerial imagery was reviewed to assign the appropriate land cover classification where the DWR classification of nonagricultural land cover types could not be directly aligned to the HCP/NCCP or RCIS/LCP classification. In the case of agriculture polygons that lacked detail, the Yolo County Agricultural Commissioner's Field Data were used to assign the appropriate polygon classification. Additionally, the Yolo Agricultural Commissioner's data were used, in the spring of 2014, to identify and update the conversion of field crops to orchards and vineyards. DWR crops are classified as nine types of structurally similar crop types or groups and three land use designations. This agricultural land cover component of the data set represents a point-in-time characterization of the agricultural landscape of the strategy area. The distribution, acreage, and types of crops grown in the strategy area, however, change annually and at larger timescales. As previously described, the implementation process provides for decision making (e.g., acquisition of lands supporting focal species habitats) based on the actual land cover types present at the time such decisions are made.

2.4 Protected Areas

As required in the RCIS Program Guidelines (June 2017 version), this RCIS/LCP uses the California Protected Areas Database and the California Conservation Easement Database to identify protected areas within the strategy area. Data used for the protected areas database include the following.

- California Protected Areas Database (California Protected Areas Database 2016).
- California Conservation Easement Database (California Conservation Easement Database 2016).
- Protected Areas Database of the United States (https://gapanalysis.usgs.gov/padus/)
- CDFW-owned/managed lands (http://www.calfish.org/ProgramsData/ReferenceLayersLandOwnership/CDFWOwnedandOperatedLands.aspx)
- National Conservation Easement Database (https://www.conservationeasement.us/)

Figure 3-1 shows the locations of these protected areas in the strategy area.

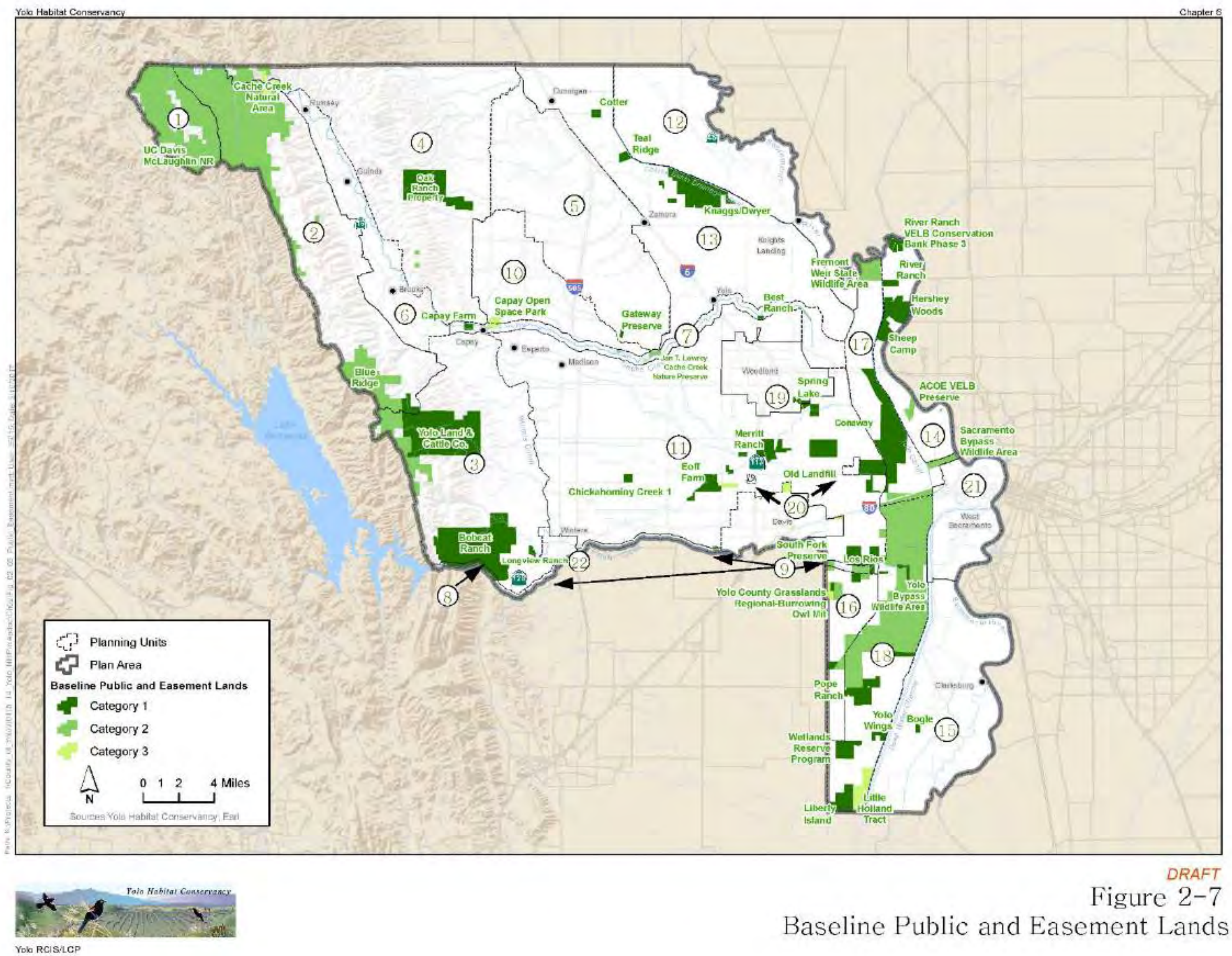
2.4.1 Protected Areas Adjacent to the Strategy Area

There are many protected areas that are connected to, but are just outside of the RCIS area. The largest of these areas is located in the northwest and provide landscape connectivity between the RCIS area and Cache Creek Wilderness Area extending north to Berryessa Snow Mountain National Monument. The Knox Wildlife Area which runs adjacent to the Strategy Area border in the northwest as well, provides connectivity from the Strategy Area to protected lands further north and west owned by the Bureau of Land Management. Along the southwest border, protected lands adjacent to the Startegy Area include Lake Berryessa Wilderness Area, Stebbins Reserve, Putah Creek Wildlife Area, and Stebbins Cold Canyon Reserve which all provide linkage to Bobcat Ranch located within the Strategy Area. Adjacent to the southern tip of the Strategy Area border is Liberty Island which extends south along the Sacramento River. Adjacent protected areas along the eastern border are limited to a few properties that include lands owned by the Natomis Basin Conservancy, California State Lands Commission, and California Department of Water Resources.

2.5 Ecoregions

Ecoregions are areas of general similarity in ecosystems based on major terrain features such as a desert, plateau, valley, mountain range, or a combination thereof as defined by the USDA, in coordination with the EPA. They provide a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. Ecoregions are hierarchical, and are identified based on patterns of biotic and abiotic phenomena, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Ecoregions can be effective units for setting regional conservation goals, as well as developing biological criteria and water quality standards.

Figure 2-7. Baseline Public and Easement Lands



Ecoregions in the strategy area are described in two ways: 1) according to the USDA ecoregion classification, and 2) according to the USGS ecoregion classification. Each classification system describes the ecoregions in the strategy area in a different way, but both are important for informing ecoregional planning and each provides unique information. In both cases, North America is divided into different levels of ecoregions, from coarsest to finest. In the USGS classification, the strategy areas overlaps with two Level III ecoregions (Griffith et al. 2016). Within each of these ecoregions there are several Level IV ecoregions (Figure 2-8a). In the USDA classification, the strategy area overlaps with two provinces (i.e., ecoregions) (Figure 2-8b) (Cleland et al. 2007). Within each of these ecoregions, the strategy area overlaps one subregion (section). The USGS and USDA ecoregion classifications are described below.

2.5.1 USDA Ecoregions

The USDA defines two ecoregions in the strategy area (Figure 2-8b). The Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow Province is defined by mountainous terrain with steep slopes. Precipitation is strongly influenced by altitude and direction of mountain ranges: winters are cold and snowy, and summers are hot and dry. Vegetation ranges from broadleaf-needle leaf woodland and shrublands to needle leaf evergreen forests. There is only one ecological section within it and within the strategy area, the Northern California Interior Coast Ranges Section. This ecological section has low- to moderate-elevation parallel ranges with crests of unequal height underlain by sedimentary rock. Vegetation is western hardwoods, chaparral-mountain shrubs, and annual grasses.

The second USDA ecoregion is the California Dry Steppe Province, which is defined by alluvial plains with low hills. The climate consists of hot summers and mild winters with precipitation in the winter. Vegetation was originally herbaceous but now is largely irrigated agricultural crops. There is only one ecological section within it and within the strategy area, the Great Valley Section. This ecological section has a low-elevation fluvial plain formed by nonmarine sedimentary rocks. Vegetation cover is agricultural; small areas of natural land cover remain, including annual grassland, western hardwoods, and wet grasslands.

2.5.2 USGS Ecoregions

2.5.2.1 Central California Foothills and Coastal Mountains

The western portion of the strategy area (about one-third) overlaps with the Central California Foothills and Coastal Mountains ecoregion (Level III) (Figure 2-8a). The primary distinguishing characteristic of this ecoregion is its Mediterranean climate of hot dry summers and cool moist winters, and associated vegetative cover comprising primarily chaparral and oak woodlands. Grasslands also occur in some low elevations, and patches of pine are found at high elevations. Large areas are ranchland and are grazed by domestic livestock. Relatively little land has been cultivated. Natural vegetation includes coast live oak woodlands, Coulter pine, and unique native stands of Monterey pine in the west, and blue oak, black oak, and gray pine woodlands in the east (Griffith et al. 2016). Several level IV ecoregions fall within the strategy area. These include the following, with descriptions from Griffith et al. (2016).

- **Foothill Ridges and Valleys.** The Foothill Ridges and Valleys ecoregion includes ridges, steep hills, and narrow valleys in the interior northern California Coast Ranges. This ecoregion is high in elevation and hilly than ecoregions to the east, but lower elevation and drier than ecoregions to the west. Vegetation includes purple needlegrass, blue oak, chamise, and foothill pine.

Figure 2-8a. USGS Ecoregions

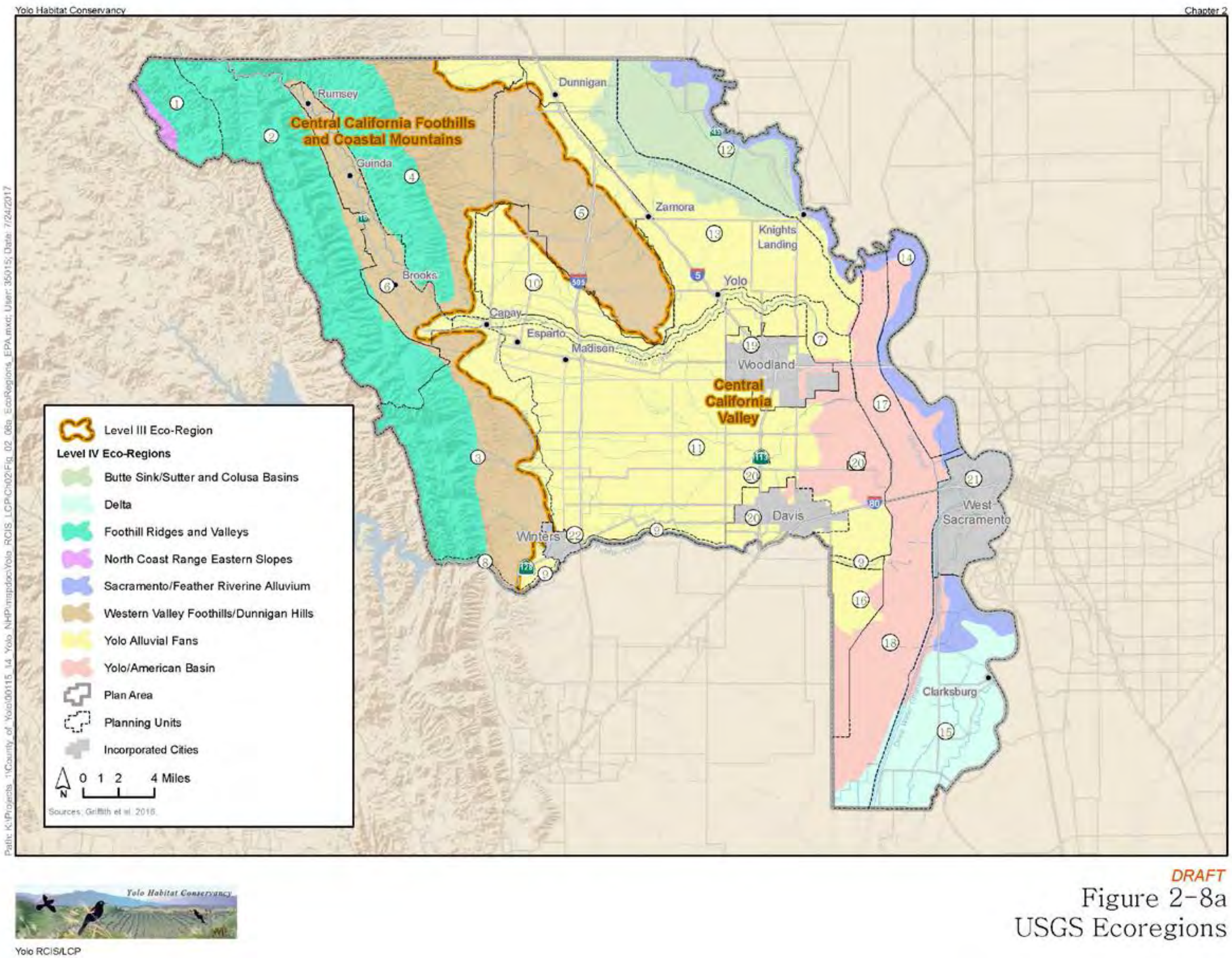
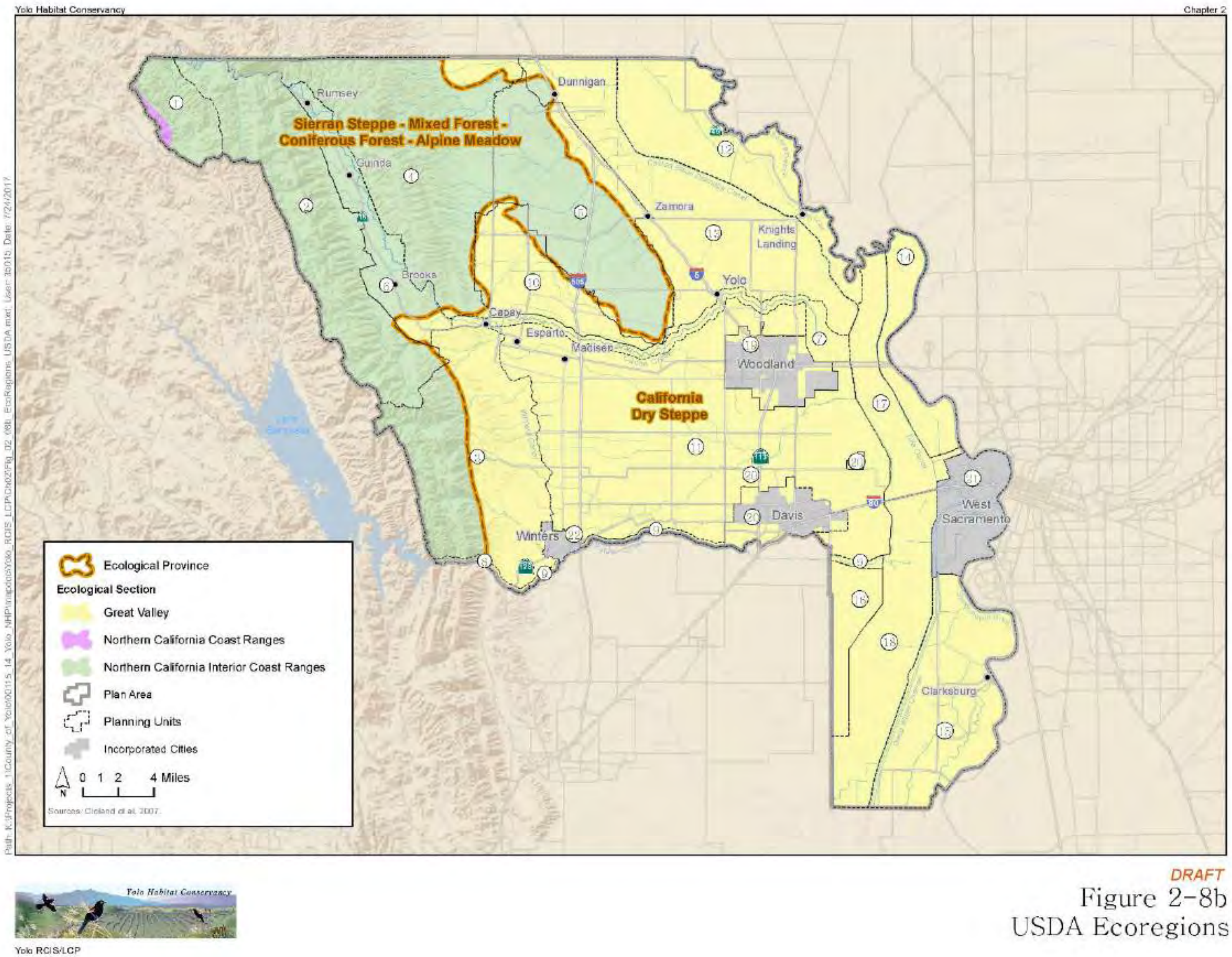


Figure 2-8b. USDA Ecoregions



- **North Coast Range Eastern Slopes.** The North Coast Range Eastern Slopes ecoregion is located along the steep, north-trending eastern edge of the Northern Coast Range mountains with sedimentary and ultramafic rocks. It has more relief and elevations than ecoregions to the east, however is vegetation with chaparral instead of grassland blue oak trees. It has few conifers compared to other high elevation ecoregions to the west. Vegetation include leather oak on serpentine soil, chamise on shallow soils, and mixed conifer on deeper, mesic soils. Soils hills contain McNab or Sargent cypress or some foothill and knobcone pine.
- **Western Valley Foothills/Dunnigan Hills.** The Western Valley Foothills/Dunnigan Hills ecoregion consist of the Dunnigan Hills, English Hills, and Capay Valley, and other low hills or terraces adjacent to the western margin of the Central California Valley ecoregion. Elevations can range from 150 to 100 feet. Common vegetation includes needlegrass grasslands and some areas of blue oak.

2.5.2.2 Central California Valley

The eastern two-thirds of the strategy area overlaps with the Central California Valley ecoregion (Level III) (Figure 2-8a). This ecoregion is flat with intensively farmed plains. Its long, hot, dry summers and mild winters distinguish the Central California Valley ecoregion from its neighboring ecoregions that are either hilly or mountainous, covered with forest or shrub, and generally nonagricultural. The Central California Valley ecoregion includes the flat valley basins of deep sediments adjacent to the Sacramento and San Joaquin Rivers, as well as the fans and terraces around the edge of the valley. The two major rivers flow from opposite ends of the Central California Valley, entering into the Sacramento–San Joaquin River Delta and San Pablo Bay. The region once contained extensive prairies, oak savannas, desert grasslands, riparian woodlands, freshwater marshes, and vernal pools. More than half of the region is now in cropland, about three-fourths of which is irrigated. Environmental concerns in the region include salinity due to evaporation of irrigation water, groundwater contamination from heavy use of agricultural chemicals, loss of wildlife and flora habitats, and urban sprawl. One Level IV ecoregion in the Coast Ranges overlaps with the strategy area.

- **Butte Sink/Sutter and Colusa Basins.** The Butte Sink/Sutter and Colusa Basins ecoregion occurs on nearly level to very gently sloping alluvial fans, floodplains, and basin floors that are split by the alluvium of the Sacramento River. Elevations range from 20 to 150 feet. Historical flood regimes created seasonal wetland and flat mashers. There is extensive agriculture of rice, and some orchards and pasture in this ecoregion; however, the region also offers wildlife habitat for waterfowl and pheasant and drainage canals support a warm-water fishery.
- **Sacramento/Feather Riverine Alluvium.** The Sacramento/Feather Riverine Alluvium ecoregion consists of nearly level floodplains and levees associated with the Sacramento, Feather and lower Yuba and Bear Rivers. Much of the unweather gravel, sand, and silt deposits are in contact with the river system and have constantly changing morphology. This ecoregion support pasture, wheat, fruit and nut orchards, and woody wetlands.
- **Yolo Alluvial Fans.** The Yolo Alluvial Fans ecoregion contains recent alluvial fan material from the Coast Ranges and from hills on the lower western side of the Sacramento Valley. Most of the region is cropland, with some areas of pastureland. Alfalfa, winter wheat, sunflower, corn, tomatoes, strawberries, and stone fruit, walnut, and almond orchards are typical crops.

- **Yolo/American Basin.** The Yolo/American Basins ecoregion includes nearly level to very gently sloping stream channels, levees, overflow basins, and alluvial fans of the main alluvial plan adjacent to the lower Sacramento River. The American Basin, just east of the river, is the northern unit, and the Yolo Basin, just west of the river, is the southern unit. Elevation range from 10 to 40 feet. Some flooding and high water tables occur during wet winters. The region includes seasonal and permanent wetlands, which provide resting and feeding habitat for migratory birds
- **Delta.** The Delta ecoregion is a low-elevation area, near sea level, at the confluence of major rivers. It is characterized by numerous sloughs where major rivers enter the ecoregion. Water entering the Delta is influenced by tidal action, streamflow, and water diversion as it flows toward the San Francisco Bay. Agriculture land use is dominant, with corn, alfalfa, hay, and wheat being the most extensive crops in the area. Many of the diked wetlands are managed for waterfowl hunting.

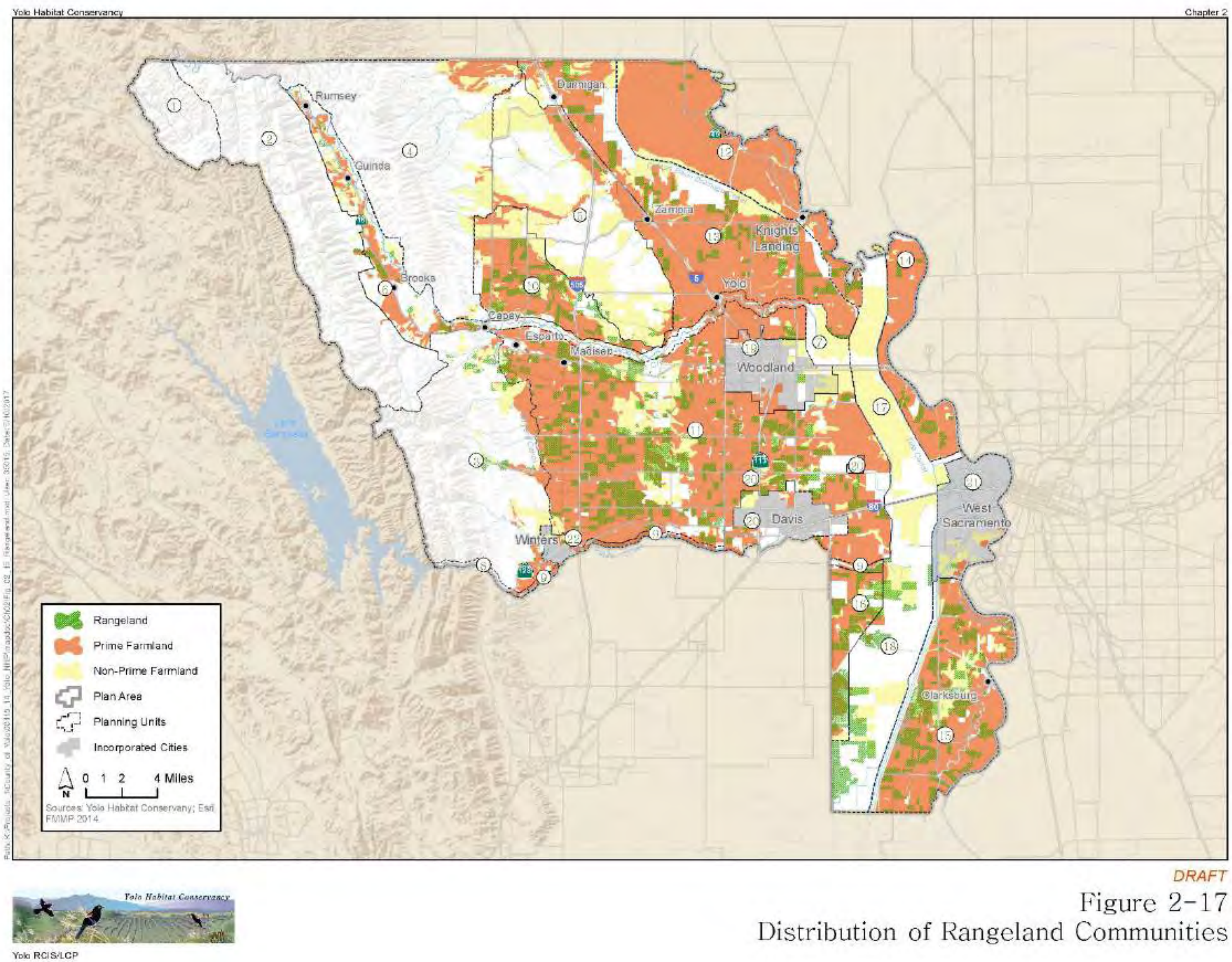
2.6 Natural and Seminatural Communities and Associated Plant and Wildlife Species

This section describes the 13 classified natural communities and associated plant and wildlife species that occur in the strategy area. The natural and seminatural communities are grouped into six categories: agriculture (categorized as a seminatural community), California prairie, serpentine, chaparral, woodlands and forest, and riparian and wetlands. The natural community categories provide a primary system for describing biological communities in this RCIS/LCP and assigning conservation measures that apply to multiple species. The natural community descriptions provide information regarding use by focal/conservation species. The descriptions focus mainly on primary uses of the habitats by species (i.e., regular use for certain key activities or periods by wildlife, or areas of typical occurrence and highest density of plants). Acreage of each natural community for the strategy area is presented in Table 2-2, *Natural Communities and Other Land Cover Types*.

2.6.1 Cultivated Land

In Yolo County approximately 297,000 acres, or 45 percent of total land cover, is harvested cropland. Most of the farmland is in the central and eastern portions of the RCIS Area (Figure 2-17). Cultivated lands in Yolo County are working lands that provide conservation benefits. CFGC 1852 (e)(1) requires that an RCIS consider “the conservation benefits of working lands for agricultural uses.” This section of the Yolo RCIS/LCP describes the conservation benefits of cultivated lands.

Figure 2-17. Distribution of Rangeland Communities



The Yolo RCIS/LCP categorizes cultivated land that supports focal and conservation species as a *seminatural* community to distinguish it from natural communities that do not support manmade crops. The following RCIS/LCP focal or conservation species occur in, but are not necessarily restricted to, the cultivated land seminatural community.

- Swainson's hawk
- White-tailed kite
- Tricolored blackbird
- Yellow-billed magpie
- Loggerhead shrike
- Western burrowing owl
- Western pond turtle
- Giant garter snake
- Mountain plover
- Black tern
- Pallid bat

2.6.1.1 Alfalfa

Alfalfa is a relatively low-growing perennial herbaceous legume species that is periodically irrigated and cut for hay. Since alfalfa fixes nitrogen, alfalfa is often used as a "green manure" fertilizer and is incorporated into the soil as part of many crop rotations. Alfalfa accounts for 48,879 acres, or approximately 7.5 percent of the strategy area (Table 2-2, *Natural Communities and Other Land Cover Types*; Figure 2-9). Alfalfa crops are also most productive on the Yolo-Brentwood soils where valley oak woodland once occurred.

The high protein content of its leaves makes alfalfa highly palatable for rodents such as ground squirrels, gophers, and voles, which are often present in high numbers in the fields. As a result of the large rodent populations, alfalfa fields support particularly high-value foraging habitat for raptors and other predators. Due to its low stature and high productivity and protein content, alfalfa may actually provide better foraging habitat for Swainson's hawk than the beardless wild rye fields of valley oak woodland they historically used for foraging.

2.6.1.2 Rice

Rice is unique among Yolo County's major crops because it is grown in flooded fields that resemble and provide some of the same ecological services as the fresh emergent wetland natural community. Rice fields consequently provide extremely important habitat for the focal species such as giant garter snake, which was formerly entirely confined to fresh emergent wetlands. Because of this species' association with permanent water in canals, however, only rice grown where this community formerly occurred in the Colusa and Yolo basins provide habitat. Rice in basins west of Plainfield Ridge formerly vegetated by seasonal marsh/prairie now and always lacked permanent water and thus do not provide habitat for this focal species. Rice covers an estimated 35,724 acres, or 5.4 percent, of the RCIS strategy area (Table 2-2, Figure 2-9). Rice mostly grows on Capay-Clear Lake soils because they retard downward drainage.

2.6.1.3 Field Crops

Diverse irrigated herbaceous crops like tomatoes, safflower, corn, and sunflower are extremely important elements of Yolo County's agricultural economy and some also provide important habitat for focal species as well as other local concern species. These crops are also most productive on the Yolo-Brentwood soils where valley oak woodland once occurred. Field crops cover an estimated 36,577 acres, or 5.8 percent, of the RCIS Area in Yolo County (Table 2-2, Figure 2-9).

2.6.1.4 Truck and Berry Crops

Truck and berry crops involve intensive agricultural operations to produce food and landscaping plants that are typically transported for sale elsewhere. Truck farming is the cultivation of fruit or vegetable crops on a relatively large scale for transport to distant markets and includes the production of tomatoes (the dominant crop), asparagus, melons, squash, cucumbers, onions, strawberries, and peppers. Nurseries produce flowering plants, shrubs, and trees for local and distant retail sales. Farming practices associated with these crops generally suppress the growth of other vegetation. These crop types support the yellow-billed magpie, a local concern species, and provide foraging habitat for wildlife species such as the red-winged blackbirds and small mammals. Truck and berry crops account for 43,576 acres, or 6.6 percent of the strategy area (Table 2-2, *Natural Communities and Other Land Cover Types*; Figure 2-9).

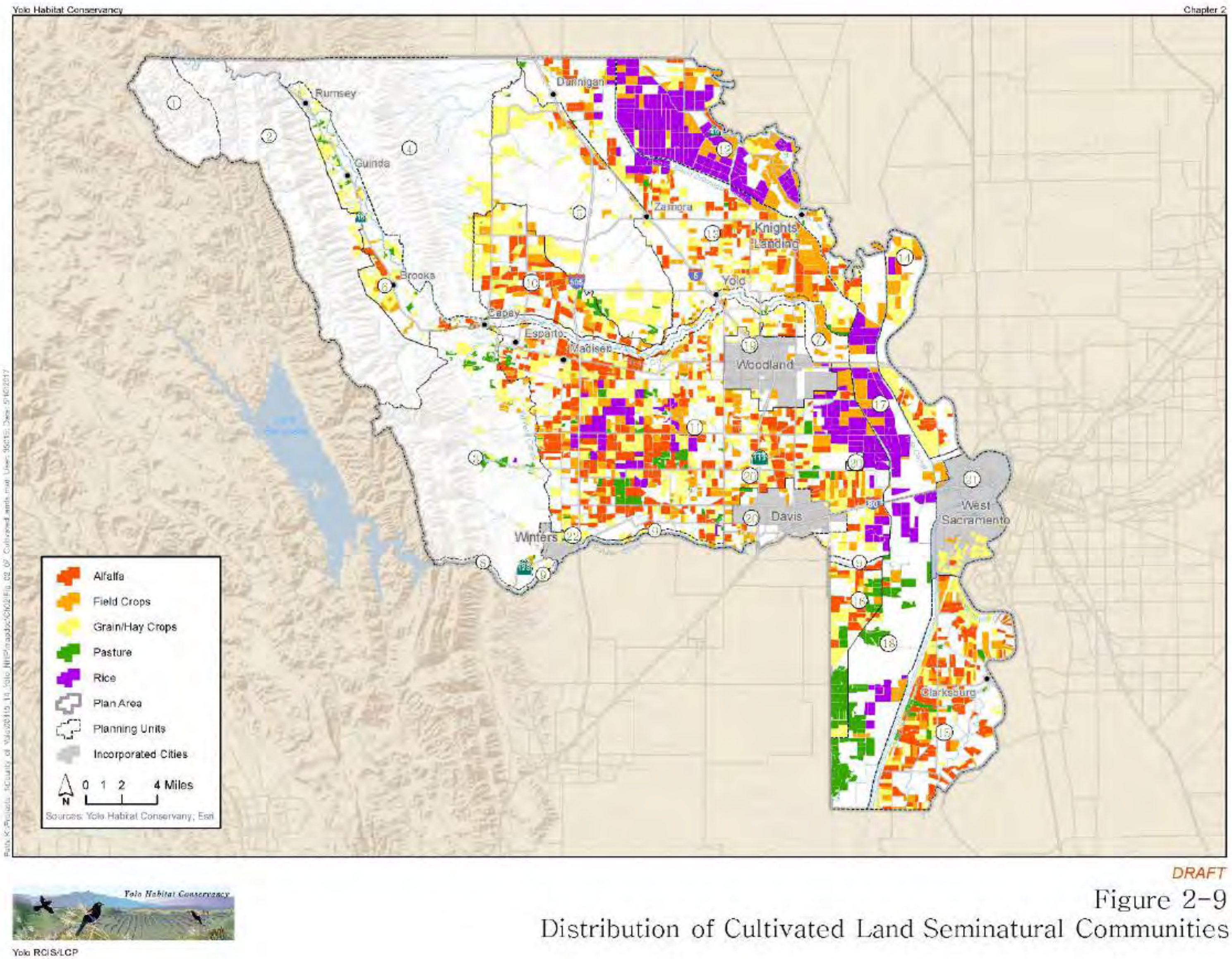
2.6.1.5 Grain and Hay Crops

These crops differ from the field crops because many, but not all, are not irrigated and their acreage can expand into and somewhat resemble California prairie at times. The most important grain species in Yolo County is wheat, which is mostly grown on Sehorn-Balcom and Rincon-Marvin-Tehama soils poorly suited for more productive irrigated farming. Triticale grain is important for nesting by the focal species tricolor blackbird (*Agelaius tricolor*) elsewhere in California but this phenomenon is not reported in Yolo County. Grain and hay crops cover an estimated 65,258 acres, or 10 percent, in the strategy area (Table 2-2, Figure 2-9).

2.6.1.6 Pastures

Pasture is typically irrigated but is most often used to feed cattle rather than to produce a plant crop. It is typically vegetated with a variety of nonnative perennial grasses and forbs and shares ecological features with both prairie and freshwater emergent wetland natural communities but is distinctly different from either. Its productivity attracts much native wildlife but most are common species. According to Table 2-2 it covers 15,188 acres, or less than 0.1 percent, of the RCIS Area. It is most extensive in the southeastern part of the county on Capay-Clear Lake soils (Figures 2-6 and 2-9) since they, as for rice, resist water loss through downward drainage.

Figure 2-9. Distribution of Cultivated Land Seminatural Communities



2.6.2 California Prairie

California has vast natural open areas with entirely herbaceous vegetation that lack trees or shrubs. These were called California prairie until 1959, when an academic mistake caused them to be increasingly called by the misnomer "grasslands." Recent research by Dr. Richard Minnich of UC Riverside has now confirmed that these open areas were historically more often dominated by non-grass forbs than by grasses, something many ecologists had suspected. Even though these native prairies are now heavily invaded by nonnative weedy grasses and forbs, their greatest biodiversity remains in native forbs which are still present. These include numerous spring annuals and bulbs like smooth tidy-tips, butter-and-eggs, and Ithuriel's spear followed by some summer perennials including narrow-leaved mule's ears and harvest brodiaea and then culminating in early fall with hayfield tarplant and virgate tarplant. The most important native grass on slopes was purple needle grass and the most important native grass on the valley floor was beardless wild rye. California prairie in the strategy area and elsewhere is now invaded by a suite of nonnative annual grasses that began with wild oat, ripgut grass, and soft chess, later included rye grass, and now includes aggressive newcomers like medusa head and barbed goat grass. Nonnative forbs, especially yellow star-thistle, can also be significant California prairie invaders.

Most of the extant California prairie in Yolo County is now located in Coast Range foothills and in the Dunnigan Hills, because their sloping topography has impeded development of irrigated agriculture. Several relict areas of California prairie are on the Central Valley floor, such as Glide Ranch west of UC Davis, which clearly indicates California prairie was once its most widespread natural community. California prairie covers an estimated 80,896 acres, or 12.4 percent, of the RCIS Area (Table 2-2, Figure 2-10).

Extant Yolo County prairie in the Hill and Ridge Landscape Unit is mostly on the Tehama formation and the less widespread Red Bluff formation, but small areas also occur on the Great Valley sequence. California prairie in the Valley Landscape Unit was once widespread on the Modesto formation and in small basins west of fresh emergent wetlands in the Colusa and Yolo Basins (Figure 2-5). Soils most currently and historically associated with California prairie in Yolo County include Corning-Hillgate, Sehorn-Balcom, and Rincon-Marvin-Tehama, but some was also present on Dibble-Millsholm and Capay-Clearlake (Figure 2-6). The latter occurred in basins in the central part of the county where historically seasonal floods occurred but were of significantly shorter duration periods than the nearly perennial flooding in the main eastern basins supporting fresh emergent wetlands. The central basins are now entirely converted to cropland, but their historic vegetation was likely a prairie seasonal marsh phase in which species like Baltic rush, tall flatsedge, and common spikerush were important.

California prairie soils are typically high in clay, which holds wet season moisture near the soil surface where it is available to the relatively shallow roots of herbs rather than the often deeper roots of woody plants. It also creates a barrier to downward movement of air and water that these deeper roots need. On more porous soils with less clay, the California prairie natural community tends to shift to blue oak woodland on Dibble-Millsholm soils and to valley oak woodland on Yolo-Brentwood soils.

The California prairie natural community is a component of Yolo County's working landscape, in that much of it is used for rangeland. In Yolo County approximately 15,000 acres, or 3 percent, of total land cover is rangeland. Rangeland is located primarily in the central and eastern portions of the RCIS Area (Figure 2-17). California prairie in Yolo County includes working lands that provide conservation benefits. CFGC 1852 (e)(1) requires that an RCIS consider "the conservation benefits of working lands for agricultural uses." This section of the Yolo RCIS/LCP describes the conservation benefits of California prairie, consistent with CFGC 1852(e)(1).

The dominant current land use of California prairie is commercial grazing by cattle, which provide ecological effects similar to those once provided by now vanished vast herds of tule elk and pronghorn. Grazing can be a critical control on nonnative invasive plants so that, contrary to conventional wisdom, native prairie plants are typically most abundant where grazing is heaviest. Elk herds once produced localized barren zones with greatly reduced prairie vegetation that several species symbiotically used as primary habitat. This barren phase of prairie is particularly important to the focal species, western burrowing owl. Mountain plover, an RCIS/LCP focal species, also occurs in the barren phase of California prairie.

The following RCIS/LCP focal and conservation species occur in, but many are not necessarily restricted to, California prairie.

Figure 2-10. Distribution of California Prairie Natural Community

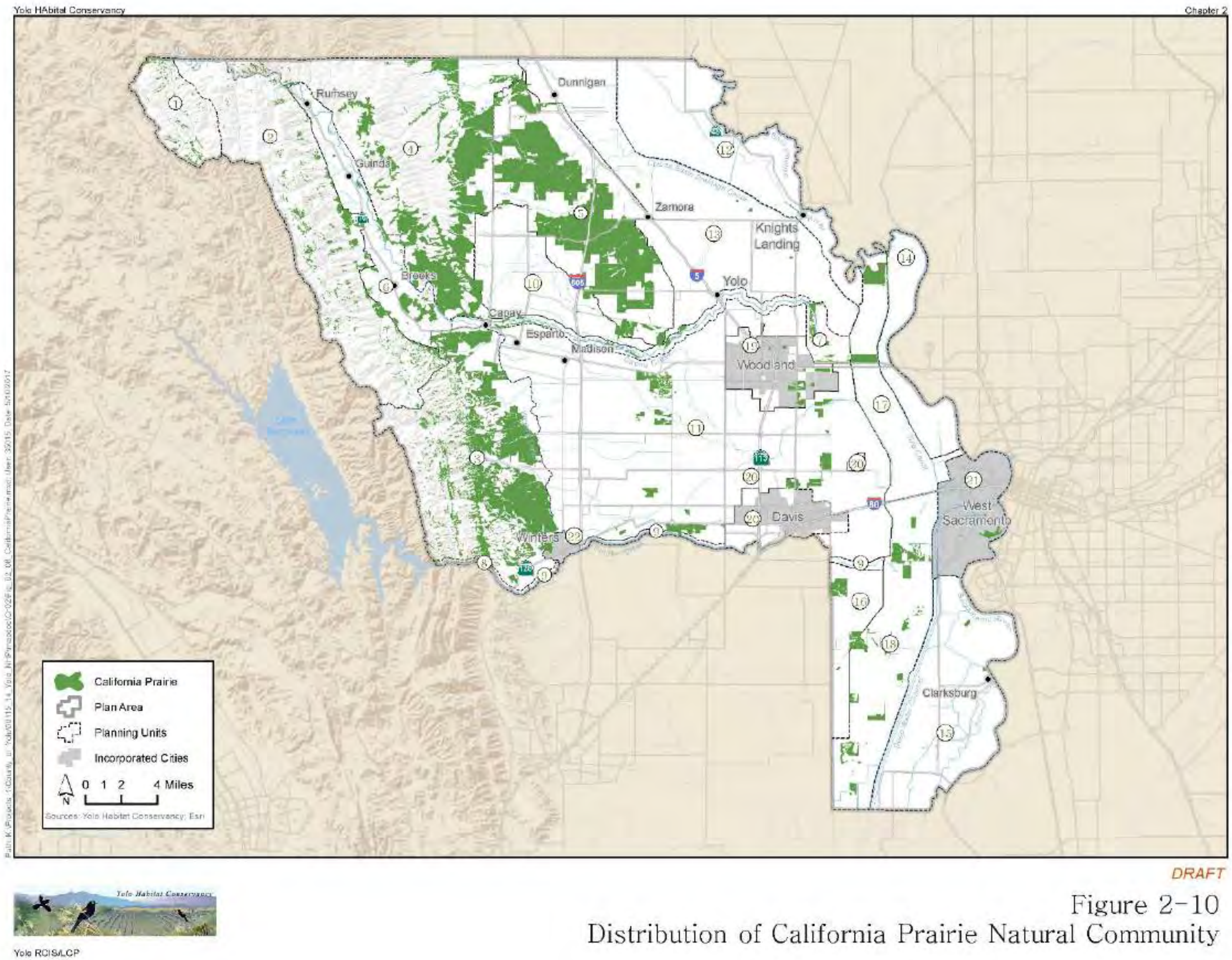


Figure 2-10
Distribution of California Prairie Natural Community

- San Joaquin pocket mouse
- American badger
- Tule elk
- Northern harrier
- Prairie falcon—for foraging
- Western burrowing owl
- Grasshopper sparrow
- Lark sparrow
- Long-billed curlew
- Mountain plover
- Ferruginous hawk
- California tiger salamander—for aestivation
- Western spadefoot
- San Joaquin whipsnake
- Molestan beetle
- Bent-flowered fiddleneck
- Round-leaved filaree
- Adobe-lily
- Hogwallow starfish
- Wooly-headed lessingia
- Cotula navarretia
- Keck's checkerbloom

2.6.3 Serpentine Natural Community

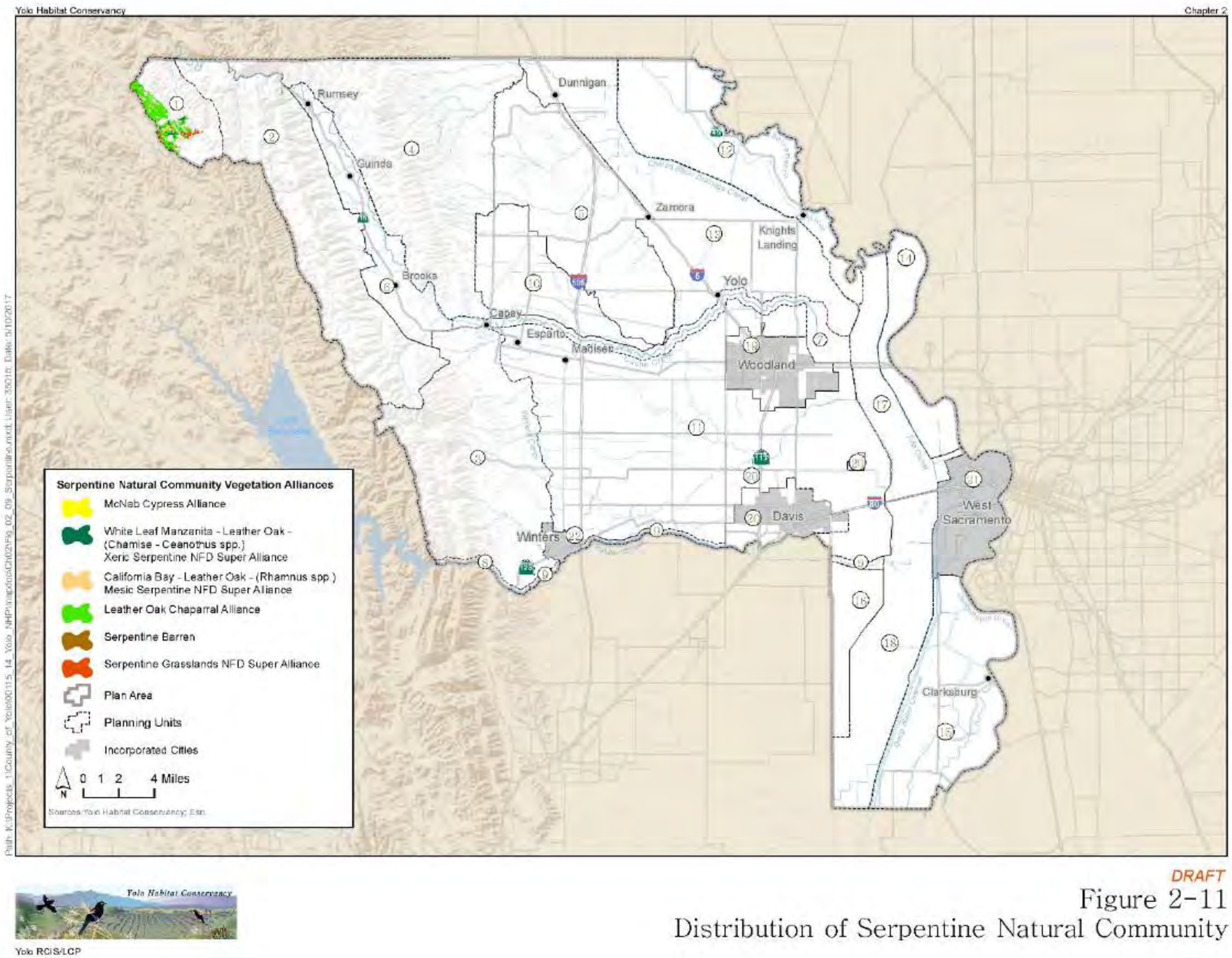
The serpentine natural community refers to a unique natural community occurring where chemically unusual rocks called serpentine were pushed upward from deep in the earth's mantle through its crust to be exposed at its surface. This process is limited to places where violent collisions between land masses occurred in western North America, when land masses called exotic terranes, carried eastward by sea floor spreading, collided with and become welded to the western edge of North America. This caused the continent to expand westward from a former shoreline in what is now western Nevada to the present California coast. This process took hundreds of millions of years and involved several distinct exotic terrane collisions and serpentine uplifts. In Yolo County, serpentine soil and its vegetation occurs in a small area in its northwestern corner identified as ultramafic (Figures 2-5, 2-11).

Serpentine is referred to as ultramafic because it is high in magnesium and several heavy metals, and low in calcium, relative to otherwise ubiquitous crustal rocks. This unique chemistry causes vegetation on serpentine to include many localized species and, unlike surrounding non-serpentine vegetation, to have a dull green color, slow growth, and distinctive structure. In Yolo County, most serpentine vegetation has a chaparral understory of leather oak, a near serpentine endemic, and often a woodland overstory of gray pine, which is also common in the county off serpentine. In the Yolo HCP/NCCP, the serpentine natural community only includes serpentine barren and serpentine grasslands land cover types. In the RCIS/LCP Table 2-1 what is defined as serpentine natural community also includes California Bay - Leather Oak mixed chaparral Alliance, Leather Oak-Chaparral alliance, White Leaf Manzanita - Leather Oak mixed chaparral-Alliance, and McNab Cypress Alliance where serpentine soil is present. An estimated 2,327 acres, or 0.3 percent of this natural community is present in the RCIS Area (Table 2-2).

The following RCIS/LCP focal and conservation species occur in, but are not necessarily restricted to, the serpentine natural community.

- Townsend’s big eared bat
- Purdyi’s onion
- Twig-like snapdragon
- Serpentine milkweed
- Brewer’s milk-vetch
- Cleveland’s milk-vetch
- Jepson’s milk-vetch
- Serpentine collomia
- Snow Mountain buckwheat
- Purdy’s fritillary
- Hall’s Harmonia
- Drymaria-like western flax
- Colusa layia
- Hoover’s lomatium
- Jepson’s navarretia
- Cleveland’s ragwort
- Green jewelflower
- Morrison’s jewelflower

Figure 2-11. Distribution of Serpentine Natural Community



2.6.4 Chaparral

Chaparral refers to all non-riparian shrub dominated vegetation in Yolo County except that on serpentine. Most county chaparral is on the Coast Range's Great Valley sequence of ancient marine sandstone and shale beds (mapped as metamorphic, intrusive, and sedimentary rocks in Figure 2-5 even though its rocks are not metamorphic or intrusive) uplifted and bent vertically to form Blue Ridge, the main Coast Range ridge along the western edge of Yolo County, and the Capay Hills, a smaller disjunct Coast Range satellite separated from the main range by the Capay Valley. Some chaparral also occurs on the much more recent and less uplifted nonmarine sediments of the Tehama formation northeast of the Capay Hills (Figure 2-12). Chaparral is adapted to a fire cycle in which it burns about every ninety years. When fire burns with this approximate frequency a rich suite of plant and animal species adapted to post-fire early succession can flourish.

The following RCIS/LCP focal and conservation species occur in and are mostly restricted to, the chaparral natural community.

- Rufous-crowned sparrow
- Bell's sparrow
- Lawrence's goldfinch
- Black-chinned sparrow
- California thrasher
- Heller's bush-mallow

Additionally, the following RCIS/LCP focal and conservation species occur in association with rock outcrops often within the chaparral natural community but also sometimes in other natural communities.

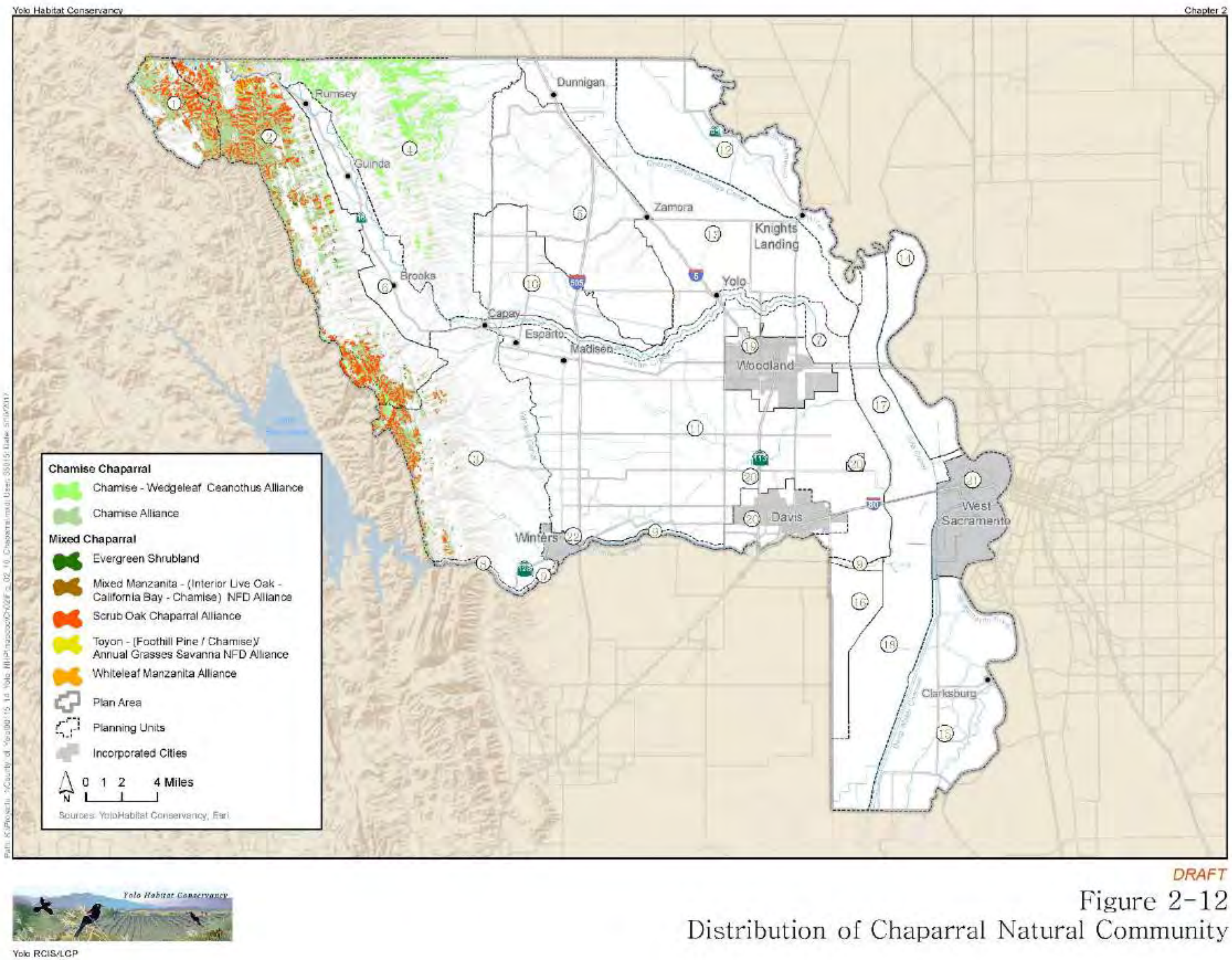
- Pallid bat—historic
- American peregrine falcon—for nesting
- Prairie falcon—for nesting
- Modest rockcress

The strategy area includes two types of chaparral, described below.

2.6.4.1 Chamise Chaparral Natural Community

Chamise chaparral, which occurs in the steepest and most arid habitats and is dominated almost exclusively by a single species, chamise. An estimated 30,137 acres, or 4.8 percent of this natural community is present in the strategy area (Table 2-2).

Figure 2-12. Distribution of Chappral Natural Community



2.6.4.2 Mixed Chaparral Natural Community

Mixed chaparral, which occurs on moister and more shaded slopes with greater soil development and is dominated by a great variety of shrubs including scrub oak, buckbrush, and birch-leaf mountain-mahogany. Both phases of chaparral tend to occur on rocky slopes with little soil development, but soils are typically somewhat more developed on mixed than on chamise chaparral. An estimated 12,425 acres, or 2 percent, of non-serpentine mixed chaparral are present in the strategy area (the Table 2-2).

2.6.5 Woodland and Forest

2.6.5.1 Oak Woodlands

Oak Woodland Types in the Strategy Area

Although Figure 2-13 lumps together on maps currently available to the Yolo RCIS/LCP, two quite distinct and extensive oak-dominated assemblages (other than riparian woodland and forests described in Section 2.8.6) as one unit, *Oak Woodlands*, described below (Figure 2-13). The RCIS/LCP conservation strategy focuses conservation on Valley oak woodland because it is the rarest and most threatened oak dominated natural community, but the RCIS/LCP is also concerned with upland woodlands and forests that provide habitat connectivity and support RCIS/LCP focal and conservation species.

Some oak woodlands in Yolo County are a component of the working landscape, in that some of it is used for rangeland. Rangeland is located primarily in the central and eastern portions of the RCIS Area (Figure 2-17). Some oak woodlands in Yolo County therefore include working lands that provide conservation benefits. CFGC 1852 (e)(1) requires that an RCIS consider "the conservation benefits of working lands for agricultural uses." This section of the Yolo RCIS/LCP describes the conservation benefits of oak woodlands that might also provide rangeland, consistent with CFGC 1852(e)(1).

The California Partners in Flight Oak Woodlands Plan (CalPIF 2002) includes the following summary regarding oak woodlands:

> Oak woodlands have the richest wildlife species abundance of any habitat in California, with over 330 species of birds, mammals, reptiles, and amphibians depending on them at some stage in their life cycle (references omitted). Wilson and others suggest that California oak woodlands rank among the top three habitat types in North America for bird richness. Oak woodlands are able to sustain such abundant wildlife primarily because they produce acorns, a high quality and frequently copious food supply. Oaks also provide important shelter in the form of cavities for nesting.

Figure 2-13. Distribution of Woodland and Forest Natural Communities

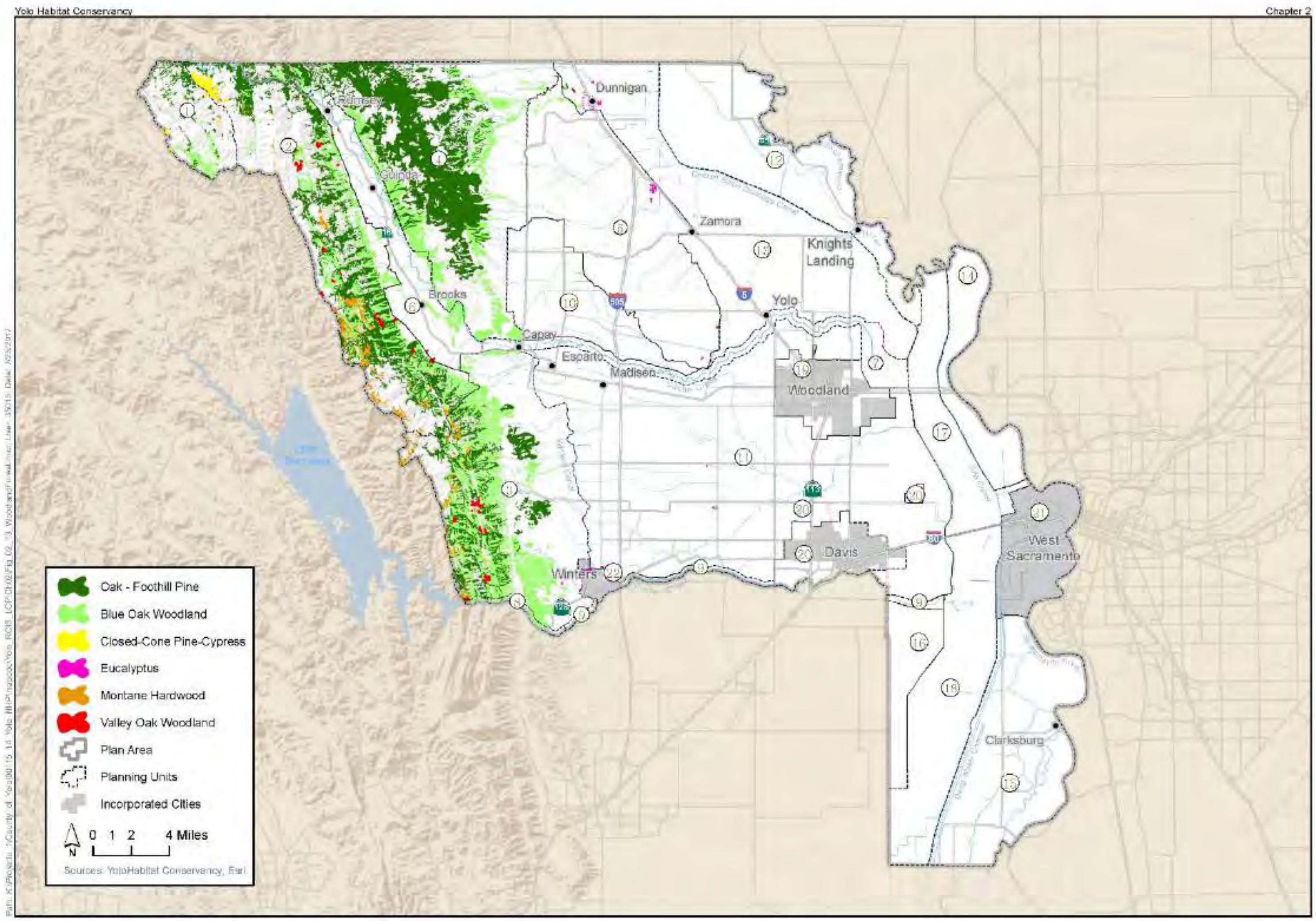


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Figure 2-13

Distribution of Woodland and Forest Natural Communities

Yolo RCIS/LCP

Upland Woodlands and Forests

Oak-Foothill Pine

The oak-foothill pine vegetation type as defined in the Yolo RCIS/LCP and the Yolo HCP/NCCP is dominated by a tall overstory of well-spaced foothill pine, a mid-level canopy of interior live oak, and an understory of tall shrubs including toyon and common manzanita. This vegetation type primarily occurs on the Great Valley sequence but also, to a more limited extent, on the Tehama formation northeast of the Capay Hills and east of Blue Ridge south of Cache Creek (Holstein, pers. comm. 2017). It typically occurs adjacent to mixed chaparral on slopes that tend to be less steep, have more soil development, and are more shaded and moist.

Blue Oak Woodland

In Yolo County, blue oak woodland consists of a variably spaced overstory of blue oak with a largely herbaceous understory of moderately shade-tolerant grasses and forbs. Native species like the grasses blue wild-rye and California melic and the forb Ithuriel's spear are common in the understory , but it is also frequently dominated by non-native species like the grasses wild oat and ripgut grass and the forb yellow star-thistle. Large shrubs of common manzanita are sometimes occasional but never dominant. Blue oak woodland is widespread on the Great Valley sequence but also significant on the Tehama formation east of the Capay Hills Blue Ridge (Figure 2-8). It occurs on sites with much greater soil development often considerably less relief than interior live oak—gray pine woodland. Sometimes blue oak woodland is separated into "woodland" and "savanna" types, which differ largely in terms of percent canopy closure. Generally, these woodlands have an overstory of scattered trees, although the canopy can be nearly closed on some sites (Pillsbury and De Lasaux 1983). Some other occasionally associated shrub species are poison oak, California coffeeberry, and buckbrush.

Montane Hardwood

The montane hardwood natural community typically consists of a dominant hardwood tree component with a shrub understory and little herbaceous vegetation. Tree spacing ranges from 10 to more than 30 feet apart. The Yolo HCP/NCCP mapped some areas as montane hardwood natural community that might be better characterized as interior live oak-foothill pine. These woodlands are found on a wide range of slopes and particularly on moderate to steep slopes. Soil depth may be shallow or deep.

Valley Oak Woodland

The valley oak woodland natural community consists of tree stands that are dominated by valley oak. The valley foothill riparian natural community, described in Section 2.8.6.1, Riparian Natural Community, can be locally dominated by valley oak but encompasses streamside communities that have a higher abundance of typical riparian species, such as cottonwoods, ash, and willows. The valley oak woodland natural community occurs primarily on valley floors on sites with deep, well-drained alluvial soils with ground water accessible to roots of the oaks, Evidence clearly indicates that woodland dominated exclusively by valley oaks was once widespread on parts of Yolo County's valley floors distant from streams in places where shallow groundwater and porous soils were present Since such conditions also indicate highly productive farmland, agriculture has now replaced almost all valley oak woodland in Yolo County. All that is left are a few scattered dense groves and, more commonly, small groves of scattered trees or isolated individual trees around farmsteads, agricultural work areas, roadsides, and agricultural fields. It is clear from some of these small surviving patches that beneath a variably open canopy of valley oaks a shrub stratum dominated by blue elderberry and an herbaceous understory dominated by the grass beardless wild-rye with associated forbs like soap plant characterized this natural community, but most of the few remaining stands of valley oak woodland in the strategy area lack this diverse understory that was present under historical conditions. Existing valley oak woodland stands outside the strategy area, in and around the Cosumnes Reserve in Sacramento County, provide an example of historical conditions in the strategy area. Yolo County's valley oak woodland was likely associated with Yolo – Brentwood and Sacramento soils (Figure 2-4) and recent alluvial and some Modesto formation substrates (Figure 2-3) but how completely it covered them is uncertain. It was likely once an important Yolo County natural community that provided primary habitat for Swainson's hawk and valley elderberry longhorned beetle (Holstein 2001, 2003).

While valley oak occurs in mixed-oak habitats in western Yolo County primarily in riparian contexts (Section 2.8.6 below), early maps and relict vegetation clearly indicate, however, that it was formerly much more abundant in woodlands that it dominated that were once widespread in the county's lowlands where abundant groundwater and porous soil were present; valley oak forest or woodland was formerly a more common habitat type in the county for many RCIS/LCP focal and conservation species. In addition, genetic evidence (e.g., Grivet et al. 2008; Gugger et al. 2013) suggests that the prior occurrence of valley oak forests in eastern Yolo County was part of a biogeographically and evolutionarily significant linkage between valley oak populations in the Coast Range and the Sierra Nevada foothills to the east. This indicates an increased conservation value in maintaining the viability of valley oak populations throughout the lowlands in Yolo County, particularly with respect to climate change adaptation (Sork et al. 2010).

The widespread historic distribution of valley oak woodland in the strategy area has important conservation implications for the Yolo RCIS/LCP conservation strategy. For example, valley foothill riparian natural community in the strategy area frequently consists of typical riparian vegetation dominated by Fremont cottonwoods and willows immediately adjacent to streams, with valley oaks more distant from the streams. These valley oaks of the valley foothill riparian natural community are essentially the same as those of the valley oak woodland natural community except for being more closely associated with a stream. Since these riparian valley oaks are associated with elderberries supporting the valley elderberry longhorn beetle, as are relict stands of non-riparian valley oaks both in Yolo County and at the Cosumnes Preserve, it is reasonable to assume that this beetle was more widespread and common in Yolo County when valley oak woodland was more widespread there (Holstein pers. comm. 2017). The same is likely also true of Swainson's hawk and white-tailed kite, associated with valley foothill riparian natural community in the strategy area. It is likely not coincidental that Swainson's hawks west of the Sierra Nevada are particularly associated with valley oaks on the Central Valley floor including non-riparian valley oaks (Griffin and Critchfield 1972). In fact, the primary nesting and foraging area for Swainson's hawk is the large non-riparian area of the Yolo-Brentwood soil association that forms a connecting corridor between the three valley foothill riparian natural community areas along Cache and Putah creeks and the Sacramento River, a connecting corridor that may once have been extensively vegetated with valley oak woodland.

According to the YCP only 181 acres of valley oak woodland survive in Yolo County, but while there is no doubt much of the county's valley oak woodland is lost, this small amount mapped in Figure 2-

8 may somewhat undercount what remains of this natural community since some may be included in valley foothill riparian. Despite immense losses of this natural community, it is among the easiest to restore along with its great habitat values where suitable soil is present.

Ecological Functions and Ecosystem Services

Oak woodlands, as defined in the RCIS/LCP, includes a variety of oak-dominated plant alliances corresponding to oak-dominated wildlife habitat types recognized by the California Wildlife Habitat Relationships Program (CWHR). These vegetation alliances are listed in Table 2-2. The oak woodland super alliance is shown on Figure 2-13. Oaks missing from this mapping include scattered oaks in the eastern portion of the strategy area and oaks along the margins of riparian (see Figure 2-14).

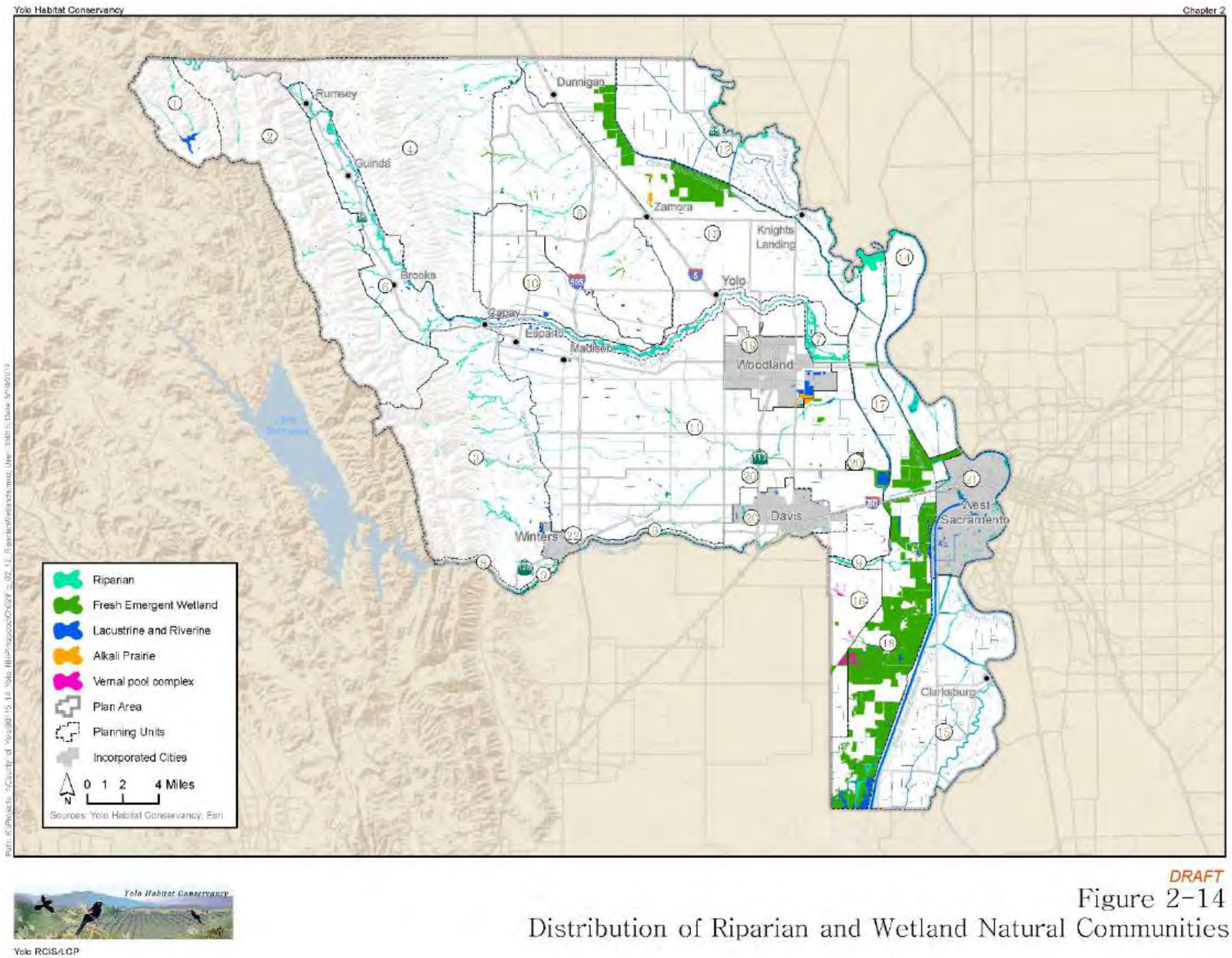
The State Wildlife Action Plan (SWAP) identifies the primary conservation planning target for the Northern California Interior Coast Ranges Ecoregion in western Yolo County as "California Foothill and Valley Forests and Woodlands" (SWAP Section 5.1 and especially Table 5.1-1). This SWAP conservation target specifically identifies the following CWHR habitat types that occur in the ecoregion: "Blue Oak Woodland; Blue Oak–Foothill Pine; Montane Hardwood; Valley Foothill Riparian; Valley Oak Woodland." All of these CWHR habitat types are included in the Yolo RCIS/LCP (Table 2-3).

The importance of oak woodland habitats for California's wildlife is well documented in the CWHR, and is well understood by wildlife ecologists. As stated in the California Oak Woodland Bird Conservation Plan (California Partners in Flight [CalPIF] 2002:8): "Oak woodlands have the richest wildlife species abundance of any habitat in California, with over 330 species of birds, mammals, reptiles, and amphibians depending on them at some stage in their life cycle. Wilson and others suggest that California oak woodlands rank among the top three habitat types in North America for bird richness."

As indicated by the CWHR, many wildlife species addressed by the RCIS/LCP are properly characterized as associated with oak-dominated woodland and forest habitats in uplands of the western part of the county; few of these species are tightly linked to one or another of the oak-dominated habitats. A completely different suite of species with little overlap, however, is linked to valley oak forests and woodlands in the county's lowlands. Many wildlife species respond to a range of ecological parameters and can occur in multiple habitats. Others, however, are much more narrowly linked to specific habitats. Further, wildlife species do not necessarily occur in discrete "communities." Many respond to a variety of habitat elements that can occur in several habitat types, so that: (1) some species typically occur in multiple and quite different habitat types; and (2) there is often overlap in habitat use among wildlife species so that they can occur in several similar habitats. However, many wildlife species require specific habitat elements (e.g., rock outcrops or springs) and may not occur in apparently otherwise suitable habitats if these elements are not present.

SWAP Appendix C (Table C-11) identifies "Species of Greatest Conservation Need" for the *California Foothill and Valley Forests and Woodlands* macrogroup. Most or all of the identified species are included in the RCIS/LCP either as focal or conservation species. The following RCIS/LCP focal or conservation species occur in oak-dominated habitat types but sort out into specific upland oak woodland and valley oak woodland groups. Gathering of location-specific information to determine conservation priorities for these species will be a component of the conservation strategy.

Figure 2-14. Distribution of Riparian and Wetland Natural Communities



DRAFT

Figure 2-14

Distribution of Riparian and Wetland Natural Communities

The following RCIS/LCP focal and conservation species occur in and are mostly restricted to, the upland oak woodland natural community.

- Deep-scarred cryptantha
- Nodding harmonia
- Jepson's leptosiphon
- Sylvan microseris
- Golden eagle
- Band-tailed pigeon
- Purple martin
- Oak titmouse
- Lewis' woodpecker
- Cooper's hawk
- Mule deer (planning species)
- Long-eared myotis
- Fringed myotis
- Long-legged myotis
- Yuma myotis
- Black bear
- Mountain lion (planning species)

Valley oak woodland species

- Swainson's hawk
- White-tailed kite
- Loggerhead shrike
- Yellow-billed magpie
- Valley elderberry longhorn beetle
- Ancient ant

2.6.5.2 Other Woodland and Forest Types

Closed-Cone Pine-Cypress Natural Community

The closed-cone pine-cypress natural community is composed of the knobcone pine alliance and MacNab cypress alliance vegetation types. Closed-cone pine-cypress is scarce in the western mountains of the strategy area but is more common in adjacent Napa County. This natural community is commonly found on serpentine soils; in Yolo County, it often includes leather oak and foothill pine.

There are localized patches of knobcone pine alliance vegetation on the north-facing slope of the Blue Ridge and at the northern boundary of Yolo County immediately above Cache Creek. Little is known about this stand. The University of California McLaughlin Reserve at Little Blue Ridge, at the intersection of Yolo, Napa, and Lake Counties, on both sides of Rayhouse Road, supports the MacNab cypress alliance vegetation. This vegetation is almost entirely confined to serpentine soils. It shares many species with the serpentine grassland natural community (Holstein 2013).

Both vegetation types contain relatively small trees that require periodic fires to stimulate the recruitment of new trees. Fire clears the overstory and causes cones to open and release their seeds, resulting in a pulse of seedling recruitment. Stands mature rapidly and typically last between 35 and 100 years, depending on local fire-return intervals (Barbour 2007). MacNab cypress trees may occur in stands of mixed serpentine chaparral or may form nearly pure stands.

The closed-cone pine-cypress natural community in the strategy generally supports the same wildlife species described for oak woodlands, above.

2.6.6 Riparian, Wetland, and Rivers and Streams

2.6.6.1 Riparian Natural Community

Riparian areas are ecological transitions between aquatic areas and terrestrial areas (National Research Council 2002, DWR 2012 *[= the CVFPP; Attachment 4 (Glossary) repeats the NRC definition]*). Riparian areas in Yolo County include the aquatic/terrestrial ecotones associated with rivers, streams, lakes, ponds, and wetlands that have prolonged aquatic stages (such as estuarine wetlands in the northern Delta). Because riparian areas affect ecological process for all aquatic areas, features such as altered streamcourses that provide drainage functions, constructed wetlands that connect to surface watercourses, and other seminatural aquatic features incorporate riparian areas. However, some conservation planning efforts for the Central Valley limit the application of "riparian" to the terrestrial portion of riparian ecotones (e.g., DWR 2016 *[= the CVFPP Conservation Strategy]*).

The riparian natural community mapped in the RCIS/LCP (Figure 2-14) is based on existing information about the distribution of woody vegetation associated with streamcourses and rivers in Yolo County; that is, while riparian areas exist for all aquatic/terrestrial transitions, the application of "riparian" is often limited to areas dominated by woody vegetation. This approach reflects the association between woody riparian vegetation and the high habitat values provided by riparian areas for wildlife. This natural community, defined by dominance of woody vegetation, covers 12,442 acres, or 19 percent, of the RCIS/LCP strategy area (Table 2-2). This map likely underestimates riparian areas because narrow or discontinuous stands of riparian woodland or shrubs are often omitted from regional maps.

Mapped riparian vegetation types are highly diverse, reflecting the diversity of riparian conditions in the county (Tables 2-2 and 2-3; note that the range of variability in species composition in the county's riparian areas is not fully reflected by the table entries). Different riparian vegetation types identified in Tables 2-2 and 2-3 represent differing relative abundances of dominant tree species. When best developed it consists of gallery forests dominated by Fremont cottonwood, valley oak , Oregon ash, box elder, red willow, black willow, and arroyo willow. A dense understory of shrubs like California wild rose is also typically present and the trees are often festooned with wild grape lianas. Since these gallery forests can utilize summer streamflow, their primary productivity (as well as that of fresh emergent wetlands) is much higher than that of more widespread upland vegetation and they resultingly provide habitat services to many wildlife species disproportionate to their relatively small area,

Many streams have such low seasonal or intermittent flow, however, that their riparian vegetation is much less developed and their productivity and wildlife values significantly lower than those of the gallery forests. Vegetation of such streams is typically a riparian scrub dominated by sandbar willow, a shrubby species also frequent on early successional sandbars adjacent to gallery forests.

A most distinctive riparian chaparral community occurs along Cache Creek between the town of Capay and the Dunnagin Hills. There coarse gravels depress groundwater sufficiently that it is largely unavailable to more typical riparian species. Instead this losing reach of Cache Creek is sparsely but nearly exclusively dominated by shrubs and perennials more typical of Coast Range uplands more typical of Coast Range uplands including California yerba santa and rayless golden aster.

Riparian natural communities are characterized by highly porous soils in zones usually too narrowly linear for mapping at the plan level except for Sycamore-Tyndall soils along the Sacramento River (Figure 2-4). These communities are mapped in Figure 2-9 and according to Table 2-1 cover 13,814 acres in Yolo County. Unfortunately this subdivides them in a complex way not readily transferable to the simple separation into three phases utilized here. Significant non-native invasive riparian species include smallflower tamarisk, Himalayan blackberry, and giant reed.

These differences, in part, are geographically related to ecoregional factors, including substrate conditions and hydrology. Riparian areas occur along streamcourses throughout Yolo County, but hydrological conditions in the western part of the county typically support less-developed riparian vegetation than in the eastern part, and species compositions in these regions typically differ. While some species (e.g., valley oak and red willow) occur in many riparian areas throughout the county, other species are often more locally restricted. Riparian habitat associated with western streamcourses in the Coast Range may be dominated by blue oak, interior live oak, and gray pine (such montane riparian areas are less distinct from adjacent upland habitats than those in eastern lowlands but may have a more complex structure); their shrub stratum may be dominated locally by California buckeye, common manzanita, toyon, and western redbud. Riparian areas in the eastern part of the county may be dominated by a diverse mixture of tree species as discussed above and have, a dense shrub understory as well as wild grape lianas

Riparian habitat is well developed along portions of the courses of the Sacramento River, Cache Creek, Putah Creek, Cottonwood Creek/Willow Slough, Dry Slough, Buckeye Creek, Salt Creek/Chickahominy Slough, Union School Slough, Enos Creek, the Colusa Basin Drain, and Sacramento River Delta sloughs including Babel Slough, Winchester Lake, and Elk Slough. Many other streams, sloughs, and canals also support riparian vegetation, although frequently it is less well-developed structurally than along larger streams. Habitat continuity provided by riparian elements in a landscape may substantially increase ecological permeability in the entire landscape, creating a “Riparian Connectivity Network” (Fremier et al. 2015); that is, the network of riparian areas along watercourses in Yolo County (Section 2.11) potentially constitutes a primary ecological connectivity element in Yolo County’s landscape (see Section 2.9 of this RCIS/LCP).

The conservation significance of the linkage functions currently provided by Cache Creek and Putah Creek is recognized in the California Essential Habitat Connectivity Project report (Spencer et al.

2010). The ecological linkage values of the Sacramento River, Cache Creek, and Putah Creek riparian corridors for the covered species in the Draft Yolo HCP/NCCP are identified in Chapter 6 of the HCP/NCCP; similar linkage functions are provided for the focal and conservation species in this RCIS/LCP by other riparian areas in Yolo County. Riparian areas associated with surface watercourses also sustain other ecological services, including maintaining pollinator diversity and pollination services (Greenleaf and Kremen 2006, Morandin and Kremen 2013) and hosting natural predators and parasitoids beneficial for the seminatural agricultural landscape in the county (Kelly et al. 2016, Kross et al. 2016).

Riparian areas provide some of the highest wildlife habitat values in the RCIS/LCP strategy area. As summarized in the Riparian Bird Conservation Plan (Riparian Habitat Joint Venture 2003):

> More than 225 species of birds, mammals, reptiles, and amphibians depend on California's riparian habitats. Riparian ecosystems harbor the most diverse bird communities in the arid and semiarid portions of the western United States. Riparian vegetation is critical to the quality of in-stream habitat and aids significantly in maintaining aquatic life by providing shade, food, and nutrients that form the basis of the food chain. Riparian vegetation also supplies in-stream habitat when downed trees and willow mats scour pools and form logjams important for fish, amphibians, and aquatic insects." Numerous studies have documented relationships between bird species richness and habitat structural complexity in riparian areas; in the Central Valley, this relationship has been demonstrated for differing avian species groups in both the breeding season and the winter. Riparian areas increase bat abundance and activity patterns in agricultural landscapes, particularly for tree-dwelling species like western red bat.

As indicated by the CWHR, many wildlife species addressed by the RCIS/LCP are associated with riparian habitats. The SWAP identifies a primary conservation planning target for the **Great Valley Ecoregion** as "*American Southwest Riparian Forest and Woodland*" (SWAP section 5.4; Table 5.4-1). This SWAP conservation target identifies a single corresponding CWHR habitat type that occurs in this ecoregion: "*Valley Foothill Riparian.*" SWAP Appendix C, Table C-18, identifies "Species of Greatest Conservation Need" for the *Warm Southwest Riparian Forest* macrogroup. Most of the identified species that occur in the Yolo County region are included in the RCIS/LCP as focal species for the RCIS and/or as conservation species for the LCP.

The following RCIS/LCP focal or conservation species occur in riparian habitats in Yolo County, although many species also utilize other habitat types.

- Northern California (Hind's) black walnut
- Valley elderberry longhorn beetle
- Western pond turtle
- Gopher snake
- Western yellow-billed cuckoo
- Bald eagle
- Swainson's hawk
- Yellow-breasted chat
- Modesto song sparrow

- Bank swallow
- Least Bell's vireo
- Yellow warbler
- Pacific slope flycatcher
- Long-eared owl
- Merlin
- Osprey
- Lesser nighthawk (riparian chaparral phase)
- Western red bat
- Ringtail
- Sacramento Valley red fox
- Mink
- River otter

Riparian Habitat Joint Venture Plan (RHJV 2004) provides the following summary regarding the importance of riparian.

> The National Research Council (2002) concluded that riparian areas perform a disproportionate number of biological and physical functions on a unit area basis and that the restoration of riparian function along America's waterbodies should be a national goal.
>
> Riparian vegetation in California makes up less than 0.5 percent of the total land area, an estimated 145,000 hectares. Yet, studies of riparian habitats indicate that they are important to ecosystem integrity and function across landscapes. Consequently, they may also be the most important habitat for landbird species in California (reference omitted). Despite its importance, riparian habitat has been decimated over the past 150 years. Today, depending on bioregion, riparian habitat covers 2 percent to 15 percent of its historic range in California.
>
> "Due to their biological wealth and severe degradation, riparian areas are the most critical habitat for conservation of Neotropical migrants and resident birds in the West (references omitted). California's riparian habitat provides important breeding and over-wintering grounds, migration stopover areas, and corridors for dispersal (references omitted). The loss of riparian habitats may be the most important cause of population decline among landbird species in western North America.

2.6.6.2 Alkali Prairie Natural Community

Alkali prairie resembles typical California prairie in its domination by herbs, but their species composition is entirely different because of high salt concentration in Willows-Pescadero soils that support this natural community. Salts accumulate and create such soils where drainage across the coalesced alluvial fans of Putah and Cache creeks is sufficiently impeded to cause their precipitation out of solution. The impediment to fan drainage creating Yolo County's extant alkali prairie was the former Yolo Basin freshwater marsh, where much fan drainage ended at its upper rim. In the county Willows-Pescadero soils also occur west of the Dunnigan Hills and their Plainfield Ridge southern extension where these uplifts presumably also impeded fan drainage, but any alkali prairie that may have once been present there has long since been converted to cropland.

Alkali prairie vegetation is most frequently dominated by spikeplant but many other salt tolerant species including salt grass, alkali heath, and San Joaquin spearscale are also prominent. This natural community is the only habitat of the focal species palmate-bracted birds-beak. An estimated 309 acres, or less than 0.1 percent, of alkali prairie are present in Yolo County (Table 2-2, Figure 2-14).

The following RCIS/LCP focal or conservation species occur in, but are not necessarily restricted to, the alkali prairie natural community.

- Western snowy plover—historic
- Ferris' milk-vetch
- Alkali milk-vetch
- Heartscale
- Brittlescale
- San Joaquin spearscale
- Parry's rough tarplant
- Palmate-bracted bird's beak
- Heckard's peppergrass
- Saline clover
- Sticky sand-spurrey

2.6.6.3 Vernal Pool Complex Natural Community

The vernal pool complex natural community consists of complexes of seasonal pools within a grassland matrix. In the strategy area, these seasonal pools form in shallow depressions that hold water due to the slow infiltration rate of the underlying clay alluvium soil. The vernal pools on the clay alluvium soils of the floodplains contain a mixture of two general types in basins between seasonal drainages: smaller vernal pools connected by swales and larger playa-type vernal pools (Bryan 1923; Thomasson et al. 1960; Olmsted and Davis 1961). Both types of clay alluvium vernal pools are located at elevations slightly above the local drainages and filled primarily by rainfall. The vernal pool complex natural community accounts for 299 acres, or less than 1 percent, of the strategy area.

Historically, the vernal pool complex natural community in the strategy area occurred in the flood plains of Cache and Putah Creeks and Willow Slough (Gerlach 2009, 2011). Clay alluvium vernal pools historically occurred in a very limited area; much of that area has since been developed or is intensively farmed.

As a result of their close physical association, intergrading formations and geomorphology, and similar native vegetation, it is often difficult to distinguish between vernal pool complex natural community and alkali prairie natural community. Remnant patches of a vernal pool complex natural community occur at Woodland Regional Park, Grasslands Regional Park, and the Tule Ranch Unit of the CDFW Yolo Bypass Wildlife Area.

The following RCIS/LCP focal or conservation species occur in, but are not necessarily restricted to, the vernal pool complex natural community.

- Conservancy fairy shrimp
- Vernal pool fairy shrimp
- Midvalley fairy shrimp
- Vernal pool tadpole shrimp
- California linderiella
- Vernal pool smallscale
- Ferris' goldfields
- Coulter's goldfields
- Little mousetail
- Baker's navarretia
- Colusa grass
- Delta wooly-marbles
- Solano grass

2.6.6.4 Fresh Emergent Wetland Natural Community

Natural communities in what is now Yolo County appear to have included extensive areas of emergent wetlands, defined as areas with hydrological and substrate conditions that require specialized adaptations by plant species rooted in these wetlands for living in their biochemically altered conditions. Fresh emergent wetlands were once widespread in the Yolo and Colusa basins, and despite their extensive drainage and conversion to cropland some is still extant there. These basins include the lowest elevations in Yolo County and historically were nearly perennially, shallowly flooded by flows from the Sacramento River and other streams then uncontrolled by dams and unconstrained by artificial levees. They were separated from the river by natural levees covered by valley oak woodland however. Such wetlands on Capay-Clear Lake soils and likely dominated most of the southeastern part of the county in 1850 (Whipple et al. 2012). Current interpretations of historical conditions indicate that most of these emergent wetlands were tidally influenced, although it is likely that the tidal influence did not involve increased salinity for most of the county's current area. The majority of the pre-settlement natural community types in southeastern Yolo

County (and likely a substantial fraction of the natural communities in eastern Yolo County as far north as the Colusa County line) were fresh emergent wetlands. The ecological composition of these historical wetlands is uncertain, although historical accounts of the Delta region (as summarized in Whipple et al. 2012) suggest that tule/hardstem bulrush and California/southern bulrush were dominant in large areas of emergent wetland in the northern Delta. The Delta wetland ecosystem, however, provided a wide variety of ecological conditions to which species could adapt, and fresh emergent wetlands in Yolo County may have included many additional plant species.

Since the mid-19th century most of the former wetlands have been converted to agricultural and urban uses. Currently approximately 26,299 acres, or 4 percent, of the RCIS/LCP strategy area are mapped as freshwater emergent wetland (Table 2-2; Figure 2-14). Most of the currently mapped occurrences are associated with management for marsh-like wetland conditions during at least part of the year, particularly in winter (such as for hunt clubs). Because the areas of neither historical nor current emergent wetlands are accurately known, the percentage reduction in emergent wetland area for Yolo County is uncertain, but may be close to the estimates of greater than 90 percent that have been made for wetlands in the Central Valley as a whole. However, it's likely that most existing emergent wetlands do not much resemble the habitat conditions provided in pre-settlement emergent wetlands.

Fresh emergent wetlands in the Central Valley currently are a conservation priority because of their importance as habitat for wintering bird species, particularly waterfowl and shorebirds. Current collaborative management approaches involving public agencies, nonprofit organizations, and landowners have resulted in land management approaches (e.g., flooding rice croplands) that increase wetland areas in the Central Valley in winter. The Central Valley has been identified as supporting about 60 percent of the waterfowl (exclusive of sea ducks) wintering in the Pacific Flyway, and as one of the most important regions for shorebirds in western North America, holding more birds in winter and spring than any other inland area (Shuford 2014). The 2006 Implementation Plan of the Central Valley Joint Venture (CVJV) identified existing wetland acreages, and target acreages for wetland acquisition, restoration, and enhancement, in Central Valley counties, including Yolo County. More recently wetland needs (acreages and habitat types) have also been articulated for other waterbird species (e.g., pelicans, egrets, cranes and rails, and gulls) in the Central Valley as part of national bird conservation planning efforts (Shuford 2014).

Most of the factors that support emergent wetland restoration and enhancement are present in eastern/southeastern Yolo County, and addressing restoration or enhancement of freshwater emergent wetlands in the RCIS/LCP strategy area will be consistent with strategies identified in this plan. However, historical fresh emergent wetlands were also present in other parts of the county (for example, in the west-county region south of Cottonwood Creek/Willow Slough), and restoration and enhancement opportunities for emergent wetlands also exist throughout the county where adequate water is available. Smaller emergent wetlands that are dispersed throughout the county could increase Yolo County populations of several RCIS/LCP focal and/or conservation waterbird species (e.g., black rail and tricolored blackbird).

The SWAP identifies a primary conservation planning target for the **Great Valley Ecoregion** as "*Freshwater Marsh*" (SWAP section 5.4; Table 5.4-1). This SWAP conservation target identifies a single corresponding CWHR habitat type that occurs in this ecoregion: "*Fresh Emergent Wetland*." SWAP Appendix C, Table C-18, identifies "Species of Greatest Conservation Need" for the *Western North American Freshwater Marsh* macrogroup. Most of the identified species that occur in the Yolo

County region are included in the RCIS/LCP as focal species for the RCIS and/or as conservation species for the LCP.

The following RCIS/LCP focal and/or conservation species are among those typically occurring in fresh emergent wetland habitats.

- Lagoon sedge
- Rose mallow
- Delta tule pea
- Mason's lilaeopsis
- Suisun Marsh aster
- Giant garter snake
- Blue-winged teal
- Redhead
- Black tern
- Least bittern
- California black rail
- Short-eared owl
- American peregrine falcon
- Bryant's savannah sparrow
- Modesto song sparrow
- Tricolored blackbird
- Yellow-headed blackbird
- Double-crested cormorant
- American bittern
- Snowy egret
- White-faced ibis

2.6.6.5 Lacustrine and Riverine Natural Community

This natural community consists of all relatively permanent open water in Yolo County including those created by human activity. Open water usually has very sparse vegetation that is limited to exclusively aquatic plants like species of *Potamogeton,* and it can occur on any soil. Stock ponds, although miniscule and humanly created examples of this community, are important as extremely critical habitat elements for breeding by species such as California tiger salamander. Lacustrine and riverine areas are mapped in Figure 2-14 and cover an estimated 13,203 acres, or 2 percent, of the RCIS strategy area (Table 2-2).

The CVFPP Conservation Strategy classifies the following seven types of landscape units in the Sacramento Valley, including Yolo County, associated with the lacustrine and riverine natural community.

- **Major River Reach.** Approximately 2-mile-wide corridors of land (i.e., corridors extending 1 mile to each side of the river's centerline) along the major rivers (Sacramento River in the strategy area) and the lowermost reaches of major tributaries.
- **Basin/Bypass.** Land in a flood basin or bypass, plus an adjacent 0.5-mile-wide buffer outside the bordering levees.
- **Other Facility/Waterway.** One-mile-wide corridors of land (i.e., corridors extending 0.5 mile to each side of the facility's centerline) along State Plan of Flood Control levees (and Urban Levee Evaluation nonproject levees) that are not part of any of the preceding types of landscape units.
- **Other Valley Conservation Planning Areas.** The remainder of the Sacramento and San Joaquin Valleys that is not part of a bypass, basin, or otherwise classified corridor.

The CVFPP Conservation Strategy classifies the following habitat types associated with the lacustrine and riverine natural community as targets for conservation (DWR 2016, p. 4-4).

- **Shaded Riverine Aquatic Cover.** Shaded riverine aquatic cover is defined. The unique near-shore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat (USFWS 1992). This aquatic area includes the following key attributes.
    - The adjacent bank is composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water.
    - The water contains variable amounts of woody debris, such as leaves, logs, branches and roots, often substantial detritus, and variable velocities, depths, and flows.

  The following attributes of shaded riverine aquatic cover make it an important component of fish and wildlife species habitat (USFWS 1992), with each attribute providing different habitat elements.

    - Overhanging riparian vegetation and (sometimes) riverbanks provide several types of habitat values to fish and wildlife species.
    - Shade moderates water temperatures, which is particularly important to salmonids.
        - Shade and cover also reduce visibility to predators.
        - Input of plant material provides instream cover for fish.
        - The terrestrial and aquatic invertebrates associated with vegetation and plant material provide food to birds and aquatic species.
        - Plant stems and branches serve as perches, and as nesting and resting areas, for birds.
    - Natural, eroding banks often have cavities, depressions, and vertical faces that support bank-dwelling species, such as bank swallow, northern rough-winged swallow, belted kingfisher, mink, beaver, and river otter, and that provide cover and shelter for fish. Bank-dwelling species may use these banks and their cavities to access the water or for nesting. Erosion of natural bank substrates provides instream spawning substrate for aquatic species, including salmonids.

- Instream cover, including overhanging or fallen trees or branches, aquatic vegetation, diverse substrate sizes, and irregular banks, provides habitat complexity to fish and wildlife, and supports a high diversity and abundance of invertebrate and fish species.

- **Riparian Habitats.** As used in the CVFPP Conservation Strategy (DWR 2016) and this RCIS/LCP, riparian habitats refers to the forest, woodland, and scrub vegetation characteristic of riparian areas in the Sacramento and San Joaquin Valleys. They typically occur in association with the lacustrine and riverine natural community, but are categorized for the RCIS/LCP as riparian natural community and described in Section 2.8.6.1, *Riparian Natural Community.*
- **Marshes and Other Wetlands.** Although marshes and other wetlands typically occur in association with the lacustrine and riverine natural community, they are categorized for the RCIS/LCP as fresh emergent wetland natural community and described in Section 2.8.6.4, *Fresh Emergent Wetland Natural Community.*

The following RCIS/LCP focal or conservation species occur in, but are not necessarily restricted to, the lacustrine and riverine natural community.

- White sturgeon
- Green sturgeon
- Delta smelt
- Central Valley steelhead
- Sacramento River winter-run Chinook salmon
- Central Valley spring-run Chinook salmon
- Central Valley fall- and late fall-run Chinook salmon
- Coho salmon
- Sacramento splittail
- Pacific lamprey
- River lamprey
- Longfin smelt
- California Roach
- Hardhead
- Sacramento perch
- Western pond turtle
- California tiger salamander (occur in stock ponds for breeding)
- Foothill yellow-legged frog

2.7 Other Land Cover Types

The land cover types described below are not classified as natural communities under this RCIS/LCP because they have little or no habitat value for the focal and conservation species.

2.7.1 Other Agricultural Land

The following agricultural land cover types do not provide habitat for most native species, and are not included in the cultivated lands natural community for the purpose of the RCIS/LCP. However, these lands may provide habitat value for some species, and can provide buffers between natural communities and nearby development. Furthermore, these lands have the potential to rotate into crop types that have value for focal species.

2.7.1.1 Citrus and Subtropical Orchards

Citrus and subtropical orchards in the strategy area are typically single-species, tree-dominated agricultural lands and do not support any local concern species. In the strategy area, this land use category includes olives, oranges, and kiwis. Citrus and subtropical orchards account for 1,159 acres, or 0.18 percent of the strategy area (Table 2-2, *Natural Communities and Other Land Cover Types*; Figure 2-13).

2.7.1.2 Deciduous Fruit and Nut orchards

Deciduous fruit and nut orchards are typically planted with a single-tree species. In the strategy area, this land use category includes various small trees such as almonds, apples, apricots, figs, peaches, nectarines, pears, pistachios, prunes, mixed deciduous fruits and nuts, and walnuts. It is most frequent on Yolo-Brentwood soils but is widespread in the county on a variety of other soils. Deciduous fruit and nut orchards support a number of common wildlife species, including American crow, American robin, and house finch. Mule deer, jack rabbits and cottontail rabbits may browse on foliage, while California ground squirrels may consume fruits and nuts. Deciduous fruit and nut orchards also do provide some support for pallid bat and yellow-billed magpie. Deciduous fruit and nut orchards account for 48,092 acres, or 6.7 percent of the strategy area but because of currently high nut prices their orchards are now expanding rapidly in Yolo County (Table 2-2, *Natural Communities and Other Land Cover Types*; Figure 2-15).

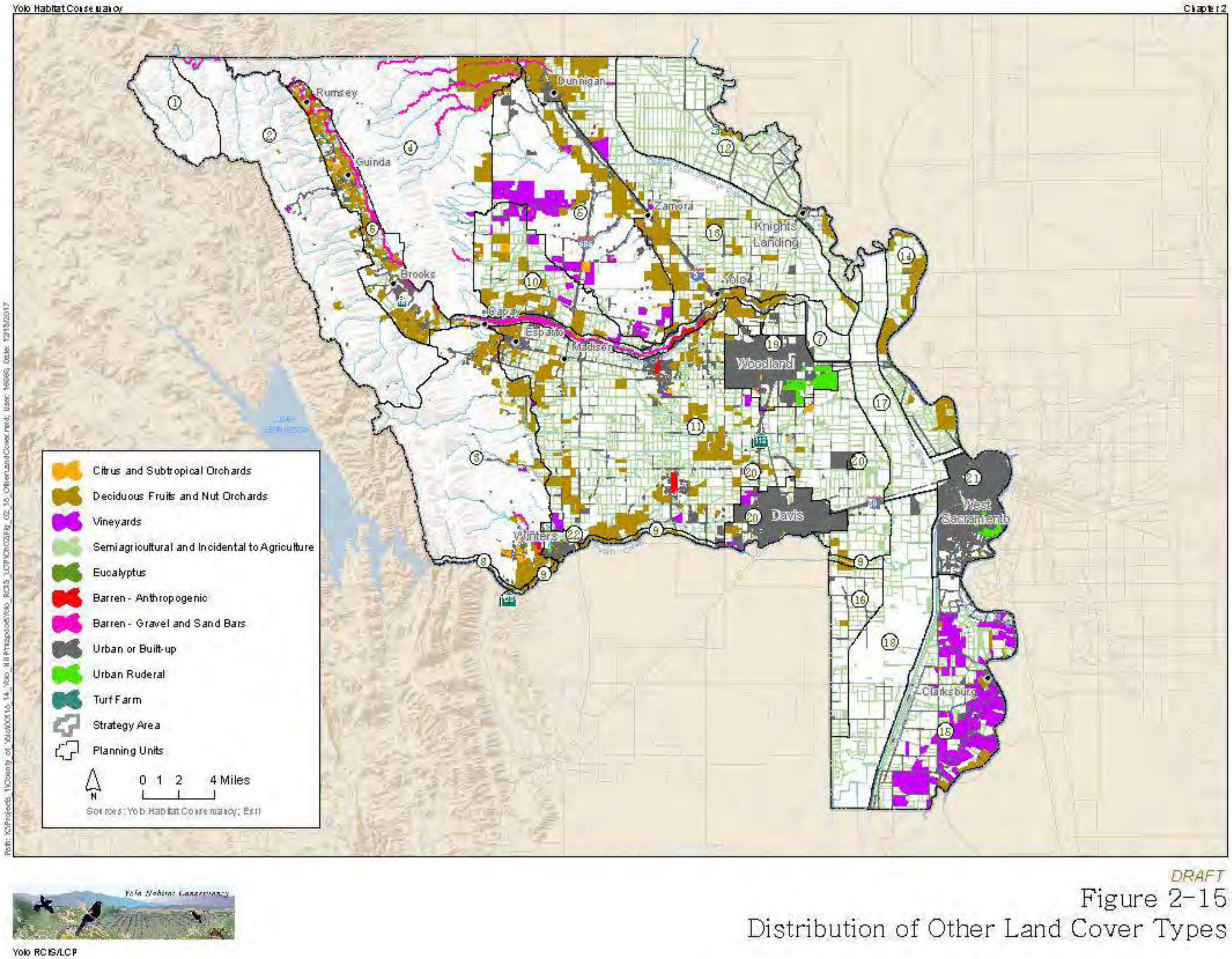
2.7.1.3 Vineyards

Grapes for wine, a vine typically grown as a shrub in vineyards, are an increasingly important Yolo County crop but provide much less habitat for its native wildlife than many others. They are primarily grown in the Dunnigan Hills on Sehorn-Balcom soils and in the southeastern part of the county on Sacramento and Sycamore-Tyndall soils (Figures 2-6 and 2-15). Vineyards cover an estimated 17,133 acres, or 2.6 percent, of the RCIS strategy area.

2.7.1.4 Turf

Turf consists of sod farms that are heavily maintained to eliminate pests. This crop undergoes frequent fertilization, watering, mowing, and vacuuming to remove grass clippings. Because of the heavy maintenance required for this crop and lack of prey base, turf has little to no habitat value for wildlife. Turf farms account for 140 acres, or less than 0.1 percent of the RCIS strategy area (Table 2-2; Figure 2-15).

Figure 2-15. Distribution of Other Land Cover Types



2.7.2 Semiagricultural and Incidental to Agriculture

Semiagricultural areas include livestock feedlots, farm steads, and miscellaneous semiagricultural features such as small roads, ditches and unplanted areas of cropped fields (e.g., field edges). Feedlots are confined livestock feeding operations that are used for preparing livestock, mainly cattle, for slaughter. They may contain thousands of animals in an array of pens and support virtually no vegetation. Poultry farms raise chickens, turkeys, ducks, and geese for meat or egg production. Egg-producing farms house birds in rows of cages or batteries. Light duration, which mimics summer day length and stimulates birds to lay eggs year round, and other environmental conditions are automatically controlled. Meat chickens, commonly called broilers, are floor-raised on litter such as wood shavings or rice hulls in climate-controlled housing. Like feedlots, chicken farms generally do not support any vegetation. This land cover type incidental to agriculture covers a surprisingly high 30,494 acres according to Table 2-2 but this figure may be high since little is visibly mapped in Figure 2-15 when compared with the previous land cover type of orchards and woodlots. This cover type includes a variety of non-crop rural landscape features that contribute structural variety and thus frequently enhance habitat for native wildlife. Semiagricultural areas account for 30,494 acres, or 4.7 percent of the strategy area (Table 2-2, *Natural Communities and Other Land Cover Types*; Figure 2-9). Most of the acreage in this land cover type consists of farmsteads and field edges, which provide habitat for Swainson's hawk, white-tailed kite, loggerhead shrike, and western burrowing owl.

2.7.3 Eucalyptus

Eucalyptus consists of monotypic eucalyptus stands that have been generally planted for wood production or as wind breaks for fields and buildings. This land cover type has a dense canopy and groundcover that consists of a thick layer of leaf litter and bark. Sparsely planted trees may have a dense, herbaceous and shrub understory. Tree spacing and species composition influence the size of mature eucalyptus groves. Eucalyptus species (primarily blue gum, *Eucalyptus globulus*) have invaded the riparian natural community in some areas, and are likely increasing, but eucalyptus is still a more localized threat than some other invasive species (e.g., tamarisk and giant reed). Eucalyptus stands account for 369 acres, or 0.06 percent of the strategy area, with most stands located in the town of Dunnigan and on a few isolated parcels that were planted as woodlots in agricultural lands (Table 2-2, *Natural Communities and Other Land Cover Types*; Figure 2-15).

Eucalyptus supports several common wildlife species, including barn owl, red-shouldered hawk, American crow, and Anna's hummingbird. One eucalyptus grove north of Davis supports a large nesting colony (rookery) of egrets and herons. Some Swainson's hawks and other native raptors regularly nest in eucalyptus trees.

2.7.4 Anthropogenic Barren

This land cover type includes an estimated 414 acres of levees, or less than 1 percent, of the RCIS strategy area (Table 2-2). As discussed for the California prairie natural community, some prairie species specifically depend on a barren prairie phase caused by heavy grazing. Among the most significant of these is the focal species western burrowing owl. Others are western snowy plover and mountain plover. As true barren prairies become scarcer in Yolo County it increasingly uses anthropogenically created barren areas as habitat. Some of these are included here, but others are likely included under other land cover types like semiagricultural rural. The "barren" land use subcategory also includes 1,372 acres of gravel and sand bars as well as 333 acres of rock outcrops.

2.7.5 Developed

Developed areas are dominated by pavement and building structures. Vegetation in developed areas generally consists of vegetated corridors (e.g., vegetation maintained adjacent to highways) and patches of mostly ornamental vegetation such as tree groves, street strips, shade trees, lawns, shrubs typically supported by irrigation. Urban lands cover 45,487 acres, or 7.0 percent of the strategy area (Table 2-2, *Natural Communities and Other Land Cover Types*). This area includes urban vegetation and all areas with structures, graded lots, roads and highway medians, anthropogenic drainage canal vegetation, rail right-of-ways and sewage treatment ponds that do not provide habitat. Among covered species Swainson's hawk uses urban trees in this habitat for nesting and purple martin uses structures for nesting primarily in adjacent Sacramento County but also rarely in Yolo County.

2.8 Focal and Conservation Species

The RCIS focal species are listed in Group 1. LCP conservation species are listed in Groups 2 and 3, as described in Section 1.5.3, *Focal and Conservation Species*. Appendix C provides species accounts for each of the focal species in Group 1 and the conservation species in Group 2. These species accounts include information on the status, life history, distribution, population trends, and habitat use of each of the focal species. The species accounts summarize the main elements of each species' life history, including habitat and species associations (e.g., vegetation communities, interspecific relationships), key habitat requirements (e.g., soils, cliffs, burrows, nest trees, flow regimes, disturbance), area requirements, dispersal abilities, reproductive requirements and abilities, forage and cover needs, temporal requirements of various needs, and relevant behavioral ecology. The species accounts are not intended to include all biological information that is known about a species. Rather, each account summarizes the scientific information that is relevant to the RCIS/LCP. The biological data presented in these accounts provide the basis for the RCIS/LCP conservation strategy.

The accounts summarize each species' overall distribution, and where in the strategy area the species is known to occur based on available GIS data, published and unpublished literature, and expert knowledge. The species accounts also identify the status and population trend for each species, and known or potential threats and other limiting factors throughout its range and specifically in the strategy area.

Information in the species accounts was used to develop species habitat models for evaluating the distribution of potentially suitable habitat in the strategy area for each Group 1 species (i.e., focal species). Information in the species accounts can be used to identify focal species conservation needs during implementation, and to inform adaptive management and monitoring. The species models are described in the species accounts. The models can be used to predict which focal species are expected to occur on lands identified for conservation, for the purpose of prioritizing lands for conservation.

2.9 Habitat Connectivity and Linkages

Figure 2-16, *Habitat Connectivity and Linkages,* shows key connections for the strategy area. These include Essential Connectivity Areas identified as a component of the California Essential Connectivity Project (Spencer et al. 2010). More than 60 federal, tribal, state and local agencies contributed to the project, a statewide assessment of large, intact blocks of natural habitat and a "least-cost" modeling of connections between them.

The California Essential Habitat Connectivity Project identifies connectivity as "the single most important adaptation strategy to conserve biodiversity during climate change." (Spencer et al. 2010:127). They reached this conclusion because of the need for connected habitat that allows organisms to respond to climate change by moving from unsuitable to suitable habitat. This movement could occur in the short term as habitat is lost or degraded, or as habitat slowly shifts to an unsuitable condition in the future because of climate change. Planning for conservation in Yolo County requires consideration of landscape connectivity in the short term (e.g., within the 10-year term of the RCIS) to assure that near-term conservation actions achieve the species and habitat goals identified in the RCIS. Achieving conservation aims within the county also requires focusing on connectivity in more remote time periods (within the next 50–100 years, the focus of the Local Conservation Plan), when habitat alterations driven by climate change may have altered current landscape connectivity.

Scientific conclusions regarding the conservation significance of landscape connectivity have appeared with increasing frequency in recent years, covering conservation across a full range of biological organization from genes to ecosystems (e.g., Rudnick et al. 2012, Fletcher et al. 2016). Landscape connectivity has been an important element in conservation discussions for decades, as it is a remedy for habitat fragmentation and related impacts on population viability and genetic isolation, part of the "rescue effect" (Brown and Kodric-Brown 1977) for small population size. Current understanding of ecological connectivity (e.g., Crooks and Sanjayan 2006) incorporates a combination of "structural connectivity" (corridors and other physical linkages established in a landscape) and "functional connectivity" (the behavioral ability of individual organisms, and of ecological elements and processes, to move across the physical structure of landscapes).

Essential Connectivity Areas identified by the California Essential Habitat Connectivity Project in the strategy area include Blue Ridge/Rocky Ridge-Capay Hills in the northwestern corner of the strategy area, and English Hills-Blue Ridge/Rocky Ridge in the southwestern corner. Both of these Essential Connectivity Areas consist of varied terrain supporting mostly woodlands, forest, and chaparral. The Dunnigan Hills/Smith Creek Essential Connectivity Area in a central portion of the strategy area supports mostly grasslands with scattered ponds, some of which are occupied by California tiger salamander. The Yolo Bypass corridor along the eastern edge of the strategy area links to the Yolo Bypass-Sacramento Bypass Essential Connectivity Area and the Little Holland Tracy-Yolo Bypass Essential Connectivity Area to the south, and links through the Clarksburg area to the Sacramento River corridor east of the strategy area.

Figure 2-16. Habitat Connectivity and Linkages

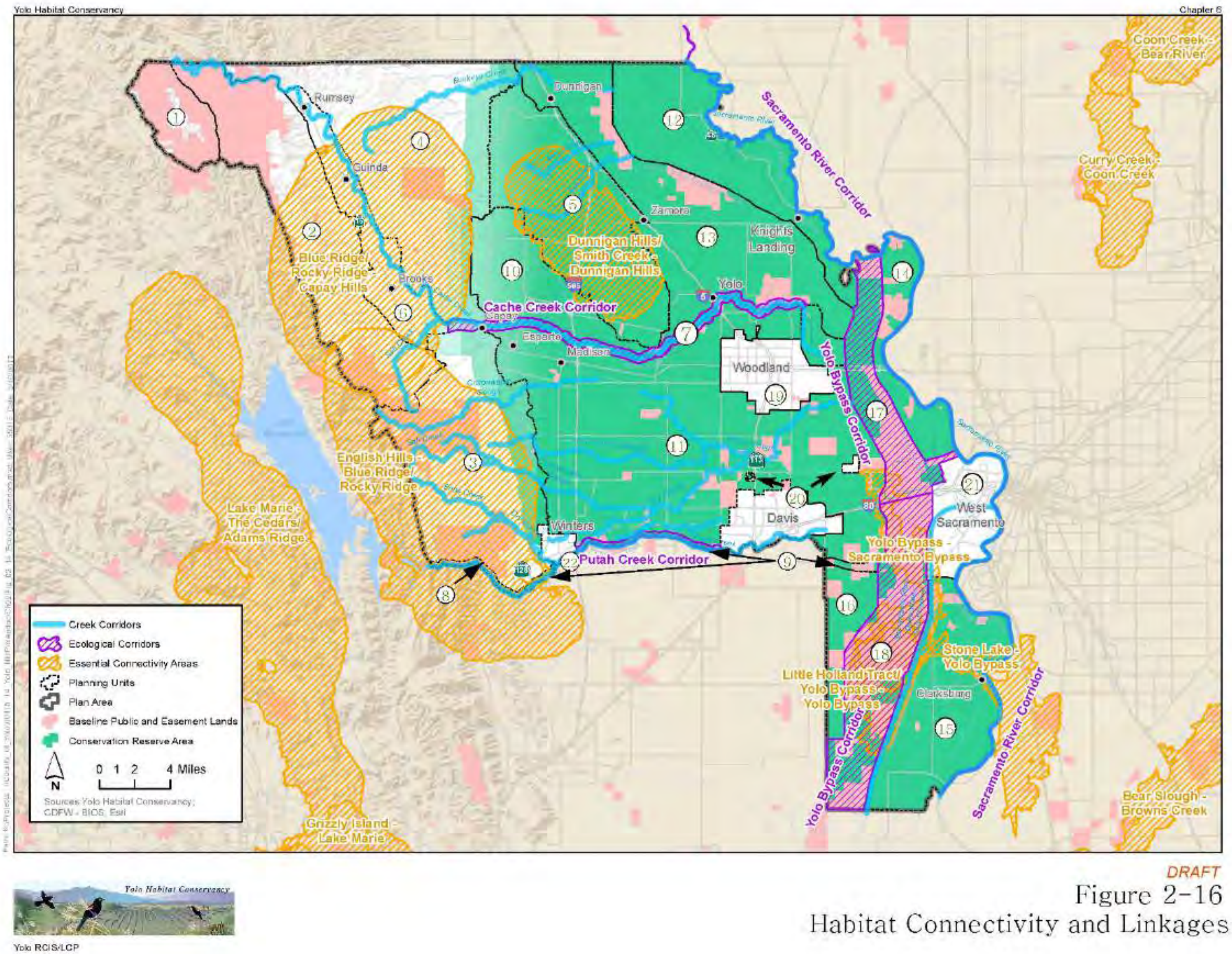


Figure 2-16 also includes linkages and corridors identified by scientists on Conservancy's Advisory Committee as key elements in the Local Conservation Plan, based on their familiarity with the ecology of the strategy area. The primary linkages identified include the Sacramento River/Yolo Bypass, Putah Creek, and Cache Creek, while other streams and drainages in the strategy area provide secondary linkages. These linkages tend to run in an east-west direct in the strategy area, although the Sacramento River/Yolo Bypass runs in a north-south direction at the eastern end of the strategy area and provides key linkage for salmonids, sturgeon, and other fish species.

2.10 Gaps in Scientific Information

The conservation strategy presented in Chapter 3, *Conservation Strategy*, is based on the best available scientific information. However, there are many gaps in that information, even in the strategy area, which has been heavily studied. This section includes a discussion about information gaps that, if filled, could change the objectives, actions, and priorities in the strategy area. Gaps can be created from a lack of information or by shortcomings in how information is disseminated.

2.10.1 Regional Gaps

Information gaps at the regional level are not unique to the strategy area. These gaps hold true for nearly all of California.

2.10.1.1 Focal and Conservation Species Occurrence Data

The California Natural Diversity Database was the primary source of species occurrence data (California Natural Diversity Database 2016), along with a few other sources. While the data are considered high quality, because of the verification process used by CDFW, there are two inherent gaps. First, only positive data are presented (i.e., where an occurrence is found). While positive occurrence data are very useful, there is no way to know where surveys have been conducted for each species with negative survey results (i.e., where an occurrence was not detected). Knowing where species do not occur, in habitat that may appear suitable, is also important. Because that information is not available, the species habitat models typically over-predict where species may occur. With negative survey data, those models could be refined by removing areas that had been surveyed where no species were found. Second, the CNDDB does not include data for large areas of potentially suitable habitat, in part because a large amount of California, including the strategy area, has never been surveyed. Oftentimes, surveys are driven by environmental compliance for projects. So for example, many CNDDB occurrences fall along gas and electric rights-of-way or roadways; places where infrastructure projects typically happen. As a result, conservation and mitigation projects often focus on limited areas with suitable occurrence data, potentially at the expense of other important areas that are occupied by target species, but have not been surveyed.

2.10.1.2 Knowing-Doing Gap

The knowing-doing gap is the phenomenon of information gained through scientific research not finding its way into the hands of land management practitioners. There are two areas addressed in this RCIS/LCP where that happens: invasive plant management and grazing management. Matzek et al. (2014) found that the majority of resource managers rarely had access to scientific, peer-reviewed literature and only found it moderately useful when they did. Instead, they frequently relied on their own experience over research-based conclusions. Additionally, when resource managers conducted research of their own, the methods rarely followed standard scientific protocols and the information was typically not disseminated to their colleagues. The same pattern can be seen in grazing management. Similar to invasive plant science, rangeland science has produced an immense amount of research on the effectiveness of grazing as a conservation management tool in the past decade. The science on grazing methods, invasive plant management using grazing, and the potential to impact water resources is ever changing. Getting that information into the hands of resource managers and ranchers is important to closing the knowing-doing gap. These gaps likely apply to other resource areas as well, but invasive plant management and grazing management are the most prevalent examples. Improving the access to, and application of, scientific research on invasive plant and grazing management by land management practitioners could improve land management practices for the benefit of native biodiversity and ecosystem processes in the RCIS area.

2.10.1.3 Habitat Connectivity and Wildlife Movement

As noted in Section 2.9, *Habitat Connectivity and Linkages*, the California Essential Habitat Connectivity Project identifies connectivity as “the single most important adaptation strategy to conserve biodiversity during climate change.” (Spencer et al. 2010:127). Planning for conservation in Yolo County requires consideration of landscape connectivity in the short term (e.g., within the 10-year term of the RCIS) to assure that near-term conservation actions achieve the species and habitat goals identified in the RCIS. Section 2.9, *Habitat Connectivity and Linkages*, lists essential connectivity areas identified by the California Essential Habitat Connectivity Project in the strategy area.

However, there is a gap in wildlife movement data in the strategy area. Specifically, information is lacking about wildlife movement through areas identified as habitat linkages. Additionally, there is a lack in data on how different wildlife species move through the agricultural lands between habitat patches in Yolo County. Knowing more about how wildlife move between these areas would allow conservation organizations to focus land acquisition and management in the most critical locations.

2.10.2 Natural Community and Species

There are many gaps in what is known about natural communities and species, both across their range and inside of the strategy area. This summary is not exhaustive, but identifies key issues in the strategy area that, if better understood, would influence how the conservation strategies were implemented.

2.10.2.1 Pond and Wetland Functionality and Longevity

Several focal species rely on freshwater wetland habitat for at least part of their life cycle (i.e., California tiger salamander, giant garter snake, tricolored blackbird). In the strategy area, particularly in the Dunnigan Hills area where California tiger salamanders occur, most of the ponds are human-made stock ponds. Like other wetlands, ponding duration and timing are important factors that affect habitat quality for a species. Under most climate change scenarios, Yolo County will get hotter and drier. That means that ponds, which primarily rely on surface runoff, will receive less water and dry up sooner in a typical year. At the very least, rainfall patterns, both the timing and amount, are likely to change, meaning that the ponds that are functioning well for species today, may not function in the same way tomorrow. Shorter ponding durations may reduce reproductive success of species such as California tiger salamander if ponding durations become too short to successfully complete reproduction and emergence from aquatic habitats. Understanding existing and future ponding durations under different climate change scenarios can inform land management and pond restoration and creation efforts in ways that may buffer aquatic species from the effects of climate change. For example, new ponds may need to be supported by well water or other sources of reliably available water, or designed to increase water storage capacity or retention while providing suitable habitat features. Vegetation may also need to be managed differently to maintain open water habitats in warmer, drier conditions. A systematic survey of the pond resources in the RCIS area, with an emphasis on their ability to provide habitat functionality for native species, would greatly inform how to prioritize land acquisitions, and restoration and enhancement actions on private and public lands.

Grazing on public lands is widespread, but the use of grazing as a management tool is still variable, particularly to manage pond vegetation. Without a well-managed grazing program, ponds often fall into disrepair, fill with sediment, and fail. This reduces the habitat quality for focal and nonfocal species over time. A better understanding of the conditions of ponds in the RCIS area could inform the use of grazing to manage habitat features in ponds.

Little is known about the timing and duration of flooding in areas mapped as fresh emergent wetlands in the strategy area. Depending on the timing and duration of flooding, these wetlands may have varying levels of habitat value for focal species such as giant garter snake and tricolored blackbird. For example, many areas mapped as fresh emergent wetland are managed for migratory waterfowl, and as such experience winter flooding rather than the summer flooding necessary to support giant garter snake. Areas mapped as modeled giant garter snake habitat may therefore not contain the appropriate characteristics to support the species. Similarly, many areas mapped as fresh emergent wetland may lack the tall emergent wetland vegetation needed to support nesting tricolored blackbirds. More detailed information on the distribution of appropriate habitat characteristics are necessary to determine the actual locations of appropriate habitat for these and other focal species.

2.10.2.2 Rare Plant Distribution

The gaps in survey effort for species is discussed above in Section 2.10.1.1, *Focal Species Occurrence Data*, but the lack of survey data for rare plant species is an issue throughout the state. Plant species are under-surveyed for two reasons: 1) lack of access to private lands, and 2) plants are not state or federally listed as threatened or endangered at the same rate as wildlife, and therefore regulatory triggers are not in place to require surveys as frequently. Further, often when botanical surveys are done in areas, protocols which involve multiple surveys across the full range of blooming periods are not completed. So even if surveys occur, some species could be missed if they are not flowering at that time. The lack of survey data for many rare plant species consequently limits planning efforts. More surveys on private lands and standardized survey efforts would help fill this data gap and allow for more informed conservation priorities for focal and nonfocal plant species.

2.10.2.3 California Ground Squirrel Distribution

Many native species in California rely on California ground squirrels as an important element of their life history. California tiger salamanders and burrowing owls rely on ground squirrels, and other fossorial mammals, to provide underground refugia and nest sites, respectively. Many species of raptors and mammals rely on ground squirrels as a food source. If the distribution of ground squirrels in the strategy area was better understood, it would allow for the refinement of species habitat models and ultimately could influence where conservation priorities are located. Gaining this knowledge would require a systematic survey effort across the study area that was repeated at regular (e.g., 5-10 year) intervals.

2.10.2.4 California Tiger Salamander Hybridization

California tiger salamanders hybridize with invasive barred tiger salamanders in the RCIS area, resulting in a reduction in the numbers of fully native California tiger salamanders. The larger, more aggressive hybrid animals routinely outcompete the native species, furthering the decline of an already rare species. Work is ongoing to understand the prevalence of hybridization in the RCIS area, and throughout the species' range, but there is still a large gap in knowledge. Fully understanding the distribution of hybrids is the first step. The level of hybridization, and extent of introgression of non-native tiger salamander genes into California tiger salamanders varies, and some level of hybridization can likely be tolerated in the native population without significantly altering ecological function (Searcy et al. 2016). While the ideal scenario is to preserve native populations, it may not be feasible for populations of California tiger salamander that have already hybridized with barred tiger salamander. Experimental evidence suggests that hybrids with relatively lower levels of barred tiger salamander genes are ecologically equivalent to fully native California tiger salamanders, and should be protected alongside native California tiger salamanders (Searcy et al. 2016). More research is needed to identify the threshold of nonnative genetic introgression below which hybrids should be retained, and above-which hybrids should be removed. Understanding that balance, so that management and monitoring can be designed to respond, is imperative.

2.11 Stressors and Pressures on Conservation Elements

CFGC Section 1852(c)(5) requires that an RCIS include a summary of historic, current, and projected future stressors and pressures in the RCIS area, including climate change vulnerability, on the focal species, habitat, and other natural resources, as identified in the best available scientific information, including, but not limited to, the SWAP. The RCIS Guidelines (California Department of Fish and Wildlife 2017) defines stressor and pressure as the following.

Stressor is a degraded ecological condition of a focal species or other conservation element that resulted directly or indirectly from a negative impact of pressures such as habitat fragmentation. A pressure is an anthropogenic (human-induced) or natural driver that could result in changing the ecological conditions of the focal species or other conservation element. Stressors are negative by definition. Pressures can be positive or negative depending on intensity, timing, and duration. Negative or positive, the influence of a pressure to the target is likely to be significant.

Understanding the pressures and stressors experienced by the focal species and their habitats within the RCIS area is one of the critical steps necessary to identify conservation actions to counteract them. The RCIS area is almost entirely within the Central Valley and Sierra Nevada province, as defined in the SWAP. The RCIS area is similarly almost entirely within portions of the Central Valley ecoregion. For the Central Valley and Sierra Nevada province, the SWAP identifies 21 categories of pressures affecting conservation targets in the province. Of these pressures, 13 are identified as affecting conservation targets in the Central Valley ecoregion, and six are identified as affecting native fish. This RCIS uses the same pressure categories identified for the RCIS area as those defined in the SWAP, with two exceptions. This RCIS does not include the pressures of logging and wood harvesting and mining and quarrying, as these pressures are generally not currently occurring in the RCIS area.

The following pressures, as defined in the SWAP, are described in the following sections.

- Agricultural and forestry effluents
- Annual and perennial nontimber crops
- Climate change
- Commercial and industrial areas
- Dams and water management/use
- Household sewage and urban waste water
- Housing and urban areas
- Invasive plants and animals
- Livestock, farming, and ranching
- Recreational activities
- Roads and railroads
- Utility and service lines

Each of these pressures and resultant stressors is discussed below in a general context, as well as in relation to the focal species and other conservation elements discussed in this chapter, including stressors to natural communities, habitat connectivity, and working landscapes. The SWAP provides a general overview of each of these pressures. For some pressures, the SWAP also includes an analysis of the pressures applicable to the Central Valley ecoregion of the Central Valley and Sierra Nevada province.

Some of these pressures result in similar or related stressors and are discussed together. A matrix showing the association between pressures and each focal species is included in Table 2-5.

Table 2-4. Pressures Acting on Each Focal Species

Focal Species	Commercial and Industrial Areas; Household Sewage and Urban Waste Water; Housing and Urban Areas	Annual and Perennial Non-timber Crops; Agricultural and Forestry Effluent; Livestock, Farming, and Ranching	Climate Change	Invasive Plants and Animals	Roads and Railroads; Utility and Service Lines	Dams and Water Management/ Use	Recreational Activities
Conservancy Fairy Shrimp	X	X	X	X	X	-	-
Vernal Pool Fairy Shrimp	X	X	X	X	X	-	-
Midvalley Fairy Shrimp	X	X	X	X	X	-	-
California Linderella	X	X	X	X	X	-	-
Vernal Pool Tadpole Shrimp	X	X	X	X	X	-	-
Valley Elderberry Longhorn Beetle	X	X	X	X	X	X	X
White Sturgeon	X	X	X	X	X	X	X
Green Sturgeon	X	X	X	X	X	X	X
Delta Smelt	X	X	X	X	X	X	X
Central Valley Steelhead	X	X	X	X	X	X	X
Sacramento Winter-Run Chinook Salmon	X	X	X	X	X	X	X
Central Valley Spring-Run Chinook Salmon	X	X	X	X	X	X	X
Central Valley Fall/Late Fall-Run Chinook Salmon	X	X	X	X	X	X	X
Sacramento Splittail	X	X	X	X	X	X	X
California Tiger Salamander	X	X	X	X	X	-	X
Foothill Yellow-Legged Frog	X	X	X	X	X	X	X
Western Spadefoot	X	X	X	X	X	-	X
Western Pond Turtle	X	X	X	X	X	X	-

Focal Species	Commercial and Industrial Areas; Household Sewage and Urban Waste Water; Housing and Urban Areas	Annual and Perennial Non-timber Crops; Agricultural and Forestry Effluent; Livestock, Farming, and Ranching	Climate Change	Invasive Plants and Animals	Roads and Railroads; Utility and Service Lines	Dams and Water Management/ Use	Recreational Activities
Giant Garter Snake	X	X	X	-	X	X	-
Tricolored Blackbird	X	X	X	-	X	X	-
Grasshopper Sparrow	X	X	X	-	X	X	-
Western Burrowing Owl	X	X	X	-	X	X	-
Swainson’s Hawk	X	X	X	-	X	X	-
Greater Sandhill Crane	X	X	X	-	X	X	-
Northern Harrier	X	X	X	-	X	X	-
Black Tern	X	X	X	-	X	X	-
Western Yellow-Billed Cuckoo	X	X	X	-	X	X	-
White-Tailed Kite	X	X	X	-	X	X	-
Loggerhead Shrike	X	X	X	-	X	X	-
Yellow-Breasted Chat	X	X	X	-	X	X	-
Bank Swallow	X	X	X	-	X	X	-
Least Bell’s Vireo	X	X	X	-	X	X	-
Townsend’s Big Eared Bat	X	X	X	-	X	X	-

2.11.1 Annual and Perennial Non-Timber Crops; Agricultural and Forestry Effluents; Livestock, Farming, and Ranching

Approximately 50% of the RCIS Strategy area are harvested croplands. The majority of these lands are on the Central Valley floor and contained in the RCIS area. Conversely, less than 1% of county lands are designated specifically for grazing. As such, the majority of the effects on the RCIS focal species and other conservation elements are tied more to crop production than to rangeland grazing or livestock production.

As described in the SWAP (page 2-36),

> Agriculture is an essential component of California's economy. The state is a major producer in the fruit, vegetable, tree nut, and dairy sectors (U.S. Department of Agriculture [USDA] 2014). Historic conversions of native habitat to agriculture in California have been significant. Today approximately 70% of the Central Valley is used for agriculture, with the vast majority of this land conversion occurring prior to the 1970s (USGS 2014). While agricultural lands no longer represent native vegetation types, they can provide important habitat for wildlife species, such as flooded rice fields of the Central Valley that provide waterfowl habitat. Habitat loss and or degradation can occur through land conversion from one type of agriculture to another, including conversion of field and row crops or grazing lands to orchards or vineyards. Deep ripping of fields to create subsurface conditions conducive to orchards and vineyards can destroy wetlands as well as essential upland habitat for sensitive species such as California tiger salamander, and lead to habitat fragmentation. Diversion of water for irrigation can contribute to altered hydrologic regimes, and nutrient laden runoff can degrade aquatic habitat. Other impacts from agricultural practices include the use of chemical fertilizers, herbicides, rodenticides, and other chemicals that can affect non-target species and degrade water quality. Illegal marijuana groves, particularly in the northern portions of the state, have similar but more pronounced impacts than other agriculture, because of their location in remote and otherwise undisturbed areas and lack of regulatory oversight.
>
> Belsky et al. (1999) found that studies overwhelmingly show that livestock grazing negatively affects water quality and seasonal quantity, stream channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife. Other researchers have found benefits from grazing and have advocated for grazing as a useful and necessary conservation tool.

Agricultural use is the primary driver of conversion of natural lands. Much of the RCIS area is in active agricultural production (363,000 acres of agriculture land cover, or approximately 50% of the RCIS area), consisting of numerous farming operations, some of which cover thousands of contiguous acres of land.

2.11.1.1 Effects on Focal Species

According to the SWAP (page 2-36),

> Ongoing agricultural practices can have a range of direct and indirect ecosystem consequences, positive or negative, based on timing, duration, and intensity. In addition, different cropping systems (e.g., organic versus conventional farming, or highly diversified fields versus large monocultures) can have different levels of impacts on natural ecosystems across the landscape. Many on-farm practices for conservation can reduce impacts/benefit ecosystems. The location of certain cropping systems and crop types are important factors in moving toward a long-term sustainable agricultural system.
>
> Field crops can provide foraging habitat for raptors, such as Swainson's hawk, and rice fields and stock ponds can provide foraging and aquatic habitat for reptiles such as giant garter snake (federal and state threatened), amphibians, bats and birds, such as tricolor blackbird. Agriculture can harm

those same species through chemical treatments, removal of nesting habitat, or direct mortality from harvesting and maintenance activities. Agricultural runoff containing fertilizers and pesticides can also pollute and degrade aquatic and marine habitat. Conversely, crop damage from wildlife can cause substantial economic loss and public health risks necessitating enhanced measures to control access to crops by wildlife.

Legislation, public policies, and landowner conservation practices have helped slow impacts of agricultural practices to species and habitats. For example, farmers can apply for subsidies to avoid disruption of tricolored blackbird nesting, to restore wetlands and other waters, to implement best management practices for grazing, and to manage field crops for the benefit of wildlife (e.g., rice field management to provide habitat for giant garter snake and migratory birds) (USDA 2015).

Other effects of farming activities are also described in the SWAP (page 5.3-27).

Rain and irrigation runoff carry silt and agricultural chemicals, degrading surface water quality and reaching groundwater. For example, significant amounts of nitrogen fertilizer applied through agricultural practices have contaminated groundwater supplies in agricultural communities throughout the State (Viers et al. 2012). Herbicides and pesticides can have toxic effects on aquatic plants and animals and chemical contaminants can upset the ecological balance of aquatic systems. For example, nutrients increase aquatic plant and algal growth, resulting in lowered oxygen levels when the excessive plant matter decomposes. Elevated nutrient levels have also been implicated in amphibian deformities, because nutrient-rich environments favor the parasitic flatworm that causes deformities in many frog species (Johnson and Chase 2004). Also, pesticide drift has been shown to favor hybrid tiger salamanders over native California tiger salamanders (Ryan et al. 2012). Silt and sediment also degrade aquatic environments, increasing turbidity and shading out aquatic vegetation, along with scouring away or smothering stream-bottom sediments that are important spawning sites and invertebrate habitats. Runoff problems are particularly severe on steeply sloping, erosion-prone soils, where strawberries, artichokes, and vineyard grapes are commonly grown. Planting practices that result in large amounts of soil disturbance, such as the establishment of vineyards and strawberry and artichoke mounds, also contribute substantially to sediment runoff.

(page 2-37) Central Valley agriculture contributes to the conservation of numerous species of waterfowl and shorebird along the Pacific Flyway, and significantly in the maintenance of winter habitat for the greater sandhill crane, a California-listed threatened species. In the absence of native habitats, grain crop fields provide essential winter flooded roost habitat for sandhill cranes, ameliorating the effects of ongoing conversion of farmlands to incompatible crops such as orchards and vineyards (Ivey et al. 2014). There is clearly a balance that can be achieved through incentive based, non-regulatory collaboration and partnerships with conscientious ranchers and farmers. SWAP 2015, as well as the California Climate Adaptation Strategy, relies upon fostering this balance as much as possible, but will require a concerted effort to sustain a dialog with farmers, ranchers, land managers, agency staff, and the public about the benefits of working together for the benefit of fish and wildlife.

In the Central Valley and Sierra Nevada province, the SWAP's discussion of grazing is primarily focused on the detrimental effects of grazing in the Sierra Nevada, and less-so on grazing in the Central Valley portion of the province. Nonetheless, some of the information provided in the SWAP is applicable to grazing, wherever it occurs. The SWAP describes the following (pages 5.4-39–5.4-41).

The effects of grazing on wildlife vary from beneficial to detrimental, depending upon how grazing is managed, including the seasonality and duration of grazing and the type and number of livestock. These effects also depend on the relative sensitivities of individual wildlife species, because not all species respond the same way to grazing. Well-managed livestock grazing can benefit sensitive plant and animal species, particularly by controlling annual grasses and invasive plants where these have become established, and by removing understory growth to create a fire-resilient landscape. These working lands are an essential part of the solution to conserving the state's wildlife.

> While recognizing the values of compatible grazing practices, this plan focuses on the negative impacts of pressures affecting wildlife species at risk. Thus, the following discussion describes those situations where excessive grazing practices result in stresses to species. Excessive grazing, as used here, refers to livestock grazing at a frequency or intensity that causes degradation of native plant communities, reduces habitat values for native wildlife species, degrades aquatic or other ecosystems, or impairs ecosystem functions. (The term "overgrazing" has a different meaning; it usually refers to the productivity of the forage crop and range condition.)
>
> The SNEP and the SNFPA also found that aquatic and riparian habitats are particularly affected by livestock grazing. Cattle are attracted to the lush forage, water, and shade of riparian habitat. In late summer and fall, especially when upland habitats have dried out, cattle can decimate riparian plant communities, grazing and trampling meadows, converting meandering meadow streams into eroded channels, and stripping forage and cover needed by wildlife. The erosion increases sediment runoff, degrading aquatic ecosystems.
>
> Livestock grazing is affecting the composition of plant communities important for wildlife diversity. Where livestock grazing is excessive, forage often becomes scarce, and both livestock and deer consume young aspen shoots, hindering the regeneration of aspen stands. Excessive grazing is a factor in reducing the regeneration of blue oak and many other plant species throughout the predominantly privately owned foothill region (CDFG 2005; McCreary 2001). Livestock compact soils and remove leaf litter, making conditions less than optimal for germination of acorns and new growth. Livestock also consume acorns and young oak saplings.

Loss of juvenile fish rearing habitat in the form of lost natural river morphology and function, and lost riparian habitat and instream cover (National Marine Fisheries Service 2014) can occur from livestock use of streams and rivers for water. Livestock enter stream channels and denude and trample riparian vegetation along the banks. Along with the loss of shaded riverine habitat, erosion occurs and can change the channel's morphology.

2.11.1.2 Effects on Other Conservation Elements

Natural communities and habitat connectivity in the RCIS area have been affected by agricultural land uses within the RCIS area. Habitat conversion to cropland has fragmented and isolated areas of remaining natural habitat, limiting habitat connectivity. Agricultural land uses, when not managed carefully, may also indirectly affect the quality of remaining natural lands through degradation of ground and surface water, overdraw of groundwater, reducing availability for remaining trees, shrubs and in-stream flows. However, the high amount of agricultural lands in the RCIS area do support the working lands conservation element

2.11.2 Industrial Areas, Household Sewage and Urban Waste Water, Housing and Urban Areas

This group of pressures generally describes those activities that result in land conversion and associated indirect effects of land conversion, including increased effluent releases into local streams. Land conversion includes the full spectrum of natural lands transformation into developed lands, often transitioning through various agricultural uses before becoming completely devoid of characteristics that support habitat for focal species.

Land conversion and associated indirect effect stressors are primarily the result of growth driven by increased populations and economic prosperity. Urban and suburban development, infrastructure projects, the conversion of natural communities and habitats to agricultural uses and subsequent conversion of agricultural land to development are primary causes of land conversion in the

RCIS/LCP strategy area. Urban/suburban and agricultural development in the RCIS/LCP strategy area has resulted in the loss, degradation, and fragmentation of natural habitats (both terrestrial and aquatic), and agricultural land. The continued loss of habitat, through permanent or temporary conversion to other purposes, is a key pressure on the focal and conservation species and their habitats in the RCIS/LCP strategy area. With approximately 50,000 acres (7 percent) of the RCIS/LCP strategy area developed, urbanization has caused some loss of historic open space and species habitat. Urban and suburban development, however, has been concentrated within the cities and clustered rural communities; most of the existing and planned development is in the cities of Davis, West Sacramento, Winters, and Woodland (Figure 2-13). Irrevocable loss of nearly all of the open space in the eastern portion of the RCIS/LCP strategy area has occurred due to agriculture conversion, which covers approximately 45 percent of the RCIS/LCP strategy area. While the agricultural lands provide habitat for many wildlife species including focal species such as Swainson's hawk and giant garter snake, lands converted to some types of agricultural uses have very little habitat value. In particular, agriculture conversion has resulted in drastic reductions in the acreage of vernal pools in the RCIS/LCP strategy area. The loss of vernal pools in Yolo County between 1989 and 2005 was approximately 75 percent, with 3,617 acres of vernal pool reduced to just 901 acres. The rate of loss by 2005 was approximately 4.7 percent per year, and if the current rate of annual habitat loss were to continue, vernal pool habitat would be completely eliminated from the Great Valley by 2087 (Holland 2009).

Human population growth and the subsequent demands placed on a limited supply of land, water, and other natural resources is the primary driver of the conversion of natural and agricultural land. Irrigation and flood-control operations have channelized many of the creeks and streams in the eastern and central portions of the RCIS/LCP Area. Infrastructure such as the Yolo Bypass and Fremont Weir complex and the Sacramento Weir and Bypass complex have significantly altered the creeks and streams near the Sacramento River channel. The Yolo Bypass during floods can convey up to 80 percent of the flow from the Sacramento River through Yolo and Solano Counties until it rejoins the Sacramento River near the city of Rio Vista. The Yolo Bypass includes 70,000 acres of farmland and wildlife areas that have been intentionally managed as a designated flood conveyance since 1926.

By 2040, expected population growth in Yolo County is approximately 46,252 people, an increase of 19 percent (from 2014) or roughly 1 percent per year (Caltrans 2015). Focal and conservation species have different tolerances to land conversion, with many of them not adapted to habitat conditions associated with more-developed land uses. Beyond direct habitat loss, converting land to more intensive human-related uses fragments habitats, isolates populations, and makes dispersal to patches of habitats across an inhospitable landscape challenging. Habitat fragmentation also has additional consequences including introduction and spread of invasive species and noise and light pollution.

Other facilities associated with urbanization including power plants, sewage plants, and other industrial facilities also contribute pollutants to local aquatic resources. An increase in the quantity of pollutants reaching local creeks through higher runoff may affect the biological and physical characteristics of aquatic habitats. High runoff temperature may also result in an increase of in-stream water temperatures when runoff enters local streams.

Urban development is also associated with an increase in garbage that finds its way into natural communities and local waterways. This issue was the primary driver behind the 2016 ban on single-use plastic bags. Urban areas also often support increased numbers of feral cats, which pose a serious threat to native birds and reptiles.

2.11.2.1 Effects on Focal Species and Habitats

In the Great Valley ecoregion of the Central Valley and Sierra Nevada province, the SWAP describes the following (page 5.4-34).

Growth and development fragment habitats into small patches that cannot support as many species as larger patches can. These smaller fragments often become dominated by species more tolerant of habitat disturbance, while less-tolerant species decline. Populations of less-mobile species often decline in smaller habitat patches because of reductions in habitat quality, extreme weather events, or normal population fluctuations. Natural recovery following such declines is difficult for mobility-limited species. Such fragmentation also disrupts or alters important ecosystem functions, such as predator-prey relationships, competitive interactions, seed dispersal, plant pollination, and nutrient cycling (Bennett 1999; ELI 2003).

Loss of habitat connectivity would affect all of the focal species in the RCIS area. Loss of connectivity between open space patches that provide habitat for focal species can cause a reduction in genetic diversity due to the loss of the ability of populations to disperse and intermix. High genetic diversity can allow populations to adapt to changing environmental conditions, evolve resistance to disease, and minimize physiological and behavior problems (Falk et al. 2001). For some species with limited ranges, especially reptiles and small mammals, habitat loss and connectivity to suitable habitat can threaten survival of a population if individuals cannot migrate to suitable replacement habitat. Maintaining connectivity allows limited-range species to shift habitats to adjacent areas if populations experience loss of habitat. Barriers to movement could also extirpate local, smaller populations of focal species in the RCIS area.

Each of the focal species are impacted by conversion of native habitats to agricultural production or urban development (Table 2-9). For example, Swainson's hawk, tricolored blackbird, and giant garter snake have experienced dramatic declines in the RCIS area due to widespread habitat loss and habitat fragmentation from the conversion of grassland habitat to the urban and agriculture uses other than livestock grazing, described above (Gervais et al. 2008). Over 90% of the wetland habitat within the historic range of western pond turtle has been eliminated due to agricultural development, water diversion projects, and urbanization (U.S. Fish and Wildlife Service 1992).

Focal fish species are also directly impacted by habitat conversion and habitat fragmentation. Habitat loss can result in the elimination of individuals or populations of these species from the area that is converted, and these species can also be affected by proximity to converted lands from runoff and pollution associated with urban development and associated infrastructure and trampling (in the case of rangelands). Loss of juvenile fish rearing habitat in the form of lost natural river morphology and function, and lost riparian habitat and instream cover (National Marine Fisheries Service 2014) can occur from residential development close to streams and rivers.

2.11.2.2 Effects on Other Conservation Elements

All the other conservation elements in the RCIS area could be affected by land conversion within the RCIS area. The major impact of new development is the conversion from undeveloped to developed land cover, which reduces biodiversity and eliminates natural habitat. Habitat conversion may further isolate areas of remaining natural habitat, increasing the edge (i.e., boundary) and the distance between habitats, limiting habitat connectivity and landscape linkages. For example habitat fragmentation may disconnect streams and their tributaries, change hydrologic regimes, and limit or obstruct natural interactions between wetland systems. Riparian and in-stream impacts may also occur as a result of urban development. Fragmentation and resulting land management activities like fire suppression modify the natural disturbance regime that historically sustained grasslands and woodlands in the RCIS area. Additionally, urban development can convert farmland and rangeland to areas with large amounts of impervious surfaces (e.g., concrete or asphalt) which have little or no value for the focal species in the RCIS area.

2.11.3 Climate Change

Climate change is a major challenge to the conservation of natural resources worldwide, in California, and in the strategy area. Climatic changes are already occurring in the state and have resulted in observed changes in natural systems. For example, migrating butterflies have been appearing earlier in the year, some bird and mammal habitat use distributions have shifted (Moritz et al. 2008, Tingley et al. 2012), and some forest species are gradually moving to higher elevations (Glick et al. 2011). Projected changes in climate, may be related to events such as wildfires, droughts, floods, extreme temperatures, and storms likely to have significant impacts on habitats, species, and human communities in the near future. Sea-level rise, drought, and flooding are discussed below in the context of climate change.

In the Central Valley and Sierra Nevada province, the SWAP describes the following stressors related to climate change (page 5.4-29–5.4-30).

Temperature

Average annual temperatures in the Central Valley are expected to increase 1.4° to 2.0°C (2.5° to 3.6°F) by 2070, and 1.5° to 4.5°C (2.9 to 7.9°F) by 2100 (PRBO 2011). January average temperatures are projected to increase 2.2° to 3.3°C (4 to 6°F) by 2050 and 4.4° to 6.7 °C (8°F and 12°F) by 2100. July average temperatures are projected to increase 3.3° to 3.9°C (6° to 7°F) in 2050 and 6.7° to 8.3°C (12°F to 15°F) by 2100 (California Emergency Management Agency 2012).

Precipitation and Snowpack

In the Central Valley, lower-elevation areas are projected to experience declines in annual precipitation of 2.5 to 5 cm (1 to 2 inches) by 2050 and up to 8.9 cm (3.5 inches) by 2100, while more elevated areas are projected to experiences losses of up to 25.4 cm (10 inches).

Freshwater Hydrologic Regimes

In the Sierra Nevada, the considerable loss in snowpack is projected to decrease the duration and magnitude of flows. Approximately 20% decrease in runoff and riverflow is expected by 2090. The combined effect of changes in precipitation, temperature, and snowpack are expected to produce an earlier arrival of annual flow volume by as much as 36 days by 2071–2100; and, warmer temperatures and more precipitation falling as rain rather than as snow are also projected to cause snowmelt runoff to shift earlier under all model simulations (PRBO 2011). Declining snowpack, earlier runoff, and reduced spring and summer streamflows will likely affect surface water supplies and increase reliance on groundwater resources in the Central Valley, which are often already overdrafted (PRBO 2011).

The SWAP provides the following overview of how the climate of the Central Valley is expected to change (page 5.4-31).

Although climate change is already affecting wildlife throughout the state (Parmesan and Galbraith 2004), and its effects will continue to increase, it has particular significance for this region's major river and estuarine systems.

In general, California winters will likely become warmer and wetter during the next century. Instead of deep winter snowpacks that nourish valley rivers through the long, dry summer, most of the precipitation will be winter rain that runs off quickly. For the Central Valley, this means more intense winter flooding, greater erosion of riparian habitats, and increased sedimentation in wetland habitats (Field et al. 1999; Hayhoe et al. 2004).

Hotter, drier summers, combined with lower river flows, will dramatically increase the water needs of both people and wildlife. This is likely to translate into less water for wildlife, especially fish and wetland species. Lower river flows will allow saltwater intrusion into the Bay and Delta, increasing salinity and disrupting the complex food web of the estuary. Water contaminants may accumulate during the summer as the natural flushing action decreases.

2.11.3.1 Effects on Focal Species and Habitats

Some of California's native species are more vulnerable than others to extended or frequent severe drought and may be at risk of extirpation. Small population size, short life expectancy relative to the drought duration, and inability to adequately cope with extreme events are reasons some taxa, including several of the Yolo County RCIS focal species, are more vulnerable than others. The impacts of drought on some types of animals are more obvious than others.

Climate change may alter habitats in the RCIS area as temperatures and precipitation levels change, which could lead to the reduction in population sizes or extirpation of focal species that rely on those habitats, or require focal species in the RCIS area to migrate to other areas. Many of the focal species in the RCIS area are of special conservation concern because of their risk of extinction (Table 1-2), and are particularly vulnerable to climate change (California Department of Fish and Wildlife 2015). Species that are particularly vulnerable often occur within a limited geographic range, exist in small populations, have specialized habitat requirements, and have low dispersal ability which make it difficult for them to migrate to more suitable areas as habitats shift with climate change. Aquatic species are particularly at risk (e.g., green sturgeon, Central Valley steelhead, Chinook salmon), because they could be extirpated by loss of aquatic breeding habitat (i.e., lethal water temperatures) during extended periods of drought. By identifying species most at risk from the effects of climate change, conservation and management efforts can be targeted to reduce and mitigate these impacts, such as by protecting and restoring existing habitat and linkages between habitats and climate change refuges, or through assisted migration. The State Wildlife Action Plan (California Department of Fish and Wildlife 2015) identifies five of the focal wildlife species as climate vulnerable: steelhead, all Chinook salmon runs and Swainson's hawk (Table 2-9).

Increased and prolonged droughts and decreasing habitat connectivity may increase mortality in both juvenile and adult focal fish populations where water supply and quality reach critical lows. This poses a high risk for species (e.g., winter-run Chinook salmon, green sturgeon) with limited distribution and low population size (California Department of Water Resources 2015). Decreased stream flow and water quality during summer months in rivers and estuaries may also impact migration, juvenile fish over-summer rearing, and adult spawning.

In the climate risk analysis for California's at-risk birds (Gardali et al. 2012), Swainson's hawk is listed as a species with moderate vulnerability to climate change because of their use of very specific habitats and their long-distance migratory patterns (i.e., the timing of their migration needs to be matched with suitable climate conditions). Alfalfa, a high water-use crop, provides important foraging habitat for Swainson's hawk in the agricultural landscapes of the Central Valley and the RCIS area. Climate change may cause a decrease in water available for agriculture, and a consequent shift from growing alfalfa to less water-intensive crops that may provide lower quality foraging habitat for Swainson's hawk (e.g., safflower) (Friends of the Swainson's Hawk 2009).

Focal species in the RCIS area could respond to climate change in a number of ways. First, the timing of seasonal events, such as migration and egg laying, may shift earlier or later. Such shifts may affect the timing and synchrony of events that must occur together. Second, range and distribution of focal species may shift (Walther et al. 2002). This is of particular concern for narrowly distributed focal species that already have restricted ranges due to urban development or altitudinal gradients. Historically, some focal species could shift their ranges across the landscape. Today, urban and rural development prevents the movement of many species across the landscape.

Increases in disturbance events, and/or the intensity of disturbance events, such as fire or drought may also occur. This could increase the distribution of disturbance-dependent land cover types, such as California annual grassland, within the RCIS area (Rogers and Westfall 2007). An increase in the frequency and intensity of disturbance could increase the likelihood that these events will harm or kill individual focal species, many of which are already quite rare. Events that occur with unpredictable or random frequency (called stochastic events) such as those described in this section can have an inordinately negative effect on the focal species.

2.11.3.2 Effects on Other Conservation Elements

As described above, temperatures are expected to increase and water availability throughout the year will decrease. This will likely affect all of the vegetated land uses in the RCIS area. With less water availability, wetlands may shrink and convert to grassland and riparian areas may similarly transition to non-aquatic land cover types. These environmental stresses may also lead to increased susceptibility to disease. These affects will further reduce already affected habitat connectivity. Reduction in water availability is also likely to increase challenges associated with successfully operating working landscapes

2.11.4 Dams and Water Management/Use

As described in the SWAP (page 2-32),

> The management of water resources in California results in numerous stresses on rivers, the Delta, wetlands, estuaries, and aquifers in the state. Across all regions of the state, limited water resources are managed to meet water and power supply needs and to accommodate urban communities and agricultural production. Agriculture is the dominant user of surface and groundwater in the state. Water management activities include the operation of dams and diversions, development and operation of irrigation canal systems, extraction of groundwater, and construction of flood-control projects such as levees and channelization. Coastal lagoons and rivers suffer from the historic and

> ongoing conversion of tributary waterways into constructed stormwater infrastructure. The stormwater conveyances are managed to convey urban runoff and floodwater and can alter the hydrologic processes that are important to ecosystem function, such as sediment deposition, water filtration, support of riparian vegetation and wildlife movement corridors. These activities can reduce the amount of water available for fish and wildlife, obstruct fish passage, and result in numerous other habitat alterations. In all regions of the state, aquatic, wetland, and riparian habitats support rich biological communities, including many special status species, and degradation of these habitats represents a serious threat to the state's biological heritage.
>
> Increasing pressures from development and agriculture, as well as the expectation of longer droughts resulting from climate change, have exacerbated California's water shortages. Additionally, climate change is expected to result in more precipitation falling as rain rather than snow, which could lead to severe flooding and further straining our aging water management infrastructure. It is anticipated that additional water conservation, water recycling, watershed management, managed wetland water supply, conveyance infrastructure, desalination, water transfers, and groundwater and surface storage will be necessary. Reduction in snowpack storage, due to climate change, affects water supply reliability, hydropower, and the amount of runoff during extreme precipitation that leads to flooding. Increased flooding potentially causes more damage to the levee system and other infrastructure (DWR 2013b).
>
> Conservation strategies in the aquatic ecosystems of the state will be heavily influenced by the ongoing efforts to manage water supplies. Many of California's water supply and flood protection infrastructure are no longer functioning properly or have exceeded their life cycles. This aging water supply and flood management infrastructure, badly in need of maintenance or replacement, has led to declines in species and ecosystems. The California Water Plan Update (DWR 2013b) identified strategies for establishing reliable water supplies and restoring ecologically sensitive areas.

In the Central Valley and Sierra Nevada province, the SWAP describes the following stressors (page 5.4-25–5.4-26).

> Water diversions are found throughout the Central Valley's rivers and tributaries. Water is diverted for agriculture, municipal and industrial uses, and managed wetlands. Up to 70% of the freshwater flow that would naturally enter San Francisco Bay is now diverted (Steere and Schaefer 2001). Dams are located on all of the major rivers in the Central Valley and on many of their tributaries.
>
> Dams and diversions have dramatically affected the aquatic ecosystems of the Central Valley, altering historical flooding regimes, erosion, and deposition of sediments that maintain floodplains. They also decrease riparian habitats and coarse gravel supplies needed for salmon and other native fish reproduction. Dam operations create rapid changes in flow rates that have led to the stranding of fish and exposure of fish spawning areas (CDFG 2005).
>
> Dams reduce the amount of water remaining in the river that is needed by fish at critical times, and they alter the flow regimes in ways that are detrimental to aquatic life. Less water in the rivers also means less water for managed wetlands. Reduced river flows down- stream also allow saltwater intrusion into the Delta, increasing the salinity levels in the San Francisco estuary and bay beyond the tolerance levels of many species (Steere and Schaefer 2001).
>
> Agricultural diversions usually get the highest quality water, discharging salty water that is then used in wildlife areas. By the time it is discharged from some wildlife areas, its salinity triggers concerns about water quality by regulatory agencies, particularly in the San Joaquin Valley. Efforts to correct this problem are complicated, owing to a poor understanding of the historic elements of salinity and the naturally saline wetlands of the San Joaquin drainage (CDFG 2005).
>
> Dams and diversions also block fish movement to upstream habitat, remove fish and wildlife habitat, alter water quality (i.e., temperature and flow), and kill fish through entrainment and entrapment. Dams have cut off salmon access to 70-95% of their historical range (State Lands Commission 1993; Trust for Public Land [TPL] 2001; Clemmins et al. 2008; NMFS 2014). The diversion of water through powerful pumps from the Delta to the canals heading to Southern California reverses Delta flows and

confuses migrating fish trying to find their way to the ocean. At times, the young fish swim with the flowing waters toward the pumps rather than toward the open ocean.

Levee, bridge, and bank-protection structures are present along more than 2,600 miles of rivers in the Central Valley and in the Delta (DWR 2005). These structures prevent flood flows from entering historic floodplains and eliminate or alter the character of floodplain habitats, such as shaded riverine habitat, and floodplain ecosystem processes. Constrained flood-level flows increase scouring and incision of river channels and reduce or halt the formation of riparian habitat, channel meanders, and river oxbow channels.

These changes in water supply also stress many upland species. Most of the resident terrestrial animals need to find adequate water during California's long, dry summer months. As human demand for water increases, there is less water available for resident wildlife species, so they experience greater physiological stress. In some cases, water management has also led to sustained year-round flows in streams that historically dried up in the summer. Central Valley habitats rely on a large and complex drainage, involving snowmelt and land uses up to 300 miles away and water imports from and exports to other river basins.

Current water management practices exemplify interactions between pressures and resulting stresses. As urban development expands, it creates more impermeable surfaces like concrete, asphalt, and the roofs of buildings. Subsequent rainfall is then less able to soak into the ground and runs off quickly. Rapid runoff reduces the recharge of groundwater reservoirs and reduces later summer stream flows. Combined with water diversions, this reduction in groundwater causes streams to dry up more quickly, thus reducing the availability of water to wildlife during summer months. Increased urban runoff also is a major source of water pollution. Urban runoff washes various pollutants out of urban areas, depositing them into creeks, rivers, and other waterbodies, adding to wildlife stress.

2.11.4.1 Effects on Focal Species

As described in the SWAP (page 5.4-27),

> Dams and diversions of the rivers that flow into the Sacramento and San Joaquin drainages have been particularly detrimental to anadromous Chinook salmon, steelhead and green sturgeon. Each of these species historically spawned in Sierra Mountain rivers and streams, their young swimming to the sea and returning a few years later as adult fish to spawn. The construction of dams and water diversions blocked fish passage, contributing to dramatic declines in salmon and steelhead populations of the Sacramento and San Joaquin drainages. Fewer anadromous fish also means fewer eggs, young fish, and fish carcasses that provide nutrients for numerous other aquatic species. Historically, one to three million Chinook salmon spawned each year in the western Sierra. Today, dams block salmon access to upstream spawning habitat in all but a few creeks. Late fall-, winter-, and spring-runs of salmon have collapsed. Steelhead and spring-run Chinook salmon are federally threatened, and winter-run Chinook salmon are listed federally and by the state as endangered. Fall- and late-fall run salmon are taxa of special concern. Natural and hatchery produced fall- run Chinook salmon continues to support ocean commercial and sport fisheries and a river fishery. Many other aquatic species are also affected by the migration impediments imposed by dams and their associated reservoirs.

Green sturgeon have also been blocked from spawning habitat in the Sacramento River by dams. Restriction of spawning habitat is considered the foremost threat for green sturgeon (National Marine Fisheries Service 2010).

General degradation of fish rearing and migrating habitat from dams and water management includes elevated water temperatures, agricultural and municipal diversions and returns, restricted and regulated flows, entrainment of migrating fish into unscreened or poorly screened diversions, depredation by nonnative species, and poor quality and reduced quantity of remaining habitat

(National Marine Fisheries Service 1998). The alteration of freshwater and estuarine habitats from human activities has resulted in a loss of estuarine/delta function for green sturgeon rearing habitat (National Marine Fisheries Service 2010). Hydropower dams and water diversions in some years have greatly reduced or eliminated instream flows during spring-run migration periods (National Marine Fisheries Service 1998b).

2.11.4.2 Effects on Other Conservation Elements

As described above, dams and other in-stream passage impediments have the greatest effect on habitat connectivity for covered fish species. Other water management facilities may also create impediments to movement. However, water supply management facilities are not entirely detrimental to other conservation elements. For example, the Yolo Bypass both provides flood protection and supports a portion of the remaining wetland habitat in the RCIS area (Yolo Bypass Wildlife Area). Dams and water supply infrastructure is also critical for the success of working lands (primarily in crop production) in the RCIS area.

2.11.5 Invasive Plants and Animals

Invasive plants can be found in many different habitats in the strategy area. Introduced aquatic habitat invaders include Brazilian waterweed, egeria, Eurasian water milfoil, hydrilla, water hyacinth, water pennywort, and parrot feather. In grasslands, some of the more challenging plant invaders include barbed goat grass, Harding grass, eucalyptus, fountain grass, gorse, medusahead, tree of heaven, and yellow star thistle. In riparian and wetland areas, invading plants include giant reed (or arundo), Himalayan blackberry, pampas grass, tamarisk (or salt cedar), pennyroyal, peppergrass, and tree of heaven (CDFW 2015). In wooded areas, invasive grasses and broom species can form dense stands that inhibit the germination of native forest species.

As described in the SWAP (page 2-43–2-44),

> Human introduction (directly or indirectly) of invasive species is a critical existing pressure that is expected to continue, and be exacerbated by climate change. Introduction of invasive species into the California ecosystem has occurred since the earliest European settlements. Some of these introductions have been intentional, such as the plants imported as ornamentals for horticulture, while other introductions have been unintentional when species arrive in the state along with the movement of people and goods. As California's population and economic activity has grown into its current size, the points of origin for people and goods coming to the state now span the globe. This has led to a diverse society and economy, but also has left California vulnerable to introductions of species from all around the world.

California is particularly vulnerable to invasive species because of its diverse ecosystems and communities. This ecosystem diversity, however, also means that species from all over the world may be able to find suitable habitat somewhere in the state. When species are introduced into these habitats they often find conditions similar to their home range that will allow for the establishment of reproducing populations. For preventing the spread of invasive weeds, the area affected currently is only part of the equation; it is also important to consider the area that could be affected in the future, if a species is allowed to spread.

The quantity of potential habitat and the high volume of transportation into California from other states and countries have had the unintended effect of introducing so many invasive species into the state that management of these non-native organisms is now a high priority for resource managers. Efforts are underway to combat invasive species and prevent new introductions such as new regulations on the release of ballast water in California waters and mandatory inspections of recreational boats in some lakes. Although most of the thousands of species brought into our state cause no harm, a small percentage is able to thrive in California to the detriment of native plants and wildlife. The colonization by invasive species, particularly invasive grasses, is expected to increase with climate change (Sandel and Dengermond 2011).

Invasive species harm California's wildlife by disrupting native plant and animal communities. Some introduced species are voracious predators, such as introduced trout species that have significantly contributed to the decline in mountain yellow-legged frog (Hammerson 2008). Others out-compete native species for resources, some spread diseases, and some are capable of re-engineering the environment to suit their needs, changing hydrology, soil chemistry, and fire regimes. In addition, some are transmitting novel diseases into the state. Many also degrade recreational activities from hunting to boating, camping, and hiking. The introduction of invasive species has been an especially detrimental pressure on estuaries such as the San Francisco estuary, which is likely the most invaded estuary in the world with over 230 species of invasive species (Cohen and Carlton 1998). Though it is difficult to quantify harm from invasive species in financial terms, a conservative estimate places the cost to the United States at over $100 billion each year, including damage to agriculture and infrastructure (Pimentel et al. 1999). In California alone, invasive plants cost the state $82 million each year (Cal-IPC 2008).

2.11.5.1 Effects on Focal Species and Habitats

Invasive plant and animal species put significant pressure on focal species within the RCIS area. Invasive species often reduce habitat quality for the focal wildlife and plant species, often due to the density and monotypic habitat that is formed by particularly invasive plants. Some invasive wildlife species depredate focal wildlife species.

In the Central Valley and Sierra Nevada province, the SWAP describes the following (page 5.4-36–5.4-37).

> Invasive plant and animal species are an important pressure on wildlife in this province, just as they are in other regions throughout the state (CALFED 2000; CalIPC 1999; CDFG 2005; Goals Project 1999; Hickey et al. 2003; Jurek 1994; Lewis et al. 1993; RHJV 2004).

Introduced animals have invaded both terrestrial and aquatic environments. Not all introduced vertebrates are invasive, and they have varying effects on wildlife. The species of most concern in the region parasitize songbird nests, dominate limited nesting habitat, prey on native species, or otherwise damage wildlife habitats.

Fifty-one new fish species have become established in California (Moyle 2002), dominating most of the rivers and streams in this region. These include species such as striped bass, white catfish, channel catfish, American shad, black crappie, largemouth bass, and bluegill. Many fish were historically introduced (via stocking) by federal and state resource agencies to provide sport fishing or forage fish to feed sport fish. Many introduced non-native fish and amphibians may out-compete native fish for food or space, prey on native fish (especially in early life stages), change the structure of aquatic habitats (increasing turbidity, for example, by their behaviors), and may spread diseases (Moyle 2002). However, not all non-native species are considered invasive, which typically refers to species whose introduction causes or is likely to cause economic or environmental harm to human health. Several of the introduced predatory fish may have increased predation levels on Chinook salmon and other native fishes (CALFED 2000).

In addition to introduced fish, native aquatic species are stressed by introduced bullfrogs, red-eared sliders (a turtle), and invertebrates. Introduced invertebrates, such as New Zealand mud snail, quagga mussels, Asian clam, zebra mussel, Chinese mitten crab, and mysid shrimp, are causing significant problems for native species in rivers, streams, and sloughs. While not all of the introduced aquatic species are invasive or have significant consequences for native species, biologists are concerned about the sheer dominance of these new species and their current and potential effects on the structure and function of the estuarine ecosystem.

Depredation by nonnative species of all runs of juvenile Chinook salmon and steelhead affects these species in the lower Sacramento River and Delta where there are high densities of non-native fish species such as striped bass, smallmouth bass, and largemouth bass. These nonnative predators, prey upon outmigrating juveniles and may have a direct impact on the population (National Marine Fisheries Service 2014). Introduced nonnative prey species can also displace native prey species. The overbite clam, *Potamorcorbula amurensis*, a non-native bivalve, became established in the San Francisco Bay Estuary in 1988 and has become the common food of white sturgeon (California Department of Fish and Game 2002). Overbite clams can pass undigested through white sturgeon and they also bioaccumulate elenium, a toxic metal that green sturgeon are highly sensitive to (Linveille et al. 2002; White et al. 1989).

Invasion of exotic pest species into habitats occupied by giant garter snake, western pond turtle, and yellow-billed cuckoo is another threat to the continued survival of these focal species in the RCIS area. Saltcedar or tamarisk (*Tamarix ramossissima*), an invasive pest plant species, is has establishes itself along riparian corridors. The changes in channel morphology, hydrology, and vegetation cover associated with saltcedar invasion has degraded and changed habitat suitability for pond turtles and yellow-billed cuckoo (Lovich and de Gouvenan 1998; Laymon 1998). Along the Sacramento River, domestic fig and black walnut have also become dominant tree species; these species likely offer little benefit to cuckoos as nesting or foraging habitat because the species' preferred prey are not found on these substrates and the trees do not provide good nest sites (Laymon 1998). The introduction of non-native turtles, including red-eared sliders (*Trachemys scripta*) and painted turtles (*Chrysemys picta*), also threatened pond turtles. The bullfrog (*Rana catesbeiana*) will consume any animal it can swallow, including hatchling and young western pond turtles (Holland 1994). The intensity of predation from bullfrogs has been shown to eliminate recruitment in some pond turtle populations (Overtree and Collings 1997). Predation by and competition with introduced species (e.g., house cats, bullfrogs, largemouth bass [*Micropterus salmoides*], catfish [*Ictalurus* spp.]) also poses threats to giant garter snake (U.S. Fish and Wildlife Service 2017; Carpenter et al. 2002). Additionally, introduced predatory fish may compete with giant garter snake for smaller forage fish, and habitat alteration may facilitate other species of garter snake to access giant garter snake habitat, allowing them to compete more successfully with giant garter snake (G. Hansen 1986 as cited in U.S. Fish and Wildlife Service 1999: 29).

2.11.5.2 Effects on Other Conservation Elements

In the Central Valley and Sierra Nevada province, the SWAP describes the following as related to natural communities (page 5.4-36–5.4-37).

Invasive plants can be found in many different habitats in this region. In grasslands, some of the more challenging plant invaders include eucalyptus, fountain grass, gorse, medusahead, tree of heaven, and yellow starthistle. In riparian and wetland areas, invading plants include edible fig, giant reed or arundo, Himalayan blackberry, pampas grass, Russian olive, tamarisk (or saltcedar), pennyroyal, pepperweed, tree of heaven, Scotch broom, and French broom. Oak woodlands are invaded by plants such as Scotch broom, French broom, pepperweed, medusahead, barbed goat grass, and yellow star thistle.

Introduced plants also invade aquatic habitats. These aquatic invaders include Brazilian waterweed, egeria, Eurasian watermilfoil, hydrilla, water hyacinth, water pennywort, and parrot feather.

2.11.6 Recreational Activities

As described in the SWAP (page 2-41–2-42),

> Outdoor recreation and exposure to nature is important to foster an appreciation of nature; however, recreation in sensitive habitats could result in habitat degradation. Recreational use of public lands in California involves a large number of visitors, both from state residents and out-of-state tourists. Extensive areas of federal and state lands offer high-quality outdoor recreation opportunities. Visitation data (BBC Research and Consulting 2011) from federal agencies (National Park Service [NPS], USFS, BLM, USFWS, and U.S. Army Corps of Engineers) indicate that federally managed lands in California average approximately 90 million visitor days per year. The California State Parks System averages approximately 78 million visitor days per year.
>
> Large numbers of outdoor recreation users in sensitive areas can directly damage natural systems by reducing vegetative cover, compacting soil, disturbing biotic soil crusts (i.e., cryptogams), increasing soil destabilization and erosion, disturbing breeding and foraging areas, contaminating natural lands and waterways through inappropriate disposal of trash and human waste, and by introducing non-native species. Indirect impacts may also occur to natural areas through increased development of recreational access points and supporting infrastructure such as roads, visitor facilities, and campgrounds. Visitor litter in parks and public lands can encourage increased corvid populations (jay, crow, and raven), which contributes to greater competition with and predation upon other native wildlife.
>
> Recreational off-highway vehicle (OHV) use can have adverse effects on soil conditions, native plant communities, and sensitive species. On public lands, authorized and unauthorized OHV trails open relatively undisturbed areas to increased use. The vehicles can disturb or run over wildlife, crush and uproot plants, spread invasive plants, and disturb soils, contributing to erosion and sedimentation of aquatic habitats.
>
> Concentrated recreational use in highly sensitive areas, such as streams, coastal habitats, and riparian zones by hikers, picnickers, mountain bikers, and equestrians can damage these systems, reducing vegetative cover and disturbing sensitive species. Concentrated fishing, especially in populated area can lead to localized depletion of fisheries. Illegal trampling, and collecting, can deplete floral and faunal populations, reduce biodiversity, and alter trophic and community structures in frequently visited natural habitats. The negative impacts of pressures from recreation can be reduced through proactive recreation planning and public education.

2.11.6.1 Effects on Focal Species

Demand for, and participation in, outdoor recreation is increasing at a notable rate. With increasing number of recreationalists, the type of recreation impacts and spatial extent of area affected are also changing (Flather and Cordell 1995). Outdoor recreation is the 2nd leading cause of decline of U.S. threatened and endangered species on public lands (Losos et al. 1995). Wildlife can be affected by recreation in a variety of ways, including direct and indirect mortality, lowered productivity, reduced used of habitat/preferred habitat, and aberrant behaviors that can reduce reproductive or survival rates (Purdy et al. 1987). The impact from recreation depends on the frequency, intensity, location, predictability, and type of use (e.g., day-hiking, bird watching, biking, snowmobiling, off road vehicle), as well as the type of wildlife including the species sensitivity to human presence, group size, age, and sex.

Birdwatching, photography, and other repeated low-impact human activity can cause an increase in the risk of nest predation of songbirds. High-use recreation areas, such as campgrounds and picnic areas, have been shown to have higher levels of nest predators, and horses can attract brown-headed cowbirds if stables or corrals are near (U.S. Fish and Wildlife Service 2002).

2.11.6.2 Effects on Other Conservation Elements

As described above, recreational use of natural communities may degrade the quality of those lands for use by focal species. Recreational use, and high-use trails in particular, may also affect connectivity for some focal species. Working lands in this RCIS area are primarily comprised of lands in rice production (37% of the RCIS area and almost 59% of all cultivated agriculture). Rice fields are often flooded in the winter, creating habitat for migrating birds and also drawing hunters to some sites. This supports the income of farmers while also providing some services for migrating waterfowl.

2.11.7 Roads and Railroads; Utilities and Service Lines

As described in the SWAP (page 2-29),

> Existing infrastructure, such as roads and highways, can be a barrier to wildlife movement, creating fragmented habitats and direct mortality from vehicle and wildlife collisions. Continued population growth increases the demand for transportation facilities for urban, regional, intercity, and long-distance travel. Caltrans estimates that the capacity of existing rail, air, and highway transportation systems will need to be increased (Caltrans 2015). The California Transportation Plan calls for an increase in intermodal transportation systems, including increased freeway reliability, express and high occupancy vehicle lanes, and increased connectivity between transportation types and across modes of transportation (Caltrans 2015). The majority of these connections will occur along existing transportation corridors and increase mobility between existing modes of transportation including intercity bus and rail (Caltrans 2015). The focus on improvements to existing corridors and connections between travel modes should minimize new habitat fragmentation from state highways. However, local roadways and other infrastructure have the potential to create additional habitat fragmentation.

2.11.7.1 Effects on Focal Species

In the Central Valley and Sierra Nevada province, the SWAP describes the following (page 5.4-34).

> Growth and development, along with associated linear structures like roads, canals, and power lines, impede or prevent movement of a variety of animals. This is generally less significant than habitat loss but makes it more difficult for those species that need to move large distances in search of food, shelter, and breeding or rearing habitat and to escape competitors and predators. Animals restricted to the ground, like mammals, reptiles, and amphibians, face such obstacles as roads, canals, and new gaps in habitats. Attempts to cross these obstacles can be deadly, depending on the species and the nature of the gap (e.g., four-lane highways with concrete median barriers compared to narrow, rural two-lane roads). Fish and other water-bound aquatic species attempting to move either upstream or downstream are blocked by lack of water resulting from diversions, physical barriers like dams, and by entrainment in diverted water. Even the movement of highly mobile species like birds and bats can be impeded by such features as transmission lines and wind energy farms, particularly in focused flight corridors like Altamont Pass, and 50 new wind energy sites are currently proposed throughout

the state on land managed by BLM (CDFG 2005) Such species either cannot see or do not avoid these structures, and many die as a result. The actual extent of bird fatalities because of power-line collision in California is unknown; however, the California Energy Commission (CEC) estimates that fatality rates because of Central Valley power-line collisions alone could reach as high as 300,000 birds per year (CEC 2002a; CEC 2002b).

Wildlife-vehicle collisions are a large and growing concern among public transportation departments, conservation organizations and agencies, and the driving public. Wildlife-vehicle collisions are a safety concern for drivers and a conservation concern for most animal species. Recently, Loss et al. (2014) estimated that between 89 and 340 million birds may die per year in the US from collisions with vehicles. Many public transportation departments are trying different methods of reducing wildlife-vehicle collisions, including fencing roadways and providing crossing structures across the right-of-way to allow safe animal passage.

The California Roadkill Observation System (CROS), a site created by UC Davis's Road Ecology Center (REC), records the locations of roadkill observations on major highways and freeways and includes records of carcasses cleaned up by the California Department of Transportation between 1987 and 2007. Using data from the CROS, the REC identifies stretches of California highways that are likely to be hotspots (i.e., stretches of highway that are statistically different from other stretches) for wildlife-vehicle collisions. The CROS accounts for both observed animal carcasses and traffic incidents, which can range from wildlife sightings on the roadway to wildlife-vehicle collisions. In 2016, in the RCIS area, I-5, I-80, and SR 113 were analyzed by the REC. There were three hotspots identified in the southern region the RCIS area along I-80 between Sacramento and Davis, along I-5 near Woodland, and north of Woodland along SR 113. Most of the observations in the RCIS area include various species birds and medium (e.g., bobcat, coyote, raccoon) and large mammals (e.g., wild pig, mountain lion, mule deer).

2.11.7.2 Effects on Other Conservation Elements

As described above, habitat connectivity is greatly affected by linear infrastructure, including roads and utility lines. Natural communities are also affected by removal. Conversion to roads is an obvious effect of development, but roads also support introduction of pollutants (e.g., gar oil and grease), litter, and sometime movement of invasive species. In the case of linear utilities, lands may be converted from a forested community to a grassland community. This is particularly true of power lines where downed trees disrupting service or starting wildfires is of great concern. Linear facilities do not have any particular adverse effects on working lands in the RCIS area

2.12 Regional Conservation Planning Environment

2.12.1 Natural Community Conservation Plans and Habitat Conservation Plans in the Strategy Area

The California Fish and Game Code Section 1852(c)(10) requires that an RCIS include "provisions ensuring that the strategy is consistent with and complements any administrative draft natural community conservation plan, approved natural community conservation plan, or federal habitat conservation plan that overlaps with the strategy area." The Yolo HCP/NCCP and six other HCPs overlap with the Yolo RCIS/LCP strategy area and are described below.

2.12.1.1 Yolo HCP/NCCP

The *Yolo Habitat Conservation Plan/Natural Community Conservation Plan* (Yolo HCP/NCCP) is a countywide plan to provide for the conservation of 12 sensitive species and the natural communities and agricultural land on which they depend. The Yolo HCP/NCCP provides a streamlined permitting process and countywide conservation strategy to address the effects of a range of future anticipated activities on the 12 covered species. These species include the following:

- Palmate-bracted bird's-beak (*Cordylanthus palmatus*)
- Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)
- California tiger salamander (*Ambystoma californiense*)
- Western pond turtle (*Actinemys marmorata*)
- Giant garter snake (*Thamnophis gigas*)
- Swainson's hawk (*Buteo swainsoni)*
- White-tailed kite (*Elanus leucurus*)
- Western yellow-billed cuckoo (*Coccyzus americanus*)
- Western burrowing owl (*Athene cunicularia hypugaea*)
- Least Bell's vireo (*Vireo bellii pusillus*)
- Bank swallow (*Riparia riparia*)
- Tricolored blackbird (*Agelaius tricolor*)

The Conservancy, which consists of Yolo County and the incorporated cities of Davis, West Sacramento, Winters, and Woodland, as well as UC Davis as an ex officio member, developed the Yolo HCP/NCCP. The Yolo HCP/NCCP provides the basis for issuance of 50-year permits under the federal Endangered Species Act (FESA) and California Natural Community Conservation Planning Act (NCCPA) that cover an array of public and private activities, including activities that are essential to the ongoing viability of Yolo County's agricultural and urban economies. Specifically, the Yolo HCP/NCCP will provide the Permittees (i.e., Yolo County, the four incorporated cities, and the the Conservancy) with incidental take authorizations from both the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) for the 12 covered species. In addition to the Permittees, the Yolo HCP/NCCP permits may cover the activities of other entities through certificates of inclusion.

2.12.1.2 UC Davis HCPs

The University of California, Davis, developed the La Rue Housing/Bowley Center (HCP) as part of its application to the U.S. Fish and Wildlife Service (Service) for an incidental take permit pursuant to section 10(a)(1)(B) of the federal Endangered Species Act of 1973 to construct the La Rue Housing/Bowley Center, a new student housing facility. The permit authorized the incidental take of the valley elderberry longhorn beetle and modification of its habitat during construction of the La

Rue Housing/Bowling Center and a greenhouse/education facility. Specifically, the permit authorized removal of 14 elderberry shrubs with 168 stems greater than 1" in diameter.

The University agreed to implement the following measures to minimize and mitigate impacts that may have resulted from incidental take of the beetle: (1) conduct mitigation and monitoring of transplanted elderberry shrubs and supplemental plantings according to the Service's Mitigation Guidelines for the Valley Elderberry Longhorn Beetle, dated September 19, 1996; (2) transplant14 affected elderberry shrubs to a mitigation site along Putah Creek on Russell Ranch, property owned by the University; (3) plan 336 additional elderberry cuttings to compensate for any adverse impacts to the 14 elderberry shrubs resulting from the proposed project; and (4) manage the mitigation area for the purpose of long-term protection of valley elderberry longhorn beetle habitat.

Also in 2002, the UC Davis completed the Campus Projects HCP to cover impacts to the valley elderberry longhorn beetle from the following capital improvement and maintenance projects.

- Genome Launch Facility
- Cole Facility Stormwater Improvements
- Center for Companion Animal Health (CCAH)
- NEES Centrifuge Support Building
- Phase 2B Electrical Improvement Project

As a condition of these and other project approvals, UC Davis committed to (1) conduct project-specific surveys of VELB habitat; (2) avoid and protect VELB habitat where feasible; and (3) where avoidance is infeasible, develop and implement a VELB mitigation plan in accordance with the most current U.S. Fish and Wildlife Service (Service) Compensation Guidelines for unavoidable take of VELB (Service 1999) pursuant to Section 10(a) of the federal Endangered Species Act (ESA).

Mitigation included an additional 18 acres added into UC Davis' La Rue/Bowley Center HCP mitigation (140 acres) for a combination of 158 acres of mitigation between this HCP and the La Rue Housing/Bowley Center HCP. The combined impact of the two HCPs is 27 acres (17 from La Rue).

Total mitigation between the two HCPs totaled 158 acres along Putah Creek at Russell Ranch to compensate for a combined total impact of 27 acres (10 acres from the Campus Projects HCP and 17 from the La Rue HCP). The University also committed to transplant and affected shrubs to Russell Ranch, plant new elderberry shrubs, and monitor and manage the Russell Ranch habitat in perpetuity.

2.12.1.3 Teichert Esparto Mining Project HCP

Teichert and Son developed the Teichert Esparto Mining Project HCP (1999) to seek coverage for take of the federally listed VELB incidental to mining activity for the Esparto Mining Project in Yolo County. The incidental take occurred on a 98-acre site in Yolo County. The site supported four blue elderberry shrubs, which constituted VELB habitat and could be occupied by the species.

To mitigate for impacts that would result from the removal of the four valley elderberry shrubs, Teichert transplanted the four elderberry shrubs to an existing mitigation site along Cache Creek in Yolo County. Additionally, Teichert achieved a 2:1 mitigation ratio, consistent with Service mitigation guidelines, by designating, maintaining, and monitoring 22 elderberry replacement seedlings with associated native plants.

2.12.1.4 SMUD HCP

The Sacramento Municipal Utility District (SMUD) HCP, currently in preparation, would overlap with a small part of the southeast strategy area. SMUD is a locally controlled not-for-profit municipal utility. SMUD generates, transmits, and distributes electric power to serve an approximately 900-square-mile service area that includes almost all of Sacramento County and small portions of Placer, Amador, El Dorado, San Joaquin, and Yolo counties. SMUD also owns and operates 76 miles of natural gas pipeline in Sacramento County and Yolo County that serves four gas-fired cogeneration power plants. SMUD's existing electrical and natural gas pipeline infrastructure requires long-term maintenance to deliver reliable electricity. SMUD also owns and operates a 200-mile telecommunication system located on existing electric line poles and towers.

This HCP covers operations and maintenance of SMUD facilities for 15 covered species, 10 of which are Yolo RCIS/LCP focal species: Swainson's hawk, least Bell's vireo, tricolored blackbird, burrowing owl, giant garter snake, western pond turtle, California tiger salamander, western spadefoot, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

2.12.1.5 Solano County HCP

The Solano County Water Agency is preparing the Solano Multispecies Habitat Conservation Plan (Solano HCP). The Solano HCP accounts for all covered activities undertaken by or under the permitting authority and control of the Plan Participants within the approximately 585,000 acre Plan Area, which encompasses approximately 577,000 ac of Solano County and approximately 8,000 acres of Yolo County.. The HCP includes a small part of Yolo County for the purposes of covering activities within the Dixon Resource Conservation District Service Area and Reclamation District 2068 Service Area. The HCP conservation actions are focused almost entirely in Solano County.

Of the 36 species covered under the Solano HCP, 22 overlap as either a focal species or conservation species in this RCIS and six overlap with the Yolo County HCP/NCCP. The Solano County HCP conservation strategy is primarily implemented through project-specific avoidance, minimization, and mitigation requirements. With a goal or preserving approximately 30,000 acres in Solano County, creating a Reserve System is the backbone of the conservation strategy in the HCP. The extent to which the Reserve System is preserving, supporting, and maintaining viable populations of Covered Species, biological diversity, and ecosystem functions will determine the overall success of the HCP.

2.12.2 Safe Harbor Agreements

The USFWS and National Marine Fisheries Service (NMFS) established a Safe Harbor Policy under the federal Endangered Species Act of 1973, as amended (64 FR 32717). This policy is intended to incentivize the maintenance, enhancement, and restoration of habitat for listed species on non-federal lands by providing landowners that enroll their property under a Safe Harbor Agreement with assurances that no additional future regulatory burdens for "incidental take" will be placed on their property as a result of their voluntary conservation actions to benefit listed species.

Three Programmatic Safe Harbor Agreements that have spatial extents that overlap portions of the RCIS/LCP strategy area have been developed. These Programmatic Safe Harbor Agreements were each developed by organizations interested in partnering with landowners to conduct voluntary riparian ecosystem management, enhancement, and restoration activities that are anticipated to provide a net conservation benefit to federally-listed species.

2.12.2.1 Programmatic Safe Harbor Agreement for the Restoration of Riparian and Wetland Habitat

Audubon California entered into a 30-year Programmatic Safe Harbor Agreement with USFWS in 2007 to benefit valley elderberry longhorn beetle and giant garter snake in Yolo County. The Programmatic Safe Harbor Agreement has the following purposes.

- To promote ecosystem restoration, enhancement and management of native riparian and/or wetland habitats in Yolo County for the conservation of the valley elderberry longhorn beetle and/or giant garter snake,
- To provide certain regulatory assurances to landowners participating in such restoration, enhancement, and management activities, and
- To accomplish the foregoing without negatively affecting farming.

The lands eligible to enroll under this Safe Harbor Agreement include non-federal properties in Yolo County. The total area that may be restored to riparian and/or wetland habitat is expected to be less than 20,000 acres.

The Programmatic Audubon Safe Harbor Agreement currently has three agreements with landowners in place which are currently being overseen by the Sacramento River Forum under an MOU with Audubon California.

2.12.2.2 Sacramento River Conservation Area Forum Programmatic Safe Harbor Agreement

In 2013, the Sacramento River Conservation Area Forum entered into a 30-year Programmatic Safe Harbor Agreement with USFWS. The purpose of this Safe Harbor Agreement is to provide a net conservation benefit to the federally-threatened valley elderberry longhorn beetle and giant garter snake.

Properties eligible to enroll under this Safe Harbor Agreement include non-federal properties within or immediately adjacent to the Sacramento River Conservation Area. The Sacramento River Conservation Area extends approximately 222 miles of the Sacramento River and the adjacent 213,000 acres of land extending from Keswick Dam in Shasta County south to the town of Verona in Sutter County. The Sacramento River Conservation Area crosses through Butte, Glenn, Colusa, Shasta, Yolo, Sutter, and Tehama Counties. The natural community types generally found on lands eligible for enrollment into this Safe Harbor Agreement include riparian, California prairie, Valley oak woodland, and riverine along with cultivated lands seminatural community.

The Sacramento River Conservation Area Forum Safe Harbor Agreement currently has one landowner agreement in place and three others that are currently being discussed.

2.12.2.3 Safe Harbor Agreement for Valley Elderberry Longhorn Beetle

Solano County Water Agency entered into a 20-year Programmatic Safe Harbor Agreement with USFWS in 2014 for the restoration and management of valley elderberry longhorn beetle habitat within riparian areas along Putah Creek and its tributaries. Habitat conservation activities associated with this Safe Harbor Agreement include the planting of elderberry shrubs, allowing for the passive establishment of elderberry shrubs within remnant and newly created riparian corridors, removal of non-native invasive plant species, and the implementation of avoidance and minimization measures intended to reduce incidental take of the species.

Properties eligible to enroll under this Safe Harbor Agreement include all properties adjacent to Putah Creek and its tributaries from Montecello Dam to the Yolo Bypass in Solano and Yolo counties. The total riparian area eligible to enroll under this Safe Harbor Agreement is approximately 2,000 acres. Roughly half of that acreage is within the RCIS/LCP strategy area.

2.12.3 Other Regional Conservation Plans and Initiatives

2.12.3.1 Local Plans

Cache Creek Resources Management Plan

The Cache Creek Resources Management Plan (CCRMP) is part of the Cache Creek Area Plan (CCAP), a focused planning policy document that is part of the Yolo County General Plan. The CCRMP eliminated in-channel commercial mining (i.e., mining inside of the Cache Creek channel) and established a program for implementing ongoing projects to improve channel stability and restore riparian habitat along Cache Creek. The CCRMP provides a policy framework for restoration of 14.5 miles of lower Cache Creek and includes specific implementation standards. The Cache Creek Improvement Program (CCIP), the implementation plan for the CCRMP, identifies specific categories of projects; including bank stabilization, channel maintenance, revegetation, and habitat restoration. The CCRMP and CCIP are implemented with the assistance of a Technical Advisory Committee, which is composed of scientists with expertise in geomorphology, biology, and hydraulic engineering.

The CCRMP covers agriculture, aggregate resources, riparian and wildlife resources, floodway and channel stability, open space and recreation, and the cultural landscape. The CCRMP includes specific goals and objectives for each of the elements, with suggested policies for implementation. The County of Yolo adopted the CCRMP and CCIP in 1996 and amended it in 2002. The County released an update to both documents in May 2017 and expects the Yolo County Board of Supervisors to adopt the update by January 2018.

Yolo County developed the CCIP to implement the goals, objectives, actions, and performance standards of the CCRMP related to the stabilization and maintenance of the Cache Creek channel, The CCIP provides the structure and authority for a Technical Advisory Committee, defines the procedures and methodologies for stream monitoring and maintenance activities, and identifies initial high priority projects for stream bank? stabilization. The three major elements of the CCIP intended to promote a more stable Cache Creek channel include (1) identification of major channel stabilization projects; (2) identification of expected channel maintenance activities; and (3) establishment of a hydrologic monitoring program.

Capay Valley Watershed Stewardship Plan

In 2003, the Cache Creek Watershed Stakeholders Group and the Yolo Resource Conservation District developed the Capay Valley Watershed Stewardship Plan. This plan is a result of a concerted effort to refine a set of goals and objectives based on the resource issues defined at a series of public stakeholder meetings and an array of available data available from studies in the region. The recommended actions in this plan are directed on two levels: projects and recommended studies for the Stakeholders Group to undertake, and possible voluntary actions that landowners can either individually or collaboratively undertake to address the resource issues they identify on their properties. The goals of this plan include the following.

- Goal 1: To manage watershed lands to minimize unnatural rates of erosion and sedimentation.
- Goal 2: To use and manage both surface and ground water wisely to meet current and future needs.
- Goal 3: To maintain and improve water quality for all water users.
- Goal 4: To maintain and improve watershed habitats to support a diversity of native plants and animals.
- Goal 5: To promote land management practices that maintain and improve local natural resources and habitats and support a productive and sustainable agricultural economy.
- Goal 6: To promote a watershed approach for decisions involving Cache Creek by supporting communication and collaboration among all stakeholders.

The Capay Valley Watershed Stewardship Plan focusses on the Capay Valley reach of Cache Creek. This area has been defined by the Cache Creek Watershed Stakeholders Group as including the area from the Blue Ridge of the Coast Range in the west to the ridgetops of the Capay Hills in the east and encompasses an approximately 20-mile section of Cache Creek from Camp Haswell down to the Capay dam. The primary natural community types that occur within this plan area include: cultivated lands seminatural community, riparian, blue oak woodland, valley oak woodland, oak-foothill pine, California prairie, chamise chaparral, montane hardwood, and mixed chaparral.

Colusa Basin Watershed Management Plan

In 2012, the Colusa Resource Conservation District (RCD) developed the Colusa Basin Watershed Management Plan as a stakeholder-driven planning process. This Plan provides a non-regulatory, community-driven, framework intended to promote projects that serve multiple benefits and will sustain and enhance watershed functions in the Colusa Basin watershed while balancing human and natural resource needs.

Eight goals identified by the Colusa Basin Watershed stakeholders and technical advisory committee are included in the Colusa Basin Watershed Management Plan as priority concerns.

1. Protect, maintain and improve water quality
2. Promote activities to ensure a dependable water supply for current and future needs
3. Preserve agricultural land and open space
4. Manage and reduce invasive plant populations
5. Reduce destructive flooding
6. Enhance soil quality and reduce erosion
7. Preserve and enhance native habitat

8. Address unknown future effects of climate change

The Colusa Basin Watershed Management Plan includes approximately 1,045,445 acres. Approximately 175,483 acres of this plan are located in the northern portion of the RCIS/LCP strategy area.

Hungry Hollow Watershed Stewardship Plan

In 2011, the Hungry Hollow Watershed Stakeholders Group and the Yolo County Resource Conservation District developed the Hungry Hollow Watershed Stewardship Plan. Hungry Hollow is a small, agricultural region within a sub-watershed of the Lower Cache Creek Watershed in the RCIS area. The oak-covered ranchlands of the Capay Hills feed the watershed in the rainy season with a series of intermittent streams which cut through the alluvial plains and level out into a matrix of cropland, sloughs, canals, and irrigation ditches. With Yolo County's mild climate, highly managed irrigation systems, and naturally deep and rich soils, Hungry Hollow is a productive agricultural landscape.

The Hungry Hollow Watershed Stewardship Plan takes a comprehensive look at the health of the natural resources of Hungry Hollow and offers a collection of recommended actions. The plan provides a community- based framework for maintaining and improving watershed health in Hungry Hollow and can be used to guide the development of individual or collaborative action plans. It also provides the opportunity for neighboring landowners to work together to address important issues on their property. While the plan is focused on the Hungry Hollow watershed, it was developed to be complementary and supportive of other watershed work and plans that are underway or in place throughout the entire Cache Creek Watershed and the larger Bay-Delta watershed. Watershed.

The goals of Hungry Hollow Watershed Stewardship Plan are as follows.

- To manage watershed lands to minimize unnatural rates of erosion and sedimentation.
- To use and manage surface, groundwater, and stormwater wisely to meet current and future needs.
- To maintain and improve water quality for all water users.
- To maintain and improve watershed habitats to support a diversity of native plants and animals.
- To promote land management that supports a sustainable and productive agricultural economy.
- To promote a watershed approach for decisions involving Hungry Hollow by supporting communication and collaboration among all stakeholders.

The plan also contains a detailed list of objectives and actions, which are included in Appendix E.

Lower Putah Creek Watershed Management Action Plan

The Lower Putah Creek Watershed Management Action Plan was developed by the Lower Putah Creek Coordinating Committee (LPCCC), with input from watershed stakeholders, to provide a framework that identifies priority restoration and enhancement opportunities based on a comprehensive assessment of the watershed's resources. The LPCCC completed the resource assessment phase of the plan effort was completed in 2005 and the project identification phase of the effort in 2008. The overarching goal of the Lower Putah Creek Watershed Management Action

Plan is to restore and enhance the lower Putah Creek watershed to a self-sustaining ecological condition in a manner that is compatible with and respectful of landowner priorities, interests, and concerns. Lower Putah Creek is identified in this plan as the main channel and riparian corridor of Putah Creek from Monticello Dam to the Yolo Bypass. The "lower Putah Creek watershed" includes the tributaries of the main channel. The project types included in the plan are primarily focused on the instream and riparian areas of lower Putah Creek and include: channel restoration, bank stabilization, habitat enhancement, invasive plant removal, and trash cleanup.

Willow Slough Watershed Integrated Resources Management Plan

The Willow Slough Watershed Integrated Resources Management Plan was developed in 1996 as the culmination of a 2-year planning process that was initiated by the Yolo County Resource Conservation District, Yolo County Flood Control and Water Conservation District, Yolo County Community Development Agency, and the California Wildlife Conservation Board to evaluate and identify opportunities to manage natural resources throughout the Willow Slough watershed in an integrated manner.

The overarching goal of this plan is to enhance the natural resources throughout the watershed through a combination of small-scale projects implemented by individual landowners and the joint management of stormwater, erosion, sedimentation, agriculture, wildlife habitat, and groundwater recharge. The management goals in support of this overarching goal are as follows.

- Improve the quantity and quality of wildlife habitat.
- Maintain and enhance the physical and economic conditions for agriculture.
- Decrease problems associated with flooding.
- Decrease the cost of vegetation maintenance along roads and canals.
- Minimize undesirable sediment deposition.
- Minimize erosion and topsoil loss.
- Improve water quality.
- Increase groundwater recharge.

The Willow Slough Watershed Integrated Resources Management Plan covers approximately 104,960 acres of land, all of which is within the RCIS/LCP strategy area. The natural community types that occur within this plan area include: cultivated lands seminatural community, fresh emergent wetland, riparian, blue oak woodland, valley oak woodland, oak-foothill pine, montane hardwood, California prairie, chamise chaparral, and mixed chaparral.

Yolo County Oak Woodland Conservation and Enhancement Plan

In 2007, Yolo County developed the Yolo County Oak Woodland Conservation and Enhancement Plan to promote voluntary efforts to conserve and enhance oak woodlands in Yolo County. This plan covers the entire RCIS/LCP strategy area although the primary focus of this plan is on the 107,000 acres of oak woodland remaining in Yolo County. Oak woodlands are primarily located in the western portion of the county along with some small remnant stands and isolated patches scattered on the valley floor in areas adjacent to riparian areas. The natural communities that are subject to the conservation efforts of this plan include, oak-foothill pine, blue oak woodland, montane hardwood, and valley oak woodland. While Yolo County Oak Woodland Conservation and Enhancement Plan does not specifically target any focal or conservation species associated with the RCIS/LCP, the following RCIS/LCP focal/conservation species are identified within this plan as being commonly found in the natural communities that targeted by the plan: American badger, Cooper's hawk, golden eagle, oak titmouse, pallid bat, yellow-billed magpie, Swainson's hawk, western pond turtle, Valley elderberry longhorn beetle, yellow-billed cuckoo.

The following are the stated goals of the Yolo County Oak Woodland Conservation and Enhancement Plan.

- Protect existing oak woodlands by creating a voluntary system, including landowner incentives, for conservation and enhancement of oak woodlands.
- Encourage the development of land use and infrastructure planning strategies that are consistent with oak woodland conservation efforts.
- Direct conservation and enhancement funding and effort to areas that have the highest oak woodland resource values.
- Direct mitigation for oak woodland impacts to areas that have the highest oak woodland resource values and are in need of protection.
- Encourage the long-term stewardship of existing oak woodlands to maintain or improve oak woodland resource values.
- Provide funding and technical assistance for oak woodland enhancement efforts that help achieve multiple benefits.
- Increase the area covered by valley oak and other oak species that are now uncommon in Yolo County because they have been cleared from much of their historical range in the county.
- Maximize the total amount of oak woodland canopy cover to achieve erosion, flood, and air quality protection benefits, while recognizing the importance of including a variety of canopy cover levels within conserved and restored woodlands to provide habitat diversity.
- Coordinate oak woodland conservation and enhancement efforts with the Yolo HCP/NCCP, the Cache Creek Resources Management Plan, and other local and state applicable conservation plans.

2.12.3.2 State Plans and Initiatives

Central Valley Flood Protection Plan and Conservation Strategy

The Central Valley Flood Protection Plan (CVFPP) is a strategic and long-range plan for improving flood risk management in the Central Valley. Prepared by the California Department of Water Resources (DWR) in accordance with the Central Valley Flood Protection Act of 2008 (Act) and adopted by the Central Valley Flood Protection Board (CVFPB) in June 2012 , the CVFPP is a critical document to guide California's participation (and influence federal and local participation) in flood risk management in the Central Valley (DWR 2012). The CVFPP proposes a systemwide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control (SPFC). The CVFPP is required to be updated every five years, with each update providing support for subsequent policy, program, and project implementation (DWR 2012).

The 2017 CVFPP Update (DWR 2017) is the first major 5-year update to the CVFPP in accordance with the Act. It updates and refines the overall near- and long-term investment needs established in the 2012 CVFPP, and includes recommendations on policies and funding to support comprehensive flood risk management actions. The planning efforts supporting the 2017 CVFPP Update (DWR 2017) were developed in close coordination with State, federal, and regional partners, and were informed by a multiyear stakeholder engagement process initiated in 2012.

The approach for developing the 2017 CVFPP Update (DWR 2017) focused on refining the systemwide investment approach through several technical studies, regional plans, and flood management system document updates completed since 2012, all supported with robust and ongoing communications and engagement with partners and stakeholders. CVFPP also aligned its approach with major statewide strategic plans and desired outcomes: the California Water Action Plan, California Water Plan, and California's Flood Future. This update process brings together technical and policy-level information to refine the systemwide investment approach and its associated cost estimates, funding, and phasing over the next 30 years. The resulting 2017 refined systemwide investment approach portfolio provides a comprehensive set of management actions and investments needed to manage flood waters for the SPFC and produce desired outcomes in the Central Valley.

CVFPP Conservation Strategy (DWR 2016)

The Conservation Strategy is an important component of the 2017 CVFPP Update (DWR 2017). It is a planning document that focuses on the improvement of ecosystem functions and describes the basis for recommending conservation actions and setting long-term goals and measurable objectives.

The goals of the CVFPP Conservation Strategy focus on promoting ecosystem functions.

- Ecosystem Processes—Improve dynamic hydrologic (flow) and geomorphic processes in the State Plan of Flood Control.
- Habitats—Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats.
- Species—Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.
- Stressors—Reduce stressors related to the development and operation of the State Plan of Flood Control and negatively affect at-risk species.

The CVFPP Conservation Strategy identifies and provides focused conservation plans for 19 target species; 13 of these target species are included as focal or conservation species in this RCIS (DWR 2016). The CVFPP Conservation Strategy identifies specific tools and approaches to improve riverine and floodplain ecosystems to benefit fish and wildlife through multi-benefit projects (DWR 2016). The CVFPP Conservation Strategy identifies five Conservation Planning Areas; the strategy area is within the Lower Sacramento River Conservation Planning Area (DWR 2016).

Lower Sacramento/Delta North Regional Flood Management Plan

The Regional Flood Management Plan (RFMP) for the Lower Sacramento/Delta North Region (Region) is the regional follow-on to the 2012 CVFPP. The RFMP establishes the flood management vision for the region and identifies regional solutions to flood management problems at a prefeasibility level. FloodProtect, a regional working group comprised of the counties, cities, flood management agencies, local maintaining agencies (LMA), water agencies, emergency response agencies, citizen groups, tribes, and other interested stakeholders in the region developed the RFMP which focuses on a geographic area including portions of Solano, Yolo, Sacramento, and Sutter Counties. One of the RFMP's objectives is to develop solutions that promote agricultural preservation, environmental enhancement, and protection of existing cultural resources, while anticipating the effects of climate change. In support of this objective, the FloodProtect team worked closely with stakeholders to identify multi-benefit flood control projects that combine flood risk reduction with habitat restoration, agricultural sustainability, recreational opportunities, and cultural resource protection. During the planning process, the FloodProtect team identified 15 Potential Conservation Sites (PCS), which are detailed in Appendix A*: Potential Conservation Sites, of the RFMP. N*ine of the PCS's are located in Yolo County. The RFMP planning process also led to the development of the Yolo Bypass/Cache Slough Integrated Water Management Plan (IWMP), which seeks to provide system-wide flood benefits through modifications to the Yolo Bypass while simultaneously implementing significant habitat conservation, water supply, and agricultural sustainability improvements.

Sacramento River Basin-Wide Feasibility Study

The Sacramento River Basin-Wide Feasibility Study (BWFS) evaluates options for improving the bypass system, including potential expansion of the Yolo Bypass and Sacramento Bypass within the strategy area. It includes detailed feasibility evaluations of various combinations of levee setbacks, weir expansions, new bypass channels, and storage management opportunities, with integrated ecosystem restoration actions. The integrated ecosystem restoration actions are described in and analyzed in two appendices to the BWFS.

- Appendix I-E: Yolo Bypass Ecosystem Concept Development and Modeling - describes the purpose, methodology, and results of integrating refined ecosystem enhancements with flood improvements in the Yolo Bypass
- Appendix I-J: Yolo Bypass Ecosystem Restoration Benefit Analysis - describes in detail the ecosystem benefit analyses for ecosystem enhancements within the Yolo Bypass at conceptual level.

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan

On June 4, 2009, the National Marine Fisheries Service (NMFS) issued a Biological Opinion and Conference Opinion on the Long-Term Operation of the Central Valley Project (CVP) and SWP (NMFS Operation BO). The NMFS Operation BO concluded that, if left unchanged, CVP and SWP operations were likely to jeopardize the continued existence of four federally listed anadromous fish species: Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, and Southern Distinct Population Segment (DPS) North American green sturgeon. The NMFS Operation BO sets forth Reasonable and Prudent Alternative (RPA) actions that would allow continuing SWP and CVP operations to remain in compliance with the FESA. DWR and the U.S. Bureau of Reclamation (Reclamation) jointly prepared the *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Draft Implementation Plan* to address two specific RPA Actions set forth in the NMFS Operation BO.

- RPA I.6.1: Restoration of floodplain rearing habitat, through the increase of seasonal inundation within the lower Sacramento River basin.

- RPA I.7: Reduction of migratory delays and loss of salmon, steelhead, and sturgeon, through the modification of Fremont Weir and other structures of the Yolo Bypass.

RPA Action I.6.1 (Restoration of Floodplain Rearing Habitat) requires increased seasonal inundation in the lower Sacramento River Basin, and RPA Action I.7 (Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass) requires multispecies fish passage improvements and assessment of their performance. While there are some differences in the requirements of the NMFS (2009) BiOp, RCIS actions will be consistent with and/or complement those required as RPAs.

In addition to proposing improvements to fish passage at the Fremont Weir in the Yolo Bypass consistent with the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan, the U.S. Bureau of Reclamation and the California Department of Water Resources are proposing to build an operable gate in the Fremont Weir to increase the frequency and duration of flooding for endangered fish species in the Yolo Bypass. The agencies will release the Public Review Draft EIS/EIR in November 2017 and expect to construct the project in 2021 or 2022.

Yolo Bypass Wildlife Area Land Management Plan

The Yolo Bypass Wildlife Area Land Management Plan guides the management of habitats, species, appropriate public use, and programs in the Yolo Bypass Wildlife Area. The Yolo Bypass Wildlife Area is located within the historic Yolo Basin of the Sacramento Valley and is part of the CDFW's Bay-Delta Region. It lies almost entirely within the Yolo Bypass in Yolo County, between the cities of Davis and West Sacramento. The Yolo Bypass Wildlife Area is made up of 17 different management units totaling approximately 16,770 acres of managed wildlife habitat and agricultural land within the Yolo Bypass.

The Yolo Bypass Wildlife Area is known to support special-status wildlife species, including many RCIS focal species. Common vegetation communities found within the Yolo Bypass Wildlife Area include seasonal and permanent wetlands, annual grasslands, riparian scrub and woodlands, vernal pools and swales, and row crop-seasonal wetlands. The primary purpose of the Yolo Bypass Wildlife Area is to manage and maintain habitat communities for waterfowl species, shorebird and wading bird species, upland game species, and many other bird species. Although management of habitat for waterfowl, shorebirds, and other bird species is a primary management goal in the Yolo Bypass Wildlife Area, the plan recognizes the importance of the Wildlife Area to other purposes, some of which are illustrated in the following goals.

- **Agricultural Resources Goal 1 (AR-2):** Manage agricultural lands to contribute to the agricultural community, to maintain agriculture as a viable economic activity in Yolo County, and to provide revenue for continued operation of the Wildlife Area.
- **Special Species Goal 1 (SS-1):** Without specifically managing for special-status species, the communities at the Yolo Bypass Wildlife Area should be managed in a way that generally improves overall habitat quality for species abundance and diversity while not discouraging the establishment of special-status species.
- **Public-Use Goal 1 (PU-1):** Increase existing and provide new long-term opportunities for appropriate wildlife dependent activities by the public.
- **Facilities Goal 1 (F-1):** Management and operation of the Yolo Bypass Wildlife Area in coordination with state and federal flood operations in the Yolo Bypass.

- **Scientific Research and Monitoring Goal 1 (SRM-1):** Support appropriate scientific research and monitoring and encourage or conduct research that contributes to adaptive management strategies and management goals of the Yolo Bypass Wildlife Area.
- **Management Coordination Goal 1 (MC-1):** Coordinate with federal, state, and local agencies regarding plans and projects that may affect habitats and/or management at the Yolo Bypass Wildlife Area.

California *EcoRestore*

The California Natural Resources Agency is coordinating California *EcoRestore*, a state initiative to help coordinate and advance 30,000 acres of habitat restoration in the Sacramento–San Joaquin Delta (Delta) by 2020, which is mandated by Biological Opinion requirements and other existing state and federal projects. Driven by the best available science, guided by adaptive management, and implemented through multiagency coordination and management, California *EcoRestore* intends to implement habitat restoration projects with clearly defined goals, measurable objectives, and financial resources to help ensure success.

The program includes a broad range of habitat restoration projects, including aquatic, sub-tidal, tidal, riparian, floodplain, and upland ecosystems. The first project under the *EcoRestore* initiative was the Wallace Weir Fish Rescue Facility, near the downstream end of the Knights Landing Ridge Cut where it enters the Yolo Bypass, near Woodland in the RCIS/LCP strategy area. The project started construction in August 2016[4] and was finished in January of 2018.

Delta Plan

In November 2009, the State of California enacted comprehensive legislation to address the range of challenges facing the Sacramento–San Joaquin Delta, including those involving water supply reliability and ecosystem health. The legislation enacting the Delta Plan advances several broad goals with regard to the Delta and specifies a range of actions to meet those goals. Among the several goals stated in the legislation is the following:

> Achieve the two co-equal goals of providing for a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The co-equal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

The Delta legislation includes the Sacramento–San Joaquin Delta Reform Act of 2009 (California Water Code 35), which provides for the establishment of an independent state agency, the Delta Stewardship Council, to further the goals of ecosystem restoration and a reliable water supply. The council, which became operational on February 3, 2010, is charged with the development and implementation of the comprehensive Delta Plan, and is vested with the authority to review actions of state and local agencies and advise on their consistency with the Delta Plan.

The Plan outlines six such zones where conservation measures are needed: the Yolo Bypass; the floodplain west of Sacramento into which the Sacramento River spills in wet years; the Cache Slough Complex, where the Bypass rejoins the body of the Delta; a nexus in the eastern Delta, where the Mokelumne River and the Cosumnes River add their strands to the Delta's web; a zone in the southern Delta along the San Joaquin River; a collection of small tracts at the western apex of the

[4] See http://www.rd108.org/wallace-weir-redevelopment/

Delta, where it narrows to meet Suisun Bay; and finally the Suisun Marsh, fringing that bay to the north. Conservation measures under the plan that would occur within the strategy area include.

- *Yolo Bypass*. Enhance the ability of the Yolo Bypass to flood more frequently to provide more opportunities for migrating fish, especially Chinook salmon, to use this system as a migration corridor that is rich in cover and food.
- No encroachment shall be allowed or constructed in the Yolo Bypass unless it can be demonstrated by appropriate analysis that the encroachment will not have a significant adverse impact on floodplain values and functions.
- *Cache Slough Complex*. Create broad nontidal, freshwater, emergent-plant-dominated wetlands that grade into tidal freshwater wetlands, and shallow subtidal and deep open-water habitats. Also, return a significant portion of the region to uplands with vernal pools and grasslands.

Delta Conservation Framework

The California Department of Fish and Wildlife, along with federal, state, and local agencies, and the Delta stakeholder community to developed a high-level conservation framework for the Sacramento-San Joaquin Delta, Yolo Bypass and Suisun Marsh. Building on prior Delta planning efforts, the draft *Delta Conservation Framework,* which was released in January 2018*,* will serve as the long-term continuation of *California EcoRestore*, a recent Delta restoration implementation initiative led by the California Natural Resources Agency. The *Delta Conservation Framework* will be one of the documents used to update the ecosystem elements of the Delta Stewardship Council's Delta Plan in 2018 and guide Delta conservation efforts to 2050.

The Delta Conservation Framework will do the following.

- Provide a shared vision and overarching goals for Delta conservation.
- Offer a forum for collaborative engagement and broad buy in.
- Inform the amendment of the ecosystem elements of the Delta Plan.
- Lay out a path for integrating stakeholder concerns into landscape scale goal setting and regional conservation strategies.
- Acknowledge challenges, potential regulatory conflicts, and other barriers to conservation project implementation.
- Solicit and integrate local, state, and federal agency feedback to ensure alignment with Habitat Conservation Plans/Natural Community Conservation Plans and other conservation opportunities.
- Inform State funding priorities.

Implementation goals of the Delta Conservation Framework are focused on achieving desired conservation and Delta community benefits by: 1) integration of Delta community and conservation goals; and 2) preservation, enhancement, restoration, and adaptive management of the function of Delta ecosystems. Conservation benefits of the framework include the following.

- ***Ecosystem Function*** includes Delta conservation practices that improve or reestablish ecological processes as a result of expected changes and major associated uncertainties in the future. This will nurture ecosystem resilience in the face of continued pressures.

- ***Delta Community and Agricultural Benefits*** include agricultural sustainability, low-impact recreation and tourism, including fishing, hunting, bird watching, and flood protection.
- ***Biophysical Benefits*** include natural functional flows, improved water quality, subsidence reversal, and carbon sequestration.
- ***Ecological Benefits*** include natural communities dominated by native species, self-sustaining populations of special status species, expanding total available habitat and patch size for targeted species and communities, improving connectivity, and reestablishing mosaics of complementary habitat types.
- ***Multiple-outcome Benefits*** result from projects that promote strategies that combine biophysical, ecological, and Delta community benefits. Examples include wildlife-friendly farming and low-impact outdoor recreation including boating, birding, fishing, and hunting.

Within the RCIS strategy area, the Delta Conservation Framework addresses opportunities for conservation as well as offering potential solutions for recognized challenges of conservation. The Yolo Bypass offers notable conservation value for wildlife species associated with floodplains, tidal wetlands, and riparian zones. This includes resident and anadromous fish and focal species such as spring-run and fall-run Chinook salmon, green sturgeon, white sturgeon, and Sacramento splittail. Other RCIS focal wildlife species which utilize the Yolo Bypass habitats include Swainson's haw, giant garter snake, and tricolored blackbird. The UC Davis Center for Watershed Sciences has identified Yolo Bypass as a primary component of the "North Delta Habitat Arc" (California Department of Fish and Wildlife 2018). It consists of a reconciled ecosystem strategy to create an arc of habitats connected by the flows of the Sacramento River. The Yolo Bypass is the upstream end of the arc, which continues through the Cache-Lindsey Slough-Liberty Island region, down the Sacramento River including Twitchell and Sherman Islands, and into Suisun Marsh. There are also opportunities for collaborative habitat restoration planning in the bypass, through the development and implementation of HCP and HCP/NCCPs, including the Yolo County Natural Heritage Program HCP/NCCP, the South Sacramento HCP, and California *EcoRestore*.

The Delta Conservation Framework also discusses several challenges to conservation within the Yolo Bypass as well as potential solutions. Land ownership and land uses within the Yolo Bypass are varied and should be taken into account when planning and implementing conservation projects. Public access in the Yolo Bypass is available at the Fremont Weir Wildlife Area for hunting, and the Yolo Bypass Wildlife Areas is managed for hunting, wildlife viewing, and environmental education, as well as agricultural activities. Parcels in the northern Bypass (north of highway 80, Figure 6) are owned by four private landowners and the state (Fremont Weir Wildlife Area), whereas a large portion of the southern part (south of highway 80) is state-owned (Yolo Bypass Wildlife Area) and includes a lot of smaller parcels and landowners. In the north, land uses are focused on fisheries management, larger scale agriculture, and some waterfowl hunting.

In the Yolo Bypass, floodplain-related conservation goals to provide extended inundation to promote juvenile salmonid rearing habitat, or tidal restoration related goals to improve the Delta food web, have the potential to conflict with existing agricultural land uses and improved recreation and public access, particularly for hunting, nature viewing, and education. Increased tidal restoration in the southern Bypass may also create the need for mosquito control and the potential for mercury contamination

The Delta Conservation Framework proposed potential solutions to these conservation challenges identified within the Yolo Bypass and include the following.

- Wildlife Friendly Agriculture
- Integrated Flood Management
- Low-Impact Recreation
- Climate Change Adaptation

The Delta Conservation Framework is a high-level conservation planning framework with a landscape-scale focus across the entire Delta, Suisun Marsh, and Yolo Bypass. It provides overarching goals and landscape-scale strategies with targeted objectives that could be integrated at the finer scale by regional conservation planning partnerships that develop Regional Conservation Strategies. Together, the existing partnerships in the Yolo Bypass could lead to the development of a long term Yolo Bypass RCIS. This would afford landscape-scale integration of the existing Yolo Bypass plans, tying them in with the Delta Conservation Framework's landscape scale goals and strategies.

Fish Restoration Program Agreement Implementation Strategy

The Fish Restoration Agreement (FRPA) program is a joint effort between DWR and CDFW in coordination with USFWS, NMFS, and Reclamation to satisfy DWR's requirements for habitat restoration and related actions to benefit fish under the Biological Opinion for the CalWaterFix project..

The goals of FRPA, as mutually agreed upon by DWR and CDFW, are as follows.

- Restore 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh, including 800 acres of mesohaline habitat to benefit longfin smelt, to enhance food production and availability for native Delta fishes.
- Restore processes that will promote primary and secondary productivity and tidal transport of resources to enhance the pelagic food web in the Delta.
- Increase the amount and quality of salmonid rearing and other habitat.
- Increase through-Delta survival of juvenile salmonids by potentially enhancing beneficial migratory pathways.

DWR and CDFW, along with other agencies and interested stakeholders will collaborate on the planning and design of project alternatives as well as developing monitoring and adaptive management plans for each restoration site. DWR will assume the lead role in project oversight, construction, contracting, and management with assistance from CDFW. Restoration targets in the RCIS strategy are includes areas within the Cache Slough Complex and Yolo Bypass.

Planned restoration projects within the Cache Slough Complex include the following.

- Lower Yolo Restoration Site
- Prospect Island
- Calhoun Cut

Within the Yolo Bypass, near-term habitat restoration actions include the following.

- Fremont Weir

- Tule Canal Connectivity
- Putah Creek
- Lisbon Weir

Environmental compliance and permitting is an integral component of action implementation. Individual projects will be subject to CEQA and possibly NEPA analysis. DWR is anticipated to be lead for most FRPA restoration actions. However, CDFW or other project proponents may implement actions. The FRPA program is funded in whole by DWR through State Water Project (SWP) funding to meet permit compliance for SWP Delta operations. Plans for individual restoration projects shall include DWR funding sufficient to accomplish full implementation of the action.

2.12.4 Species Recovery Plans

Recovery of endangered or threatened animals and plants to the point where they are again secure, self-sustaining members of their ecosystems is a primary goal of our endangered species program and the Endangered Species Act of 1973, as amended (FESA; 16 U.S.C. 1531 et seq.). Recovery means improvement of the status of listed species to the point at which listing is no longer appropriate under the criteria specified in section 4(a)(1) of the Act. A recovery plan is one of the most important tools in the recovery process. It provides a sound scientific foundation and guides decision-making for partners implementing the plan and its actions. Recovery plans provide a framework for targeting conservation efforts and modifying actions based on new science and changing circumstances. Recovery plans provide guidance and are voluntary; they do not have the force of law. As such, the success of recovery efforts ultimately depends on partnerships and cooperation to ensure the implementation of actions to advance species' long-term recovery.

A species recovery plan includes scientific information about the species and provides criteria that enable USFWS to gauge whether downlisting or delisting the species is achievable. Recovery plans help guide recovery efforts by describing actions that USFWS consider necessary for each species' conservation and by estimating time and costs for implementing needed recovery measures.

Recovery plans focus on restoring the ecosystems on which a species is dependent, reducing threats to the species, or both. A recovery plan constitutes an important USFWS document that presents a logical path to recovery of the species based on what we know about the species' biology and life history, and how threats impact the species. Recovery plans help to provide guidance to the USFWS, States, and other partners on ways to eliminate or reduce threats to listed species and measurable objectives against which to measure progress toward recovery. Recovery plans are advisory documents, not regulatory documents, and do not substitute for the determinations and promulgation of regulations required under section 4(a)(1) of the FESA. A decision to revise the listing status of a species or to remove it from the Federal List of Endangered and Threatened Wildlife (50 CFR 17.11) or Plants (50 CFR 17.12) is ultimately based on an analysis of the best scientific and commercial data available to determine whether a species is no longer an endangered species or a threatened species.

2.12.4.1 California Tiger Salamander

The Central California Distinct Population Segment (DPS) of the California tiger salamander (*Ambystoma californiense*) was listed as threatened on August 8, 2004 (U.S. Fish and Wildlife Service 2004). USFWS published a final rule designating critical habitat for the Central California tiger salamander on August 23, 2005 (U.S. Fish and Wildlife Service 2005). California listed the California tiger salamander throughout its entire range as threatened on August 19, 2010 (California Fish and Game Commission 2010). The Central California tiger salamander is restricted to disjunct populations that form a ring along the foothills of the Central Valley and Inner Coast Range from San Luis Obispo, Kern, and Tulare Counties in the south, to Sacramento and Yolo Counties in the north.

The strategy to recover the Central California tiger salamander focuses on alleviating the threat of habitat loss and fragmentation to increase population resiliency (i.e., ensure each population is sufficiently large to withstand stochastic events), redundancy (i.e., ensure a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events), and representation (i.e., conserve the breadth of the genetic makeup of the species to conserve its adaptive capabilities). Recovery of this species can be achieved by addressing the conservation of remaining aquatic and upland habitat that provides essential connectivity, reduces fragmentation, and sufficiently buffers against encroaching development and intensive agricultural land uses. Appropriate management of these areas will also reduce mortality by addressing threats not related to habitat, including those from nonnative and hybrid tiger salamanders, other nonnative species, disease, and road mortality.

The goal of this recovery plan is to reduce the threats to the Central California tiger salamander to ensure its long-term viability in the wild and allow for its removal from the list of threatened and endangered species. The following are recovery objectives of the plan.

1. Secure self-sustaining populations of Central California tiger salamander throughout the full range of the DPS, ensuring conservation of genetic variability and diverse habitat types (e.g., across elevation and precipitation gradients).
2. Ameliorate or eliminate the threats that caused the species to be listed, and any future threats.
3. Restore and conserve a healthy ecosystem supportive of Central California tiger salamander populations.

2.12.4.2 Delta Smelt and Other Fish

The U.S. Fish and Wildlife Service listed the Delta smelt [*Hypomesus transpacificus*] as a threatened species in 1993 (U.S. Fish and Wildlife Service 1993). The USFWS released the *Sacramento-San Joaquin Delta Native Fishes Recovery Plan* in 1996 to outline a recovery strategy for the Delta smelt, as well as the following fish species.

- Sacramento splittail (listed as threatened in the 1999 and changed to a species of special concern in 2003)
- longfin smelt (listed in 2009 under state ESA)
- southern green sturgeon (listed in 2006)
- spring-run (listed as threatened in 1999), late-fall-run Chinook, and San Joaquin fall-run Chinook salmon
- Sacramento perch (species of concern)

The *Sacramento-San Joaquin Delta Native Fishes Recovery Plan* proposed to not only recover the delta smelt (as required by FESA), but to provide a strategy for the conservation and restoration of the entire Sacramento-San Joaquin Delta, focusing on native fishes. The plan outlines a recovery strategy to manage the estuary in a way that provides better habitat for native fish in general and delta smelt in particular. According to the plan, improved habitat would increase the distribution of the delta smelt throughout the Delta and Suisun Bay. At the time of publication, most of the fish covered by the plan (with the exception of delta smelt) were species of special concern. Three of the species have been listed under either the state or federal Endangered Species Act (or both) since the plan was published.

The Sacramento-San Joaquin Delta Native Fishes Recovery Plan provides restoration objectives and restoration criteria for each of the eight species, with a focus on restoring delta smelt to a population and distribution pattern similar to those that existed from 1967-1981 because data demonstrated that populations stayed reasonably high in most years during this period. The recovery plan outlines an ambitious implementation schedule to accomplish over 70 management actions. The management actions in the plan focus on reestablishment of spawning habitat, migration corridors, and rearing areas in upstream areas, the Delta, and Suisun Bay and Marsh. The actions cover a broad range of activities, such as increasing freshwater flows, reducing entrainment losses to water diversions, reducing the effect of contaminants, regulating ship ballast discharges, and other measures. The plan stresses that active management will be required for the near future to enhance and restore aquatic habitat to reverse declines of native fish and recover numbers and distributions to historical levels.

2.12.4.3 Giant Garter Snake

The U.S. Fish and Wildlife Service listed the giant garter snake (*Thamnophis gigas*) as a threatened species on October 20, 1993 (U.S. Fish and Wildlife Service 1993) under FESA, as amended. Since the 1993 listing rule, threats assessments and reviews of the biological status for the species were conducted in 5-year increments in 2006 and 2012 (U.S. Fish and Wildlife Service 2006a, 2012). The FESA requires the development of recovery plans for listed species, unless such a plan would not promote the conservation of a particular species. In 2015, USFWS released the *Revised Draft Recovery Plan for Giant Garter Snake* and in October 2017 USFWS released the final and signed *Recovery Plan the Giant Garter Snake* (*Thamnophis gigas*)[5] (U.S. Fish and Wildlife Service 2017). The recovery plan provides a framework for the recovery of species so that protection under the Act is no longer necessary.

The goal of the recovery plan is to improve the status of giant garter snake so that it can be delisted. To meet the recovery goal of delisting the species, the USFWS identified the following objectives in the *Recovery Plan for Giant Garter Snake.*

1. Establish and protect self-sustaining populations of the giant garter snake throughout the full ecological, geographical, and genetic range of the species.
2. Restore and conserve healthy Central Valley wetland ecosystems that function to support the giant garter snake and its community members.
3. Ameliorate or eliminate, to the extent possible, the threats that caused the species be listed or are otherwise of concern, and any foreseeable future threats.

The recovery strategy for the giant garter snake focuses on protecting existing, occupied habitat, and identifying and protecting areas for habitat restoration, enhancement, or creation including areas

[5] https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=C057

necessary to provide connectivity between populations. Appropriate management for all giant garter snake conservation lands will ensure the maintenance of stable and viable populations in occupied areas, and promotes the colonization in restored and enhanced unoccupied habitat. USFWS defined nine recovery units that correspond directly to the nine geographically and genetically distinct populations, to aid in the recovery planning: Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin, Delta Basin, Cosumnes–Mokelumne Basin, San Joaquin Basin, and Tulare Basin.

According to the recovery plan, habitat must be preserved in multiples of two block pairings of habitat. Each block pair should consist of one, at least 539-acre block of contiguous buffered perennial wetland habitat (existing, restored or enhanced) and one at least 1,578-acre block of contiguous active ricelands separated by no more than 5 miles. Alternatively, a pair of blocks may consist of two 539-acre blocks of buffered perennial wetlands. All pairs of habitat blocks must be connected with the other pairs of habitat blocks within and between the management units by corridors of suitable habitat, and recovery units should be connected to one another by similar corridors. The recovery plan selected paired habitat blocks because perennial wetlands are known to support core populations of giant garter snake throughout a wide range of hydrologic conditions, and rice fields and the associated water conveyance infrastructure provide habitat for the species when the fields are in active production. The size requirement of the perennial wetland habitat block is derived from Wylie et al. (2010, in USFWS 2017), which reported a self-sustaining population of giant garter snake is supported by 539-acres of perennial wetlands; additionally, this amount of perennial wetland is similar to amounts preserved in several giant garter snake conservation banks. The size requirement of the rice lands also originates from Wylie et al. (2010, in USFWS 2017). These values represent the target sizes for perennial wetlands and rice lands, not the minimum or maximum acreage.

2.12.4.4 Salmon and Steelhead

In July 2014, NOAA Fisheries released the Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. The recovery plan is guided by the best available science. It includes a range of actions to restore winter- and spring-run Chinook salmon, steelhead, and their habitats. It sets priorities to guide investments and incorporates an adaptive management approach to make adjustments based on new information. Recovery of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead across such a vast and altered ecosystem as the Central Valley will require a broadly focused, science-based strategy. The scientific rationale for the strategy in this plan focuses on two key salmonid conservation principles. The first is that functioning, diverse, and interconnected habitats are necessary for a species to be viable. That is, salmon and steelhead recovery cannot be achieved without providing sufficient habitat. Anadromous salmonids persisted in the Central Valley for thousands of years because the available habitat capacity and diversity allowed species to withstand and adapt to environmental changes including catastrophes such as prolonged droughts, large wildfires, and volcanic eruptions. To help return the habitat capacity and diversity in the Central Valley to a level that will support viable salmon and steelhead, NOAA Fisheries identified and prioritized recovery actions based on a comprehensive life stage specific threats assessment. Minimizing or eliminating stressors to the fish and their habitat in an efficient and structured way is a key aspect of the recovery strategy.

The second salmonid conservation principle guiding the recovery strategy is that a species' viability is determined by its spatial structure, diversity, productivity, and abundance (McElhany et al. 2000). Abundance and population growth rate are self-explanatory parameters that are clearly important to species and population viability, while spatial structure and diversity are just as important, but less intuitive. Spatial structure refers to the arrangement of populations across the landscape, the distribution of spawners within a population, and the processes that produce these patterns. Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (e.g., a single landslide) than are species with more widespread and complex spatial structure. Species or population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genetic characteristics of populations. Phenotypic diversity allows more populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genetic diversity, on the other hand, provides populations with the ability to survive long-term changes in the environment. It is the combination of phenotypic and genetic diversity expressed in a natural setting that provides populations with the ability to adapt to long-term changes (McElhany et al. 2000).

2.12.4.5 Vernal Pools

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* features 33 species of plants and animals that occur exclusively or primarily within a vernal pool ecosystem in California and southern Oregon. The 20 federally listed species include 10 endangered plants, 5 threatened plants, 3 endangered animals, and 2 threatened animals. These vernal pool species occur primarily in vernal pool, swale, or ephemeral freshwater habitats largely confined to a limited area by topographic constraints, soil types, and climatic conditions. Surrounding (or associated) upland habitat is critical to the proper ecological function of these vernal pool habitats. The primary threats to the species are habitat loss and fragmentation due to urban development and associated infrastructure, agricultural conversion, altered hydrology, nonnative invasive species, inadequate regulatory mechanisms, exclusion of grazing in areas where grazing has been a historic land use, and inappropriate grazing regimes (overgrazing or undergrazing). Resulting small population sizes are subject to extinction due to random, naturally occurring events.

This recovery plan presents an ecosystem-level strategy for recovery and conservation because all of the listed species and species of concern co-occur in the same natural ecosystem and are generally threatened by the same human activities. The likelihood of successful recovery for listed species and long-term conservation of species of concern is increased by protecting entire ecosystems. This task can be most effectively accomplished through the cooperation and collaboration of various stakeholders.

2.12.4.6 Valley Elderberry Longhorn Beetle

In 1984, USFWS published the Valley Elderberry Longhorn Beetle Recovery Plan (U.S. Fish and Wildlife Service 1984). The recovery plan summarizes biological information known of the valley elderberry longhorn beetle, prescribes actions necessary to acquire additional biological data, and describes preliminary recommendations for actions necessary for the beetle's preservation, maintenance, and recovery. At the time of publication of the recovery plan, the specific life history characteristics and ecology of the beetle were unknown. The life histories of related *Desmoscerus* species was used to describe the basic life history of valley elderberry longhorn beetle.

Because there was insufficient information regarding the species' life history, distribution and habitat requirements, interim objectives and actions were outlined in the recovery plan focusing on preventing the further loss and degradation of the beetle's existing habitat. Interim objectives included the following: protect the three known localities, survey riparian vegetation along Central California rivers for beetle colonies and habitat, provide protection to remaining habitat in the species' suspected historic range, and collect additional information necessary to delist the species.

In 2006, USFWS published a 5-Year Review of the Valley Elderberry Longhorn Beetle (U.S. Fish and Wildlife Service 2006a). Since the publication of the recovery plan, new information regarding the beetle's distribution, biology, and ecology indicate that the recovery criteria may no longer be appropriate for the species. Based on the most current information about the species, the review discusses each of the primary interim objects in the recovery plan and progress toward those objectives.

2.12.4.7 Bank Swallow

In 1992, CDFW published a recovery plan for the bank swallow (California Department of Fish and Wildlife 1992). The goal of the recovery plan is the maintenance of a self-sustaining, wild population. The primary objectives necessary to achieve this goal include 1) ensuring that the remaining population does not suffer further declines in either range or abundance, and 2) preservation of sufficient natural habitat to maintain a viable wild population. The plan did not specify a specific population target for recovery or recovery units.

The recovery plan identifies numerous actions needed to protect the banks swallow, including the following.

- Preserving major portions of the remaining bank swallow habitat in California.
- Avoiding impacts to natural bank habitats through use of alternatives to bank stabilization.
- Mitigating impacts from bank stabilization projects.
- Using set-back levees reestablishing river meander-belts.
- Modifications of current preserve plans to include habitat requirements of bank swallow.
- Evaluating the use of artificial bank nesting habitat.

In reviewing existing bank swallow management activities, the Bank Swallow Technical Advisory Committee[6] (BANS-TAC) found that "few of the recommendations included in the recovery plan were implemented to a significant degree" (Bank Swallow Technical Advisory Committee 2013). In response to the continued decline of bank swallow populations, the BANS-TAC published a conservation strategy in 2013 to guide the preservation, protection, and restoration of natural river processes along the Sacramento River to support the conservation and recovery of bank swallow, as well as benefit other natural river system-dependent species. The conservation strategy emphasizes that natural river processes need to be restored on a significant portion of the Sacramento River and its tributaries to recovery the bank swallow population in California.

The Banks Swallow Conservation Strategy makes the following recommendations.

[6] The BANS-TAC is a coalition of State and Federal agency and non-governmental organization staff, created in response to the continued decline of bank swallow populations on the Sacramento River.

- Avoid new impacts to river processes, as well as to existing nesting habitat and colonies.
- Use alternatives to bank stabilization.
- Maintain non-impacting flow regimes during the nesting season.
- Maintain appropriate buffers between construction activities and nest colonies.
- Protect suitable habitat and reestablish and connect river floodplains.
- Restore nesting habitat and river processes on the Sacramento and Feather Rivers by removing revetment, restoring floodplains, and managing flow regimes to improve floodplain connectivity and reduce inundation of active bank swallow nest colonies.
- Mitigate unavoidable impacts to bank swallow habitat and river processes by removing revetment and conserving nesting habitat.

2.12.5 Critical Habitat Designations

The federal Endangered Species Act defines critical habitat as aspecific geographic areas that contain features essential to the conservation of an endangered or threatened species and that may require special management and protection. Critical habitat may also include areas that are not currently occupied by the species but will be needed for its recovery.

To be included in a critical habitat designation, the habitat within the area occupied by the species must first have features that are ‘‘essential to the conservation of the species.’’ Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas on which are found those physical and biological features essential to the conservation of the species (primary constituent elements), as defined at 50 Code of Federal Regulations (CFR) 424.12(b)). Five focal species in this RCIS/LCP have designated critical habitat that occurs in the strategy area, as described below.

2.12.5.1 California Tiger Salamander

In 2005, the USFWS designated approximately 199,109 acres of critical habitat for the Central population of the California tiger salamander (*Ambystoma californiense*) (70 FR 49380). The areas designated as critical habitat for the Central population of the California tiger salamander represent occupied aquatic and upland habitat throughout the range of the population. The individual areas of critical habitat are identified as critical habitat units and are distributed among four regions that were developed based on genetic variation across the population. The Central Valley Geographic Region includes an area of approximately 4.9 million acres that spans from northern Yolo County south to include eastern Solano and Contra Costa counties and extends generally southeast to the northern half of Madera County. Of the twelve critical management units within the Central Valley Geographic Region, the Dunnigan Hills Unit (Unit 1), is the only one located within Yolo County. This unit is in the Dunnigan Hills region of the county and represents northernmost portion of the species’ range. It includes approximately 2,730 acres contained entirely within the RCIS/LCP strategy area. The California prairie natural community and cultivated lands semi-natural community are the dominant natural community types within this critical habitat unit.

All lands within the Dunnigan Hills Unit are currently under private ownership and are predominantly used for agricultural purposes. USFWS has identified the primary threats specific to the Dunnigan Hills Critical Habitat Unit as being agricultural land conversion and the introduction of non-native predators, such as mosquito fish, to ponds that California tiger salamanders rely on for aquatic habitat

2.12.5.2 Delta Smelt

In 1994, the USFWS designated critical habitat for the delta smelt (*Hypomesus transpacificus*) (59 FR 65256). The total acreage of the critical habitat area is not explicitly stated in the critical habitat designation; however, it is described as being “areas of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cuttoff, First Mallard (Spring Branch), and Montezuma sloughs; and to the existing contiguous waters contained within the Delta as defined in Section 12220 of the California Water Code.” The critical habitat designation for this species includes the entire range for the species, without exclusion, to provide for the habitat necessary for all life stages of the species. The applicable areas within the RCIS/LCP strategy area generally consist of the locations containing contiguous riverine and fresh emergent wetland natural community types within portions of Yolo County located south of Interstate 80 in the area identified as the Legal Delta as per the 1959 Delta Protection Act.

2.12.5.3 Green Sturgeon

In 2009, the National Marine Fisheries Service (NMFS) designated critical habitat for the threatened Southern distinct population segment of the North American green sturgeon (*Acipenser medirostris*) (74 FR 52300) as spanning marine areas and certain coastal bays and estuaries from Cape Flattery, Washington south to Monterey Bay, California; the baylands of San Francisco, San Pablo, and Suisun; and the Sacramento River, lower Feather River, and lower Yuba River. The portions of the designated critical habitat for Green Sturgeon that overlap with the RCIS/LCP strategy area include all portions of the Sacramento River that are within or immediately adjacent to Yolo County and the Yolo Bypass.

2.12.5.4 Salmonid Evolutionarily Significant Units and Distinct Population Segments

In 2005, the NMFS designated critical habitat for two Evolutionarily Significant Units (ESUs) of Chinook salmon (*Oncorhynchus tshawytscha*) and five Distinct Population Segments (DPSs) of steelhead (*O. mykiss*) (70 FR 52488). An ESU is defined as a sub-population of a species that is substantially reproductively isolated from other sub-populations of the species. A DPS is defined as a species that is separable from the rest of its species and biologically and ecologically significant. Of the seven salmonids identified in the critical habitat designation, the Central Valley spring-run Chinook salmon and Central Valley steelhead are the only two whose migratory range occurs within the RCIS/LCP strategy area.

2.12.5.5 Vernal Pool Species

In 2005, the USFWS updated the critical habitat designation for four vernal pool crustaceans and eleven vernal pool plants for a total of 858,846 acres designated for critical habitat for vernal pool species (70 FR 46924). RCIS/LCP focal species included in this critical habitat designation are: vernal pool tadpole shrimp (*Lepidurus packardi*), Conservancy fairy shrimp (*Branchinecta conservation*), vernal pool fairy shrimp (*Branchinecta lynchi*), Colusa grass (*Neostapfia colusana*), and Solano grass (*Tuctoria mucronata*). In 2006, the USFWS subsequently published species-specific critical habitat designations for each of these individual species (71 FR 7118). RCIS/LCP focal species found within the vernal pool complex natural community that have all or a portion of their designated critical habitat located within the strategy area include vernal pool tadpole shrimp, Colusa grass, and Solano grass. Approximately 440 acres of the 228,785 acres designated as critical habitat for vernal pool tadpole shrimp are located within the strategy area. Approximately 440 acres of the 152,093 acres designated as critical habitat for Colusa grass are located within the strategy area. The entire 440 acres designated as critical habitat for Solano grass is located within the strategy area. While Conservancy fairy shrimp and vernal pool fairy shrimp are also found within the strategy area, the critical habitat designated for these species is located outside of the RCIS/LCP strategy area.

2.12.6 Mitigation and Conservation Banks

California Fish and Game Code Section 1852(c)(12) requires an RCIS to include a summary of mitigation banks and conservation banks approved by the department or the U.S. Fish and Wildlife Service that are located within the strategy area or whose service area overlaps with Yolo County. Several mitigation banks operate in Yolo County that have conservation credits for focal species, including Swainson's hawk, giant garter snake, and valley elderberry longhorn beetle. Three mitigation banks in Yolo County target salmonids and other fish species. Table 2-6 lists the mitigation banks in Yolo County or banks with service territories that overlap with the strategy area.

Table 2-5. Mitigation Banks in Yolo County or with Service Area

Bank	Bank Purpose	Bank Located in Yolo County	Status[a]	Total Credits[b] (Acres)
Burke Ranch Conservation Bank	California tiger salamander; vernal pools; Swainson's hawk; burrowing owl	No	Active	962
Campbell Ranch Conservation Bank	Vernal pool restoration	No	Active	160
Colusa Basin Mitigation Bank	Giant garter snake; seasonal wetlands	No	Active	163
Dolan Ranch Conservation Bank	Vernal pool restoration	No	Active	251
Elsie Gridley Mitigation Bank	California tiger salamander; vernal pool crustaceans; vernal pool restoration	No	Active	1,800
French Camp	Valley elderberry longhorn beetle	No	Active	188
Goldfields Conservation Bank	Vernal pool ecosystems	No	Active	152
Laguna Creek Conservation Bank	Valley elderberry longhorn beetle	No	Active	780
Liberty Island Conservation Bank	Chinook salmon; Central Valley steelhead; Delta smelt; longfin smelt;	Yes	Active	186
Mountain House Conservation Bank	California red-legged frog	No	Sold Out	145
Noonan Ranch Conservation Bank	California tiger salamander	No	Active	190
Nicolaus Ranch VELB Conservation Bank	Valley elderberry longhorn beetle	No	Active	42
North Bay Highlands Conservation Bank	California red-legged frog	No	Active	441
North Suisun Mitigation Bank	California tiger salamander; vernal pool ecosystems	No	Active	593
Ohlone West Conservation Bank	California red-legged frog	No	Active	638
Oursan Ridge Conservation Bank	Calirfornia red-legged frog	No	Active	430
Pope Ranch North Swainson's Hawk Preserve	Swainson's hawk	Yes	Sold out	287
Pope Ranch Conservation Bank	Giant garter snake	Yes	Sold out	387

Bank	Bank Purpose	Bank Located in Yolo County	Status[a]	Total Credits[b] (Acres)
River Ranch Valley Elderberry Longhorn Beetle Conservation Bank	Valley elderberry longhorn beetle	Yes	Active	155
Ridge Cut Giant Garter Snake Bank (Teal)	Giant garter snake	Yes	Active	186
River Ranch Wetland Mitigation Bank	Wetlands	Yes	Active	101
River Ranch Swainson's Hawk Preserve	Swainson's hawk	Yes	Active	838
Putah Creek Mitigation Bank	Wetlands and riparian	Yes	Approved	434

[a] Status as of October 2017.
[b] Total credits in bank. For available credits, contact the bank.

2.12.7 Williamson Act

In 2013 there were 312,984 acres of land tied to Williamson Act contracts in Yolo County (California Department of Conservation 2015). The primary purpose of the Williamson Act is to provide a state program for the retention of private land in agriculture and open space use. The Williamson Act provides for arrangements whereby private landowners enter into a 9-year or 10-year contract with counties and cities to maintain their land in agricultural and compatible open-space uses in exchange for a reduction in property taxes. The contract is automatically renewed for an additional year unless it is cancelled. The contract may be cancelled if the land is being converted to an incompatible use.

2.13 Development and Major Infrastructure

2.13.1 Local Government Planning Boundaries and General Plans

The RCIS strategy area includes the incorporated areas of Davis, West Sacramento, Winters, and Woodland and unincorporated areas of Yolo County. Yolo County has a rural character, consisting almost entirely of undeveloped land, with both existing and planned development clustered primarily in the incorporated cities. This section includes information on general plans for each city and unincorporated areas of Yolo County. Its population, housing, and employment conditions and projections provide an overview of existing and planned development for each city and unincorporated Yolo County. This section also describes the conservation and open space policies in the general plans for each city and unincorporated Yolo County.

2.13.1.1 Yolo County

Yolo County is located in the agricultural region of the Central Valley and the Sacramento River Delta. The county line is directly west of Sacramento, northeast of the Bay Area Counties of Solano and Napa, south of Colusa County, and west of Sutter County. Approximately half of Yolo County's unincorporated population and housing units are located within existing unincorporated communities. Existing urban development makes up approximately 20,000 acres, or approximately 3 percent, of the 621,224 acres in the unincorporated area. The county's total size is 653,549 acres (or 1,021 square miles). This includes both the incorporated area (the cities of Davis, West Sacramento, Winters and Woodland), which totals 32,325 acres, and the unincorporated area.

The total population of the unincorporated areas of Yolo County was 29,293 (out of 209,035 total in Yolo County) in 2010. The total countywide population is projected to reach 290,558 in 2035, an increase of 39 percent (Sacramento Area Council of Governments 2005a). Assuming a consistent growth rate beyond 2035 (the last year from which SACOG projections are available), the population of Yolo County as a whole will reach 471,100 in 2065, an increase of 135 percent compared with 2010 levels.

The number of housing units in unincorporated Yolo County totaled 7,825 (approximately 70,000 total in Yolo County) in 2012. The number of housing units is projected to reach 10,258 in 2036, an increase of 31 percent (Sacramento Area Council of Governments 2014). Assuming a consistent growth rate beyond 2036 (the last year from which SACOG projections are available), the number of housing units in Yolo County will reach 14,228 in 2065, an increase of 82 percent.

General Plan

On November 10, 2009, the Yolo County Board of Supervisors adopted the 2030 Countywide General Plan, which determines land use planning throughout the unincorporated area (County of Yolo 2009). The General Plan provides comprehensive and long-term policies for the physical development of the county and is often referred to as "the constitution" for local government. The Yolo County General Plan is guided by seven separate elements that establish goals, policies, and actions for each given topic. These elements include: Land Use and Community Character, Circulation, Public Facilities and Services, Agricultural and Economic Development, Conservation and Open Space, Health and Safety, and Housing Element.

Many elements of this RCIS/LCP are responsive to policies and other components of the Yolo County General Plan. A partial list appears in Section 3.2.3, below (Multi-Benefit Approach).

2.13.1.2 City of Davis

Davis is located in the southeast part of Yolo County, along Interstate (I-) 80 and the main Union Pacific railroad line. Davis is northeast of the San Francisco Bay area and 15 miles west of Sacramento. Davis is separated from surrounding cities in Yolo and Solano Counties by 10 to 15 miles of agricultural land. Surrounding cities in Yolo County are: Woodland to the north, West Sacramento to the east, and Winters to the west. Located between Davis and West Sacramento is the 2-mile wide Yolo Bypass, one of the overflow drainageways that provide flood protection for the Sacramento River valley.

The current population of Davis is approximately 67,000 and is projected to reach 76,665 in 2035. Assuming a consistent growth rate beyond 2035 (the last year from which Sacramento Area Council of Governments [SACOG] projections are available), the population of Davis will reach 98,327 in 2065, an increase of 50 percent compared with 2010 levels.

The number of housing units in Davis is projected to reach 28,351 in 2036, an increase of 7 percent (Sacramento Area Council of Governments 2014). Assuming a consistent growth rate beyond 2036 (the last year from which SACOG projections are available), the number of housing units in Davis will reach 30,845 in 2065, an increase of 17 percent compared with 2012 levels.

General Plan

The City of Davis's General Plan is the community's vision of its long-term physical form and development (City of David 2007). The general plan is comprehensive in scope and represents the city's expression of quality of life and community values; it should include social and economic concerns, as well. General plans are prepared under a mandate from the State of California, which requires that each city and county prepare and adopt a comprehensive, long-term general plan for its jurisdiction and any adjacent related lands.

The General Plan area consists of approximately 160 square miles. The General Plan area is bounded on the north by County Road 27 and the City of Woodland planning area, on the east by the easterly boundary of the Yolo Bypass, to the south by Tremont Road, and the Pedrick Road–I-80 interchange in Solano County, and on the west by an extension of County Road 93. This boundary generally matches the westerly boundaries of the General Plan areas of Dixon and Woodland. Because Davis is located in the corner of Yolo County, a portion of the planning area is in Solano County. The General Plan, amended in 2007, guides community development using the following elements: Land Use, Circulation, Housing, Conservation, Open Space, Noise, and Safety.

2.13.1.3 City of West Sacramento

West Sacramento is located across the Sacramento River from the state Capitol, in the eastern part of Yolo County, in California's Sacramento Valley. The city is bounded by the Sacramento River on its northern and eastern borders and the Sacramento Deep Water Ship Channel and Yolo Bypass to the west.

The current population of West Sacramento is approximately 52,000 and is projected to reach 87,402 in 2035 (Sacramento Area Council of Governments 2005a). Assuming a consistent growth rate beyond 2035 (the last year from which SACOG projections are available), the population of West Sacramento will reach 222,475 in 2065, an increase of 356 percent. The number of housing units is projected to reach 32,039 in 2036 (Sacramento Area Council of Governments 2014). Assuming a consistent growth rate beyond 2036 (the last year from which SACOG projections are available), the number of housing units in West Sacramento will reach 60,706 in 2065, an increase of 222 percent compared with 2012 levels.

General Plan 2035

General Plan 2035 will guide growth in West Sacramento over the planning period (City of West Sacramento 2016). The City will continue to urbanize with most of the growth focused on infill and refill opportunities in the Bridge District, Washington, Pioneer Bluff, and the Central Business District. Southport will continue to grow as well. West Capitol Avenue and Sacramento Avenue will move in a more flexible, mixed-use direction. The General Plan 2035 focuses on 10 elements that guide growth in the city through 2035. The following elements are included in the plan: Land Use, Urban Structure and Design, Housing, Economic Development, Mobility, Public Facilities and Services, Parks and Recreation, Natural and Cultural Resources, Safety, and Healthy Community.

2.13.1.4 City of Winters

Winters is located in the southwestern corner of Yolo County, approximately 14 miles west of Davis and just east of the Vaca Mountains. The city is bordered by Dry Creek and Putah Creek on the south and southwest. I-505 and State Route (SR) 128 are located in and near the city, serving as key links to I-80, approximately 10 miles to the south, and I-5, 23 miles to the north. SR 128 intersects the city and serves as a major access route to Lake Berryessa.

The population of Winters is projected to reach 12,360 in 2035 (Sacramento Area Council of Governments 2005a). Assuming a consistent growth rate beyond 2035 (the last year from which SACOG projections are available), the population of Winters will reach 33,532 in 2065. The number of housing units in Winters is projected to reach 3,126 in 2036 (Sacramento Area Council of Governments 2014). Assuming a consistent growth rate beyond 2036 (the last year from which SACOG projections are available), the number of housing units in Winters will reach 4,364 in 2065.

General Plan

The City of Winters adopted its most recent general plan in 1992. There have been minor amendments since that time; the Housing Element was revised in October 2013. The horizon year for the City of Winters General Plan is 2021 for the Housing Element and 2018 for the other elements of the general plan. The General Plan Policy Document includes a land use diagram that outlines the standards of population density and building density for land designations within the Urban Limit Line. The plan seeks to maintain the traditional small-town qualities and agricultural heritage of Winters while focusing on contained development (City of Winters 1992). The general plan addresses ten subject areas: land use; housing; population; economic conditions and fiscal considerations; transportation and circulation; public facilities and services; cultural and recreational resources; natural resources; health and safety; and scenic resources and urban design.

2.13.1.5 City of Woodland

Woodland, nicknamed “City of Trees,” is the County seat of Yolo County, located 20 miles northwest of Sacramento at the intersection of I-5 and SR 113. The Yolo Bypass lies approximately 3 miles east of the city, Willow Slough is 1 mile southeast, and Cache Creek is 2 miles north.

The current population of Woodland is approximately 58,000 and is projected to reach 76,132 in 2035 (Sacramento Area Council of Governments 2005a). Assuming a consistent growth rate beyond 2035 (the last year from which SACOG projections are available), the population of Woodland will reach 126,359 in 2065. The number of housing units in Woodland is projected to reach 23,571 in 2036 (Sacramento Area Council of Governments 2014). Assuming a consistent growth rate beyond 2036 (the last year from which SACOG projections are available), the number of housing units in Woodland will reach 28,684 in 2065.

General Plan

The City of Woodland released a public draft of the city’s General Plan Update on July 11, 2016, for review. The General Plan Update envisions Woodland maintaining its small-town atmosphere, rich historical buildings, and commitment to the protection of agricultural soils. The plan has a horizon year of 2035 (City of Woodland 2016). The General Plan applies to the entire incorporated city (totaling 9,624 acres) plus a 3,148-acre area outside the city, within the unincorporated area of Yolo County. The General Plan Update contains elements that guide the Woodland's future development through a list of goals and policies. The Draft General Plan Update contains the following Elements: Land Use, Community Design, Historic Preservation, Healthy Community Element, Conservation and Open Space, Safety, and Housing.

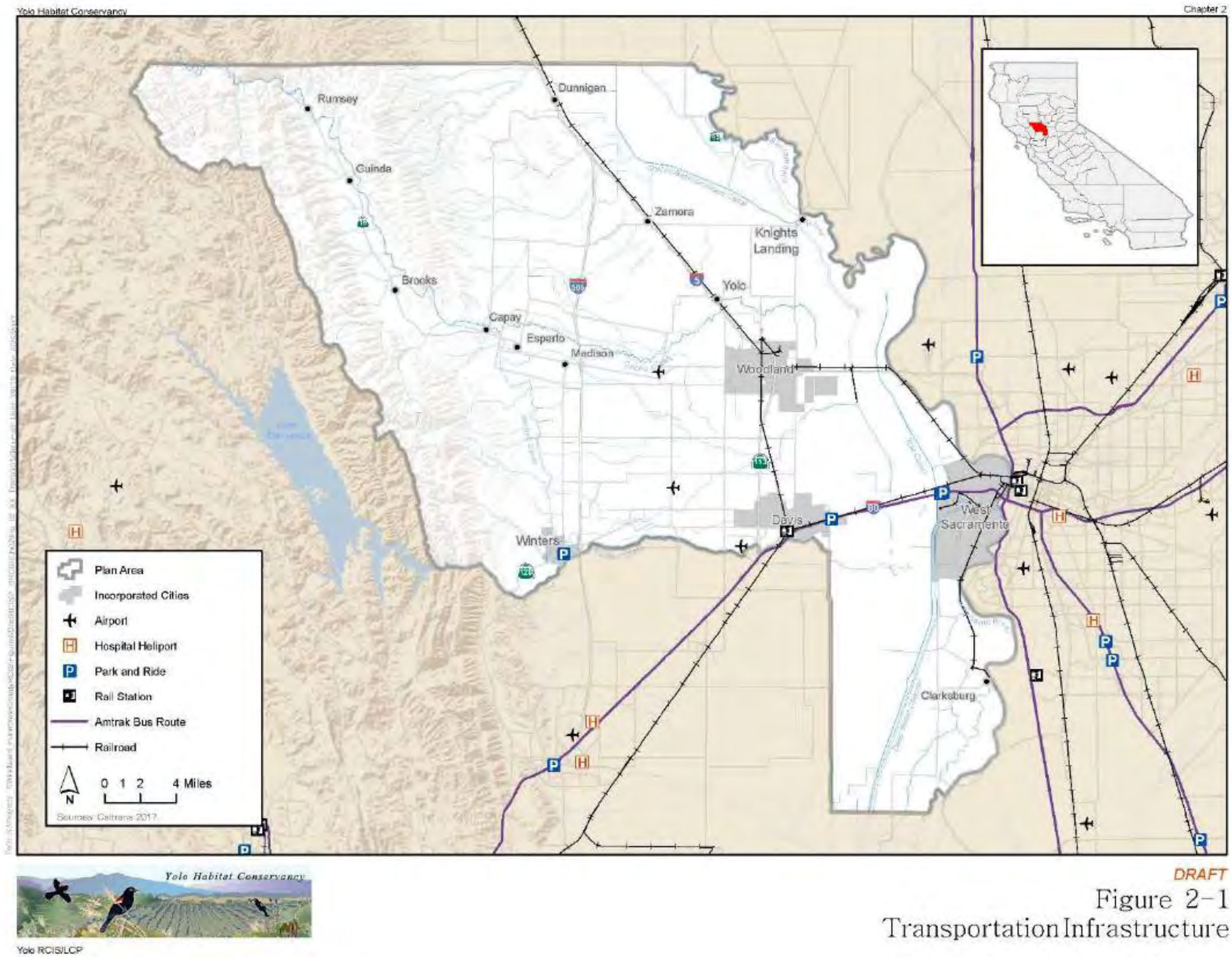
2.13.2 Major Infrastructure

The California Fish and Game Code Section 1852(c)(6) requires that an RCIS consider "major water, transportation and transmission infrastructure facilities . . . that accounts for reasonably foreseeable development of major infrastructure facilities, including, but not limited to, renewable energy . . . in the [RCIS] strategy area." This section describes existing and reasonably foreseeable development of major infrastructure facilities in the strategy area, including major water, transportation, transmission facilities, and renewable energy projects.

2.13.2.1 Transportation

This section describes the transportation agencies in the RCIS strategy area. Figure 2-1 shows major transportation infrastructure within the RCIS strategy area, including airports, transit hubs, transit priority areas, state highways, passenger railways, and rail stations.

Figure 2-1. Transportation Infrastructure



California Department of Transportation

The California Department of Transportation (Caltrans) manages more than 50,000 miles of California's highway and freeway lanes, provides inter-city rail services, permits more than 400 public-use airports and special-use hospital heliports, and works with local agencies. Caltrans is proposing a safety improvement project at three separate locations on SR 16 in Yolo County between Cadenasso and the I-505 interchange. The project proposes to widen shoulders to 8 feet, install shoulder rumble strips and provide a 20-foot clear recovery zone (which includes the shoulder) at all three locations. In addition, the project would add a left turn pocket at Location 1, a two-way left turn lane at location 3, flatten horizontal curves at Locations 1 and 2, and potentially add an additional access to the Madison Migrant Center from County Road 89. The safety improvement project at Location 2 was completed in 2016. The projects at Locations 1 and 3 are expected to be completed by November 2020. The locations are as follows (limits are approximate).

- Location 1—In Cadenasso at County Road 79 (from 0.3 mile west to 0.4 mile east of County Road 79)
- Location 2—2.2 miles west of Capay near County Road 82B (from 0.3 mile west to 200 feet west of County Road 82B); completed in 2016
- Location 3—Esparto to 0.2 miles west of I-505 (from 400 feet west of County Road 21A to South Folk Willow Slough)

Yolo County Transportation District

The Yolo County Transportation District administers YOLOBUS, which operates local and intercity bus service 365 days a year in Yolo County and neighboring areas. YOLOBUS serves Davis, West Sacramento, Winters, Woodland, downtown Sacramento, Sacramento International Airport, Cache Creek Casino Resort, Esparto, Madison, Dunnigan and Knights Landing.

2.13.2.2 Water

Water Resources Association of Yolo County

The Water Resources Association of Yolo County (WRA) is a consortium of entities authorized to provide a regional forum to coordinate and facilitate solutions water infrastructure issues in Yolo County. It was widely recognized that managing water supplies from the standpoint of quantity, quality, and environmental considerations could not be done by individual agencies and that collaboration was essential. The WRA was formed in 1994 to provide regional leadership in the development of water resources management for the county. Members of the WRA include the following agencies.

- City of Davis
- Dunnigan Water District
- Reclamation District 2035
- University of California, Davis
- City of Winters

- City of West Sacramento
- City of Woodland
- Yolo County
- Yolo County Flood Control and Water Conservation District

In 2007, the WRA published the Yolo County Regional Integrated Water Management Plan (IRWMP), which provides a wide-ranging vision for the future water management in Yolo County. High-priority water management actions including projects, programs, or policies identified to improve water management in Yolo County. The IRWMP describes integrated water management actions that combine elements of five water management categories.

1. Water Supply and Drought Preparedness
2. Water Quality
3. Flood Management and Storage
4. Aquatic and Riparian Ecosystem Enhancement
5. Recreation

The WRA currently has no future large-scale water infrastructure development plans.

2.13.2.3 Flood Protection

West Sacramento Levee Improvement Program

The West Sacramento Area Flood Control Agency (WSAFCA) is implementing a multi-year plan to meet the 200-year level of flood protection requirement imposed by new state law and new federal levee standards. The Southport Levee Improvement Project, currently under construction, involves the construction of flood risk-reduction measures along 5.6 miles of the Sacramento River South Levee in the city of West Sacramento. Levee improvements will include a combination of fix in place and a new setback levee construction. The project will provide significant opportunities for ecosystem restoration and public recreation. This project is covered under the Yolo HCP/NCCP.

Central Valley Flood Protection Plan

The Central Valley Flood Protection Plan (CVFPP) is a strategic and long-range plan for improving flood risk management in the Central Valley. It was prepared by the California Department of Water Resources (DWR) in accordance with the Central Valley Flood Protection Act of 2008 (Act) and adopted by the Central Valley Flood Protection Board (CVFPB) in June 2012. The CVFPP is a critical document to guide flood risk management in the Central Valley (DWR 2012). The CVFPP proposes a systemwide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control. The CVFPP is required to be updated every five years, with each update providing support for subsequent policy, program, and project implementation (DWR 2012).

The 2017 CVFPP Update (DWR 2017) is the first major 5-year update to the CVFPP in accordance with the Act. It updates and refines the overall near- and long-term investment needs established in the 2012 CVFPP, and includes recommendations on policies and funding to support comprehensive flood risk management actions. The planning efforts supporting the 2017 CVFPP Update (DWR

2017) were developed in close coordination with State, federal, and regional partners, and were informed by a multiyear stakeholder engagement process initiated in 2012. The 2017 CVFPP update (DWR 2017) incorporates new information and provides greater specificity to help guide both short-term and long-term investments in the Central Valley flood management system. This new information is documented in a series of detailed studies, including two Basin-Wide Feasibility Studies for the Sacramento River Basin and the San Joaquin River Basin, respectively, six Regional Flood Management Plan studies (RFMP), a Conservation Strategy, a CVFPP Investment Strategy, and other studies. The CVFPP related documents relevant to the Yolo RCIS strategy area are described below.

Sacramento River Basin-Wide Feasibility Studies

The Sacramento River Basin-Wide Feasibility Study (BWFS) evaluates options for improving the bypass system, advancing the CVFPP planning and implementation process by updating and refining the options for improving the flood management system. It includes detailed feasibility evaluations of various combinations of levee setbacks, weir expansions, new bypass channels, and storage management opportunities, with integrated ecosystem restoration actions. Many of the major flood system improvements evaluated in the Sacramento River BWFS (DWR 2016) are located in the strategy area, including potential widening of the Fremont Weir and Sacramento Weir, and expansion of the Yolo Bypass and Sacramento Bypass.

Lower Sacramento River/Delta North Regional Flood Management Plan

The Regional Flood Management Plan (RFMP) for the Lower Sacramento/Delta North Region (Region) is the regional follow-on to the 2012 CVFPP. The RFMP, prepared in 2014, establishes the flood management vision for the region and identifies regional solutions to flood management problems at a prefeasibility level. The RFMP, focuses on a geographic area which includes portions of Solano, Yolo, Sacramento, and Sutter Counties, and was developed by FloodProtect, a regional working group comprised of the counties, cities, flood management agencies, local maintaining agencies (LMA), water agencies, emergency response agencies, citizen groups, tribes, and other interested stakeholders in the region. The RFMP identified a list of 116 regional improvements with over $2 billion in total cost, many of which are located in Yolo County.

Lower Elkhorn Basin Levee Setback Project

DWR is proposing the Lower Elkhorn Basin Levee Setback project in Yolo County to reduce flood risk to the Cities of Sacramento, West Sacramento, and Woodland, and improve system performance consistent with the 2012 CVFPP and the 2017 CVFPP Update (DWR 2017). The project would set back approximately 7 miles of levees in the Lower Elkhorn Basin, including the Sacramento Bypass North Levee and a portion of the Yolo Bypass East Levee, thereby increasing the capacity of the Yolo and Sacramento Bypasses and reducing flood risks on the upper Yolo Bypass and Sacramento River. The project would also implement several ecosystem project elements to increase habitat for special-status species. The Lower Elkhorn Basin Levee Setback project is currently scheduled for construction beginning in 2020.

Sacramento River General Reevaluation Report

The Sacramento River General Reevaluation Report was initiated in October, 2015 by USACE, with CVFPB and DWR as partner agencies. The general reevaluation will assess a combination of one or more ecosystem restoration and flood risk management measures, including widening existing bypasses, modifying existing weirs, optimizing weir operations, constructing setback levees, developing floodplain management plans, restoring riverine aquatic and riparian habitat, removing barriers to fish passage, and restoring natural geomorphic processes, among others. Some of these measures are being contemplated in the Yolo Bypass.

American River Common Features General Reevaluation Report

The American River Common Features Project was initiated following major flooding that occurred in 1986. The American River Common Features General Reevaluation Report was finalized by USACE in December 2015. The purpose of the study is to improve flood protection for the Sacramento and West Sacramento urban area. While most of the measures identified in the American River Common Features General Reevaluation Report focus outside the strategy area, it does include an expansion of the Sacramento Weir and Bypass in Yolo County. Widening the Sacramento Weir and Bypass by 1,500 feet would divert increased flows to the Yolo Bypass to reduce the water surface elevation in the Sacramento River.

2.13.2.4 Gas and Electric Transmission

Transmission lines in the RCIS strategy area include those supporting distribution of natural gas and electricity. Figure 2-2 shows transmission facilities in the RCIS strategy area, including operational hydroelectric power plants, transmission lines, and natural gas pipelines.

Pacific Gas and Electric Company

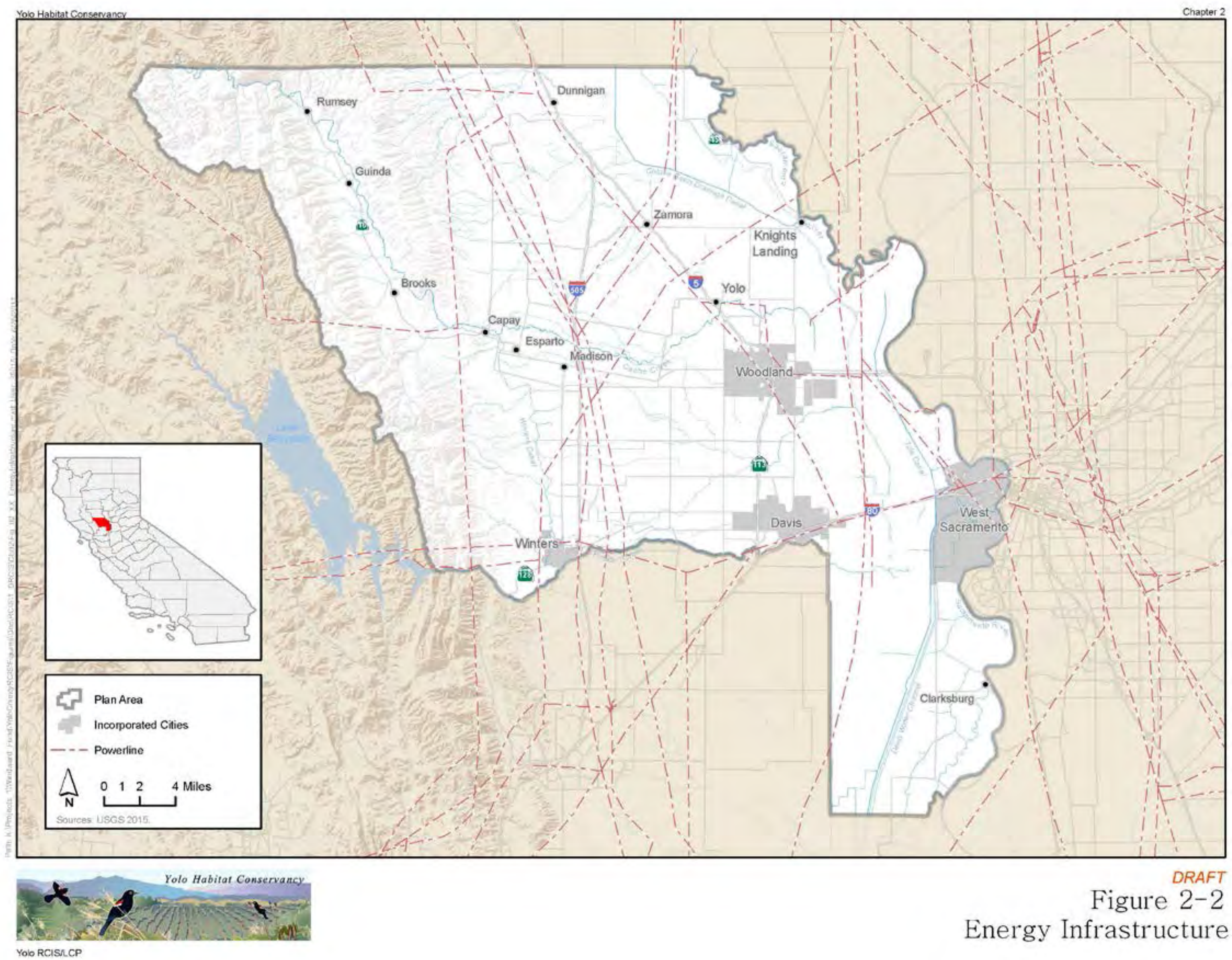
Pacific Gas & Electric (PG&E) owns and operates most of the gas and all of the electric transmission lines in the RCIS strategy area. The company provides natural gas and electric service to approximately 16 million people throughout a 70,000-square-mile service area in northern and central California. PG&E currently has no large-scale transmission/utility projects planned in the RCIS strategy area.

2.13.2.5 Renewable Energy

Yolo County has a high potential for photovoltaic solar energy production. National Renewable Energy Laboratory data indicates that solar energy is the most promising option for future renewable energy generation in the county. According to the National Renewable Energy Laboratory, Yolo County receives enough energy from the sun to produce approximately 5.0 to 5.5 kilowatt hours per square meter per day. In 2013, Yolo County joined with SunPower to install 6.8 megawatts of solar power facilities at three locations in the county. Another solar facility, the 18-acre Putah Creek Solar Farm in Winters produces 2.6 megawatts of electricity.

Currently, there are no large-scale (i.e., commercial scale) renewable energy projects planned in the RCIS strategy area. Instead, renewable energy projects tend to be at the scale of individual residences (e.g., residential solar) of approximately 10 acres or less.

Figure 2-2. Energy Infrastructure



2.13.2.6 Capital Improvement Programs

Yolo County Capital Improvement Plan 2017-2019

The Yolo County Capital Improvement Plan (CIP) includes capital projects that are in the stages of implementation and those projects to be implemented within the next 3 fiscal years. The CIP continues to be used as a tool for the implementation of projects included in various plans adopted by the Yolo County Board of Supervisors, including the Yolo County General Plan. All projects meeting the definition of a capital asset project are included in the CIP along with detail regarding project funding. Considered a strategic planning tool, the CIP may be used by the Board to prioritize countywide capital projects. While the CIP does not indicate approval of specific projects, only projects included in the Board-approved CIP will be considered for funding, with the exception of emergency needs at the Board of Supervisor's direction.

City of Davis Capital Improvement Program

The Capital Improvement Program includes the following projects that the City of Davis has planned for the downtown area of Davis.

- Third Street: The Third Street Improvements Project represents comprehensive streetscape improvements of the two-block segment of Third Street between A Street and B Street at the western entrance to the Downtown Core. The primary project objectives include improving bicycle and pedestrian safety/access, beautifying the street to create a sense of place, establish a City/UC Davis gateway, upgrading infrastructure to support current and planned mixed use infill, and improving stormwater drainage to reduce localized flooding while employing sustainable stormwater quality management practices.
- Centennial Plaza: Still waiting for City to update descriptions.
- Regal Lot: Still waiting for City to update descriptions.
- Spencer Alley: Still waiting for City to update descriptions.
- Bike Pump Track: The city is constructing a Bike Pump Track which will be approximately 9,000 sq. ft. with a perimeter fence and entry gates. Bike pump tracks are typically a minimum of 9,000 square feet, with a four foot tall perimeter fence with entry gates provided for both cyclists and maintenance equipment. The track provides a safe space for kids and adults to enjoy the benefits of off-road cycling in a relatively small and controlled space, offering participants a local place to get cardiovascular exercise, good core work out for the upper and lower body, and achieve personal empowerment through the navigation of obstacles. As of December 2017, the location of the Bike Pump Track is undetermined.

City of West Sacramento Capital Improvement Program

The City of West Sacramento's Public Works Department delivers capital improvement projects which help maintain and improve infrastructures, transportation, maintenance, and public safety. Current major capital improvement projects include the following.

- ADA Transition Plan and Access Improvements, no set completion date.

- Broadway Bridge. The project team expects to initiate the final design and right-of-way acquisition by 2020, with construction completion between 2025 and 2030.
- California Indiana Heritage Center. Construction began in 2017 and is expected to be completed by 2020.
- South River Road Bridge and Village Parkway Extension. No start set for the project. Project will take approximately 24-months to complete.
- Sacramento River Crossings Study. Expected to be completed by 2025.

Chapter 3
Conservation Strategy

3.1 Overview

This chapter identifies and prioritizes conservation opportunities in Yolo County. This Yolo County RCIS/LCP uses the best available science to identify conservation goals and objectives (defined in Section 3.2.3.1, *Conservation Goals and Objectives*), conservation actions, and conservation priority areas (defined in Section 3.2.3.2, *Conservation Actions and Priority Areas*) to aid California's declining and vulnerable species by protecting, restoring, creating, enhancing, and reconnecting habitat.

Consistent with Yolo County's longstanding emphasis on preserving agricultural land and a vibrant agricultural economy, the RCIS/LCP conservation strategy described in this chapter is intended for implementation in a manner that achieves its objectives on working agricultural lands where feasible. This will often require consideration of available means to further multiple public objectives through a single "multi-benefit project." Such multi-benefit projects are defined herein as projects that are designed to achieve a primary public objective (by way of example only, reducing flood risk) while also creating additional public benefits such as enhancing fish and wildlife habitat, sustaining agricultural production, improving water supply and water quality, increasing groundwater recharge, and providing public recreation and educational opportunities, or any combination thereof.

This RCIS/LCP has the following six primary conservation purposes, as identified by the Advisory Committee.

1. To conserve the sustainability of all native species, reduce environmental stressors, and maintain or enhance the resilience[7] of natural communities (plants and animals, terrestrial and aquatic) in Yolo County.
2. To maintain or create habitat connectivity for movement, dispersal, and migration of native plant and animal species.
3. To allow, maintain, and enhance ecological processes that create and sustain habitats for naturally occurring species.
4. To reduce or eliminate stressors on wildlife health and natural communities.
5. To conserve agricultural habitat values for focal species and natural communities.
6. To protect and enhance habitat features throughout the county that sustain pollinator organisms, including but not limited to insects, birds, and bats.

[7] Resilience is defined as the capacity of an ecosystem to return to its original state following a perturbation, including maintaining its essential characteristics of taxonomic composition, structure, ecosystem functions, and process rates. In the context of climate change, resilience is defined as the ability of an ecosystem to recover from or adjust easily to change, measured more in terms of overall ecosystem structure, function, and rates and less in terms of taxonomic composition (California Landscape Conservation Cooperative https://lccnetwork.org/sites/default/files/Resources/CA%20LCC%20Scientific%20Management%20Framework%20hyperlink%20single%20pages%20FINAL.pdf)

3.2 Methods and Approach

3.2.1 Conservation Gap Analysis

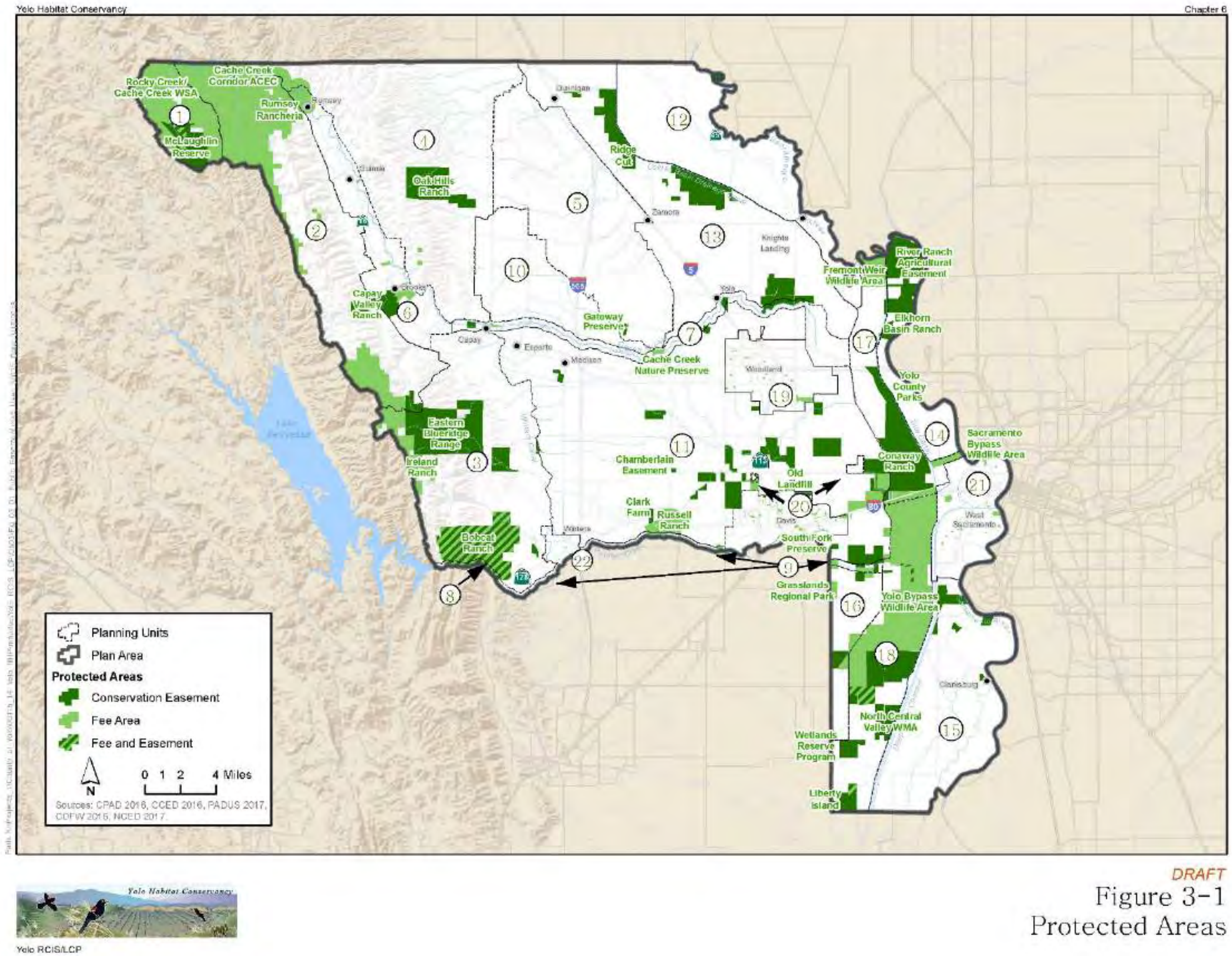
A key step in the development of a regional conservation investment strategy is to determine the existing level of protection for natural communities, landscape connectivity, and focal species. Species or natural communities with low levels of existing protection or those lacking functional landscape connectivity may require greater emphasis in the strategy to ensure their conservation in Yolo County. In contrast, species or natural communities that are well protected and which occur within functionally well-connected landscapes may need little or no additional conservation focus in the strategy. For well-protected species, the conservation goals and objectives may focus on habitat restoration or improved habitat management in existing protected areas.

The analysis conducted to determine the levels of existing protection of species and natural communities is called a *conservation gap analysis*. The methods used were based on similar approaches that have been applied at the national, state, and local levels (Yolo Habitat Conservancy 2017; Wild 2002). Some aspects of landscape connectivity assessment are included in gap-analysis assessments, particularly those aspects important in identifying larger high-quality habitat areas (sometimes considered "reserves").

Conservation biology theory holds that by protecting a wide range of ecosystems and natural communities or land cover types at a broad scale, the majority of the biological diversity contained within these natural communities will also be protected (Noss 1987). This approach is complemented by then focusing on finer scale resources such as species occurrences, species habitat, or unique physical features to conserve biological diversity not protected by the broader-scale approaches. That additional focus is incorporated through prioritizing conservation of areas supporting focal and planning species. Recent developments in conservation biology theory incorporate the importance of landscape connectivity (both structural and functional; Crooks and Sanjayan 2007) in planning for conservation for biological diversity at multiple scales (Rudnick et al. 2012; Theobald et al. 2012; Fletcher et al. 2016); however, protected-land assessment does not address connectivity directly, and this plan considers landscape connectivity as an additional conservation component (see Sections 2.11.5 and Table 3-3, Goal L1).

To determine the gaps in protection in Yolo County, GIS data layers for the natural communities and Group 1 species (i.e., focal species) were overlaid with a GIS layer of protected areas (Figure 3-1). The protected areas data is from the California Protected Areas Database and California Conservation Easement Database. The amount of each natural community type to be protected through the Yolo HCP/NCCP was also included in the analysis.

Figure 3-1. Protected Areas



3.2.2 Geographic Units of Conservation

To facilitate the development of a spatially explicit conservation strategy, Yolo County is divided into two landscape units that are composed of 22 planning units (Figure 3-2, *LCP Landscape Units and Planning Units*). The landscape units were established for the Yolo HCP/NCCP to reflect the elevation break and associated ecological differences between the hills and ridges in the western Strategy Area and the valley floor and floodplains dominating the remainder of Yolo County. The Hill and Ridge Landscape Unit encompasses planning units 1–6 and 8, and is characterized by the dominant woodlands and forest, California prairie, and chaparral natural communities. This landscape unit generally encompasses the Bailey (USDA) Ecoregion identified in Chapter 2 as the "Northern California Interior Coast Ranges." The Valley Landscape Unit encompasses planning units 7 and 9–22, and is dominated by farmed lands. Yolo County's urbanized areas within incorporated cities are located within the Valley Landscape Unit in planning units 19–22. This landscape unit generally encompasses the Bailey (USDA) Ecoregion identified in Chapter 2 as the "Great Valley."

The planning units were delineated to capture lands that support similar ecological, topographical, natural community, and land use conditions.[8] The primary purpose of the planning units is to identify the specific areas in which conservation actions (such as land acquisition and habitat restoration) will occur without identifying individual parcels for the actions.

While planning units were generally identified for major natural geomorphic and ecological features, the specific planning unit boundaries were delineated using clearly recognizable features, such as roads and parcel boundaries that best approximated natural geomorphic and ecological boundaries. Using readily identifiable existing features as boundaries facilitates clear recognition of boundaries for planning and implementing the RCIS/LCP. In this way, the RCIS/LCP uses the planning units to identify conservation actions in a spatially explicit manner while maintaining the flexibility to implement conservation actions on different parcels to meet the same conservation objectives (e.g., to respond to willing sellers where they arise). Planning units used in the RCIS/LCP are the same as those used in the Yolo HCP/NCCP, to help ensure consistency between the conservation strategies of the two plans.

3.2.2.1 Hill and Ridge Landscape Unit—Planning Unit Descriptions

Planning Unit 1—Little Blue Ridge. The Little Blue Ridge Planning Unit (Figure 3-2) incorporates unique geomorphic, geologic, and soil conditions that support specialized vegetation types. The RCIS/LCP defines the boundaries as the Yolo County boundaries with Napa, Lake, and Colusa Counties on the north, south, and west, and Lang's Peak Road on the east. The 11,832-acre area is dominated by chamise and mixed chaparral natural communities, with lesser amounts of oak woodland and California prairie. Little Blue Ridge also supports the only occurrences of serpentine natural community and closed-cone cypress woodland natural community in Yolo County.

Planning Unit 2—North Blue Ridge. The North Blue Ridge Planning Unit encompasses 52,853 acres of mostly steep, rugged terrain. This planning unit is bounded on the north by State Highway 16 and the Colusa County line; on the east by flatter lands, used predominantly for agriculture in the Capay Valley; on the south by lower Cache Creek watershed boundary; and on the west by Napa

[8] As described in Chapter 2, the term "natural communities" also includes semi-natural communities such as agricultural lands.

County. The Planning Unit supports abundant chamise and mixed chaparral natural communities and oak-dominated woodland, with lesser amounts of California prairie. The North Blue Ridge Planning Unit includes nearly two-thirds of the montane hardwood natural community in Yolo County and a substantial proportion of the small amount of closed-cone pine-cypress natural community in Yolo County.

Planning Unit 3—South Blue Ridge. The South Blue Ridge Planning Unit supports topography, geology, and vegetation similar to the North Blue Ridge Planning Unit. South Blue Ridge consists of 56,259 acres of mostly steep, rugged terrain dominated by chaparral, oak woodland, and California prairie. This planning unit is defined on the north by lower Cache Creek watershed boundary and on the east by the Winters Canal and the flatter lands that are used predominantly for agriculture. To the south, this planning unit is bounded by the Upper Putah Creek Planning Unit (Planning Unit 8). The Napa County line forms the western boundary. The South Blue Ridge Planning Unit supports abundant California prairie and oak woodland, with lesser amounts of chamise and mixed chaparral natural communities and riparian woodland. This planning unit includes nearly one-third of the montane hardwood natural community in Yolo County.

Planning Unit 4—Capay Hills. The Capay Hills Planning Unit encompasses the hill formation that separates Capay Valley from Hungry Hollow and the Dunnigan Hills. The area consists of 66,934 acres of mostly steep land. This planning unit extends north to the Colusa County line, with its eastern boundary demarcated by the lowlands adjacent to the Dunnigan Hills, County Road 85, the south fork of Buckeye Creek, the Tehama-Colusa Canal, and flat terrain of the Hungry Hollow Basin (Planning Unit 10). The southern and western boundaries are the Hungry Hollow Canal and the floor of Capay Valley, respectively. Oak woodland and California prairie are the dominant natural communities, with substantial amounts of chaparral, and small amounts of lands farmed in grain.

Planning Unit 5—Dunnigan Hills. The Dunnigan Hills Planning Unit is delineated to recognize this hilly topographic area. The planning unit is demarcated on the north by the county line, on the southeast and south by the Acacia and West Adams Canals, County Road 85, and a lowland area separate the northwest boundary of the Dunnigan Hills from the Capay Hills. This 48,038-acre planning unit is dominated by California prairie and agricultural lands, including dryland farmed grains and vineyards.

Planning Unit 6—Upper Cache Creek. The Upper Cache Creek Planning Unit consists of the narrow (0.5- to 3-mile-wide) Capay Valley bottomland area located between North Blue Ridge and the Capay Hills, and northwest of the town of Capay. The 17,919-acre area supports a wide variety of natural communities, including Cache Creek and its associated riparian woodland and scrub, numerous small farms, areas of California prairie, upland woodland, and valley oak woodland typical of adjacent planning units, and some developed areas.

Planning Unit 8—Upper Putah Creek. The Upper Putah Creek Planning Unit consists of 1,023 acres of the creek, the adjacent floodplain, and associated lands in the steeper upland portion of Putah Creek. This narrow planning unit is bounded on the south by the Solano County boundary and on the north by steep topography, generally delimited by Highway 128. The planning unit supports riparian woodland and scrub and aquatic habitats, but also includes substantial areas of upland oak woodland, California prairie, and farmland.

Figure 3-2. Landscape and Planning Units

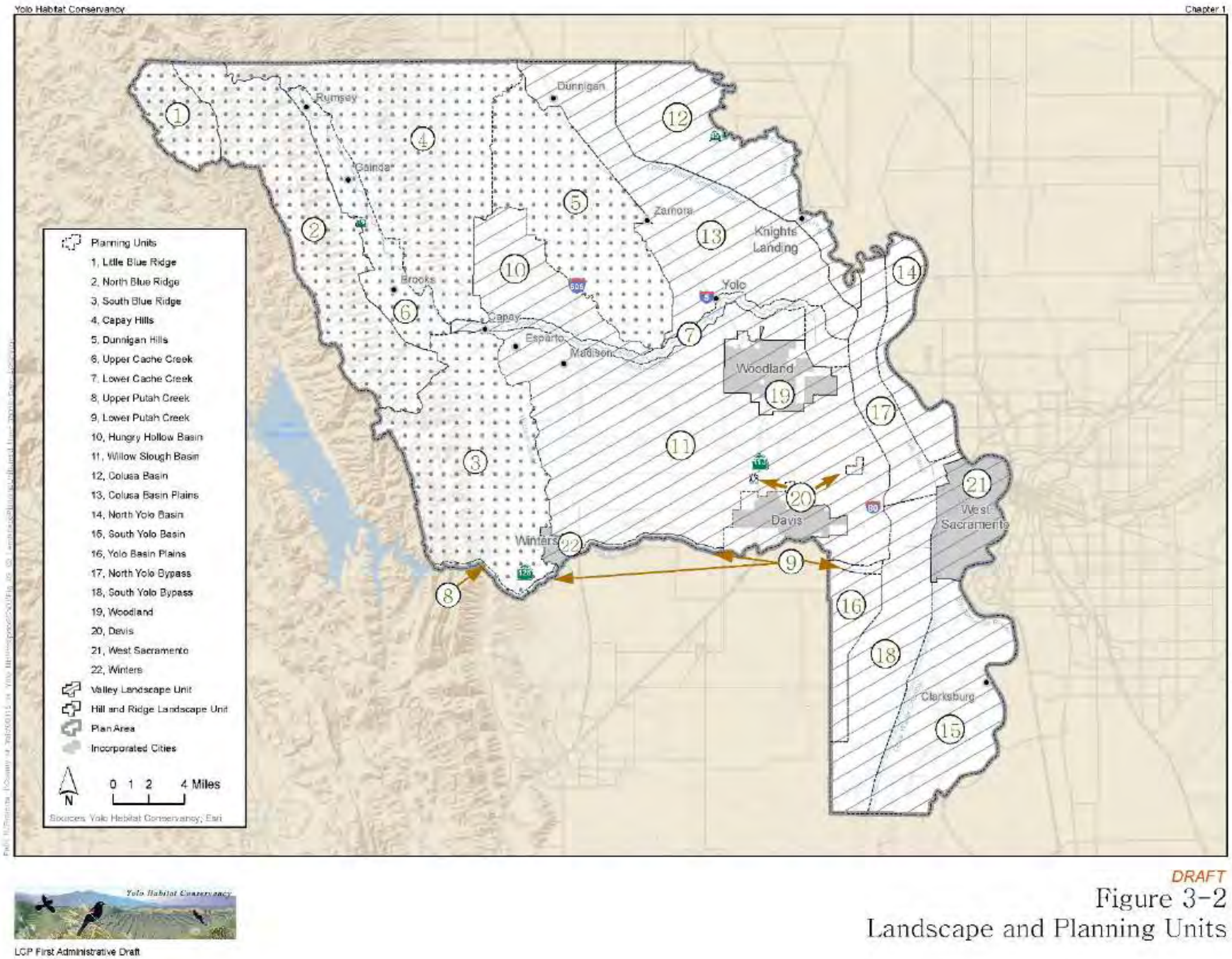
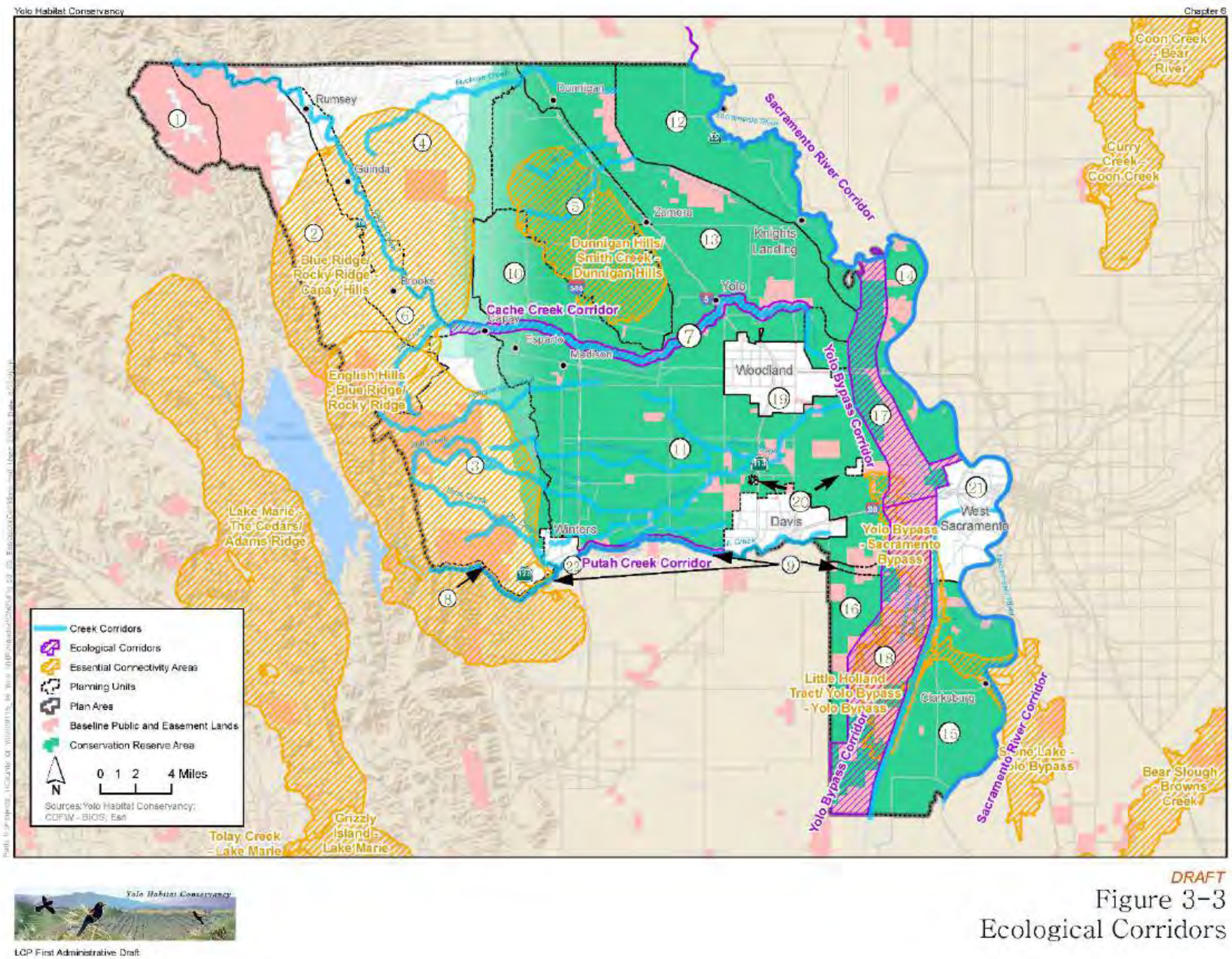


Figure 3-3. Ecological Corridors



3.2.2.2 Valley Landscape Unit—Planning Unit Descriptions

Planning Unit 7—Lower Cache Creek. The 11,361-acre Lower Cache Creek Planning Unit consists of Cache Creek and its adjacent riparian corridor downstream of the town of Capay to its terminus in the Cache Creek Settling Basin. The area supports abundant riparian and aquatic habitat and encompasses some adjacent agricultural lands and aggregate mining areas.

Planning Unit 9—Lower Putah Creek. The 2,612-acre Lower Putah Creek Planning Unit includes Putah Creek and its floodplain and adjacent lands in the lower gradient lowland portion of Putah Creek. The western part of this narrow east-west unit is bounded on the north by farmed areas and on the south by the creek, which is the boundary with Solano County. In this unit's eastern part, both sides of the creek are within Yolo County and this planning unit, where they are bordered by agricultural lands. Riparian woodland is a dominant natural community in this planning unit, with most habitat consisting of older mature woodland, but over half of the lands included are adjacent agricultural lands, predominantly in orchards and various field crops.

Planning Unit 10—Hungry Hollow Basin. The Hungry Hollow Basin Planning Unit comprises 21,069 acres of mostly agricultural lands between the Capay Hills and Dunnigan Hills and north of Cache Creek. The south boundary of this planning unit is the Cache Creek corridor, the north boundary follows the South Fork Oak Creek, and the east boundary is the Hungry Hollow Canal. Approximately 93 percent of the lands in the Hungry Hollow Basin Planning Unit are in agricultural use, with pasture and grain comprising over half of agricultural crops.

Planning Unit 11—Willow Slough Basin. The Willow Slough Basin Planning Unit is the largest planning unit, comprising 118,060 acres in the central portion of the county between Cache and Putah Creeks. The planning unit is bounded by the Cache Creek corridor, Cache Creek Settling Basin, and Woodland on the north; the western Yolo Bypass levee on the east; Davis and Putah Creek on the south; and Winters Canal on the west. Agriculture occupies 90 percent (approximately 106,000 acres) of the planning unit, with a wide variety of crop types grown. Urban and California prairie together compose most of the remaining land area, with smaller but important amounts of riparian, alkali sink, wetlands, and open water natural communities.

Planning Unit 12—Colusa Basin. The Colusa Basin Planning Unit encompasses 35,091 acres in the northeast portion of Yolo County. The planning unit boundaries consist of the Colusa County line on the north, the Sacramento River on the northeast, the Yolo Bypass on the southeast, and the Knights Landing Ridge Cut and Colusa Basin Drainage Canal on the southwest. Approximately 92 percent of the lands are used for agriculture and supporting water management, with rice as the predominant crop. Riparian woodland is concentrated along the Sacramento River.

Planning Unit 13—Colusa Basin Plains. The Colusa Basin Plains Planning Unit consists of 56,381 acres dominated by agricultural uses. Knights Landing Ridge Cut and the Colusa Basin Drainage Canal define the boundary on the northeast. Yolo Bypass forms the southeast boundary, the Cache Creek Corridor and Settling Basin define the southern boundary, and Dunnigan Hills and the Union Pacific Railroad define the southwest boundary. Approximately 84 percent of the planning unit is in agricultural uses, with a wide variety of crops grown. The remaining lands consist primarily of managed wetlands, California prairie, and urban areas, and also include significant relict stands of Valley oak woodland.

Planning Unit 14—North Yolo Basin. The North Yolo Basin Planning Unit includes lands between the Sacramento River and the Yolo Bypass along the eastern edge of Yolo County, north of West Sacramento. The planning unit consists of 13,293 acres of land located east of the Yolo Bypass at Fremont Weir, south and west of the Sacramento River, and north of the Sacramento Weir. It includes the Freemont Weir State Wildlife Area. Over 87 percent of lands are in agricultural use, including large areas of field crops, grain and hay crops, orchards, and pasture. The remaining lands consist primarily of California prairie, riparian woodland, and open water, mainly along the Sacramento River.

Planning Unit 15—South Yolo Basin. The South Yolo Basin Planning Unit comprises 38,929 acres. A line from Garcia Bend west to the Sacramento Ship Channel forms the northern boundary of this planning unit. Other boundaries are the Sacramento River on the east, the Solano County line on the south, and the Yolo Bypass on the west. Agriculture is the primary land use (approximately 85 percent), with pasture, vineyard, and field crops the dominant crop types. Other major land cover types include California prairie and urban areas. Substantial riparian and open water habitats occur along the Sacramento River, Elk Slough, and other waterways.

Planning Unit 16—Yolo Basin Plains. The Yolo Basin Plains Planning Unit is relatively small (10,284 acres), bounded by the lower Putah Creek corridor on the north, the Yolo Bypass on the east and south, and the Solano County line on the west. While these lands are subject to flooding from the Yolo Bypass, the planning unit encompasses land above areas that flood frequently. Approximately 83 percent of the land is used for agriculture, primarily pasture, field crops, and grain and hay. Other major habitats include California prairie and managed emergent wetlands. This planning unit supports some of the last remnants of natural vernal pool habitat in Yolo County.

Planning Unit 17—North Yolo Bypass. The 17,776-acre North Yolo Bypass Planning Unit consists of lands within the northern portion of the constructed flood bypass for the Sacramento River. The Sacramento River forms the northern boundary at the Fremont Weir. The southern boundary is Interstate 80. The flood control levees of the bypass form the east and west boundaries. Approximately 64 percent of the lands within the North Yolo Bypass Planning Unit are agricultural, farmed primarily in rice and field crops. Most remaining lands consist of riparian scrub, California prairie, and managed wetlands.

Planning Unit 18—South Yolo Bypass. The South Yolo Bypass Planning Unit consists of 32,301 acres within the southern portion of the Yolo Bypass. Interstate 80 forms the northern boundary. The southern boundary and part of the western boundary consist of the Solano County line. East and west boundaries are the flood control levees of the Yolo Bypass and designated flood areas, as well as county roads and the boundary with Solano County. Managed and natural wetlands, open water, and riparian habitat comprise nearly 40 percent of the lands within the planning unit. Agricultural lands, primarily pasture, field crops, and rice, occupy 33 percent of the lands. California prairie and associated vernal pools and alkali sink habitats make up most of the remainder of the planning unit.

Planning Unit 19—Woodland. The Woodland Planning Unit includes 12,765 acres of land within the City of Woodland's Urban Limit Line as defined in the City's 2002 General Plan as updated in 2006. This planning unit includes the existing urbanized area within the Woodland city limits and lands projected for growth under the City's General Plan. Approximately 66 percent of the planning unit is developed and over 25 percent of the land is currently in various agricultural crops. This planning unit supports important and regionally rare alkali prairie natural community.

Planning Unit 20—Davis. The 10,804-acre Davis Planning Unit includes lands within the City of Davis' sphere of influence as updated in the 2008 Davis General Plan. Urban uses are present on approximately 76 percent of land in this planning unit and agriculture on approximately 19 percent of the planning unit. Natural areas include riparian natural community along the North Fork of Putah Creek and California prairie on the city's outskirts.

Planning Unit 21—West Sacramento. The 14,682-acre West Sacramento Planning Unit includes the city's existing developed areas and lands within its jurisdiction that are projected for urban growth under the West Sacramento General Plan. This planning unit is bounded by the Sacramento Bypass on the north, the Yolo Bypass on the west, the Sacramento River on the east and southeast, and the city limits on the south. Existing urban areas comprise about 73 percent of the planning unit. Other major habitats include California prairie, agriculture, riparian woodland, and open water (mostly within the Sacramento River and Sacramento deepwater ship channel and associated Port of Sacramento).

Planning Unit 22—Winters. The 1,978-acre Winters Planning Unit includes the city's existing developed and undeveloped areas within its urban limit line. Urban uses occur on 39 percent of land and agriculture occupies approximately 32 percent of land in this unit. Natural areas include riparian habitat along Putah Creek and California prairie habitats near the city's northern boundary.

3.2.3 Multi-Benefit Approach

The RCIS/LCP encourages the application of a multi-benefit approach. This includes implementation of multi-benefit projects, defined herein (as set forth in Section 3.1, above) as projects that are designed to achieve a primary public objective (by way of example only, reducing flood risk) while also creating additional public benefits such as enhancing fish and wildlife habitat, sustaining agricultural production, improving water supply and water quality, increasing groundwater recharge, and providing public recreation and educational opportunities, or any combination thereof.

In Yolo County the protection of agriculturally productive lands is a widely adopted public goal. The CVFPP Conservation Strategy (DWR 2016) (at p. 6-22) identifies strategies for implementing multi-benefit projects on working agricultural lands to achieve solutions that:

Keep farmers on the land,

- Maintain agricultural and economic viability in the project area,
- Provide environmental and habitat benefits,
- Are consistent with State, regional, and County policies, and
- Support the stability of local governments and special districts.

These objectives also mirror policies in the 2030 Countywide General Plan for Yolo County. For example, the General Plan includes principles that emphasize protecting "farmland and farming practices through conservation easements, land use controls and regional collaboration," while also promoting "[a] diverse landscape that connects habitat and enhances ecological integrity." (General Plan, Vision & Principles at pp. VI-4 and VI-5.) Numerous General Plan policies also promote a balanced approach to integrating habitat conservation, restoration, and enhancement projects into the predominantly agricultural landscape. For example:

From the Agriculture & Economic Development Element

Policy AG-2.8 Facilitate partnerships between agricultural operations and habitat conservation efforts to create mutually beneficial outcomes.

Policy AG-2.9 Support the use of effective mechanisms to protect farmers potentially impacted by adjoining habitat enhancement programs, such as safe harbor programs and providing buffers within the habitat area.

Policy AG-2.10 Encourage habitat protection and management that does not preclude or unreasonably restrict on-site agricultural production.

Policy AG-2.13 Promote wildlife-friendly farm practices, such as tailwater ponds, native species/grasslands restoration in field margins, hedgerows, ditch management for riparian habitat, restoration of riparian areas in a manner consistent with ongoing water delivery systems, reduction of pesticides, incorporating winter stubble and summer fallow, etc. (*see also Policy CO-2.17*)

From the Conservation and Open Space Element

Policy CO-1.28 Balance the needs of agriculture with recreation, flood management, and habitat within the Yolo Bypass.

Policy CO-2.17 Emphasize and encourage the use of wildlife-friendly farming practices within the County's Agricultural Districts and with private landowners, including:

- Establishing native shrub hedgerows and/or tree rows along field borders.
- Protecting remnant valley oak trees.
- Planting tree rows along roadsides, field borders, and rural driveways.
- Creating and/or maintaining berms.
- Winter flooding of fields.
- Restoring field margins (filter strips), ponds, and woodlands in non-farmed areas.
- Using native species and grassland restoration in marginal areas.
- Managing and maintaining irrigation and drainage canals to provide habitat, support native species, and serve as wildlife movement corridors.
- Managing winter stubble to provide foraging habitat.
- Discouraging the conversion of open ditches to underground pipes, which could adversely affect giant garter snakes and other wildlife that rely on open waters.
- Widening watercourses, including the use of setback levees.

Policy CO-2.5 Protect, restore and enhance habitat for sensitive fish species, so long as it does not result in the large-scale conversion of existing agricultural resources.

Policy CO-2.20 Encourage the use of wildlife-friendly Best Management Practices to minimize unintentional killing of wildlife, such as restricting mowing during nesting season for ground-nesting birds or draining of flooded fields before fledging of wetland species.

Policy CO-2.24 Promote floodplain management techniques that increase the area of naturally inundated floodplains and the frequency of inundated floodplain habitat, restore some natural flooding processes, river meanders, and widen riparian vegetation, where feasible.

Together, the CVFPP Conservation Strategy (DWR 2016) and Yolo County General Plan furnish an appropriate framework for evaluating projects proposed to implement this RCIS/LCP on farmed lands. Some of the conservation opportunities identified in this chapter—in particular, those set forth in Table 3-3, Goals CL1 through CL3 —directly account for the habitat value of cultivated land and promote activities that complement continued farming. In other cases, the conservation opportunities identified in this chapter may include restoration or other activities on farmed lands that could conflict with farming or other existing land uses. These potential conflicts should be given thorough attention during project siting, design, and implementation, and reduced or avoided whenever feasible. Projects proposed to implement this RCIS/LCP should demonstrate careful consideration of potential effects on agriculture and other existing land uses, together with opportunities to provide multiple public benefits, and other aspects of the land use and regulatory setting relevant to this plan.

3.2.4 Structure of the Conservation Strategy

3.2.4.1 Conservation Goals and Objectives

The *conservation goals* of this RCIS/LCP reflect the commitment to achieve broad, desired outcomes for the focal species and other conservation elements in Yolo County. These conservation goals address the unique pressures on focal and conservation species and important conservation elements identified in Chapter 2 and the species accounts (Appendix C). *Conservation objectives* are intended to be concise, measurable statements of the target outcome for each focal species and other conservation elements, to achieve the conservation goals. The conservation objectives focus on conserving landscape elements, protecting or restoring natural communities and focal/conservation species' habitats, managing and enhancing landscape connectivity in the RCIS/LCP Strategy Area, and managing and enhancing land in Yolo County by a conservation easement or other instrument providing for perpetual protection of land. MCAs may include conservation actions such as management and enhancement on lands that are already protected, as well as lands that the MCA commits to protect. All conservation goals and objectives are intended to be achieved through the implementation of the conservation actions as described in Section 3.2.3.2, *Conservation Actions and Priority Areas*.[9]

The conservation goals and objectives are organized hierarchically on the basis of the following ecological levels of organization:

- **Landscape.** The landscape-level conservation goals and objectives form the overarching framework for the conservation strategy and focus on the extent, distribution, and connectivity among natural communities and improvements to the overall condition of hydrological,

[9] The RCIS Program Guidelines (June 2017 version) recommend that conservation objectives be achievable within the 10-year lifespan of the initial approval of the RCIS. The conservation objectives in this RCIS/LCP, however, do not have a deadline because of the uncertainty in the pace of implementation and the desire to align with the longer timeframe of the overlapping HCP/NCCP (50 years). Instead, RCIS/LCP conservation priorities are designed to be implemented within an approximately 10-year timeframe.

physical, chemical, and biological processes (including connectivity and climate change adaptation) in Yolo County;

- **Natural community.** The natural community conservation goals and objectives focus on maintaining or enhancing ecological functions and values of specific natural communities. Achieving natural community goals and objectives will also provide for the conservation of habitat of associated focal and conservation species and other native species; and
- **Species.** The species-specific conservation goals and objectives address stressors and habitat needs of individual focal species (or, in some cases, groups of species with similar needs) that are not addressed under the landscape and natural community goals and objectives. As described in Section 3.4.4, *Conservation Species Strategy,* the conservation strategies for conservation species rely primarily on the landscape-level and natural community-level goals and objectives, and prioritization of conserving lands that support these species.

In addition, the Yolo RCIS/LCP provides rationale for the conservation objectives. For each focal species (Group 1), the Yolo RCIS/LCP lists the landscape-level and natural community-level goals and objectives that would benefit the species, followed by the objectives developed for that species or group of species, and their associated rationale. For the most part, the Yolo RCIS/LCP addresses the conservation species (Groups 2 and 3) through goals and objectives at the landscape and natural community levels. Species-specific goals and objectives were developed only when additional factors, such as specific habitat requirements or population factors, needed to be addressed to provide for the conservation of the species in Yolo County.

Most of the conservation goals and objectives are designed to maintain current populations of focal species and retain the other conservation elements. The conservation goals and objectives also provide for the long-term persistence of focal and conservation species and other conservation elements through habitat protection and enhancement. In some cases, populations of focal/conservation species are expected to increase as a result of land preservation, management, habitat enhancement, and habitat restoration. Where there is overlap between the RCIS/LCP and the Yolo HCP/NCCP, the conservation objective includes the required habitat protection, restoration, or enhancement of the HCP/NCCP for context. The conservation provided by the HCP/NCCP is assumed to occur because it will be an obligation of the state and federal endangered species permits expected in 2018.

All conservation goals and objectives are given unique codes so that they can be easily identified and tracked by those implementing conservation actions.

3.2.4.2 Conservation Actions and Priority Areas

The *conservation actions* of this RCIS/LCP are intended to be implemented to accomplish the conservation goals and objectives. Conservation actions are defined by the RCIS Program Guidelines (June 2017 version) as “actions that would preserve or restore ecological resources, including habitat, natural communities, ecological processes, and wildlife corridors, to protect those resources permanently, and would provide for their perpetual management.” For each conservation objective or set of objectives, the RCIS/LCP lists a number of conservation actions that may be implemented to achieve the objective(s). These include actions that directly address the threats and stressors to the focal/conservation species. For example, if habitat loss is a threat, then protection and restoration of habitat would be the action that addresses that threat. If invasive vegetation is the threat, then managing invasive plants would be the action.

The Yolo RCIS/LCP uses *priority areas* for RCIS (Group 1) focal species (Section 3.3.2, *Focal* Species) to highlight important locations where conservation actions should occur in the next 10 years (Table 3-3). Section 3.4, *Conservation Strategy,* lists conservation priority areas for each RCIS focal species. Section 3.5.4, *Unique Areas,* describes areas the Advisory Committee identified as important for conservation due to unique ecological attributes, for the purpose of the LCP.

The conservation actions and priorities are not limited to those identified in this chapter. Additional actions and new priorities will likely become apparent as additional information becomes available about the changing future environment in Yolo County. Those implementing conservation in Yolo County should consider any opportunity to contribute to the conservation goals and objectives of this RCIS/LCP if the expected outcome will benefit the long-term viability of the native species in Yolo County.

3.2.4.3 Ensuring Consistency with Other Conservation Plans

Fish and Game Code Section 1852(c)(10) requires that an RCIS include provisions ensuring that the strategy is consistent with and complements any administrative draft natural community conservation plan, approved natural community conservation plan, or federal habitat conservation plan that overlaps with Yolo County. Fish and Game Code Section 1852(c)(11) requires that an RCIS include an explanation of whether and to what extent the strategy is consistent with any previously approved strategy or amended strategy, state or federal recovery plan, or other state or federal approved conservation strategy that overlaps with Yolo County.

This conservation strategy has been developed to complement the Yolo HCP/NCCP, described in Section 2.12.1.1. The RCIS/LCP Steering Committee designed the conservation goals and objectives for focal species that overlap with Yolo HCP/NCCP covered species, to build off of the HCP/NCCP biological goals and objectives. Appendix E provides a crosswalk between the Yolo RCIS/LCP and HCP/NCCP goals and objectives, to demonstrate consistency between the two plans. Appendix E also includes a letter from the Conservancy, the expected HCP/NCCP implementation sponsor, certifying that the RCIS is consistent with and complements the HCP/NCCP. Appendix E also provides a crosswalk between the RCIS/LCP goals and objectives and other local conservation plans described in Section 2.12.3, *Other Regional Conservation Plans.*

The RCIS/LCP Steering Committee also developed the conservation goals and objectives for federally listed species to be consistent with recovery plans developed for those species. Appendix F, *Conservation Strategy Rationale,* provides the rationale for the goals and objectives related to each focal species, and for federally listed species with recovery plans, the rationale includes descriptions of how the goals and objectives are consistent with the species recovery plans.

This conservation strategy has also been developed to support and contribute to the CVFPP's conservation objectives for landscape functions and processes, natural communities, and focal species addressed in the CVFPP Conservation Strategy (DWR 2016). The CVFPP Conservation Strategy also informs the implementation of this RCIS/LCP in another way—by contributing a multi-benefit approach to project development and implementation that affords careful attention to existing land uses and related policy and legal issues. This element of the CVFPP Conservation Strategy is particularly relevant to this RCIS/LCP because many of the projects that carry out the actions and priorities set forth in this section will occur on or near actively cultivated lands. The Yolo County General Plan describes the preservation of agriculture as "fundamental to the identity of Yolo County." (2030 Countywide General Plan, Goal AG-1.) Preserving compatible agricultural uses on conservation lands is thus a priority, and multi-benefit projects (which will often but not always preserve existing agricultural uses) are also more likely to navigate past traditional feasibility constraints such as available funding, statutory authority, policy constraints, cost-effectiveness, and acceptability. Projects that implement this RCIS/LCP should thus seek to align with this element of the CVFPP Conservation Strategy, as discussed further in Section 3.4, below.

3.3 Results of Conservation Gaps Analysis

Section 3.2.1, *Conservation Gaps Analysis,* describes the purpose and methods for the conservation gap analysis. The sections below provide the results of this analysis.

3.3.1 Natural Communities

Table 3-1 presents the results of the conservation gap analyses for natural communities in Yolo County. Data are presented by the type of protection through existing mechanism (pre-RCIS/LCP protected areas) and lands the Yolo HCP/NCCP will protect. Together, these results lay the groundwork for RCIS/LCP protection goals in Yolo County.

As described in Chapter 2, Yolo County is dominated by agricultural lands on the valley floor and oak woodlands and other natural lands in the foothills., More than 25 percent of many natural land cover types in Yolo County are already protected because local governments, conservation organizations, and the state and federal government have conserved significant amounts of land in the past, as illustrated by the number of acres already These protected areas can be leveraged when protecting new areas to gain a larger conservation benefit for natural communities and species.

Natural land cover types with the highest percentage of protection (including acres to be protected under Yolo HCP/NCCP) include serpentine (86 percent), closed-cone pine-cypress (95 percent), vernal pool complex (86 percent), and fresh emergent wetland (87%). While these natural communities are mostly protected they are considered rare and will be conserved to the maximum extent possible. The natural land cover types with the lowest proportion in open space and the largest conservation gaps overall are non-rice cultivated lands (14 percent), California prairie (18 percent), and lacustrine and riverine (21 percent).

Table 3-1. Natural Community Gap Analysis

Natural Community	Existing Acres in Strategy Area (acre)	Total Protected		Total Unprotected		Yolo HCP/NCCP Protection		Total Protected with HCP/NCCP		Total Unprotected with HCP/NCCP[a]	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Cultivated Lands – Rice	35,724	5,466	15%	30,258	85%	2,800	8%	8,266	23%	27,458	77%
Cultivated Lands – Non-rice	214,939	16,624	8%	198,315	92%	14,362	7%	30,986	14%	183,953	86%
California prairie	80,911	10,248	13%	70,663	87%	4,430	5%	14,678	18%	66,233	82%
Serpentine	2,327	2,004	86%	323	14%	0	0%	2,004	86%	323	14%
Chamise	30,187	15,622	52%	14,565	48%	0	0%	15,622	52%	14,565	48%
Mixed Chaparral	14,518	9,918	68%	4,600	32%	0	0%	9,918	68%	4,600	32%
Oak and Foothill Pine	43,772	10,100	23%	33,672	77%	0	0%	10,100	23%	33,372	77%
Blue Oak Woodland	35,891	8,390	23%	27,501	77%	10	<1%	8,400	23%	27,491	77%
Closed-Cone Pine-Cypress	212	201	95%	11	5%	0	0%	201	95%	11	5%
Montane hardwood	3,087	975	32%	2,112	68%	0	0%	975	32%	2,112	68%
Valley Oak Woodland	181	36	20%	145	80%	20	11%	56	31%	125	69%
Alkali Prairie	312	89	29%	223	71%	33	11%	122	39%	190	61%
Vernal pool complex	299	257	86%	42	14%	0	0%	257	86%	42	14%
Fresh Emergent Wetland	26,309	22,290	85%	4,019	15%	500	2%	22,790	87%	3,519	13%
Valley foothill Riparian	12,565	2,592	21%	9,973	79%	1,600	13%	4,192	33%	8,373	67%
Lacustrine and Riverine	13,493	2,214	16%	11,279	84%	600	4%	2,814	21%	10,679	79%
Total Natural Communities	**512,646**	**107,027**	**21%**	**405,619**	**79%**	**24,294**	**5%**	**131,321**	**74%**	**381,325**	**74%**

[a] These columns are meant to show the total gap in protection with existing and Yolo HCP/NCCP protection. There is no legal requirement under this RCIS/LCP to protect the unprotected acres quantified in these columns.

3.3.2 Focal Species

Table 3-2 presents the results of the conservation gap analyses for the 22 RCIS focal species (i.e., Group 1 species) for which habitat models are available. Data are presented by the type of protection through existing mechanism (pre-RCIS/LCP public and easement lands). These results lay the groundwork for prioritizing RCIS/LCP protection of focal species in Yolo County in addition to the habitat to be protected or restored under the Yolo HCP/NCCP.

The RCIS guidelines identify a conservation priority for “Species of Greatest Conservation Need,” based on the 2015 State Wildlife Action Plan (SWAP). The SWAP species of greatest conservation need are identified in Appendix C of the SWAP. Appendix Table C-11 identifies species of greatest conservation need in the Northern California Interior Coast Ranges (USDA) Ecoregion. Appendix Table C-18 identifies species of greatest conservation need in the Great Valley (USDA) Ecoregion. As noted in Chapter 2, nearly all of the species of greatest conservation need identified in these tables are included in the RCIS/LCP either as focal/conservation (Group 1) species in the RCIS or as conservation (Group 2 and Group 3) species in the LCP.

Some focal species have a high percentage (i.e., more than 75 percent) of their habitat protected relative to the total acres of land cover that occurs in Yolo County). These include Baker’s navarretia (97 percent), Solano grass (100 percent), Colusa grass (100 percent). These species occur in vernal pool complexes. While these species are already highly protected, they are considered rare and will be conserved to the maximum extent possible. Focal species with the lowest proportion (under 20 percent) of their habitat in open space overall and where the conservation gaps are greatest are western spadefoot (14 percent), tricolored blackbird foraging (16 percent), grasshopper sparrow (15 percent), western burrowing owl (12 percent), and bank swallow (17%).

Table 3-2. Gap Analysis for Focal Species (Excluding Fish)

Species	Modeled Habitat (acres)	Pre-Yolo HCP/NCCP Protected Areas	Yolo HCP/NCCP Habitat Protection	% of Modeled Habitat Within Protected Areas (with HCP/NCCP)	Total Unprotected with Yolo HCP/NCCP[a] (acres)
Alkali milk vetch	576	89	33	21%	454
Heckard's pepper-grass	576	349	33	66%	194
Brittlescale	583	350	33	66%	200
San Joaquin spearscale	583	350	33	66%	200
Baker's navarretia	301	260	33	97%	8
Palmate-bracted bird's-beak	312	89	33	39%	190
Solano grass	1.2	1.2	0	100%	0
Colusa grass	1.2	1.2	0	100%	0
Conservancy fairy shrimp	576	349	0	61%	227
California Linderiella	576	349	0	61%	227
Midvalley fairy shrimp	576	349	0	61%	227
Vernal pool fairy shrimp	576	349	0	61%	227
Vernal pool tadpole shrimp	576	349	0	61%	227
Valley elderberry longhorn beetle (Rip)	9,447	1,909	1,600	37%	3,509
Valley elderberry longhorn beetle (Nonrip)	3,923	788	0	20%	3,135
CA tiger salamander - upland	86,505	9,031	2,000	13%	75,474
CA tiger salamander - aquatic	1,004	581	36	61%	387
Foothill yellow-legged frog - upland	232	152	0	66%	80

Species	Modeled Habitat (acres)	Pre-Yolo HCP/NCCP Protected Areas	Yolo HCP/NCCP Habitat Protection	% of Modeled Habitat Within Protected Areas (with HCP/NCCP)	Total Unprotected with Yolo HCP/NCCP[a] (acres)
Foothill yellow-legged frog - aquatic	274	173	0	63%	101
Western spadefoot - upland	52,379	5,678	2,000	15%	44,701
Western spadefoot – aquatic	847	84	36	14%	727
Western pond turtle - upland	137,185	45,849	3,475	36%	87,861
Western pond turtle - aquatic	53,907	11,110	2,400	25%	40,397
Giant garter snake - upland	6,162	2,184	1,160	54%	2,818
Giant garter snake - aquatic	6,596	1,579	420	30%	4,597
Giant garter snake – fresh emergent wetland	25,897	22,242	500	88%	3,155
Giant garter snake - rice	31,168	3,606	2,800	21%	24,762
Tricolored blackbird - nesting	4,680	3,366	200	76%	1,114
Tricolored blackbird - foraging	261,133	25,948	16,610	16%	218,575
Black tern	40,243	8,640	420	23%	31,183
Grasshopper sparrow	80,376	7,626	4,430	15%	68,320
Loggerhead shrike	214,545	52,998	unknown	25%	161,547
Western yellow-billed cuckoo	3,868	1,306	500	47%	2,062
Greater sandhill crane	9,520	194	0	2%	9,326
California black rail	49	40	0	81%	9

Species	Modeled Habitat (acres)	Pre-Yolo HCP/NCCP Protected Areas	Yolo HCP/NCCP Habitat Protection	% of Modeled Habitat Within Protected Areas (with HCP/NCCP)	Total Unprotected with Yolo HCP/NCCP[a] (acres)
Northern harrier	321,824	48,847	17,965	21%	255,012
Western burrowing owl	103,853	8,955	3,330	12%	91,568
Swainson's hawk - nesting	15,673	9,421	1,600	70%	4,652
Swainson's hawk - foraging	293,415	38,678	18,730	20%	236,007
White-tailed kite - nesting	31,732	5,970	1,600	24%	24,162
White-tailed kite - foraging	236,498	29336	18,685	20%	188,477
Bank swallow	962	111	50	17%	801
Yellow-breasted chat	2,925	692	600	44%	1,633
Least Bell's vireo	4,719	1,442	600	43%	2,677
Townsend's big-eared bat	284,812	44,125	24,294	24%	216,393

[a] This column are meant to show the total gap in protection with existing and Yolo HCP/NCCP protection. There is no legal requirement under this RCIS/LCP to protect the unprotected acres quantified in this column.

3.4 Conservation Strategy

The following conservation goals and objectives provide a voluntary roadmap for conservation organizations and project proponents with mitigation needs to inform future land acquisition and land use decisions that assist in implementing the RCIS/LCP in Yolo County. Section 3.4.1, below, provides specific conservation goals and objectives, conservation actions, and conservation priority for the RCIS/LCP. Section 3.4.2 provides supplementary conservation guidelines developed by the Advisory Committee for prioritizing conservation lands. These supplemental conservation guidelines can be used by anyone implementing the LCP, RCIS, or both.

3.4.1 Conservation Goals, Objectives, Actions, and Priority Areas

Section 3.2.3, *Structure of the Conservation Strategy,* describes the tiered approach for the conservation goals and objectives (landscape, natural community, and species levels) and how the conservation strategy is composed of goals, objectives, conservation actions, and conservation priority areas. Table 3-3, below, provides the goals, objectives, conservation actions, and conservation priority areas for this RCIS/LCP. Appendix F provides the rationale for the conservation objectives and describes how the tiered approach conserves focal species and natural communities at multiple levels (i.e., landscape, natural community, and species-specific levels).

Table 3-3. Conservation Goals and Objectives and Applicable Conservation Actions

Biological Goals and Objectives	Applicable Conservation Actions
LANDSCAPE-LEVEL GOALS AND OBJECTIVES	
Goal L1: Large Interconnected Landscapes. Maintain interconnected landscapes in Yolo County with the range of physical and biological attributes (e.g., slope, soils, hydrology, climate, and plant associations) that support the distribution and abundance of focal and conservation species and their habitats, provide for the movement and genetic interchange among populations of focal and conservation species, support adaptive adjustments in species distributions in response to climate change, and sustain native biodiversity.	
Objective L1-1: Landscape Connectivity. Establish landscape connections within and between natural communities where connectivity is currently poorly developed or lacking. Maintain connectivity where it currently exists and/or is well developed, and avoid fragmentation.	**L1-1.1.** Evaluate key landscape connections in Yolo County (including ECAs, creek corridors, and other ecologically important connections based on the best available data), and determine whether they are intact or highly constrained connections. **L1-1.2.** Prioritize protection of intact connections and restoration or enhancement of constrained connections. **L1-1.3.** Prioritize actions that increase habitat connectivity between transitional habitats along the Sacramento River, Putah Creek, and Cache Creek. (Also see RCIS/LCP Objective L1.5, *Ecotone conservation,* below.) **L1-1.4.** Prioritize actions to increase habitat connectivity among transitional habitats along secondary riparian corridors involving perennial and intermittent streams in Yolo County. These streams with secondary riparian corridors include, but may not be limited to, Tule Canal, Enos Creek/Dry Creek, Dry Slough, Salt Creek/Chickahominy Slough, Cottonwood Creek, Willow Slough, Thompson Canyon/Salt Creek, Oat Creek, Bird Creek, and Buckeye Creek. (Also see RCIS/LCP Objective L1.5, *Ecotone conservation,* below.) **L1-1.5.** Maintain connectivity among landscape elements within Yolo County and avoid fragmentation of the landscape (the opposite of connectivity) in seeking to include environmental gradients. (Also see RCIS/LCP Objective L1.3, *Environmental gradients,* below.) **L1-1.6.** Provide connectivity among landscape elements within Yolo County and ecologically significant landscape elements outside Yolo County. **L1-1.7.** Incorporate existing protected areas within the system of conserved lands, and to the extent possible, prioritize additions to the system that maintain connectivity within the protected landscape.
Objective L1-2: Areas to support sustainable populations. Maintain sufficient natural community or habitat areas to support sustainable populations of naturally occurring species in Yolo County.	**L1-2.1.** Prioritize land acquisitions adjacent to protected lands. **L1-2.2**. Prioritize maintenance of habitat connectivity among valley floor habitats, upland habitats, and habitats in higher elevations in the western mountains. **L1-2.3.** Protect habitat for area-limited planning species (species with large home ranges or migratory patterns, such as American badger, black-tailed deer) based on the minimum habitat patch sizes and design guidelines provided in Table 3-3. Protect habitat to facilitate seasonal migration for black-tailed deer.

Biological Goals and Objectives	Applicable Conservation Actions
Objective L1.3: Environmental Gradients. Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities within Yolo County. Provide reserve system connectivity across gradients.	**L1-3.1.** Prioritize land acquisitions that add to the range of environmental gradients on protected lands in Yolo County.
Objective L1-4: Natural Community Restoration. Increase the extent of natural communities through restoration, in a manner that maximizes the likelihood of their long-term functioning, taking into consideration both historic conditions and potential future conditions with climate change.	**L1-4.1.** Restore species composition and ecological processes in natural communities in areas with the appropriate soils, hydrology, and other physical conditions that support the community. **L1-4.2.** Implement initial restoration actions according to recommendations in a restoration handbook such as Griggs (2009) that is widely accepted among restoration scientists. **L1-4.3.** Consider the historic conditions of a site when developing restoration plans. A site is typically more likely to support a vegetation community that it supported historically, unless key physical components have been irreversibly altered by factors such as climate change or extreme human disturbance. **L1-4.4.** Consider potential future conditions resulting from climate change when developing restoration plans. **L1-4.5.** Adaptively adjust restoration approaches on the basis of additional knowledge gained from monitoring or observing previously implemented restoration actions. Incorporate knowledge gained from restoration science generally to the extent that it addresses conditions in Yolo County. **L1-4.6.** Use locally native plant material. **L1-4.7.** Use native local soils. **L1-4.8.** Do not import fill. **L1-4.9.** Do not compact soil. **L1-4.10.** Protect restored areas against degradation that may result from undesirable practices in or management of adjoining land uses or other disturbances.
Objective L1-5: Ecotone Conservation. Protect, restore and enhance ecotones between natural communities.[10]	**L1-5.1** Protect transitional areas between riparian and oak woodland or savanna laterally along rivers, streams, sloughs, canals, and drainages. **L1-5.2.** Protect ecotones that provide connectivity between natural communities. **L1-5.3.** Protect ecotones that have high biodiversity as a result of the overlap of two natural community types.

[10] An *ecotone* is a region of transition between two biological communities.

Biological Goals and Objectives	Applicable Conservation Actions
	L1-5.4. Remove invasive species from degraded ecotones, where feasible and where desirable to accomplish ecological goals. **L1-5.5.** Protect or restore natural soil structure within ecotones.
Goal L2: Ecological Processes and Conditions. Maintain or restore ecological processes and conditions in Strategy Area landscapes that sustain natural communities, native species, and landscape connectivity.	
Objective L2-1: Hydrologic and Geomorphic Processes Improve dynamic hydrologic and geomorphic processes[11] in watercourses and floodplains in a way that avoids or minimizes impacts on terrestrial species habitat (including the HCP/NCCP) and agricultural land. Allow floods to promote fluvial processes, such that bare mineral soils are available for natural recolonization of vegetation, desirable natural community vegetation is regenerated, and structural diversity is promoted; or implement management actions that mimic those natural disturbances.	**L2-1.1.** Restore riverine geomorphic process on the Sacramento River, Putah Creek, Cache Creek, Tule Canal, and other watercourses in the Strategy Area. • Create riparian management corridors that can accommodate natural lateral channel migration. • Relocate levees away from watercourses to reduce the physical forces acting on them, and to allow natural lateral channel migration. • Create or improve secondary channels and overflow swales that add riverine and floodplain habitat values (e.g., resting or rearing areas for fish migrating downstream) and provide escape routes for fish during receding flows. • Minimize new bank protection actions, or remove non-critical bank protection features, to allow channels to meander naturally within the floodplain. **L2-1.2.** Increase access to natural floodplains. • Protect entire floodplains around watercourses where possible. • Set levees back to widen floodplains and expand available in-stream, secondary channel, or floodplain habitat. • Modify floodplain topography to provide sustained inundation for 14 days or longer between late November and late April. **L2-1.3.** Modify the floodplain to improve function and support focal species. • Modify floodplains in locations where higher ground impedes flow connectivity or capacity, to increase the hydrologic connectivity and capacity of the active floodplain, improve fish migration, reduce stranding potential, and allow additional riparian vegetation to establish without significantly impeding flows. • Modify floodplains to provide greater topographic and hydrologic diversity. Eliminate depressional features (such as isolated gravel pits or deep borrow pits) that strand fish when water recedes, but recognize that depressional features such as ponds can be important refugia for species such as western pond turtle and giant garter snake. • Create higher ground in floodplains that can serve as refugia from floodwaters for wildlife species, including giant garter snake and California black rail. **L2-1.4.** Manage water on agricultural land in the Yolo Bypass to provide floodplain functions

[11] Hydrologic and geomorphic processes are further described in the rationale for this objective, in Appendix F, *Conservation Strategy Rationale.*

Biological Goals and Objectives	Applicable Conservation Actions
	• Sustain inundation for 14 days or longer between late November and early March on agricultural lands to benefit anadromous fish.
Objective L2-2. Fire. Allow or mimic natural fire regimes in areas where fires naturally occur and are a key component of the ecosystem.	**L2-2.1.** Incorporate prescribed fire and managed wildfire into management programs in areas where fires naturally occur, where feasible.
Goal L3: Landscape-level Stressors. Reduce landscape-level stressors that cause widespread effects on native species and ecosystems and on natural processes.	
Objective L3-1. Invasive Species. Control or eradicate invasive species that may cause reduced habitat quality for desired native species, reductions in biological diversity, or degraded ecosystem processes.	**L3-1.1.** Implement applicable elements of the Invasive Plant Management Plan (Appendix E of the CVFPP Conservation Strategy [DWR 2016]) within the CVFPP CPAs. See Appendix H of this Yolo RCIS/LCP for excerpts. **L3-1.2** Prioritize invasive species for control, based on level of threat to native species, biodiversity, or ecosystem processes. **L3-1.4** Find and eliminate seed/propagule sources of invasive plant species in restoration projects in Yolo County. **L3-1.5.** Identify and implement suitable control programs, including appropriate use of herbicides, grazing, flooding, and fire, as well as other proven methods, for invasive plant species (including, but not limited to, barbed goat grass, yellow starthistle, perennial pepperweed, tamarisk, and giant reed). **L3-1.6.** Identify and implement suitable control programs, including the appropriate use of chemical agents, trapping, and controlled hunting, as well as other proven methods, for invasive animals (e.g., feral or free-roaming dogs, cats, rats, wild pig, invasive fish, European starling, and bullfrog).
Objective L3-2. Pollutants and Toxins. Reduce the effects of known pollutants and toxins that threaten native species.	**L3-2.1.** Identify and implement actions to reduce the effects of known pollutants and toxins, such as mercury toxicity in Cache and Putah Creeks. **L3-2.2.** Incorporate best management practices (BMPs) into riverine, riparian, and wetland restoration projects to minimize mercury methylation, consistent with the Cache Creek Total Maximum Daily Load (TMDL) and the Delta TMDL. **L3-2.3.** Support the use of least-toxic approaches to pest management. **L3-2.4.** Discourage the use of herbicides, fungicides, insecticides, rodenticides, and other chemical poisons near ecologically sensitive areas generally and to the extent practicable in flood control areas in accordance with state and federal operation and maintenance laws and requirements. **L3-2.5.** Establish buffer zones around established habitat reserve areas, in cooperation with farmers, at sufficient distance to avoid or limit over-spray or wind drift from agricultural operations adjacent to or near habitat reserve areas.
Objective 3-3. Hazardous Human Land Uses. Reduce impacts from hazardous	**L3-3.1** Prepare and implement guidance for buffers between natural lands and adjacent human activities.

Biological Goals and Objectives	Applicable Conservation Actions
human land uses, such as roads, that negatively affect the sustainability of natural communities and RCIS/LCP focal and conservation species.	**L3-3.2.** Identify key road conflict areas and implement practices such as "funnel fencing" to reduce road mortality (road kill); design culverts and bridges to allow safe animal passage through or under them. **L3-3.3.** Implement BMPs for operations and maintenance programs and for flood-control activities that minimize adverse effects on natural communities, biological diversity and ecosystem processes, and focal and conservation species to the extent such BMPs do not violate state and federal operation and maintenance laws and requirements for flood control projects.
Goal L4: Biodiversity, Ecosystem Function, and Resilience. Maintain and increase biodiversity, ecosystem function, and resilience across landscapes, including agricultural and grazed lands. Maintain landscape elements and processes that are resilient to climate change which will continue to support a full range of biological diversity in Yolo County.	
Objective L4-1: Heterogeneity within Agricultural Lands. Maintain a heterogeneous landscape of agricultural and natural lands throughout the Valley Landscape Unit, including on- and off-the-reserve system, with large and structurally complex patches of native vegetation connected by corridors and habitat stepping stones, situated within a matrix of agricultural lands that, where possible, provides structural characteristics similar to those of native vegetation.	**L4-1.1.** Protect and maintain “stepping-stone” patches (small areas of natural vegetation distributed throughout the landscape) and corridors (elongated strips of vegetation that link patches of native vegetation) of natural lands within the agricultural matrix. Natural habitat patches should be large, with round or square shapes that protect as much “interior” habitat condition as possible. Landscape linkages should be wide, incorporating as much natural habitat as possible. **L4-1.2.** Restore, enhance, and/or protect existing natural (riparian) habitat values associated with interconnected aquatic areas (including major water-supply and drainage infrastructure elements) throughout the landscape matrix, creating a regional conservation lattice. **L4-1.3.** Incorporate and maintain structural complexity, including trees, snags, and other structural elements in the landscape of agricultural and grazed lands to provide cover, shade, and nesting, perching, and roosting opportunities for native wildlife. **L4-1.4.** Create or maintain buffers around sensitive areas. **L4-1.5.** Maintain buffers along waterways and adjacent to natural vegetation, in cooperation with farmers, to diminish any adverse effects of agricultural practices on those habitats and to provide complementary habitat features (e.g., upland refugia and hibernacula for giant garter snake). (From CVFPP Conservation Strategy [DWR 2016]) **L4-1.5.** Retain selected trees and snags and plant trees to provide habitat features for raptors (including Swainson’s hawk) and other wildlife. (From CVFPP Conservation Strategy [DWR 2016])
RCIS/LCP Objective L4-2: Resilience to Climate Change. Promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change.	**L4-2.1.** Initially, identify and map species-rich locations in the RCIS/LCP area without respect to current level of rarity or legal status. Amend the RCIS/LCP over time to incorporate new biologically significant locations not already in the RCIS/LCP’s conservation framework. **L4-2.2.** Potential elements in a climate-adaptation strategy may include, but are not limited to, the following: • Gaps in managed lands that block landscape connectivity may be closed; seek collaborative management with landowners or acquire lands to bridge/close gaps. • Restore desired habitat conditions to degraded areas in the landscape.

Biological Goals and Objectives	Applicable Conservation Actions
	• Develop adaptive elements for RCIS/LCP management that address invasive species control or eradication for invasive species that may become more predominant with climate change. **L4-2.3.** Increase landscape resilience by providing multiple protected areas within the landscape framework. **L4-2.4.** Incorporate resilience into RCIS/LCP management by adapting to landscape changes likely to result from climate change, based on best available science. An adaptive strategy to offset landscape changes resulting from climate effects may include, but is not limited to, the following: • Address the effects of increased temperatures, altered precipitation patterns, and drought on natural communities and habitats in Yolo County where possible, based on the best available scientific and technical information. • Address the effects of increased disturbance (e.g., fire, wind) frequency and severity where possible, based on the best available scientific and technical information. • Identify practices to offset the climate-related changes, possibly including introducing selected plant species not currently present (i.e., identify functional roles and select species to fill them should natural habitat be significantly altered), provided there is a high degree of certainty the ecological benefits will outweigh ecological risks. **L4-2.5.** Incorporate resilience to the effects of climate change into the landscape by actively managing the landscape matrix to increase habitat values within it. With additional habitat functions provided by the matrix, the integrity of the designated reserve system elements will be augmented by a matrix that is permeable (i.e., not hostile) to mobile species, and also provides additional habitat values. The following actions (among others) increase the value of the matrix as habitat: • Restore or establish desired ecological conditions in damaged/degraded/burned areas. • Restore fluvial processes, adequate streamflows and wetland hydrology, and riparian functions to aquatic features, while planning for possible future increases in peak flows and flood events. • Incorporate oaks throughout the matrix, as well as establishing multi-hectare oak woodland habitat areas. (see Section 3.4.2.4 for additional considerations for oak woodland areas). **L4-2.6.** Incorporate principles of Climate Smart Conservation (Stein et al. 2014) into the management of Yolo County, including the following: • Assess climate impacts and vulnerabilities, identifying specific components of vulnerability (exposure, sensitivity, and adaptive capacity) to provide a useful framework for linking actions to impacts. • Review/revise conservation goals and objectives, which should be climate-informed as needed to address new information about climate change and changing conditions. • *Identify possible adaptation options* for reducing key climate-related vulnerabilities or taking advantage of newly emerging opportunities, with particular attention given to crafting possible management actions.

Biological Goals and Objectives	Applicable Conservation Actions
	• *Evaluate and select adaptation actions* to determine which are likely to be most effective from an ecological perspective, and most feasible from social, technical, and financial viewpoints. • *Implement priority adaptation actions*, engaging diverse partners and emphasizing benefits to multiple sectors of society. • *Track action effectiveness and ecological responses,* using monitoring approaches designed to ensure that they are capable of guiding needed adjustments in strategies and actions, in order to inform adaptive management.
RCIS/LCP Objective L4.3: Natural Community and Habitat Resilience with Climate Change. Promote resilience in natural communities and habitat values (i.e., maintenance of habitat values) under conditions resulting from climate change.	**L4.3-1.** Initially, evaluate baseline distributions and densities of focal species in and adjacent to Yolo County, documenting previously unrecorded occurrences of these species. Validate data on special habitat elements, including serpentinitic substrates, wetlands, and other habitat elements associated with focal species in and near Yolo County, and identify and document previously unrecorded occurrences of these elements. **L4.3-2.** Among focal and conservation species in Yolo County, assess species according to genetic importance for conservation purposes, including degree of relatedness among serpentine taxa, degree of differentiation of range-margin taxa from central populations, unique or very different adaptation complexes (e.g., insect-plant associations that differ from those elsewhere), and other genetically related conservation criteria. **L4.3-3.** Develop a planning/management/monitoring strategy for focal and conservation species under climate change, based on best available science, including elements required by federal or state laws and regulations. **L4.3-4.** Monitor population status of focal and conservation species as they respond to climate change. Species with reduced but stable population sizes may not require direct intervention. For species appearing to be substantially affected by climate change, develop and implement action plans to stabilize or recover populations. Plans could include assisted migration to suitable habitat at other locations if, based on the best available information, such action is determined to be ecologically desirable with little or no risk of unintended detrimental effects that would outweigh the benefits.

Biological Goals and Objectives	Applicable Conservation Actions
NATURAL COMMUNITY-LEVEL GOALS AND OBJECTIVES	
Cultivated Lands	
Goal CL1: Cultivated land habitat conservation Conservation of cultivated land habitat values for focal and conservation species and natural communities	
Objective CL1.1: Mixed agricultural uses with habitat values Encourage a mix of agricultural uses and appropriate land protection measures that provide for the needs of species that use farmland as habitat.	**CL1.1-1.** Identify and describe the agricultural uses that benefit wildlife and estimate the habitat values of individual crops. This may include incorporation of the habitat valuation system for croplands developed by the Habitat Exchange Program for Swainson's hawk and other species. **CL1.1-2.** Increase the quality of existing cropland as habitat for Swainson's hawk foraging by increasing the extent of alfalfa, irrigated pasture, and low-height row crops, particularly as alternatives to orchards and vineyards. (From CVFPP Conservation Strategy [DWR 2016]) **CL1.1-3.** Cultivate grain crops near greater sandhill crane roosting sites and defer tillage of crops to increase foraging opportunities for cranes. (From CVFPP Conservation Strategy [DWR 2016]) **CL1.1-4.** Assess trends in cropping patterns countywide, so that any desired intervention (such as incentives to grow particular crops types, or purchasing conservation easements) can be based on sound information. **CL1.1-5.** Enter into contracts to pay farmers to grow crop types that benefit covered species. **CL1.1-6.** Purchase easements from willing sellers to prevent conversion to crops that do not provide suitable habitat benefits. **CL1.1-7.** Identify solutions to potential conflicts between conservation efforts and ongoing agricultural operations, including mechanisms (e.g., safe harbor agreements, compensation) to mitigate or avoid conflicts or impacts.
Objective CL1.2: Incorporation of habitat features Encourage farming practices that increase habitat values in areas of contact between working agricultural lands and wildlands throughout Yolo County, including habitat features such as hedgerows and patches of natural habitat (e.g., riparian patches) within the agricultural matrix.	**CL1.2-1.** Add hedgerows to farm edges to provide cover and feeding habitat for focal and conservation species. Work with Yolo RCD, NRCS, and UC Cooperative Extension to provide incentives for wildlife-friendly management practices, such as fencing, hedgerows, tailwater ponds, timing of operations, and weed control. **CL1.2-2.** Flood appropriate harvested fields during fall and winter to provide habitat for wading birds (including greater sandhill crane). (From CVFPP Conservation Strategy [DWR 2016]) **CL1.2-3.** Manage grazing of floodways in a manner that sustains habitat for targeted species (e.g., Swainson's hawk). (From CVFPP Conservation Strategy [DWR 2016]) **CL1.2-4.** Flood appropriate harvested fields during winter and spring to provide rearing habitat for juvenile salmonids. **CL1.2-5.** Restore, enhance, and/or protect habitat values associated with interconnected aquatic areas in the agricultural landscape, including major canals and other water-supply infrastructure elements, throughout the landscape matrix, creating a regional conservation lattice supporting local habitat while also providing corridors for wildlife movement.

Biological Goals and Objectives	Applicable Conservation Actions
	CL1.2-6. Develop and maintaindynamic channel zones for watercourses that allow streamflow access to floodplains and movement of eroded materials through the floodplain area. **CL1.2-7.** Maintain buffers and hedgerows along waterways and adjacent to natural vegetation to diminish the adverse effects of agricultural practices on those habitats and to provide complementary habitat features (e.g., upland refugia and hibernacula for giant garter snake) (From CVFPP Conservation Strategy [DWR 2016]) **CL1.2-8.** Retain selected trees and snags and planting trees to provide habitat features for raptors (including Swainson's hawk). (From CVFPP Conservation Strategy [DWR 2016]) **CL1.2-9.** Maintain water in canals and ditches during the active periods of sensitive species (e.g., giant garter snake). (From CVFPP Conservation Strategy [DWR 2016]) **CL1.2-10.** Manage canal and ditch vegetation to facilitate dispersal and other movements of giant garter snakes. (From CVFPP Conservation Strategy [DWR 2016]) **CL1.2-11.** Acquire easements to widen riparian corridors on and adjacent to agricultural properties. **CL1.2-12.** Enhance riparian areas on agricultural properties.
Objective CL1.3: Cultivated land pollinators Maintain pollinators within the agricultural landscape.	**CL1.3-.**1 Protect existing natural habitat (e.g., prairies, oak woodlands, chaparral, and riparian areas associated with major streams) that occurs in the vicinity of agricultural areas near wildlands. Avoid pesticide drift from agricultural areas into wildland pollinator habitats. **CL1.3-2.** Identify and protect existing pollinator habitat within agricultural landscapes: • Areas of natural or seminatural habitat such as riparian areas, wetlands, species-rich grasslands, and vegetated road verges • Areas supporting flowers, such as buffer areas, forest edges, hedgerows, roadsides, ditchsides, and fallowed fields. • Potential bee nesting sites such as areas of untilled bare soil, snags, and pithy-stemmed shrubs. **CL1.3-3.** Create or restore habitat: • Such habitat can take the form of hedgerows, pollinator meadows ("bee pastures"), orchard understory plantings, riparian and rangeland revegetation, and flowering cover crops. • Have at least three plant species blooming each season (spring, summer, and fall). • Use native plants wherever possible. • Nonnative plants may be suitable on disturbed sites and for specialty uses such as cover cropping. • Include bee nest sites in habitat patches. • Restored patches should be 0.5 acre or more in size. • If crop pollination is the focus, habitat patches should be no more than 600 meters from the crop (or from each other); shorter distances—250 to 300 meters—would be optimal. • Create linear habitats along roads and tracks, ditches, and field margins to increase connectivity across the landscape.

Biological Goals and Objectives	Applicable Conservation Actions
	CL1.3-4. Minimize pesticide use, especially adjacent to natural areas or known pollinator habitat: • Pesticides should not be applied when bees are actively foraging on flowers. • Integrated Pest Management principles should be followed when planning pest management. • If possible, apply pesticides in fall or winter, or at night. • Select the formulation and application method that will minimize overspray or drift into pollinator habitat. • Reduce spraying near field margins. **CL1.3-5.** Carefully plan grazing, mowing, or the use of fire in any pollinator habitat. **CL1.3-6.** Fit imported bumblebee colonies with queen excluders and use only in glasshouses. **CL1.3-7.** Do not use commercially reared bumblebees for open-field pollination.
California Prairie	
Goal CP1: Large contiguous areas of California prairie to support native species Maintain or increase the extent of large contiguous areas of California prairie to sustain and enhance the distribution and abundance of associated focal and other native species in Yolo County.	
Objective CP1.1: California prairie protection Prioritize protection of California prairie where large, contiguous patches are present and where native species are abundant in the Hill and Ridge Landscape Unit and Planning Unit 5.	**CP1.1-1.** Identify priority areas for protection based on patch size and abundance of native species. **CP1.1-2.** Focus protection in priority areas.
Objective CP1.2: Increase and enhance California prairie. Increase the extent (through restoration) and enhance native prairie	**CP1.2-1.** Create California prairie habitat by planting and establishing large areas of native grasses and forbs, or planting native species as components of projects that have temporary ground disturbance or that create features on the landscape (e.g. levees) that require vegetation. **CP1.2-2.** Vegetate flood management features (i.e., levees, seepage berms, O&M areas) with native grasses and forbs. **CP1.2-3.** Adjust grazing regimes to enhance native species. **CP1.2-4.** Avoid disturbing the soil profile. **CP1.2-5.** Enhance habitat for native herbivores like ground squirrels and ungulates.
Objective CP1.3: Burrowing rodents Maintain and enhance the functions of protected California prairie as habitat for focal, conservation, and other native species by maintaining areas with	**CP1.3-1.** Identify priority areas with an abundance of burrows. **CP1.3-2.** Identify and implement management practices that promote or maintain burrowing rodents on lands (including ground squirrels) protected for conservation purposes pursuant to a conservation easement or similar other instrument providing for perpetual protection of land, except as otherwise prohibited by state and federal laws and regulations related to flood control infrastructure protection.

Biological Goals and Objectives	Applicable Conservation Actions
burrowing rodents such as ground squirrels and gophers.	
Objective CP1.4: Grazing regimes. Maintain and enhance the functions of protected California prairie in the reserve system as habitat for focal, conservation, and other native species by implementing appropriate grazing regimes.	**CP1.4-1.** Integrate grazing management into management plans for protected lands. **CP1.4-2.** Apply monitoring and adaptive management to grazing regimes, adjusting grazing as needed to minimize invasive species, maximize native biodiversity, and provide the necessary habitat for focal and conservation species.
Objective CP1.5: California prairie pollinators Maintain pollinators within the California prairie landscape.	**CP1.5-1.** Identify and protect existing pollinator habitat: • Areas of natural California prairie or seminatural grassland that support a diverse native flora. • Potential bee nesting sites such as areas of bare soil, snags, and pithy-stemmed shrubs. **CP1.5-2.** Restore and enhance California prairie to provide native pollinator habitat. • Control and remove invasive weeds. • Use native forbs to enhance diversity of California prairie. **CP1.5-3.** Use grazing, mowing, or fire carefully to avoid harming pollinators. • Treat only part of the area in one year. • Leave areas untreated as refugia for pollinators. • Time grazing to avoid periods of major bloom. • Do not mow while flowers are in bloom, except as required pursuant to flood infrastructure maintenance laws and requirements. . • Use burning to suppress shrubs and trees, where safe and ecologically appropriate, except as required pursuant to flood maintenance laws and requirements. • Allow habitat to recover fully between burns. **CP1.5-4.** Reduce spraying and protect California prairie from drift from adjacent fields.
Chaparral	
Goal CH1: Chaparral conservation. Maintain conserved chaparral that supports viable populations of native wildlife and plant species, supports connectivity in the landscape, and assists in maintaining diverse pollinator species.	
Objective CH1.1: Protect chamise chaparral for connectivity. Protect chamise chaparral as needed to achieve landscape connectivity.	**CH1.1-1.** Protect stands of chamise chaparral that aid in maintaining landscape connectivity within Yolo County.
Objective CH1.2: Protect mixed chaparral.	**CH1.2-1.** Protect stands of mixed chaparral that aid in maintaining landscape connectivity within Yolo County. **CH1.2-2.** Prioritize protection of mixed chaparral that supports focal species.

Biological Goals and Objectives	Applicable Conservation Actions
Prioritize protection of mixed chaparral where it supports focal or conservation species or contributes to key connectivity.	
RCIS/LCP Objective CH1.3: Manage chaparral Manage chaparral to promote native plant and wildlife diversity.	**CH1.3-1.** Encourage research by collaborating agencies (e.g., Bureau of Land Management, U.S. Forest Service, the University of California and other academic institutions, and nonprofit conservation organizations) investigating ecological relationships in chaparral in the region, including the roles of fire and other disturbances and the effects of climate change on chaparral in the region. Amend the LCP to reflect the results of this research. **CH1.3-2.** Allow natural post-fire regeneration. **CH1.3-3.** Avoid post-fire seeding with nonnatives. **CH1.3-4.** Minimize soil disturbance, including during firefighting.
CH1.4: Chaparral pollinators Maintain pollinator (especially native bee) populations within chaparral.	**CH1.4-1.** Identify and protect existing pollinator habitat. • Areas of natural or seminatural chaparral that support a diverse native flora. • Potential bee nesting sites such as areas of bare soil, snags, and pithy-stemmed shrubs. **CH1.4-2.** Enhance degraded chaparral. • Control and remove invasive plant species. • Use native shrubs and forbs to enhance diversity of chaparral. **CH1.4-3.** Use grazing, mowing, or fire carefully to avoid harming pollinators. • Treat only part of the area in one year. • Leave areas untreated as refugia for pollinators. • Time grazing and other management actions to avoid periods of major bloom. • Do not mow while flowers are in bloom except as required pursuant to flood infrastructure maintenance laws and requirements. . • Use burning to suppress shrubs and trees, where safe and ecologically appropriate. • Allow habitat to recover fully between burns, except as required pursuant to flood infrastructure maintenance laws and requirements. **CH1.4-4.** Reduce spraying on chaparral and protect chaparral from drift from adjacent fields.
Woodlands and Forests	
Goal WF1. Valley oak protection and restoration Protect and restore valley oak woodland, forest, savanna, and individual trees in Yolo County, with an emphasis on restoration over protection.	
RCIS/LCP Objective WF1.1: Increase valley oaks	**WF1.1-1.** Find patches and stringers (narrow rows of trees) and add to them. Increase size of existing stands. **WF1.1-2.** Limit plantings to local source valley oaks/material (valley oaks in Yolo County are genetically significant, an island of unique genetic make-up).

Biological Goals and Objectives	Applicable Conservation Actions
Increase the extent of valley oaks in Yolo County through restoration and enhancement.	**WF1.1-3.** Prioritize riparian areas for valley oak restoration and enhancement (see Goal WF3 regarding oak woodland in riparian areas). **WF1.1-4.** Plant on sites with suitable soils and hydrology (this is particularly important for valley oaks but is a factor for all restoration). See conservation actions under LCP Objective L1.4 for additional actions related to restoration of natural communities.
Objective WF1.2: Protect valley oaks Protect existing stands, individual trees, patches, and stringers of valley oaks.	**WF1.2-1.** Consider the prioritization criteria in Section VI of the Yolo County Oak Woodland Conservation and Enhancement Plan (January 2007), with respect to the following resource values, when prioritizing areas for valley oak protection. • Stand composition, integrity, and functionality • Habitat for plant and wildlife species • Landscape function **WF1.2-2.** Provide landowner incentives for protecting valley oaks on agricultural lands and other private lands. **WF1.2-3.** Reduce or eliminate impacts of cattle grazing and other land uses on protected, enhanced, and restored areas.
Goal WF2. Upland oak protection and restoration/enhancement Implement protection and restoration or enhancement of upland oaks in the Hill and Ridge Landscape Unit, with an emphasis on protection over restoration.	
Objective WF2.1: Protect upland oaks Protect upland oaks in the Hill and Ridge Landscape Unit, including contiguous forests, woodland and savannas, and patches and stringers of upland oak woodland, prioritizing protection of oak woodland surrounded by natural lands rather than developed lands, and those on lands contributing to connectivity.	**WF2.1-1.** Consider the prioritization criteria in Section VI of the Yolo County Oak Woodland Conservation and Enhancement Plan (January 2007: Appendix X), with respect to the following resource values, when prioritizing protection of upland oaks in the Hill and Ridge Landscape Unit. • Stand composition, integrity, and functionality • Habitat for plant and wildlife species • Landscape function. **WF2.1-2.** Reduce or eliminate impacts of cattle grazing and other land uses on protected, enhanced, and restored areas.
Objective WF2.2: Increase Upland Oaks. Increase the extent of upland oak woodland, forest, or savanna through restoration, to increase connectivity and stand size (reduce fragmentation).	**WF2.2-1.** Restore areas to include high native plant biodiversity, primarily in the understory. **WF2.2-2.** Restore/protect natural soil structure at restoration sites. Changing soil profiles can render areas less suitable for native plants. See conservation actions under RCIS/LCP Objective L1.4 for additional actions related to restoration of natural communities.
	Goal WF3. Riparian Oak Protection and Restoration

Biological Goals and Objectives	Applicable Conservation Actions
	Protect, restore, or enhance oak woodland and forest in riparian areas, with a focus on the Hill and Ridge Landscape Unit
RCIS/LCP Objective WF3.1: Protect Riparian Oaks and Oak Woodlands Protect oak woodland and forest in riparian areas in the Hill and Ridge Landscape Unit.	**WR3.1-1.** Consider the prioritization criteria in Section VI of the Yolo County Oak Woodland Conservation and Enhancement Plan (January 2007), with respect to the following resource values, when prioritizing protection of upland oaks in the Hill and Ridge Landscape Unit. • Stand composition, integrity, and functionality • Habitat for plant and wildlife species • Landscape function **WR3.1-2.** Work with willing landowners to reduce or eliminate impacts of livestock grazing and other land uses on protected, enhanced, and restored areas. It may be particularly important to fence riparian areas, for example to prevent erosion and water quality degradation because of the tendency for cattle to concentrate in riparian areas.
Objective WF3.2: Increase and Enhance Riparian Oaks and Oak Woodlands. Increase the extent of, through restoration, and enhance oak woodland and forest in riparian areas in the Hill and Ridge Landscape Unit.	**WF3.2-1.** Plant in areas with suitable hydrology (or restore/enhance hydrology if not present). **WF3.2-2.** Focus on riparian oak woodland and forest in the Hill and Ridge Landscape Unit. **WF3.2-3.** Increase the widths and habitat quality in existing stringers (narrow strips of trees) to enhance landscape linkage functions (i.e., widen corridors). **WF3.2-4.** Use locally sourced material. **WF3.2-5.** Restore/enhance native biodiversity and remove invasive exotics. **WF3.2-6.** Prioritize valley oaks for riparian restoration and enhancement where ecologically appropriate.
Goal WF4. Oak woodland management Manage oak woodland and forest natural communities outside of riparian areas to enhance habitat quality supporting native biodiversity, and to provide enhanced ecosystem functions and services.	
Objective WF4.1. Manage and Enhance Oak Woodlands Manage and enhance oak woodlands to maintain or increase native biodiversity.	**WF4.1-1.** Increase locally native plant biodiversity through plantings, primarily in the understory (taking into account potential species range shifts with climate change, where necessary, when developing plant palettes). **WF4.1-2.** Protect oak woodlands from disturbances that inhibit oak regeneration, such as overgrazing. **WF4.1-3.** Protect the natural soil profile. **WF4.1-4.** Maintain or enhance native biodiversity by controlling/removing invasive exotics.
Objective WF4.2. Oak woodland pollinators Maintain pollinator (especially native bee) populations within oak woodlands and forests.	**WF4.2-1.** Reduce or prevent fragmentation of woodland and forest areas. **WF4.2-2.** Adjust grazing to reduce the impact on flowering plants. • The best time to graze varies by site, but grazing should be limited to periods of low pollinator activity. • Establish exclosures and rotate grazing to allow the vegetation community to recover. **WF4.2-3.** Control invasive species.

Biological Goals and Objectives	Applicable Conservation Actions
	WF4.2-4. Use prescribed fire, where safe and ecologically appropriate except as otherwise required by state or federal law, as a natural disturbance to manage the habitat. • Burn only small areas at one time. • Do not burn the same area more frequently than every 5 years, to the extent practicable. • During burns, skip areas to leave as refugia from which pollinators can recolonize. **WF4.2-5.** If pesticides are required for pest management: • Do not apply to significant patches of foraging flowers. • Do not apply while pollinators are active. • Choose least-toxic options, such as pheromone traps. **WF4.2-6.** Restore habitat with locally native species only (taking into account potential range shifts from climate change when developing plant palettes).
Objective WF4.3: Burrowing rodents. Maintain and enhance the functions of protected oak woodlands as habitat for focal and other native species by maintaining areas with burrowing rodents such as ground squirrels and gophers.	**WF4.3-1.** Identify priority areas with an abundance of burrows. **WF4.3-2.** Focus protection in priority areas. **WF4.3-3.** Identify and implement management practices that promote or maintain burrowing rodents on lands protected by a conservation easement or other instrument providing for perpetual protection of land, such as grazing regimes that promote conditions suitable for burrowing rodents, except where such practices would conflict with state and federal laws and regulations related to protecting flood infrastructure.
Objective WF4-4: Grazing Regimes. Maintain and enhance the functions of protected oak woodland as habitat for focal and other native species by implementing appropriate grazing regimes.	**WF4.4-1.** Integrate grazing management into management plans for protected lands. **WF4.4-2.** Apply monitoring and adaptive management to grazing regimes, adjusting grazing as needed to minimize invasive species, maximize native biodiversity, and provide the necessary habitat for focal species.
Goal FW1: Fresh Emergent Wetland Conservation. Conserve, restore, and enhance fresh emergent wetlands in Yolo County.	
Objective FW1.1: Protect fresh emergent wetlands. Prioritize protection of fresh emergent wetlands that support focal or conservation species.	**FW1.1-1.** Identify fresh emergent wetlands supporting focal species. **FW1.1-2.** Prioritize protection in identified areas.
Objective FW1.2: Increase fresh emergent wetland areas. Increase the acres of fresh emergent wetlands in Yolo County for focal species.	**FW1.2-1.** Restore fresh emergent wetlands in areas that are likely to support RCIS/LCP focal species, with restoration design features that contribute to habitat value for focal species. **FW1.2-2.** See conservation actions under Objective L1.4, Natural community restoration, for additional actions related to restoration of natural communities.

Biological Goals and Objectives	Applicable Conservation Actions
Objective FW1.3: Maintain or enhance fresh emergent wetland habitat areas. Maintain or enhance the habitat quality of fresh emergent wetland areas	**FW1.3-1.** Maintain fresh emergent wetlands habitats that support focal species. **FW1.3-2.** Control or eliminate invasive wetland plant species that would otherwise create large monotypic stands lacking in structural diversity.
Riparian	
Goal R1: Riparian conservation Establish, maintain, and protect functional riparian habitat well distributed throughout the Yolo County, including protection of existing, and restoration and enhancement of diminished, riparian habitat values.	
Objective R1.1: Protect riparian areas Protect existing riparian areas associated with watercourses within Yolo County, prioritizing drainages that provide key landscape linkages.	**R1.1-1.** Protect existing riparian areas through conservation easements, prioritizing the drainages shown on Figure 2-16, *Ecological Corridors*. **R1.1-2.** Restore, enhance, and protect riparian habitat associated with interconnected aquatic areas in the agricultural landscape, including irrigation canals and other water-supply infrastructure and drainage elements, throughout the landscape matrix, creating a regional conservation lattice supporting local habitat while also providing corridors for wildlife movement. **R1.1-3.** Provide financial incentives to private landowners to maintain existing riparian areas on private lands, or to allow riparian habitat to naturally establish and be retained on sites with suitable soils and hydrology, particularly sites associated with the drainages shown on Figure 2-16, *Ecological Corridors*.
Objective R1.2: Increase Riparian Habitat Areas Increase riparian habitat area and distribution in Yolo County through restoration, prioritizing drainages that provide key linkages, particularly where restoration closes gaps in vegetation along the length of drainages, widens riparian zones or provides wide riparian nodes adjacent to drainages, or provides lateral linkage between drainages and adjacent natural communities.	**R1.2-1.** Restore riparian areas to provide continuous lengths of vegetation along drainages. Riparian areas should be as wide as soil, hydrologic, and other constraints will allow. . **R1.2-2.** If it is infeasible to provide wide areas of riparian habitat along the entire channel, restore areas to provide wide nodes of riparian habitat along the channel. **R1.2-3.** See conservation actions under LCP Objective L1.4 for additional actions related to restoration of natural communities.
Objective R1.3: Maintain or enhance riparian habitat areas Maintain or enhance the functional habitat value of existing riparian habitat areas by maintaining or increasing the complexity of the riparian vegetation.	**Objective R1.3-1.** Introduce tall, broad-canopied tree species like valley oak and shorter species such as elderberry and California rose, which increase the structural complexity of the riparian habitat and the complexity of food webs in the habitat. **Objective R1.3-2.** Manage existing riparian habitats to maintain key food resources for breeding and wintering birds. Incorporate plant species that provide food resources for summer and winter migratory species into riparian enhancement and restoration plans.

Biological Goals and Objectives	Applicable Conservation Actions
	Objective R1.3-3. Control or eliminate invasive riparian plant species such as arundo that would otherwise create large monotypic stands lacking in structural diversity. **Objective R1.3-4.** Create conditions that provide fluvial processes that periodically disturb riparian areas, thereby promoting various successional stages and increased structural diversity. An example of an action that would provide fluvial processes would be to set back levees to widen the floodplain.
Lacustrine	
RCIS/LCP Goal LR1: Stream conservation. Conserve and enhance stream systems in Yolo County.	
Objective LR1.1. Fluvial equilibrium. Maintain and/or restore fluvial equilibrium[12] between erosion and deposition in Strategy Area streams.	**LR1.1-1.** Avoid stream channelization. **LR1.1-2.** Avoid unnecessary vegetation removal. **LR1.1-3**. Minimize erosion in uplands that contributes to excessive sedimentation in Strategy Area streams. Maintain vegetative cover, using native species, to stabilize slopes and reduce effects of precipitation in generating erosion. **LR1.1-4.** Maintain vegetation cover in uplands as an approach to increase infiltration of precipitation and reduce excessive runoff into Strategy Area streams. **LR1.1-5.** Maintain and/or restore riparian and floodplain vegetation to stabilize and maintain equilibrium between sediment and streamflow in Strategy Area stream channels. **LR1.1-6.** Maintain a sediment supply in channels below dams and other channel obstruction that can contribute sediments to downstream reaches in order to maintain a dynamic equilibrium between channel erosion and aggradation.
Objective LR1.2. American beavers. Protect lacustrine/riverine systems supporting American beavers.	**LR1.2-1.** Target portions of streams that support American beavers for protection. **LR1.2-2.** Incorporate beaver management practices into management plans for lands protected by a conservation easement or other instrument providing for perpetual protection of land supporting or potentially supporting this species (where consistent with existing laws and regulations related to flood easement areas). Such management may include protection of existing beaver dams where possible, and installation of deceiver or bypass devices where necessary, rather than dam removal. Management may also include wrapping trees identified for retention with wire cylinder tree wraps or cages.
Objective LR1.3: Native vegetation. Promote the establishment and maintenance of native vegetation along natural and constructed waterways.	**LR1.3-1.** Encourage ecologically sustainable water management practices, including continuous bank vegetation along ditches and other constructed features. **LR1.3-2.** Establish native plant species demonstrated to provide ecological and water-quality benefits along waterways. **LR1.3-3.** Where possible, conduct ditch/canal maintenance only on one side of each canal or ditch per year.

[12] Fluvial equilibrium is described further for this objective in Appendix F, *Conservation Strategy Rationale.*

Biological Goals and Objectives	Applicable Conservation Actions
	Also see conservation actions in Section 3.4.2.6, *Riparian*, related to establishing and maintaining riparian areas along waterways.
Objective LR1.4: Stream processes and conditions. Maintain and/or restore and protect stream processes and conditions in Yolo County streams.	**LR1.4-1.** Encourage maintenance of appropriate minimum streamflows throughout the annual cycle to maintain aquatic life in Strategy Area streams. Flows may not be perennial in many streams, although subsurface (hyporheic) flows often continue to maintain riparian processes even when no surface flow occurs. Conservation of stream processes is related to maintaining subsurface flow and groundwater that are hydrologically part of the streamflow in each watershed (Winter et al. 1998). **LR1.4-2.** Maintain or reestablish streamflow dynamics that resemble the natural runoff patterns that sustain instream and riparian/floodplain ecosystems in Yolo County, including flow dynamics that support the reproduction of desired native riparian plant species (e.g., Fremont cottonwood). LR1.4-3. Encourage maintenance of habitat conditions that favor native fish species in Strategy Area streams. Where feasible, eliminate invasive nonnative plant, fish, and invertebrate species from Yolo County streams. **LR1.4-4.** Expand and protect riparian vegetation along Strategy Area streams where possible in accordance with flood management and operation laws and requirements. See conservation actions under LCP Objective L1.4 for additional actions related to restoration of natural communities.
Alkali Prairie	
Goal AP1: Alkali Prairie Conservation. Conserve alkali prairie in Yolo County.	
Objective AP1.1: Protect Alkali Prairie. Protect currently unprotected alkali prairie where it supports focal or conservation species.	**AP1.1-1.** Place conservation easements on alkali prairie supporting focal or conservation species.
Vernal Pool Complex	
Goal VP1: Vernal Pool Conservation. Conserve vernal pool complexes in Yolo County.	
LCP Objective VP1.1. Vernal pool Pollinators. Maintain pollinator (especially native bee) populations within vernal pools.	**VP1.1-1.** Protect existing vernal pool complexes, including upland areas. **VP1.1-2.** Do not excavate new pools in upland areas within vernal pool complexes. **VP1.1-3.** Carefully manage grazing to help maintain native plant communities and retain longer flooding periods. **VP1.1-4.** Avoid pesticide drift or overspray from adjacent crops. **VP1.1-5.** Protect specialist bees with a buffer of 500 feet around the pools. **VP1.1-6.** Use a wider buffer (1 kilometer) for aerial spraying of insecticides, especially during the active flight period of the specialist bees (which coincides with blooms of the plants).

Biological Goals and Objectives	Applicable Conservation Actions
SPECIES-LEVEL GOALS AND OBJECTIVES	
Focal Plant Species	
Goal PLANT1: Conserve plant populations. Conserve focal and conservation plant species populations in Yolo County.	
Objective PLANT1.1: Protect focal plant species habitat and occurrences. Protect currently known but unprotected or newly discovered unprotected habitat for focal plant species, prioritizing occupied habitat.	**PLANT1.1-1.** Place conservation easements on existing Category 2 and 3 protected lands, prioritizing lands that support occurrences of the focal plant species. **PLANT1.1-2.** Place conservation easements on any newly discovered areas supporting the focal plant species.
Objective PLANT1.2. Maintain or increase focal plant species abundance. Maintain or increase the mean annual abundance of focal plant species in protected habitat within Yolo County.	**Plant1.2-1.** Monitor and adaptively manage focal plant species populations in Yolo County, using the best available information to adjust management and enhancement actions as necessary to maintain or increase populations relative to the baseline range of abundance (see Appendix C, Covered Species Accounts).
Focal Plant Species Priority Areas: Prioritize conservation actions in occupied habitat in planning units 13 and 16.	
Vernal Pool Invertebrates	
Goal VPI1: Vernal Pool Invertebrate Conservation. Conserve vernal pool invertebrates in protected habitat in Yolo County.	
Objective VPI1.1: Maintain or increase vernal pool invertebrate populations. Maintain or increase the abundance of Conservancy fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, California linderiella, and vernal pool tadpole shrimp on protected lands in Yolo County.	**VPI1.1-1.** Monitor and adaptively manage populations of Conservancy fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, California linderiella, and vernal pool tadpole shrimp in Yolo County, using the best available information to adjust management and enhancement actions as necessary to maintain or increase populations.
Vernal Pool Invertebrate Priority Areas: Prioritize conservation actions in vernal pools occupied by the focal vernal pool invertebrate species in planning units 13 and 16, and any newly discovered occupied habitat.	
Goal VELB1. Maintenance of valley elderberry longhorn beetle populations. Maintenance of the distribution and abundance of valley elderberry longhorn beetle in Yolo County.	
Objective VELB1.1: Protect and manage valley elderberry longhorn beetle populations	**VELB1.1-1.** Protect known valley elderberry longhorn beetle colonies (from CVFPP Conservation Strategy [DWR 2016]). **VELB1.1-2.** Find and protect currently unknown valley elderberry longhorn beetle colonies (from CVFPP Conservation Strategy [DWR 2016]).

Biological Goals and Objectives	Applicable Conservation Actions
Increase protection and management of valley elderberry longhorn beetle colonies in Yolo County.	**VELB1.1-3** Monitor and adaptively manage protected colonies based on the best available science to maintain or increase colony size (from CVFPP Conservation Strategy [DWR 2016]).
Objective VELB1.2: Valley elderberry longhorn beetle habitat amount, connectivity, and quality. Increase the amount, connectivity, and quality of valley elderberry longhorn beetle habitat.	**VELB1.2-1.** Protect areas supporting, or capable of supporting, elderberry shrubs within the species' current and historic range (from CVFPP Conservation Strategy [DWR 2016]). **VELB1.2-2.** Restore habitat in areas that connect existing colonies to each other, and to unoccupied habitat (from CVFPP Conservation Strategy [DWR 2016]). **VELB1.2-3.** Monitor and adaptively manage protected habitat based on the best available science to maintain or increase habitat quality (from CVFPP Conservation Strategy [DWR 2016]). **VELB1.2-4.** Incorporate elderberry shrubs into habitat restored in riparian areas, especially within 12 miles of habitat occupied by valley elderberry longhorn beetle (from CVFPP Conservation Strategy [DWR 2016]).
VELB Priority Areas. Prioritize conservation actions in or adjacent to occupied habitat in areas that also contribute to meeting the landscape and natural community-level objectives.	
Focal Fish Species	
Goal FISH1: Protected and enhanced focal fish species habitat. Protect and enhance focal fish species spawning, rearing, and migration habitat in Yolo County.	
Objective FISH1.1: Shaded riverine aquatic habitat. Increase the area of shaded riverine aquatic habitat in Yolo County that supports focal fish species.	**FISH1.1-1.** Maintain, restore, or enhance shade that moderates water temperatures and reduces visibility to predators. **FISH 1.1-2.** Maintain, restore, or enhance in-stream and overhanging vegetation cover that reduces visibility to predators and provides shade and instream cover for fish. **FISH 1.1-3.** Enhance the biomass of overhanging or fallen branches and in-stream plant material to support the aquatic food web, including terrestrial and aquatic invertebrates that provide food for fish, and to provide habitat complexity that supports a high diversity and abundance of fish species.
Objective FISH1.2: In-stream marsh habitat. Increase the area of in-stream marsh habitat in Yolo County that supports the focal fish species.	**FISH1.2-1.** Prioritize fresh emergent wetland restoration in areas that support focal fish species such as areas near northern Liberty Island and Prospect Island, Elk Slough and Duck Slough. For example, the Lower Yolo Ranch project at the northern end of Liberty Island is expected to provide habitat and food production for Delta Smelt and other native species.
Objective FISH1.3: Passage Barriers. Remove or modify passage barriers that prevent access of focal fish species to spawning and rearing habitat, and build or modify barriers to prevent passage into detrimental locations.	**FISH1.3-1.** Conservation actions that would contribute to this objective include, but are not limited to, remediating the following priority structures that obstruct fish passage in the Yolo Bypass, identified by the CVFPP Conservation Strategy (DWR 2016):

Biological Goals and Objectives	Applicable Conservation Actions
	• Sacramento Weir • Fremont Weir • Lisbon Weir • Tule Canal crossings (five)
Objective FISH1.4: Large Woody Material. Increase large woody material in focal fish species habitat to provide complexity and predator refuges for focal fish species in streams in Yolo County.	**FISH1.4-1.** Restore vegetation along streambanks, to increase input of large woody material to streams **FISH1.4-2.** Install large woody material directly into streams and along stream banks as a component of restoration or enhancement projects.
RCIS/LCP Objective FISH1.5: Yolo Bypass inundation. Increase inundation in the Yolo Bypass so that it reaches an optimized magnitude, frequency, and duration that will benefit native fish while using an Integrated Water Management (IWM) approach. An IWM approach utilizes a system-wide perspective and considers all aspects of water management, including public safety and emergency management, environmental sustainability, and the economic stability of agricultural and recreational uses of the Bypass.	**FISH1.5-1.** Provide access to additional spawning habitat for Sacramento splittail (Sommer et al. 2001a, 2002, 2007a, 2008; Moyle 2002; Feyrer et al. 2006). Because splittail are primarily floodplain spawners, successful spawning is predicted to increase with increased floodplain inundation. **FISH1.5-2.** Provide additional juvenile rearing habitat for Chinook salmon, Sacramento splittail, and possibly steelhead (Sommer et al. 2001a, 2001b, 2002, 2007a, 2008; Moyle 2002; Feyrer et al. 2006). Growth and survival of larval and juvenile fish can be higher within the inundated floodplain compared to those rearing in the mainstem Sacramento River (Sommer et al. 2001b). **FISH1.5-3.** Improve downstream juvenile passage conditions for Chinook salmon, Sacramento splittail, river lamprey, and possibly steelhead and Pacific lamprey. An inundated Yolo Bypass is used as an alternative to the mainstem Sacramento River for downstream migration of juvenile salmonids, Sacramento splittail, river lamprey, and sturgeon; rearing conditions and protection from predators are believed to be better in this area. Sommer et al. (2003, 2004) found that, other than steelhead and Pacific lamprey, juveniles from all of these species inhabit the Yolo Bypass during periods of inundation. The expected increased habitat and productivity resulting from increased inundation of Yolo Bypass are likely to also provide some benefits to covered species, including steelhead and lamprey. **FISH1.5-4.** Improve adult upstream passage conditions of migrating fish using the bypass, such as Chinook salmon, steelhead, sturgeon, and lamprey. An inundated Yolo Bypass is used as an alternative route by upstream migrating adults of these species when Fremont Weir is spilling. Increasing the frequency and duration of inundations will provide these improved conditions for more covered species over longer portions of their migrations. However, the increased use of the bypass could put more fish at risk, if stranding conditions occur when flows are reduced. The overall benefits of providing additional flow in the bypass will be assessed through adaptive management (Section 3.6, Adaptive Management and Monitoring Program). Monitoring for fish stranding will also be implemented, and fish salvage and rescue operations will be carried out, as necessary, to avoid stranding and migration delays for covered fish species. FISH1.5-5. Increase food for rearing salmonids, Sacramento splittail, and other covered species on the floodplain (Sommer et al. 2001a, 2001b, 2002, 2004, 2007a, 2008; Moyle 2002; Feyrer et al. 2006). During

Biological Goals and Objectives	Applicable Conservation Actions
	periods when the bypass is flooded, a relatively high production of zooplankton and macroinvertebrates serves, in part, as the forage base for many of the covered fish species (Benigno and Sommer 2008). **FISH1.5-6.** Increase the availability and production of food in the Delta, Suisun Marsh, and bays downstream of the bypass, including restored habitat in Cache Slough, for delta smelt, longfin smelt, and other covered species, by exporting organic material and phytoplankton, zooplankton, and other organisms from the inundated floodplain into the Delta (Schemel et al. 1996; Jassby and Cloern 2000; Lehman et al. 2008). **FISH1.5-7.** Increase the duration of floodplain inundation and the amount of associated rearing and migration habitat during periods that the Yolo Bypass is receiving water from both the Fremont Weir and the westside tributaries (e.g., Cache and Putah Creeks). **FISH1.5-8.** Reduce losses of adult Chinook salmon, sturgeon, and other fish species to stranding and illegal harvest by improving upstream passage at the Fremont Weir and monitoring for fish stranding below Fremont Weir as flow into Yolo Bypass from the Sacramento River recedes. As necessary, implement fish salvage and rescue operations to avoid stranding and migration delays for covered fish species. **FISH1.5-9.** Reduce the exposure and risk of juvenile fish migrating from the Sacramento River into the interior Delta through the Delta Cross Channel and Georgiana Slough, by decreasing the number of fish passing through these areas (Brandes and McLain 2001). **FISH1.5-10.** Reduce the exposure of outmigrating juvenile fish to entrainment or other adverse effects associated with the proposed north Delta intakes and the proposed Barker Slough Pumping Plant facilities by passing juvenile fish into and through the Yolo Bypass upstream of the proposed intakes. **FISH1.5-11.** Improve fish passage, and possibly increase and improve seasonal floodplain habitat availability, by retrofitting Los Rios Check Dam with a fish ladder, or creating another fish-passable route by which water from Putah Creek can reach the Toe Drain. **FISH1.5-12.** Modify the Tule Canal to accommodate additional flows resulting from modifications to the Fremont Weir. **FISH1.5-13.** Modify Fremont Weir to allow for sustained inundation of the Bypass for 14 days or longer between late December and March 15 to benefit anadromous fish. • Improve agricultural crossings in the Tule Canal to improve fish passage and water movement. • Improve the Sacramento Weir • Improve Lisbon Weir • Retrofit the Los Rios Check Dam with a fish ladder • Realign Lower Putah Creek in the Yolo Bypass for fish benefits. • Restore instream focal fish habitat in Putah Creek.

Biological Goals and Objectives	Applicable Conservation Actions
Objective FISH1.6: Restore Putah Creek Fish Habitat. Support and partner with existing efforts to restore Putah Creek habitat in Yolo County to enhance spawning, rearing, and migration of focal fish species.	**FISH1.6-1.** Restore instream spawning, rearing, and migration habitat for focal fish species in Putah Creek. **FISH1.6-2.** Restore shaded riverine aquatic habitat along Putah Creek. **FISH1.6-3.** Restore geomorphic and fluvial properties along Putah Creek. **FISH1.6-4.** Remove invasive species. **FISH1.6-5.** Bank stabilization. **FISH1.6-6.** Trash clean-up.
Objective FISH1.7: Non-native predators. Reduce non-native predator habitat by restoring more natural hydrologic and geomorphologic processes in streams.	**FISH1.7-1.** Restore and enhance natural habitats, as described under *Objective FISH1.2: In-stream Marsh Habitat* and *Objective FISH1.6: Restore Putah Creek Fish Habitat*
Objective FISH1.8: Research. Support short-term research projects to gain an understanding of multiple benefits of seasonal inundation on agricultural lands, including providing focal fish species spawning and rearing habitat.	**FISH1.8-1.** Fund short-term research projects to better understand multiple benefits of seasonal inundation on agricultural lands in Yolo County.
Fish Priority Areas: Prioritize conservation actions in the Sacramento River, Yolo Bypass, and Putah Creek for the focal fish species.	
California tiger salamander	
Goal CTS1: California tiger salamander conservation. Conserve California tiger salamander in Yolo County.	
Objective CTS1.1: Protect Upland Habitat. Increase protection of California prairie providing California tiger salamander upland habitat (within 1.3 miles of aquatic habitat) in the Dunnigan Hills Planning Unit, in addition to the upland habitat protected under the Yolo HCP/NCCP. Prioritize protection in designated critical habitat.	**CTS1.1-1.** Establish perpetual conservation easements on California tiger salamander upland habitat in areas consistent with Objective CTS1.1.
Objective CTS1.2: Protect and Restore Aquatic Habitat. Increase protection and restoration of aquatic habitat for California tiger salamander in the Dunnigan Hills planning unit, in addition to aquatic habitat protected and restored	**CTS1.2-1.** Establish perpetual conservation easements on suitable California tiger salamander aquatic habitat in the Dunnigan Hills Planning Unit, prioritizing occupied habitat. **CTS1.2-2.** Restore or create ponds suitable for supporting California tiger salamander, within the species' range in Yolo County, in the Dunnigan Hills Planning Unit.

Biological Goals and Objectives	Applicable Conservation Actions
by the Yolo HCP/NCCP. Prioritize protection in designated critical habitat. Within the protected and restored aquatic habitat, include California tiger salamander breeding pools that are found to support all life stages of the salamander through all water year types.	
California Tiger Salamander Priority Areas: Prioritize conservation actions in designated critical habitat and recovery units for California tiger salamander, in the Dunnigan Hills Planning Unit.	
Foothill yellow-legged frog	
RIS/LCP Goal FYLF1: Maintenance or Increase of Foothill Yellow-legged Frog Distribution and Abundance. Maintain or increase the distribution and abundance of foothill yellow-legged frogs within their range in Yolo County.	
Objective FYLF1.1: Protect Aquatic and Upland Habitat. Increase protection and enhancement of foothill yellow-legged frog habitat distributed among the planning units 1, 2, 4, 6, and/or 8, prioritizing occupied habitat.	**FYLF1.1-1.** Place perpetual conservation easements over foothill yellow-legged frog habitat, prioritizing occupied areas.
Foothill Yellow-legged Frog Priority Areas: Prioritize conservation actions in and near occupied habitat in planning unite 1, 2, 4, 6, and/or 8.	
Western spadefoot	
Goal WS1: Maintenance or Increase of of Western Spadefoot dDstribution and Abundance. Maintain or increase the distribution and abundance of western spadefoot within its range in Yolo County.	
RCIS/LCP Objective WS1.1: Habitat Protection. Increase protection and enhancement of western spadefoot habitat in ponds and associated uplands distributed among planning units 3–5 and/or 10, prioritizing occupied habitat.	**WS1.1-1.** Place perpetual conservation easements over foothill yellow-legged frog habitat, prioritizing occupied areas.
Western Spadefoot Priority Areas: Prioritize occupied areas for placement of conservation easements.	
Western pond turtle	
Goal WPT1: Maintenance or Increase of Western Pond Turtle Distribution and Abundance. Maintain or increase the distribution and abundance of western pond turtle within its range in Yolo County.	
Objective WPT1.1: Protect and enhance habitat. Increase protection and	**WPT1.1-1.** Place perpetual conservation easements over western pond turtle habitat, prioritizing occupied areas.

Biological Goals and Objectives	Applicable Conservation Actions
enhancement or restoration of western pond turtle habitat in riverine and lacustrine and associated upland areas.	**WPT1.1-2.** Add rocks and logs to aquatic habitat to provide basking sites and cover, as needed.
Western Pond Turtle Priority Areas: Prioritize conservation actions in occupied habitat in planning units 1-16 and 18.	
Giant garter snake	
Goal GGS1: Giant Garter Snake Conservation. Conserve giant garter snake in Yolo County, including the Willow Slough/Yolo Bypass subpopulation and a segment of the Colusa Basin subpopulation, and connectivity between the two subpopulations.	
Objective GGS1.1: Protect and Restore Large Interconnected Blocks of Giant Garter Snake Habitat. Build on existing protected habitat and habitat protected by the Yolo HCP/NCCP, to increase protected areas and to create habitat blocks at least 539 acres in size, within five miles of larger areas of perennial wetland, and connected by corridors of aquatic and upland habitat of at least 0.5 mile wide.	**GGS1.1-1.** Actions that protect and restore habitat include but are not limited to: Land acquisition in fee title or conservation easement Establish mitigation banks for giant garter snake Marsh restoration **GGS1.1-2.** Minimize or removes barrier to connectivity by removing roads or creating undercrossings such as appropriately designed culverts that facilitate the movement and dispersal of snakes. (CVFPP Conservation Strategy [DWR 2016])
Objective GGS1.2: Manage and Enhance giant garter snake habitat. Enhance giant garter snake habitat by providing sufficient water during the active season, improving water quality, and incorporating refugia from floodwaters and basking sites for improved thermoregulation.	**GGS1.2-1.** Management agreements with landowners to manage rice land and marshes to maintain or enhance habitat for giant garter snake (e.g., NRCS WRP, Central Valley Habitat Exchange) **GGS1.2-2.** Maintain water levels in canals and ditches during the snake's active season (particularly during years when rice is fallowed). (CVFPP Conservation Strategy 2016 [DWR 2016]) **GGS1.2-3.** Fallow rice fields for short periods to flush contaminants and promote prey production (CVFPP Conservation Strategy 2016 [DWR 2016]) **GGS1.2-4.** Manage rice lands to minimize ground disturbance in uplands adjacent to canals and ditches during the snake's overwintering period. (CVFPP Conservation Strategy 2016 [DWR 2016]) **GGS1.2-5.** Enhance habitat including creating refugia and basking sites in marshes, elevate areas in the Yolo Bypass to provide refugia from floodwaters. (CVFPP Conservation Strategy 2016 [DWR 2016]) **GGS1.2-6.** Strategically lower floodway elevations in the Yolo Bypass to form marshes and modify the floodway to achieve greater topographic and hydrologic diversity, to create habitat conditions that support giant garter snakes. Supporting a mosaic of marsh habitat and high-water refugia could create movement corridors, basking sites, and burrowing opportunities in close proximity to foraging sites. **GGS1.2-7.** Improve habitat in or adjacent to the Yolo Bypass, such as by incorporating perennial wetlands that support a suitable prey base, vegetation for cover from predators, and upland refugia, to provide expansive suitable habitat that mimics historical conditions while also decreasing the giant garter snake's reliance on rice fields and canals. (CVFPP Conservation Strategy 2016 [DWR 2016]).

Biological Goals and Objectives	Applicable Conservation Actions
	GGS1.2-8. Incorporate habitat that straddles the bypass levees, coupled with habitat enhancement on those levees, to provide upland refugia during high-water events. (CVFPP Conservation Strategy 2016 [DWR 2016]) **GGS1.2-9.** Maintain lowflow channels in Yolo Bypass to minimize invasive plants, to provide suitable habitat and movement corridors for giant garter snake.
Giant Garter Snake Priority Areas. Prioritize conservation actions in planning units 11–13 and 18, in areas that do not experience winter floods, or if flooding occurs, upland refugia are available or can be created.	
Tricolored blackbird	
Goal TRBL1: Tricolored Blackbird Conservation. Conserve tricolored blackbird populations in Yolo County.	
Objective TRBL1.1: Protect Nesting and Foraging Habitat, and Nesting Colonies. Increase protection of nesting and foraging tricolored blackbird habitat, beyond what is protected by the Yolo HCP/NCCP, prioritizing areas supporting nesting colonies.	**TRBL1.1-1.** Establish conservation easements on tricolored blackbird habitat. **TRBL1.1-2.** Prioritize protection within 5 miles of occupied or recently occupied (within the last 15 years) nesting tricolored blackbird habitat, with preference given to previously occupied sites.
Objective TRBL1.2: Manage and enhance habitat. Manage and enhance protected tricolored blackbird habitat to maintain habitat value for this species.	**TRBL1.2-1.** Nesting habitat. Management and enhancement of tricolored blackbird nesting habitat should be consistent with the recommendations provided by Kyle (2011). The following criteria will guide management of emergent wetland habitat to benefit tricolored blackbird. • Burn, mow, or disc bulrush/cattail vegetation every 2 to 5 years as needed to remove dead growth and encourage the development of new vegetative structure. • Maintain large continuous stands of bulrush/cattail that are at least 30 to 45 feet wide to provide adequate space for breeding as well as protection from predators. • Provide a 50:50 to 60:40 ratio of bulrush/cattail marsh to open water in areas intended to support tricolored blackbird nesting **TRBL1.2-2.** Foraging habitat. Plant agricultural areas with cover strips and hedgerows to provide habitat to increase prey (insect) abundance for tricolored blackbird. Where possible, plant in high and very high value crop types, as defined below. Crop types have foraging habitat values for tricolored blackbird as follows (natural lands are not listed below) (Meese, pers. comm. 2013): • Very high value: Native pasture. • High value: Rice, sunflower, alfalfa, mixed pasture. • Medium value: Fallow lands cropped within three years, new lands prepped for crop production. • Low value: Mixed grain any hay crops. • Marginal value: Rice.
Tricolored Blackbird Priority Areas: Prioritize conservation actions in and near occupied habitat in planning units 2–6, 11–16, and 18.	

Biological Goals and Objectives	Applicable Conservation Actions
Grasshopper Sparrow	
Goal GRSP1: Maintenance of Grasshopper Sparrow Distribution and Abundance. Maintain the distribution and abundance of grasshopper sparrows within Yolo County.	
Objective GRSP1.1: Protect Habitat. Increase the protection of habitat with known grasshopper sparrow nesting occurrences.	**GRSP1.1-1.** Perpetual conservation easement acquisition, prioritizing occupied habitat.
Objective GRSP1.2: Maintain and enhance habitat. Maintain and enhance the habitat functions of protected grasshopper sparrow habitat.	**GRSP1.2-1.** Reduce areal extent and biomass of nonnative plant species that degrade habitat. **GRSP1.2-2.** Manage livestock grazing to maintain cover conditions that support grasshopper sparrow nesting.
Grasshopper Sparrow Conservation Priority Areas: Prioritize conservation actions in and near occupied habitat in planning units 2–7 and 9–16, in areas that also contribute to the landscape-level goals and objectives.	
Western burrowing owl	
Goal WBO1: Western burrowing owl conservation. Conserve western burrowing owls in Yolo County.	
Objective WBO1.1: Protect Habitat and Active Nest Sites. Increase protection of western burrowing owl primary habitat in Yolo County, in addition to the habitat protected by the Yolo HCP/NCCP, prioritizing areas with active nest sites.	**WBO1.1-1.** Place conservation easements on habitat lands (prioritizing occupied habitat) **WBO1.1-2.** Protect sufficient habitat surrounding occupied burrows to sustain the breeding pairs, consistent with Staff Report on Burrowing Owl Mitigation (CDFG 2012). The 2012 CDFG report recommends determining the acreage needed around burrowing owl burrows to sustain breeding pairs based on site specific conditions and information on the species' natural history. Gervais et al. (2003) suggests that burrowing owls concentrate foraging efforts within 600 meters of a nest burrow. Based on this information, protected burrowing owl occurrences should include 600 meters of foraging habitat surrounding the nesting burrows. A different configuration may be protected, however, if based on site-specific information and the best available scientific information on the species, sufficient habitat is protected surrounding the burrows to sustain the breeding pairs of western burrowing owl. Land that is disked for fire control or other purposes should not count toward the acreage commitments for western burrowing owl.
Objective WBO1.2: Manage and Enhance Habitat. Implement management and enhancement practices to encourage burrowing owl occupancy on protected lands.	**WBO1.2-1.** Maintain appropriate vegetation height. **WBO1.2-2.** Prohibit rodenticides on protected habitat. **WBO1.2-3.** Minimize the spread of invasive weed species. **WBO1.2-4.** Encourage the presence of ground squirrels. **WBO1.2-5.** Install artificial burrows to augment natural burrows where they are lacking. **WBO1.2-6.** Create berms as future burrowing sites. **WBO1.2-7.** Create debris piles to enhance prey populations.

Biological Goals and Objectives	Applicable Conservation Actions
Western Burrowing Owl Conservation Priority Areas. • First priority for protection: Occupied western burrowing owl habitat. Assign the highest priority to occupied habitats where established western burrowing owl colonies are present. • Second priority for protection: Lands that support suitable habitat and are adjacent to occupied habitat, • Third priority for protection: Other lands that support suitable habitat and are appropriate for management and enhancement actions.	
Swainson's hawk	
Goal 1: Swainson's Hawk Conservation. Conserve Swainson's hawks in Yolo County.	
Objective SWHA1.1: Protect Agricultural and Natural Foraging Habitat and Associated Nest Trees. Increase protection of cultivated lands with crops that support Swainson's hawk foraging habitat, grasslands, and associated nest trees in addition to the habitat protected by the Yolo HCP/NCCP.	**SWHA1.1-1.** Consider the distribution of protected habitat in Yolo County to ensure that protected habitat meets the needs of the Swainson's hawk, which is wide ranging across Yolo County landscape and not highly dependent on habitat connectivity. Consistent with *A Proposed Conservation Strategy for the Swainson's Hawk in Yolo County* (Estep 2015), strategically acquire conservation easements to maintain blocks of contiguous Swainson's hawk foraging habitat throughout the planning units that support the bulk of the nesting population. Newly protected habitat can be consolidated and form larger contiguous blocks or can be a series of separate, smaller blocks scattered throughout each planning unit. Acquisition of newly protected lands for the Swainson's hawk should focus on planning units 5, 10, 11, 13, 15, and 16, but can include others as determined by the Conservancy's Scientific and Technical Advisory Committee (STAC). Since the majority of the nesting population and available nesting habitat occurs within planning units 10, 11, 13, 15, and 16, protecting habitat here will maintain habitats nearest the majority of nesting habitats. Protecting grassland habitat in planning unit 5 will benefit Swainson's hawk by providing natural habitat for this grassland species (Dechant et al. 2000). Historically, Swainson's hawk occupied large grassland and shrubstep habitats in California (Woodbridge 1998); protecting this natural habitat will provide Swainson's hawk foraging habitat in Yolo County that is not subject to variation as a result of changing agricultural crop patterns. **SWHA1.1-2**. Prioritize protection of active nest trees (defined as trees with nests that have been active within the last five years). Also see conservation actions under Objectives AG1.1 and AG1.2 for actions to benefit Swainson's hawk on cultivated lands.
Objective SWHA1.2: Maintain or Enhance Nest Tree Density. Maintain or enhance the density of Swainson's hawk nest trees on cultivated land foraging habitat to provide a minimum density of one tree suitable for Swainson's hawk nesting (native trees at least 20 feet in height, particularly valley oaks if conditions are suitable) per 10	**SWHA1.2-1.** Plant and maintain suitable nest trees (defined as native trees that grow to over twenty feet in height) on foraging habitat. Also see conservation actions under Objectives AG1.1 and AG1.2 for actions to benefit Swainson's hawk on cultivated lands.

Biological Goals and Objectives	Applicable Conservation Actions
acres of cultivated lands in the reserve system. Where existing protected trees do not meet that minimum requirement, plant suitable nest trees to meet this density requirement.	
Swainson's Hawk Conservation Priority Areas: Prioritize conservation actions in and near occupied habitat in planning units 5, 10, 11, 13, 15, and 16.	
Greater Sandhill Crane	
Goal GSHC1: Protection and expansion of greater sandhill crane. Protect and expand the greater sandhill crane winter range in Yolo County.	
Objective GSHC1.1: Protect Foraging Habitat. Increase protection of high- to very high-value foraging habitat for greater sandhill crane, with at least 80 percent maintained in very high-value types in any given year. Protected habitat should be in planning unit 15, within 2 miles of known roosting sites, and should consider sea level rise and local seasonal flood events. Patch size of protected cultivated lands should be at least 160 acres.	**GSHC1.1-1.** Establish conservation easements on greater sandhill crane foraging habitat. **GSHC1.1-2.** Maintain appropriate crops on protected habitat to provide the needed habitat values for greater sandhill crane (Table 3-5).
Objective GSHC1.2: Create high-value foraging habitat. Increase the acres of high-value greater sandhill crane winter foraging habitat by protecting low-value habitat or nonhabitat areas and converting it to high- or very high-value habitat. Created habitat should be in Planning Unit 15, within 2 miles of known roosting sites, and should consider sea level rise and local seasonal flood events.	**GSHC1.2-1.** Establish conservation easements or purchase in fee-title on lands where high value foraging habitat can be created. **GSHC1.2-2.** Convert low-value habitat or non-habitat areas on cultivated lands to high-value habitat by switching to high value crop types.
Objective GSHC1.3: Create managed wetland roosting habitat. Increase the acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within	**GSHC1.3-1.** Establish conservation easements on greater sandhill crane roosting habitat. **GSHC1.3-2.** Create managed wetlands that provide roosting habitat as follows (Gary Ivey, pers. comm. 2014). • Develop roost sites as a series of shallow, open ponds separated by a system of checks and levees. Small upland islands can also be created within the ponds. Cranes often congregate to roost or loaf on

Biological Goals and Objectives	Applicable Conservation Actions
the Greater Sandhill Crane Winter Use Area in Planning Unit 15, with consideration of sea level rise and local seasonal flood events. The wetlands should be located within 2 miles of existing permanent roost sites and protected in association with other protected natural community types at a ratio of 2:1 upland to wetland to provide buffers around the wetlands.	the checks and other areas of higher ground and forage in the shallow water contained within the ponds. • Design checks, levees, and other upland sites with sloping banks, which allow cranes to walk from the flooded pond to the adjacent uplands. • In addition to the presence of water, food availability, and loafing opportunities, selection of roosting sites by greater sandhill cranes is based in part on predator avoidance. Therefore, the development of the ponds and checks should consider the ability of predators to access roosting cranes along checks and levees. • Selected roost sites will have direct access to sufficient irrigation water to maintain required water depths. **GSHC1.3-3.** Manage or enhance managed wetland roost sites as follows (Ivey et al. 2014)). • Place gravel or grit on the upland islands or on portions of the levees between the roosts and contiguous upland buffers. • Mow or burn sloped banks prior to flooding to increase crane access and predator sightings. • Maintain water depth throughout the winter season at an average depth of 10 centimeters, but should range across the roost site between 5 and 20 centimeters. • Begin flood-up of roosts by September 1. For roosts in close proximity, flood some in early September, additional roosts by early October, and other roosts at later dates to optimize foraging use during flood-up. Begin drawdown no earlier than March 15. • Manage vegetation at roosting sites to ensure no more than 10 percent cover of tall emergent plants, such as tules (*Schoenoplectus* spp.), cattails (*Typha* spp.), trees, and large shrubs. Site the 10 percent cover within the wetland basin as cranes can and do use this emergent cover for thermal cover during adverse weather conditions. • To enhance food value, employ moist soil management techniques to achieve and maintain substantial stands of high-value plants such as native smartweed (*Polygonum* spp.), yellow nut sedge (*Cyperus esculentus*), and swamp timothy (*Crypsis schoenoides*). A variety of other plant species may also be used, including grasses and clovers. Moist soil management may also require occasional irrigation during the dry spring and summer months as well as periodic summertime discing. Burn, mow, or disc bulrush/cattail vegetation as needed to maintain as < 10 percent of the composition and every 2 to 5 years to remove dead growth and encourage the development of new vegetative structure.
Objective GSHC1.4: Create flooded cornfield roosting and foraging habitat. Increase the acres of roosting habitat within 2 miles of existing permanent roost sites, consisting of active cornfields that	**GSHC1.4-1.** Establish conservation easements on lands within the greater sandhill crane Winter Use Area that can support cornfields for flooding. **GSHC1.4-2.** Create flooded cornfields that provide roosting and foraging habitat. **GSHC1.4-3.** Manage or enhance flooded fields as follows (Ivey pers. comm. 2014).

Biological Goals and Objectives	Applicable Conservation Actions
are flooded following harvest to support roosting cranes and that provide highest-value foraging habitat. Individual fields should be at least 40 acres and can shift locations throughout the Greater Sandhill Crane Winter Use Area (see species account, Figure A).	• Deferring the tilling of corn and grain fields until after December 21, to increase the amount and availability of forage for greater sandhill crane. • Where feasible, a portion of corn or grain fields may be left unharvested to increase the quantity of forage available to greater sandhill cranes. Forage gradually becomes available as senescent plant stalks fall over as a result of weathering. If using a corn seed variety designed for increased standability (in which case the plants may not fall over as a result of weathering), plant in lower densities or employ techniques such as alternating strips of standing corn and low growing vegetation and/or fallow land between the strips of standing corn to provide greater access by greater sandhill cranes. • To increase the foraging and roosting value of cultivated lands for greater sandhill cranes, shallowly flooded some corn, grain, and irrigated pasture during fall and winter. Cultivated land roosting habitat should consist of blocks of at least 180 acres that will be sequentially flooded to maintain a minimum of 40 acres of roosting habitat at any given time during the winter when cranes are present. This is intended to minimize disturbance and provide not only the roost water, but also new foraging opportunities throughout the season in close proximity to the roosting habitat. For example, if the field block is divided into two 90-acre parcels (180 acres total), half of one field may be flooded early in the fall and half of the other field may be flooded and maintained from mid-winter until the end of the season, while the first is drained or left to evaporate. Birds will benefit from having new foraging area close to the roost while it is being converted.
Greater Sandhill Crane Conservation Priority Areas: Prioritize conservation in areas within the greater sandhill crane Winter Use Area that are not subject to the effects of sea level of rise.	
Norther harrier	
Goal NH1: Northern harrier habitat. Sufficient protected habitat to support the population of northern harrier in Yolo County.	
Objectives - As described in Appendix F, the landscape and natural community-level goals and objectives will contribute toward the northern harrier goal.	
Northern Harrier Conservation Priority Areas: Prioritize habitat protection in and near occupied habitat in planning units 2-1, 9-16, and 18, in areas that also contribute to the landscape-level and natural community-level goals and objectives.	
Bank Swallow	
Goal BS1. Bank Swallow Conservation. Conserve bank swallow in Yolo County.	
Objective BS1.1: Protect Habitat. Increase protection of floodplain habitat for bank swallow along Cache Creek and the Sacramento River, prioritizing protection of occupied sites.	**BS1.1-1.** Protect channel banks from anthropogenic alterations (predominantly bank stabilization and rip-rapping)

Biological Goals and Objectives	Applicable Conservation Actions
Objective BS1.2: Manage and enhance habitat Manage and enhance bank swallow habitat to improve bank swallow foraging habitat values.	**BS1.2-1.** Avoid degrading bank swallow habitat when vegetating banks to restore riparian and provide shaded riverine aquatic habitat for fish. **BS1.2-2.** Promote scouring and flooding to create banks that provide suitable nesting habitat (consistent with Objective L2.1, Fluvial processes) **BS1.2-3.** Promote open grass and forb vegetation along floodplains for bank swallow foraging habitat. **BS1.2-4.** Control invasive plant species (consistent with RCIS/LCP Objective L3.1, Invasive species). **BS1.2-5.** Remove unnecessary rip-rap on the banks of the Sacramento River.
Black tern	
Goal BT1: Black Tern Habitat. Sustain sufficient habitat area to support black terns that migrate through Yolo County and to support future reestablishment of a nesting population in Yolo County.	
Objectives - As described in Appendix F, the landscape and natural community-level goals and objectives will contribute toward the black tern goal.	
Black Tern Conservation Priority Areas: Prioritize conservation actions in and near occupied habitat in planning units 11 - 13, in areas that also contribute to the landscape-level and natural community-level goals and objectives.	
Western yellow-billed cuckoo	
Goal WYBC1: Western Yellow-billed Cuckoo Habitat. Sufficient western yellow-billed cuckoo habitat in Yolo County to provide opportunities for migration and breeding.	
Objective WYBC1.1: Protect Western Yellow-billed Cuckoo Habitat. Increase protection of western yellow-billed cuckoo habitat, in addition to the habitat protected by the Yolo HCP/NCCP.	**WYBC1.1-1.** Establish conservation easements on suitable western yellow-billed cuckoo habitat, prioritizing occupied habitat, if any.
Objective WYBC1.2: Restore Western Yellow-billed Cuckoo Habitat. Increase the acres of western yellow-billed cuckoo habitat in Yolo County, with the land cover types that comprise the species' modeled habitat (in addition to the habitat restored by the Yolo HCP/NCCP).	**WYBC1.2-1.** Restore least western yellow-billed cuckoo habitat. **WYBC1.2-2.** Consider habitat needs for western yellow-billed cuckoo when designing riparian restoration projects to maintain mature riparian forest intermixed with early- to midsuccessional riparian vegetation. **WYBC1.2-3.** Restore patches of riparian habitat greater than 100 acres in size and 660 feet in width to provide high-quality habitat for western yellow-billed cuckoo, where there is potential for occupancy (from CVFPP Conservation Strategy [DWR 2016]). **WYBC1.2-4.** To meet habitat needs for this species, design restoration projects to include cottonwoods, willows, and other riparian plant species to provide greater than 40 percent canopy closure, with a mean canopy height of approximately 7 to 10 meters (Laymon et al. 1997).
Western Yellow-billed Cuckoo Priority Areas: Prioritize conservation actions in and near occupied habitat, if any, where there is potential to maintain or restore fluvial processes that contribute to the creation or maintenance of large patches of suitable western yellow-billed cuckoo habitat.	

Biological Goals and Objectives	Applicable Conservation Actions
Least Bell's vireo	
Goal LBV1: Least Bell's Vireo Habitat. Sufficient habitat in Yolo County to support least Bell's vireos that migrate through, and to support potential future reestablishment of a nesting population.	
Objective LBV1.1: Protect and Manage Least Bell's Vireo Habitat. Increase protection of least Bell's vireo habitat, in addition to habitat protected by the Yolo HCP/NCCP, and manage that habitat to support the species.	**LBV1.1-1.** Establish conservation easements on suitable least Bell's vireo habitat, prioritizing occupied habitat, if any. **LBV1.1-2.** Control cowbirds (consistent with RCIS/LCP Objective L3.1, Invasive species). Least Bell's vireo is particularly vulnerable to nest parasitism by brown-headed cowbirds (Sharp and Kus 2006). Cowbird control may be an important aspect of managing least Bell's vireo habitat in Yolo County. This species was previously thought to be extirpated from Yolo County, but has recently been discovered in and near Yolo County (Appendix C, Covered Species Accounts), and a population may become reestablished as a result of habitat restoration and management. Cowbird trapping. Cowbird trapping is an effective short-term management tool in recovery of endangered riparian birds (Kus and Whitfield 2005). Cowbird trapping has proven successful in reversing downward population trends for least Bell's vireo. Annual trapping in southern California eliminated or reduced cowbird parasitism relative to pretrapping rates and thereby enhanced productivity of nesting pairs, resulting in an eightfold increase in vireo numbers between 1986 and 2005 (Kus and Whitfield 2005). For cowbird trapping to be effective, it must be implemented on an annual basis for a sustained period. When cowbird trapping is not necessary to improve native bird populations or has minimal benefits, the funds and resources used for trapping could be used for other, more beneficial conservation efforts (U.S. Fish and Wildlife Service 2002a). Furthermore, sustained cowbird trapping might result in cowbirds developing either learned or genetic resistance to trapping, and in the capture of some nontarget species (U.S. Fish and Wildlife Service 2002a). For these reasons, cowbird trapping should only be implemented under limited circumstances, as described below; alternative methods to reduce cowbird nest parasitism may also be implemented to benefit least Bell's vireo. Landscape-level management. Cowbirds typically feed in areas with short grass and in the presence of ungulates such as domesticated livestock. They also feed in areas associated with anthropogenic influences such as golf courses and suburban lawns with bird feeders. Cowbirds commute on a daily basis from these feeding areas to riparian areas where they parasitize native birds (U.S. Fish and Wildlife Service 2002a). Therefore, proximity to potential cowbird feeding areas should be a consideration in siting riparian restoration projects. Protected lands may also be managed to discourage grazing and other activities that could attract cowbirds near riparian areas that support nesting least Bell's vireos or yellow-breasted chats. Natural community-level management. Parasitism rates and cowbird densities usually decline with increases in the density of vegetation; therefore, cowbird parasitism might be reduced by measures that result in denser vegetation, such as supplemental plantings of vegetation that tends to grow in dense patches (U.S. Fish and Wildlife Service 2002a; Sharp and Kus 2006).

Biological Goals and Objectives	Applicable Conservation Actions
	Species-level management. Because only a small number of least Bell's vireos, if any, are expected to nest in Yolo County in the near term, nest monitoring and removal or addling of cowbird eggs, if present, are likely to be the most cost-effective method for reducing cowbird parasitism on the species. This method has the added benefit of providing information on the extent to which parasitism threatens nesting vireos in Yolo County. Addling is preferred over egg removal, because the host might abandon a nest if the combined volume of eggs is reduced below a certain value by removal of cowbird eggs (U.S. Fish and Wildlife Service 2002a). Cowbird trapping may be necessary, if the least Bell's vireo population in Yolo County has grown to a level at which cowbird egg addling or removal is no longer cost-effective, but monitoring determines that parasitism is threatening the population (at least 25 percent parasitism rate, or based on the best available information and consultation with species experts). Cowbird trapping should not be implemented unless pretrapping data indicate that cowbird parasitism may be threatening the least Bell's vireo population and cowbird egg removal or addling is determined to be less cost-effective. Prior to initiating cowbird trapping, a trapping plan should be developed that includes clear goals for the program, criteria for determining when trapping will be discontinued, and a siting strategy for placement of traps in locations expected to result in the greatest success in reducing parasitism on least Bell's vireo (U.S. Fish and Wildlife Service 2002a). The number of cowbirds or eggs removed, parasitism rate, and vireo nesting success should be documented to determine whether the program goals have been met.
Objective LBV1.2: Restore Least Bell's Vireo Habitat. Increase the acres of least Bell's vireo habitat in Yolo County, with the land cover types that comprise the species' modeled habitat (in addition to the habitat restored by the Yolo HCP/NCCP).	**LBV1.1-1.** Restore patches of riparian habitat greater than 10 acres in size to provide habitat for least Bell's vireo, where potential for occupancy is high (from CVFPP Conservation Strategy [DWR 2016]).
Least Bell's Vireo Conservation Priority Areas: Prioritize conservation actions in and near occupied or previously occupied areas, such as in the Yolo Bypass.	
White-tailed kite	
Goal WTK1: White-tailed Kite Habitat. Sufficient protected habitat to support the population of white-tailed kites in Yolo County.	
Objectives - As described in Appendix F, the landscape and natural community-level goals and objectives will contribute toward the white-tailed kite goal.	
White-tailed Kite Conservation Priority Areas: Prioritize conservation actions in and near occupied habitat in planning units 3-7, 9, and 11-14, in areas that also contribute to the landscape-level and natural community-level objectives.	

Biological Goals and Objectives	Applicable Conservation Actions
California black rail	
Goal CBR1: California Black Rail Habitat. Provide suitable habitat conditions for California black rail in Yolo County.	
Objective CBR1.1: Protect California Black Rail Habitat. Increase the protection of California black rail habitat in Yolo County, including patches of marsh greater than 20 acres in size, with land cover types and in locations that comprise the species' modeled habitat, prioritizing protection of occupied habitat or habitat where potential for occupancy is high (species account, Appendix C).	**CBR1.1-1.** Establish conservation easements on California black rail habitat, prioritizing occupied areas.
Objective CBR1.2: Restore California Black Rail Habitat. Increase the acres of California black rail habitat in Yolo County, with the land cover types and in locations that comprise the species' modeled habitat (species account, Appendix C).	**CBR1.2-1.** Restore marsh habitat for California black rail, consisting of shallowly inundated emergent vegetation at the upper edge of the marsh (within 50 meters of upland refugia habitat) with adjacent riparian or other shrubs that will provide upland refugia, and other moist soil perennial vegetation.
Objective CBR1.3: Enhance Black Rail Habitat. Enhance California black rail habitat by increasing its ability to support the species.	**CBR1.3-1.** Increase amount and quality of emergent wetlands (patches greater than 20 acres). **CBR1.3-2.** Increase amount and quality of high-water refugia. **CBR1.3-3.** Minimize stressors (e.g., habitat degradation, noise, vibrations, and human disturbance from operations and maintenance activities; predation; flooding; or sea level rise).
California Black Rail Conservation Priority Areas: • Prioritize conservation actions in or near occupied or previously occupied habitat, in areas that do not experience winter floods, or if flooding occurs, upland refugia are available or can be created. • Prioritize conservation actions in areas that would not be adversely affected by sea level rise.	
Loggerhead Shrike	
Goal LHSH1: Maintenance of Loggerhead Shrike Distribution and Abundance. Maintain the distribution and abundance of loggerhead shrikes within Yolo County.	
Objective LHSH1.1: Protect Habitat. Increase the protection of habitat with known loggerhead shrike nesting occurrences.	**LHSH1.1-1.** Perpetual conservation easement acquisition, prioritizing occupied habitat.

Biological Goals and Objectives	Applicable Conservation Actions
Loggerhead Shrike Priority Areas: Prioritize conservation actions in or near occupied or previously occupied habitat.	
Yellow-Breasted Chat	
Goal YBCH1: Maintenance of Yellow-Breasted Chat Distribution and Abundance. Maintain the distribution and abundance of yellow-breasted chats within Yolo County	
Objective YBCH1.1: Protect Habitat. Increase the protection of habitat with known yellow-breasted chat nesting occurrences.	**YBCH1.1-1.** Perpetual conservation easement acquisition, prioritizing occupied habitat.
Yellow-Breasted Chat Priority Areas: Prioritize conservation actions in or near occupied habitat.	
Townsend's Big-Eared Bat	
Goal TBEB1: Maintenance of Townsend's Big-Eared Bat Distribution and Abundance. Maintain the distribution and abundance of Townsend's big-eared bats within Yolo County	
Objective TBEB1.1: Protect Roost Sites Increase the protection of roost sites occupied by Townsend's big-eared bat, particularly sites that support maternal colonies.	**TBEB1.1-1.** Perpetual conservation easement acquisition, prioritizing occupied habitat.
Townsend's Big-Eared Bat Priority Areas: • Prioritize conservation of occupied mining sites in the Little Blue Ridge planning unit.	

Table 3-4. Patch Size, Configuration, and Habitat Connectivity Considerations for Planning Species

Planning Species	Natural Communities	Minimum Size/Configuration Considerations	Habitat Connectivity Considerations
American badger	Grasslands in the Hill and Ridge Landscape Unit.	Variable home range of between 395 and 2,100 acres (Messick and Hornocker 1981) Minimum patch size is 400 acres, to correspond with the lower home range estimate.	Connectivity is essential for home range and dispersal movements, and to facilitate protection of badger populations. Set connectivity goals to create multiple intact contiguous reserves of 1,200 acres to meet the average home range estimate (Messick and Hornocker 1981).
Black-tailed deer (migratory herds – mid-elevation foothills and higher elevations)	Woodlands and forest, shrublands, and scrub	Since black-tailed deer migrate through Yolo County, large patch size would be required to manage habitat for it. Black-tailed deer home ranges are relatively large and variable in size (168 to 1,581 acres, with a mean home range size of 370 acres [McCoy and Gallie 2005]). Minimum patch size for purposes of managing this landscape should be correspondingly large and generally correspond to the mean home range size. Preserved patches should be at least 300 acres and contiguous with other protected habitat areas to allow for unobstructed movement though Yolo County. The location and configuration should be based on proximity to high resident-deer use areas or known migratory routes.	Connectivity of suitable deer habitat through Yolo County is essential for migratory herds. Prioritize preservation of habitat areas that provide connectivity with other habitat areas to provide movement corridors for resident and migratory herds.

Table 3-5. Assigned Greater Sandhill Crane Foraging Habitat Value Classes for Agricultural Crop Types

Foraging Habitat Value Class	Agricultural Crop Type
Very high	Corn, rice
High	Alfalfa, irrigated pasture, wheat
Medium	Other grain crops (barley, oats, sorghum)
Low	Other irrigated field and truck crops
None	Orchards, vineyards

3.4.2 RCIS Conservation Prioritization Guidelines

Table 3-6, below, provides guidelines to assist in prioritizing the multiple conservation actions identified in this plan. In recognition of the need to adjust priorities over time to address changing conditions such as climate change, the primary intent of Table 3-6 is to provide guidance for prioritizing actions during the ten-year term of the RCIS. These guidelines therefore pertain primarily to the RCIS component of the plan rather than the LCP component. For guidelines focused on longer-term conservation for the LCP (i.e., more than ten years), see Section 3.4.3, *Additional LCP Guidelines.*

The RCIS guidelines identify preferred characteristics of conservation sites. Not all of the 12 parameters may apply or may be useful in prioritizing among conservation choices. Moreover, these parameters and preferred characteristics may be adjusted as conservation in the strategy area progresses. These guidelines are intended to be re-evaluated at the end of the ten-year term of the RCIS, if the RCIS is updated at that time.

Table 3-6. RCIS Prioritization Guidelines

Parameters (RCIS Section)	Preferred Characteristics
Conservation goals and objectives (Section 3.4.1, Table 3-3)	Contributes to three or more conservation goals and objectives in RCIS/LCP
RCIS/LCP Priority Area (Section 3.4.1, Table 3-3)	Within a Priority Area identified in Table 3-3
Size of site (acres) (Section 3.4, Goal L1)	Large site (> 160 acres)
Site configuration (i.e., shape) and adjacent land uses (Section 3.4, Goal L1)	Sites with compatible adjacent land uses or with incompatible land uses adjacent[1] and with low ratio of edge:area
Focal or conservation species (Table 1-2)	Site supports occupied habitat for one or more focal or conservation species
Patch size for focal and conservation species (Section 3.4.1, Table 3-3)	Suitable habitat on site above minimum patch size identified in Table 3-3 for target focal species
Site connectivity to protected area (Section 3.4, Goal L1)	Within or adjacent to existing protected area(s) that are managed for ecological purposes
Regional connectivity (Section 2.9)	Site partially or entirely within Essential Habitat Connectivity Area, Ecological Corridors, or Creek Corridor identified for RCIS/LCP area (Figure 2-16)
Rare natural communities (Section 3.3.1)	Site supports rare natural communities as described in Section 3.3.1 (i.e., the least abundant natural communities in Yolo County).
Long-term management commitments (Section 3.4.1, Table 3-3)	Site includes commitments to ensure long-term sustainability of target biological values[2]
Restoration potential (Objective L1-4)	Site has potential for restoration in terms of area and ability to support one or more focal or conservation species
Threats to site (Section 3.2.4.2)	Site has threat of land use conversion or other degradation
Multiple benefits (Section 3.2.3)	For working lands and flood control areas, the project supports the multi-benefit approach described in Section 3.2.3.[a]

[a] Prioriization for the multi-benefit approach only applies to projets in working lands (e.g., cultivated lands, grazed lands) and flood control areas. This prioritization criterion does not apply when meeting goals and objectives that require protection or restoration of natural communities or habitats incompatible with other uses.

3.4.3 Additional LCP Conservation Guidelines

The following additional conservation guidelines apply to the LCP. Conservation guidelines are described below as general guidelines, guidelines for natural communities, guidelines for conservation species, and guidelines for unique areas.

3.4.3.1 General Guidelines

- The highest priority for the RCIS/LCP is to implement the landscape framework described in the landscape-level goals and objectives in Table 3-4, to support and enable conservation of native species, natural habitats, and ecological processes at county-wide and regional scales. This guideline implements the most important conservation measure (landscape connectivity that allows species to adapt to changing conditions and increased environmental stressors, restores genetic diversity among local populations, and increases local population abundances that reduce extirpation likelihoods) identified in conservation science and practice (refs), particularly as climate change, increased human populations, and altered land use patterns affect natural landscapes during this century and thereafter (refs).

  This guideline recognizes that landscape-scale conservation planning assigns higher value to habitat areas that consolidate "core" habitat areas and habitat that enables and supports landscape linkages than to equivalent habitat areas that do not achieve those results. As described elsewhere in this RCIS/LCP, general conservation guidance for landscape-scale conservation emphasizes protected areas that are as large as can be achieved, with minimized perimeter/area ratios, as this achieves increased protection for "core" habitat and increases the likelihood of occurrence of area-sensitive wildlife species (refs). In addition, landscape linkages among habitat areas function best when they are sufficiently large to provide "core" habitat conditions within the linkages (refs).

- A second priority for this RCIS/LCP is the conservation of communities that support multiple RCIS/LCP focal and conservation species over communities that support fewer species. This guideline recognizes the long-established conservation principle that protecting habitat areas supporting greater richness of sensitive species ("hotspots") in the short term in order to maintain their populations is an essential element in developing landscape-scale conservation plans that protect those species in the long-term (refs). If resources to achieve conservation objectives are limited, the RCIS/LCP places higher value on areas that currently support higher numbers of sensitive (i.e., focal and conservation) species.

- The conservation of areas in the county with high degrees of threat to loss before areas of lower-degree threat constitutes a third guideline for this RCIS/LCP, assuming that resources for acquisitions, restorations, and other conservation actions are limited and prioritization is required. This guideline reflects a widely adopted practical goal in conservation planning (refs). The Natural Community Gap Analysis in Table 3-2 is an important tool for providing guidance to accomplish this guideline.

- This RCIS/LCP adopts as a fourth guideline the conservation of habitat areas within landscapes having fewer major stressors (e.g., major or high-volume roads or high-impact land uses such as development are absent near potential conservation areas) over areas having high intensities of factors that adversely affect the conservation values of conserved lands. Roads are a major source of mortality for wildlife, conduits for the introduction of exotic species into the landscape, and a source of vehicle-derived pollutants in their vicinities (refs). Development is directly associated with habitat loss, fragmentation, and the loss of landscape connectivity; typically results in the introduction of nonnative predators (e.g., free-ranging cats) as well as abundant nonnative vegetation; is often associated with alterations in hydrology and drainage patterns that affect areas outside the developed area; and is generally accompanied by an increased use of pesticides and herbicides that may affect adjacent undeveloped areas (refs). If alternative candidate habitat areas have similar values otherwise, this RCIS/LCP places higher value on areas that are less subject to major stress or degradation from adjacent land uses.

- A fifth guideline for the RCIS/LCP is the conservation of existing high-quality species' habitats before creating new habitat areas except in planning units that lack high quality habitat areas, and for natural communities that are limited in extent such as valley oak woodland. Existing high-quality habitat areas already provide the conditions that support many ecological functions and high species richness, conditions that are frequently difficult to establish/reestablish in areas that have been altered or that are naturally less ecologically complex (refs), and the RCIS/LCP emphasizes the importance of protecting such high-quality areas. However, when a planning area currently lacks high-quality habitat areas the RCIS/LCP recognizes that a better conservation outcome may sometimes result through the intentional creation or restoration of desired natural communities in areas where they are currently absent or poorly developed.
- The RCIS/LCP adopts as a sixth guideline the restoration/enhancement of areas within the county lacking sufficient representation of native prairie, freshwater emergent wetlands, and particularly complex areas of forest, woodland, and chaparral communities, where such communities are ecologically likely to occur. In restoring/enhancing these community types, attention to factors known to be associated with desired ecological functions and habitat values should be emphasized. For example, sometimes the species richness of the vegetation is itself a positive element in maintaining high ecological function and habitat values (refs).

3.4.3.2 Conservation Species Guidelines

The RCIS/LCP prioritizes lands supporting conservation species as follows:

- The LCP assigns higher conservation priority to the rarest and most threatened conservation species than more widespread species or species facing a lower degree of threat. Rarity and degree of threat is based on state and federal status; California Native Plant Society status; status identified in regional, statewide, or national conservation plans (e.g., Partners in Flight's 2016 "Landbird Conservation Plan"); and the best available information on the species.
- Additional conservation priority is allocated in the RCIS/LCP to species identified in Appendix C of the 2015 State Wildlife Action Plan (SWAP) as "Species of Greatest Conservation Need." SWAP Appendix Table C-11 identifies species of greatest conservation need in the Northern California Interior Coast Ranges (USDA) Ecoregion. Appendix Table C-18 identifies species of greatest conservation need in the Great Valley (USDA) Ecoregion. As noted in Chapter 2, nearly all of the species of greatest conservation need identified in these tables are included in the RCIS/LCP either as focal species in the RCIS or as conservation species in the LCP.
- Lands with important populations of conservation species (e.g., particularly large populations, core (source) populations, or genetically unique populations) have higher conservation priority than otherwise equivalent lands with less significant populations.
- Lands with multiple conservation species have higher conservation priority than otherwise equivalent lands with few to no conservation species.

3.4.3.3 Unique Areas

The Advisory Committee identified the following natural resources in Yolo County with unique plant assemblages or microclimate. The LCP prioritizes these unique areas for conservation.

Coastally Influenced Areas in the South Blue Ridge Planning Unit

The South Blue Ridge Planning Unit (Planning Unit 3) includes a unique assemblage of plants for Yolo County, resulting from marine-influenced atmospheric conditions (both winter storms and especially cooler and moister air masses intruding from the southwest during other seasons) rising over the hilltops from coastal areas, providing a moister local climate (Gilliam 2002). This area includes Ireland Ranch and parts of Bobcat Ranch. This area supports plant species that are more typical of coastal plant alliances such as ocean spray (*Holodiscus discolor*) and osoberry (*Oemleria cerasiformis*). It is uncertain how far northward along the Rocky/Blue Ridge line this influence extends (some have suggested Cottonwood Canyon/Creek). Vegetation around Crooker Spring on the Ireland Ranch, in a north-flowing tributary of Salt Creek, includes black oak as a co-dominant riparian species and a number of other species that reflect a coastal influence.

Buckeye Creek and Associated Drainages in the Capay Hills Planning Unit

Buckeye Creek basin, Oat Creek, and Bird Creek originate in a relatively geologically young landform and flow eastward into the Sacramento Valley. Oat Creek and Bird Creek flow through the upper end of Hungry Hollow, then cut through the higher elevations of the Dunnigan Hills to flow east rather than south to Cache Creek. The fluvial characteristics of Buckeye Creek are still relatively intact, and the basin is erosional, reflecting the recent uplift of the Dunnigan Hills in combination with the conversion of the landscape to agricultural uses (there are numerous orchards, and the woodlands appear to be more intensively grazed than the prairies farther south). The remnant riparian areas (including the physical and hydrological influences as well as the vegetation) of Buckeye Creek appear to reflect fluvial processes dominated by flashy hydrology.

3.5 Monitoring and Adaptive Management Framework

In order for an individual or entity to develop a mitigation credit agreement (MCA) under this Yolo RCIS/LCP, an adaptive management and monitoring framework is required in the RCIS. This section provides an overview of what monitoring and adaptive management is and provides the framework that should be used when developing monitoring and adaptive management plans for each MCA located in Yolo County. Monitoring and adaptive management plans will only be required for implementation of conservation actions or habitat enhancement actions under MCAs. Monitoring and adaptive management plans are recommended (but not required) for all other conservation actions associated with the RCIS (i.e., those unrelated to an MCA) or LCP.

This section outlines and describes the key elements of the framework. The level of detail and application of the framework will vary depending on the size and complexity of the MCA site or sites, the resources being monitored, and the nature of the conservation or enhancement actions being executed. Unless otherwise determined by CDFW or other participating regulatory agencies, the elements of the monitoring and adaptive management framework described in this section will need to be addressed in any MCA prepared under this Yolo RCIS/LCP.

A monitoring and adaptive management framework is not required for the LCP, which is a voluntary commitment by citizens and local agencies in Yolo County to develop and implement a conservation plan that does beyond the required elements for 12 covered species in the Conservancy's HCP/NCCP.

A monitoring and adaptive management plan could be developed for any voluntary conservation action in Yolo County (i.e., unrelated to an MCA), but it is not required. Such a monitoring and adaptive management plan consistent with the framework described in this section would provide the same benefits as those described for mitigation actions.

3.5.1 Objectives

The overarching objective of monitoring and adaptive management is to ensure that conservation and enhancement actions are being implemented in ways that benefit focal species and other resources credited under the agreement, and contribute to the achievement of conservation goals and objectives stated in the RCIS/LCP. This section presents a framework that should be referenced when developing site-specific monitoring and adaptive management strategies for each MCA site(s). Additional objectives of monitoring and adaptive management include the following.

- Create a structured decision-making framework that can be used as the basis for collecting information, verifying hypotheses, and designing and changing management practices.
- Develop and implement effective and efficient monitoring protocols to ensure that data collected will inform adaptive management.
- Document the baseline condition of biological resources on mitigation lands and other key habitat outside of mitigation parcels using existing data, modeling, and the results of ongoing field surveys.
- Provide an organizational framework and decision-making process for evaluating monitoring and other data to determine whether and how to adjust management actions.

3.5.2 Phases of Monitoring and Adaptive Management

The monitoring and adaptive management program for any conservation site, once established, should consist of three phases: baseline inventory, management planning, and long-term monitoring and adaptive management.

This section describes key tasks expected in each phase. In general, activities in the baseline inventory phase will occur during the first 1 to 2 years following the commitment to conduct conservation or enhancement actions. The baseline inventory phase will begin as soon as possible after sites for conservation or enhancement actions are identified and secured (e.g., land acquisition, conservation easement, management agreement with landowner, or other mechanism). In some cases, baseline information may have been collected during the site assessment process. The long-term monitoring phase will begin on each site after the baseline inventory phase is complete and any near-term restoration or enhancement actions have been largely completed.

3.5.2.1 Baseline Inventory Phase

The baseline inventory phase will occur on new mitigation sites prior to or when they are secured. Baseline information collected during this phase will be used to assess changes in biological resources once conservation or enhancement actions are applied and will lay the foundation for monitoring and adaptive management. Inventories may need to occur over multiple seasons to ensure that all focal species present are identified, or to accommodate any climatic variation between years (e.g., below-average rainfall).

The MCA proponent will inventory and assess populations or status (e.g., presence/absence) of focal species, as appropriate, on mitigation properties. At a minimum, baseline monitoring data must be designed and collected so that MCA proponents can do the following.

- Measure their contribution to the relevant conservation goals and objectives in this Yolo County RCIS.
- Measure the net ecological gain in the area and quality of habitat or other natural resource values.
- Measure progress towards performance-based milestones and achievement of ecological performance standards to determine when and how many mitigation credits are released.

During the baseline inventory phase, the MCA proponent may also develop and test hypotheses about key relationships between species, habitats, and processes; the identification and assessment of threats and stressors to natural communities and species; the prioritization of conservation actions on the mitigation site; and the selection of biotic and abiotic indicators for evaluating habitat condition over time.

Baseline conditions on the mitigation site need to be documented to enable management planning and to serve as a comparison point for all future monitoring. Accordingly, resources of interest that occur on a site need to be assessed, documented, and mapped. Documenting baseline conditions will consist of historical data and trends, as available and appropriate, and surveys focused on presence/absence of focal species, for which mitigation credit is being sought, and condition of habitats that support those species. If mitigation credit is being sought for other conservation elements (e.g., wildlife linkage implementation, aquatic resources, rare or unique land cover types) those resources should be assessed as well. Baseline assessments of resources that are regulated by other federal, state, or local agencies, or are subject to other permits within CDFW (i.e., LSAA) should be consistent with standards and protocols recognized by those agencies where possible, to create monitoring efficiency.

3.5.2.2 Planning Phase for Management and Monitoring

Once the baseline condition of the mitigation site is understood, MCA preparers develop the required monitoring and long-term adaptive management plan. The monitoring and long-term adaptive management plan will memorialize the desired outcomes and success criteria for the mitigation site, as described in the MCA. Management and monitoring planning will generally consist of the following tasks.

- Describe management actions that will be used to improve habitat for focal species or conditions for other conservation elements.

- Describe desired outcomes of management actions, including species population response, habitat condition, or change in other conservation element.
- Prioritize implementation of conservation actions to best achieve mitigation objectives.
- Describe monitoring protocols (i.e., methods and equipment used, monitoring frequency, monitoring timing) and identify sampling design.
- Develop criteria for measuring success of any enhancement or restoration efforts.
- Describe condition of infrastructure and necessary infrastructure improvements needed to execute the management program.
- Develop an adaptive management strategy to adjust the monitoring protocols.
- Create and maintain a data repository that includes monitoring and survey results used for tracking progress toward achieving the RCIS/LCP conservation goals and objectives.

As much as possible the management plan should be a practical guide to management and monitoring actions that will occur on the mitigation site over time, written with the land manager and monitors in mind. The implementation sponsor may seek assistance from potential collaborating groups in voluntarily conducting monitoring tasks and carrying out research which may inform adaptations in the understanding on the ecology of the focal species, conservation species, and the conservation principles on which the LCP is based. Examples of potential collaborating groups include county, state, and federal agencies, Resource Conservation Districts, nonprofit conservation organizations, UC Davis, and other academic institutions.

3.5.2.3 Long-Term Monitoring Phase

The planning phase will be followed by long-term monitoring to determine the status and trends of focal species and habitats and the effectiveness of the management of the MCA mitigation site.

The long-term monitoring phase includes the following tasks.

- Monitor species response to any enhancement, restoration, or habitat creation described in the MCA and management plan.
- Monitor restoration sites for success; remediate sites if initial success criteria are not being met. The management plan will identify triggers for remediation, if necessary.
- Assess status and trends of focal species by monitoring species populations, habitat, and other indicators over time.

In many cases, as sites approach and ultimately meet their performance-based metrics, monitoring frequency and intensity can be reduced. Similar to management actions, the monitoring program can change over time in response to the information collected and the trends observed. This adaptive approach to the monitoring program will ensure that enough data is being collected by MCA sponsors to determine whether the mitigation site is performing as expected, while also avoiding unnecessary monitoring costs. The CDFW will verify all determinations of performance made by MCA sponsors.

3.5.2.4 Adaptive Management

Adaptive Management is a decision-making process promoting flexible management such that actions can be adjusted as uncertainties become better understood or as conditions change. Monitoring the outcomes of management is the foundation of an adaptive approach, and thoughtful monitoring can both advance scientific understanding and modify management actions iteratively (Williams et al. 2007).

Adaptive management is necessary because of the degree of uncertainty and natural variability associated with ecosystems and their responses to management. It is possible that additional and different conservation actions not described in the RCIS or MCA will be identified in the future and proven to be more effective. Results of monitoring may also indicate that some management measures are less effective than anticipated. To address these uncertainties, an adaptive approach will be used to inform management on land subject to MCAs.

The cornerstone of a monitoring and adaptive management program is an approach in which monitoring will yield scientifically valid results that inform management decisions. Information collected through monitoring and other experiments will be used to manage mitigation lands and help determine progress towards conservation objectives. The adaptive management process will be administered by the MCA holder in coordination with CDFW.

Adaptive management tasks include the following.

- Evaluate efficacy of monitoring protocols.
- Incorporate best available scientific information into management.
- Review any unexpected or unfavorable results and test hypotheses to achieve desired outcome.
- Adjust management actions and continue to monitor.
- Adjust success criteria and conservation actions, if necessary.

3.5.3 Types of Monitoring

Each MCA sponsor must develop a monitoring plan, which must be approved by CDFW as part of the MCA approval process. The monitoring plan will comprise the two types of monitoring described in this section, routine monitoring and effectiveness monitoring. The monitoring will include protocols, indicators, monitoring schedule, and success criteria based on the guidance offered in this section. .

3.5.3.1 Routine Monitoring

Routine monitoring (also known as easement monitoring) tracks the status of mitigation site and documents that the requirements of the conservation easement or other management agreements are being met. Routine monitoring verifies that the MCA holder and landowner (if these are different parties) are carrying out the terms of the MCA and the easement. All MCA sponsors will be required to conduct routine monitoring that will, at a minimum, track the components listed below.

- Maintaining the property in a condition consistent with the easement.
- Maintaining infrastructure and access as stated in the easement.
- Implementing enhancement and restoration actions as described in the MCA.

- Implementing management actions as described in the MCA.
- Reporting of monitoring activities conducted.

3.5.3.2 Effectiveness Monitoring

Effectiveness monitoring assesses the biological success or failure of conservation actions or enhancement actions and is only required on actions that have been approved for mitigation credit under an MCA. Effects monitoring may also be used on voluntary conservation investments in order to determine if management actions are achieving the desired outcomes, but they are not required. Specific detail regarding what needs to be included in a monitoring plan for a mitigation credit agreement is expected to be provided in the forthcoming Program Guidelines for MCAs.

Effectiveness monitoring is focused on the status of focal species or other conservation elements within Yolo County for which mitigation credit has been assigned under the MCA. Understanding the effects of management actions is a critical component of the monitoring and adaptive management program. The purpose of effects monitoring is to ascertain the success of management in achieving desired outcomes, to provide information and mechanisms for altering management if necessary, and to evaluate whether the mitigation credit agreement was successful. Monitoring results may also be used to determine when mitigation credits can be released and when they are available for use or sale. Further, results from effectiveness monitoring can be used to establish how implementation of the MCA or voluntary conservation investment contributes to the achievement of conservation goals and objectives.

Effectiveness monitoring will include the development and assessment of success criteria (i.e., performance-based milestones) for conservation and enhancement actions. The conservation goals and objectives will determine the nature of the success criteria. In other words, success criteria should be structured in a way that allows the MCA proponent, CDFW, or other interested agencies to determine whether implementation of the conservation or enhancement action achieves, or partially achieves, one or more conservation objectives.

3.5.3.3 Key Elements of Monitoring Program

In addition to the guidelines described previously, the following steps are recommended for MCA sponsors and others who implement conservation actions when designing their monitoring program. Utilizing this monitoring design process will help managers to determine necessary changes in management.

- **Determine what to measure.** Establish the attributes or variables that the monitoring will measure to answer the question defined above. This step includes the development of measurable success criteria for evaluating management actions.
    - **Species status.** Monitoring whether species are present and comparing species status (e.g., species health, life history stages, population size) across years can determine whether and how well management actions are working.
    - **Habitat quality**. Monitoring the function and health of certain habitat types can allow for conclusions about several species at one time, without surveying for each species. This includes assessing how species respond to restoration or enhancement actions on mitigation lands.

- **Develop monitoring protocols.** Questions to be answered by the monitoring program will be at the species or habitat level. Monitoring protocols will vary depending on the species or habitat type being monitoring. In some cases, standardized or CDFW-approved protocols exist.[13] When appropriate, those protocols should be used, although sometimes variations in those protocols may be warranted.
- **Ensure monitoring frequency matches need.** Monitoring frequency should be tied directly to the needs of the MCA and the cycles of the focal species and other natural resources. In some cases, especially early in implementation, monitoring may need to occur frequently to ensure conservation and enhancement actions make progress towards performance-based milestones (and, ultimately, credit release). In other cases, monitoring may need to occur more infrequently. Ensure that the frequency of monitoring efforts matches the question being asked. Factors that may influence the frequency or type of monitoring include, but are not limited to, the following.
  - Natural history of the species being monitored.
  - Habitat variability between years due to uncontrollable factors (e.g., rainfall).
  - Variability in species population levels between years due to uncontrollable factors.
  - Variability in habitat quality between potential sampling locations.

Use indicator species, if appropriate. In some cases, groups of species or indicator species will streamline monitoring. Indicators are selected because they are easy to survey and provide usable information on the species, habitat, or ecosystem in question.

[13] However, many CDFW-approved protocols are designed to detect species presence on proposed development sites and may not be suitable for long-term monitoring to detect species trends or responses to management actions.

Chapter 4
Implementation

4.1 Overview

Following approval by the California Department of Fish and Wildlife (CDFW), conservation organizations, local and state agencies, landowners, or other private entities can immediately use the regional conservation investment strategy/local conservation plan (RCIS/LCP). These entities can use the RCIS/LCP to inform decisions related to land acquisition, restoration, enhancement, and management actions for focal species, other species, and other conservation elements addressed by the RCIS/LCP. Examples of how these entities may use the RCIS/LCP voluntarily include the following.

- Inform conservation investments made by conservation organizations in the Strategy Area.
- Inform grant or permit application evaluations made by state or federal agencies for local conservation or research projects.
- Guide how project proponents site and design compensatory mitigation projects and project-level permitting for listed species.
- Guide the establishment of mitigation or conservation banks or development of mitigation credit agreements (MCA) by landowners, public agencies, private entities, or other interested entities, to facilitate compensatory mitigation.

Once approved, this RCIS will be valid for a period of 10 years, or to 2028. CDFW may extend the duration of this RCIS for additional periods of up to 10 years each, after this RCIS is updated with new scientific information and if CDFW finds that this RCIS continues to meet the requirements of CFGC 1852 (see Section 4.3.1, *Updating this RCIS*). The LCP component of this RCIS/LCP will not expire. The Yolo Habitat Conservancy may update the LCP from time to time, based upon responses to climate change or other factors affecting conservation needs in the county.

This chapter describes the RCIS implementation process and provides an overview of the new tool enabled by the RCIS, an MCA. This chapter also identifies RCIS/LCP implementation tasks required by the California Fish and Game Code (CFGC) and the RCIS Program Guidelines (California Department of Fish and Wildlife 2017), and suggests optional tasks that exceed those requirements. For the purposes of the Yolo RCIS/LCP, the *implementation sponsor* is the entity or entities responsible for conducting the two tasks required by the CFGC and the RCIS Program Guidelines and described in Section 4.2.1, *Required Responsibilities of Implementation Sponsor*. The Yolo Habitat Conservancy is the public agency sponsoring and submitting the RCIS/LCP for CDFW approval.

The Yolo Habitat Conservancy is also, provisionally, the implementation sponsor of the Yolo RCIS/LCP. Their provisional commitment is contingent on confirmation in the final RCIS/LCP of their obligations and expected costs of implementing the Yolo RCIS/LCP.

Items that are suggestions and not requirements are denoted as those tasks the implementation sponsor *may* do, as opposed to required elements that they *will* do or *shall* do. Section 4.2.2, *Optional Implementation Activities*, describes tasks that are not required, but are recommended and may prove helpful. Anyone may perform or support the optional tasks.

Voluntary users of the RCIS/LCP conservation actions will collectively implement the RCIS/LCP. These users could include, but are not limited to, any or all of the entities listed above.

4.2 Goals of Implementation

The RCIS/LCP provides information to facilitate conservation actions or habitat enhancement actions in the Strategy Area, preferably through multi-benefit projects where feasible. These actions may include those driven by regulatory needs (primarily in the form of mitigation) as well as voluntary conservation actions. State and local agencies developed this RCIS/LCP to guide investments in conservation, infrastructure, and compensatory mitigation, promote a balanced approach to conservation that is compatible with existing land uses such as agriculture, and help ensure conservation actions and habitat enhancement actions in the Strategy Area achieve a high degree of conservation benefit at a regional scale.

4.3 Required RCIS Implementation

The RCIS component of the Yolo RCIS/LCP may be used by anyone or any agency to develop an MCA. For an RCIS to support an MCA, CFGC 1856(b) lists three elements that an RCIS must include:

"(1) An adaptive management and monitoring strategy for conserved habitat and other conserved natural resources.

(2) A process for updating the scientific information used in the strategy, and for tracking the progress of, and evaluating the effectiveness of, conservation actions and habitat enhancement actions identified in the strategy, in offsetting identified threats to focal species and in achieving the strategy's biological goals and objectives, at least once every 10 years, until all mitigation credits are used.

(3) Identification of a public or private entity that will be responsible for the updates and evaluation required pursuant to paragraph (2)."

This RCIS has been written so that it can support MCAs. The adaptive management and monitoring framework is described in Section 3.6, *Monitoring and Adaptive Management Framework*. The responsibilities of the implementation sponsor and its partners to update the RCIS and track its progress are described below.

4.3.1 Updating this Strategy

In compliance with CFGC 1856(b), the implementation sponsor in consultation with Conservancy, DWR and CNRA will at least once every 10 years conduct a review to update and refine, if necessary, the strategy based on current scientific information. The implementation sponsor may use various data sources to inform the update, including, but not limited to, recent scientific literature, technical reports or studies, and guidance from regulatory agencies. The review may reconsider the assumptions on which the strategy was built, particularly related to focal species and conservation priorities. The implementation sponsor may present the results of this either as part of a progress report (Section 4.4.1, *Progress Report*) or as a stand-alone document. If the results of this review reveal that fundamental aspects of this RCIS are no longer valid, the implementation sponsor may elect to amend this RCIS to address the changes, as outlined in Section 4.6, *Amending the RCIS*.

There is no requirement to update the LCP. However, the implementation sponsor and its partners may choose to update the LCP components of this RCIS/LCP at the same time as the RCIS components are updated, or at other times during the life of the LCP as warranted by conditions in Yolo County such as climate change.

4.3.2 Assessing Progress

To comply with CFGC 1856(b) for the RCIS, the implementation sponsor will, in coordination with the Conservancy, DWR, CNRA, and CDFW, conduct the following tasks at least once every 10 years or until all mitigation credits created by MCAs in the Strategy Area are used:

- track whether conservation actions and habitat enhancement actions identified in Chapter 3, *Conservation Strategy*, have been implemented;
- evaluate the effectiveness of conservation actions and habitat enhancement actions identified in Chapter 3, *Conservation Strategy*, in
  - offsetting identified threats to focal species and
  - achieving the conservation goals and objectives of the RCIS.

Sponsors of MCAs are required to track the same information for their MCA and report it annually to CDFW and the public (see Section 4.5.1, *Mitigation Credit Agreements*). Therefore, to track the progress of all MCAs in the Strategy Area, the implementation sponsor will simply compile the information provided by MCA sponsors to date. If the RCIS is used by other parties such as state or local agencies (e.g., to inform or evaluate grant applications) or conservation organizations, the RCIS implementation sponsor should contact those parties to determine how the RCIS was used, and the conservation outcomes of that use (if known or monitored). To aid in the data collection, the implementation sponsor may develop a template questionnaire or data form.

There are no requirements for how the progress assessment should be provided to CDFW. The implementation sponsor will work with CDFW to determine an acceptable format for the progress assessment.

4.3.3 Funding for Required RCIS Implementation Tasks

The amount of effort required for the implementation sponsor to conduct the two implementation tasks described above will depend on how much the RCIS/LCP is used voluntarily. For example, if there are multiple MCAs developed, each with several species covered, there could be considerable work needed to assess implementation progress cumulatively across these MCAs. Similarly, if the RCIS is used by numerous local conservation organizations and local and state agencies, then it may take substantial work to obtain this information and compile it to assess RCIS progress. In contrast, if there are no MCAs and little use of the RCIS by others, the implementation tasks will be relatively simple.

Currently, there is no funding source(s) identified for the implementation sponsor to conduct the required implementation tasks. The implementation sponsor would need to secure funding for these tasks during implementation, or partner with other agencies or organizations to conduct the tasks on their behalf.

This strategy assumes that entities pursuing MCAs under the RCIS would fully fund their involvement in, and development of, those MCAs, including the required annual reporting to CDFW and the public. Therefore, the implementation sponsor would bear no financial responsibility for development or monitoring of MCAs (unless the implementation sponsor developed their own MCA).

4.4 Optional RCIS and LCP Implementation Activities

The following subsections describe optional tasks that the implementation sponsor may consider to further support the RCIS and LCP.

4.4.1 Progress Report

The implementation sponsor may prepare an RCIS/LCP implementation progress report. Progress reports may prove useful in communicating the progress made toward achieving the conservation goals and objectives in the RCIS. If prepared, the progress report could include the following.

- An overview of the conservation actions and habitat enhancement actions that the implementation sponsor and implementation committee is aware of, and only those specifically implemented under this RCIS/LCP.
- An assessment of progress in offsetting identified threats to focal species and other conservation elements and in achieving this RCIS/LCP's conservation goals and objectives.
- An evaluation of the effectiveness of conservation actions and habitat enhancement actions in offsetting identified threats to focal species and in achieving the strategy's conservation goals and objectives.

MCA proponents must conduct monitoring of their conservation actions to determine whether they have met performance-based milestones that allow release of mitigation credits. MCA proponents provide these reports to CDFW, who must post them on-line. The implementation committee, if created, can use these public reports, and other data, to assess the progress and effectiveness of conservation actions in the Strategy Area to contribute to the RCIS/LCP conservation goals and objectives.

4.4.2 Implementation Committee

The implementation sponsor may choose to team with other public agencies, organizations, or collaborators to form an RCIS implementation committee to help guide implementation and updates of the Yolo RCIS/LCP, particularly in instances where implementation of this RCIS/LCP would support the missions of these other organizations. Potential implementation committee members may include, but are not limited to, representatives from the following organizations:

- California Department of Water Resources,
- California Natural Resources Agency,
- Yolo County,
- Yolo Habitat Conservancy,
- City of Davis,

- City of Woodland,
- City of West Sacramento,
- City of Winters,
- UC Davis,
- Non-profit organizations based in the Strategy Area or that conduct a substantial amount of conservation work within the Strategy Area,
- other interested jurisdictions, or parties.

The role of the implementation committee would be to periodically assist the implementation sponsor on all aspects of implementation. The implementation committee may also choose to serve as a group to help inform and educate potential RCIS/LCP users of how it can be used and the benefits it provides. The implementation committee will not arbitrate or negotiate mitigation on behalf of project proponents. Such responsibility will remain with the entity pursuing the mitigation and the regulatory agencies.

In summary, the following are potential roles for the implementation committee (this list is not exhaustive).

- Publicize the Yolo RCIS/LCP and its successful implementation to participating agencies and other entities that may use this RCIS/LCP to inform conservation actions and habitat enhancement actions in the Strategy Area.
- Answer questions from users and potential users of the Yolo RCIS/LCP.
- Develop guidance, as needed, to clarify and refine components of the Yolo RCIS/LCP.
- Assist with preparation of the progress report, or other documents for CDFW, as needed, documenting the implementation of the RCIS and MCAs, as appropriate.
- Support the implementation sponsor in undertaking periodic updates of the RCIS (at least every 10 years) based on significant new information on the focal species and their conservation.

If established, the implementation committee should meet periodically (e.g., annually) to review how the Yolo RCIS/LCP is being utilized, and to assess whether information updates or an amendment is needed.

4.4.3 Public Meeting

The implementation sponsor or one of its partners may host periodic public meetings to update the general public on the progress and challenges with RCIS and LCP implementation. The meeting is an opportunity to update the public on any changes the implementation sponsor has made to the RCIS/LCP, including the addition of any new information. The implementation sponsor may organize this meeting to coincide with the release of any progress reports (discussed below). The implementation sponsor would develop the agenda for the meeting in cooperation with the advisory committee (below) to ensure the general public an opportunity to discuss key issues related to implementation.

4.4.4 Public Advisory Committee

The implementation committee may form a Public Advisory Committee to discuss technical issues, and lessons learned, as well as make recommendations to the implementation committee or implementation sponsor for improvements to the process. The Advisory Committee could include conservation scientists, species experts with knowledge of the Strategy Area, and other interested parties, and stakeholders, such as climate scientists, representatives from the environmental community, development community, agricultural community, private landowner community, mitigation banking community, or other specialists who can knowledgably inform the implementation of the RCIS/LCP. Resource agencies and local jurisdictions may send representatives to advisory committee meetings who have appropriate technical expertise. At a minimum, the Advisory Committee would meet once a year. Additional meetings would be scheduled if needed. The responsibilities of the Advisory Committee could include the following:

- Review any new information and progress in implementation.
- Monitor progress toward achieving the conservation goals and objectives.
- Evaluate and make recommendations to the implementation committee concerning the effectiveness of the RCIS/LCP and its implementation.
- Recommend key issues to discuss during the public meeting.

4.5 Regulatory Uses of the RCIS

4.5.1 Mitigation Credit Agreements

An important benefit of the RCIS component of the RCIS/LCP is that, once it is approved by CDFW, it allows anyone to create an MCA within the Strategy Area. A landowner, private entity, nonprofit organization, or state or local public agency may apply to CDFW for an MCA to create mitigation credits for use or sale, consistent with the conservation goals and objectives of this RCIS/LCP. An MCA identifies the type and number of credits a person or entity proposes to create by implementing one or more conservation actions or habitat enhancement actions, as well as the terms and conditions under which project proponents may use those credits. Typically, credits by project proponents to meet compensatory mitigation obligations for impacts on aquatic resources or special-status species. Applicants for an MCA are called an *MCA sponsor*[14]. The MCA sponsor must prepare MCAs according to the requirements of CFGC 1856 and any mandated elements of the Program Guidelines (California Department of Fish and Wildlife 2017).

An MCA helps establish advance mitigation and can provide a number of significant benefits, particularly for agencies or entities with predictable long-term mitigation needs. An MCA can provide the following benefits.

[14] The MCA sponsor is the entity who will design and implement the proposed conservation actions or enhancement actions that generate the mitigation credits. The MCA sponsor can be the landowner on which those actions will occur, a third party, or both.

- The MCA sponsor can set aside or purchase lands, when doing so is most cost effective, knowing those lands will provide useful mitigation values in the future (e.g., credit revenue, mitigation offsets for future project impacts).
- Mitigation credits can be pooled across large sites or multiple sites, providing economies of scale to deliver mitigation more efficiently across many projects.
- An MCA provides certainty and predictability to the MCA sponsor for the future costs of project mitigation under state laws.
- An MCA gives CDFW and other resources agencies some assurance that proposed mitigation fits within a larger conservation framework (the RCIS) and that investments in resource protection, restoration, and enhancement collectively contribute to meeting regional conservation goals and objectives.

A person or entity, including a state or local agency, with mitigation needs may choose to enter into an MCA with CDFW for one mitigation site, one large mitigation site with multiple phases, several mitigation sites, or even a specific region (e.g., watershed boundary or municipality) within the Strategy Area. As described below, once mitigation credits are established, project proponents with compensatory mitigation needs may purchase these credits from the MCA sponsor. Alternatively, the MCA sponsor may use the credits for their own compensatory mitigation needs.

An MCA is designed primarily to address the mitigation needs of project proponents under California laws such as the California Endangered Species Act, Native Plant Protection Act, or California Environmental Quality Act. However, MCA sponsors may design and create mitigation credits to meet the mitigation requirements associated with federal environmental laws and regulations with the approval of applicable federal regulatory agencies.

4.5.1.1 Developing Mitigation Credit Agreements

MCAs identify the types and amounts of mitigation credits that implementation of conservation actions and habitat enhancement actions will create and provide a schedule for their release based on relevant implementation milestones (e.g., land protection, restoration goal achievement). These implementation milestones are established by the MCA sponsor and approved by CDFW. MCA sponsors can establish mitigation credits for any conservation action or habitat enhancement action that contributes to the achievement of conservation goals and objectives outlined in this Yolo RCIS/LCP. CDFW must approve the release of all credits after the MCA sponsor meets performance-based milestones established by the MCA.

Typically, applicants will establish mitigation credits by undertaking the following types of conservation actions and habitat enhancement actions.

- Permanent acquisition of land development rights and protection of land in perpetuity (purchase in fee title, purchase and/or placement of a permanent conservation easement).
- Restoration of resources that create new or increases existing habitat function for a focal species or other species for which the Yolo RCIS/LCP analyzes conservation need.
- Enhancement of focal species or conservation species, habitat conditions, or habitat connectivity.

An MCA developed under the Yolo RCIS/LCP must also be consistent with any previously approved or amended RCIS, the Yolo HCP/NCCP, a state or federal recovery plan, or other state or federal approved conservation strategy that overlaps with the Strategy Area (Section 2.12, *Regional Conservation Planning Environment*). An MCA must also take into account any approved mitigation bank and available mitigation credits at these banks in the RCIS area (Section 2.12.6, *Mitigation and Conservation Banks*). The MCA must explain how available mitigation credits at approved banks will be purchased or used in combination with the MCA mitigation credits. If the applicant will not purchase or use available bank credits, an MCA must explain why. The CDFW website is expected to be updated to provide more information on the MCA development and approval process for the RCIS program[15].

By law, an MCA developed under the Yolo RCIS/LCP must occur within the Strategy Area. The MCA will describe the *service area* of the mitigation credits that will be created. The service area is the area in which projects with compensatory mitigation needs can use or purchase the mitigation credits created and released under the MCA. The service area of an MCA under this RCIS/LCP must occur entirely within the Strategy Area. However, if another RCIS occurs adjacent to this RCIS, CDFW has indicated that an MCA could be developed that has an *extended service area* that spans both RCIS strategy areas, as long as the two RCISs and the MCA meet certain criteria described below.

As of the preparation of this RCIS/LCP, the only adjoining RCIS is being developed in eastern Colusa and western Sutter County by the California Department of Water Resources, Reclamation District 108 (RD108), and other stakeholders. This RCIS, called the Mid and Upper Sacramento River RCIS, borders the Yolo RCIS/LCP in northeastern Yolo County. The Mid and Upper Sacramento River RCIS is expected to have several focal species in common with the Yolo RCIS/LCP, which provides an opportunity—subject to applicable legal requirements—to create mitigation credits in either RCIS and that could potentially be used or sold to projects in both RCISs.

According to an informal opinion expressed by CDFW[16], an MCA service area can extend into an adjacent RCIS as long as:

- The RCISs are adjacent (i.e., share the same boundary) and approved;
- the conservation goals and objectives in the two RCISs are essentially the same or compatible with respect to the extended service area of the MCA for the applicable species;
- the MCA sponsor provides and CDFW approves an ecological justification that the proposed extended service area is based on sound ecological principles and geographic appropriateness including the range and key habitat features of the MCA covered focal species or other conservation elements (e.g., specific vegetation community, vegetation structure, soil type, hydrologic regime, ecosystem process, or other features); and
- the applicants for both RCISs consent in writing to the extension of the MCA service area over both RCISs; and
- the MCA is approved in advance by the Implementation Sponsor of any local HCP/NCCP(s) with a plan area that includes the proposed MCA site, as discussed in the following section.

[15] https://www.wildlife.ca.gov/Conservation/Planning/Regional-Conservation

[16] CDFW provided these criteria to ICF verbally on July 27, 2017. This or similar language is expected to be included in the upcoming MCA Guidelines that CDFW will release, possibly after the completion of this RCIS/LCP.

4.5.1.2 Mitigation Credit Agreements and the Yolo HCP/NCCP

MCA sponsors who wish to create mitigation credits are required by CFGC 1856(j) to avoid duplicating or replacing the mitigation requirements in any approved NCCP in the RCIS Strategy Area. To ensure this, MCA sponsors seeking to create mitigation credits must obtain the advance written approval of the NCCP's implementing entity prior to approval of those credits by CDFW (the Yolo HCP/NCCP implementing entity is the Conservancy).

Once approved, the Yolo HCP/NCCP will require through local ordinances that all projects and activities covered by that plan pay fees or provide other types of equivalent mitigation. To ensure the financial integrity of NCCPs, CFGC 1856(j) also requires that mitigation credits created by an MCA can only be used for covered activities under the approved NCCP only in accordance with the requirements of that NCCP. Also as required by CFGC 1856(j), a project proponent that is eligible for coverage under the Yolo HCP/NCCP as a special participating entity[17] may use mitigation credits created through an MCA under the Yolo RCIS/LCP only if the Conservancy declines to extend coverage under the HCP/NCCP to the project proposed by that eligible individual or entity.

4.5.2 Conservation or Mitigation Banks

An important potential use of this RCIS/LCP is by conservation or mitigation bankers who wish to establish a bank in the Strategy Area. A conservation or mitigation bank is privately- or publicly-owned land that is managed for its natural resource values, with an emphasis on a target resource such as a listed species or important natural community. Conservation banks may include restoration projects, but they focus more heavily on the protection and management of occupied habitats of the target species. In exchange for permanently protecting and managing the land—and in the case of mitigation banks, restoring or creating natural resources—the bank operator is allowed to sell credits to project proponents who need to satisfy legal requirements for compensating environmental impacts of development projects.

The goals of private mitigation banks are often compatible with and support regional conservation strategies such as the Yolo RCIS/LCP. (See Section 2.12.6, *Mitigation and Conservation Banks*, for information on the conservation and mitigation banks with available credits whose service area overlaps the Strategy Area.) Therefore, individuals interested in establishing conservation or mitigation banks in the Strategy Area are encouraged to review the conservation goals and objectives and priority conservation actions described in Chapter 3, *Conservation Strategy*. This information is intended to provide guidance for future mitigation and conservation banks in Yolo County.

Private parties wishing to develop and establish a new mitigation or conservation bank in the Strategy Area should also consult guidance and instructions provided by CDFW and the U.S. Fish and Wildlife Service.[18]

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[17] See Yolo HCP/NCCP Chapter 7 for description of special participating entities, which are the same as "participating species entities" in CFGC 1856(j).

[18] For additional information on banking see the following websites: <www.dfg.ca.gov/hcpb/conplan/mitbank/mitbank.shtml> and <www.fws.gov/sacramento/es/cons_bank.htm>.

4.5.3 In-Lieu Fee Programs

In-lieu fee programs are identified by 33 Code of Federal Regulations (CFR) 332, Compensatory Mitigation for Losses of Aquatic Resources (also known as the Mitigation Rule), as a preferred approach to meeting compensatory mitigation needs for adverse effects on waters of the United States, second to mitigation banks. As defined in 33 CFR 332.2, an in-lieu fee program involves:

> ". . . the restoration, establishment, enhancement, and/or preservation of aquatic resources through funds paid to a governmental or non-profit natural resources management entity to satisfy compensatory mitigation requirements for DA [Department of the Army] permits. Similar to a mitigation bank, an in-lieu fee program sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the in-lieu program sponsor. However, the rules governing the operation and use of in-lieu fee programs are somewhat different from the rules governing operation and use of mitigation banks. The operation and use of an in-lieu fee program are governed by an in-lieu fee program instrument."

The National Fish and Wildlife Foundation's (NFWF) Sacramento District operates an in-lieu fee program that provides mitigation credits for impacts to aquatic species and habitats covered under the Clean Water Act, Rivers and Harbor Act, Porter-Cologne Water Quality Control Act, and Endangered Species Act. The operational area for the in-lieu fee program mirrors the U.S. Army Corps Sacramento District's jurisdictional boundary in California, covering the Central Valley, the Sierra Nevada Mountains, and the northeastern corner of the state. The NFWF offers two categories of mitigation credits, vernal pool credits for impacts to vernal pool wetlands in 12 vernal pool service areas, and aquatic resource credits for impacts to wetlands, other waters of the U.S., waters of the state and aquatic species. Watershed boundaries divide the aquatic resource areas to capture the headwaters and floodplains associated with the major river systems in the Central Valley. The Cache/Putah aquatic resource service area entirely overlaps Yolo County. The Solano-Colusa vernal pool service area overlaps the central portion of Yolo County, excluding both the eastern and western edges. The NFWF in-lieu fee program is approved for use by the regulatory agencies that govern the environmental acts described above (National Fish and Wildlife Foundation 2017).

4.6 Amending the RCIS

Under current state law, CDFW may extend the duration of an approved or amended RCIS for additional periods of up to 10 years upon finding that the Yolo RCIS/LCP is updated with new scientific information and that the RCIS continues to meet the requirements of CFGC 1852.

Additionally, CDFW may amend the RCIS through the amendment process described in CFGC 1854 (a), which states, "For purposes of this section, an amended strategy means a complete regional conservation investment strategy prepared by a public agency to amend substantially and to replace an approved strategy submitted by the public agency."

The process and timelines for amending an existing RCIS are the same as for developing a new RCIS, including requirements for public outreach and CDFW review and approval. An RCIS may be amended for a variety of reasons, which may include one or more of the following.

- Changing the RCIS area.
- Adding or removing focal species.
- Substantially changing the conservation goals and objectives of focal species.

- Substantial advancement in the best available science on which the conservation goals and objectives are based (e.g., climate change projections).

4.7 Conservation Partners

The Yolo RCIS/LCP provides a framework for identifying regional conservation priorities and actions for focal species and other conservation elements within the Strategy Area. The conservation goals and objectives are designed to be broad-based yet comprehensive in identifying those actions necessary to ensure the long-term conservation of the focal species and conservation species addressed by this RCIS/LCP. While centered on focal species, this RCIS also addresses other key conservation elements including habitat connectivity and wildlife linkages, working landscapes, natural communities, and conservation species in the Strategy Area. As such, a combination of conservation investments, conservation actions, and compensatory mitigation completed outside of an MCA will likely be needed to achieve this RCIS/LCP's conservation goals and objectives. The RCIS/LCP also anticipates that success in meeting the conservation goals and objectives will require flexibility, creativity, and establishment of partnerships in conservation.

To that end, the Yolo RCIS/LCP encourages agencies and organizations that choose to use the RCIS/LCP to guide their conservation investments to consider partnerships. The needs and goals of other agency or organization partners operating in the Strategy Area may help support more robust and more effective implementation of conservation priorities. The following entities, among others, are currently engaged in conservation activities in the Strategy Area.

- American Rivers
- Audubon California
- Bureau of Land Management
- Cache Creek Conservancy
- California Department of Fish and Wildlife
- California Department of Water Resources
- California Invasive Plant Council
- California Natural Resources Agency
- California Native Plant Society
- California Waterfowl Association
- Center for Land Based Learning
- City of Davis
- City of Woodland
- City of West Sacramento
- City of Winters
- Delta Conservancy
- Lower Putah Creek Coordinating Committee

- National Marine Fisheries Service
- Natural Resources Conservation Service, Wetlands Reserve Program
- Putah Creek Council
- Sierra Club
- The Nature Conservancy
- Tuleyome
- University of California, Davis
- US Fish and Wildlife Service
- Yolo Basin Foundation
- Yolo County
- Yolo County Resource Conservation District
- Yolo Habitat Conservancy

The implementation committee, when and where appropriate, will look for innovative ways to support others taking the lead in making conservation investments and developing MCAs provided that they are consistent with this Yolo RCIS/LCP and would help to achieve the goals and objectives of this RCIS/LCP.

Chapter 5
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Appendix A
Letter to CDFW

Yolo Habitat Conservancy

County of Yolo • City of Davis • City of Winters • City of West Sacramento
City of Woodland • University of California, Davis

February 12, 2018

Charlton H. Bonham, Director
California Department of Fish and Wildlife
1416 Ninth Street
Sacramento, CA 95814

Subject: Draft of Yolo Regional Conservation Investment Strategy/Local Conservation Plan

Dear Mr. Bonham:

In accordance with California Fish and Game Code Section 1852(c)(2), the Yolo Habitat Conservancy requests the California Department of Fish and Wildlife (CDFW) review the Yolo Regional Conservation Investment Strategy (RCIS) for completeness. The 653,549-acre RCIS strategy area comprises all of Yolo County. This area is of statewide importance for conservation, as it supports numerous rare and endangered fish, wildlife, and plant species. This RCIS updates the existing Yolo Local Conservation Plan (LCP) developed by the Yolo Habitat Conservancy from 2014-2016. We are not requesting that CDFW review the portions of the joint RCIS/LCP that are LCP only, but we welcome comments if provided.

The Yolo Habitat Conservation Plan/Natural Community Conservation Plan (Yolo HCP/NCCP), which the Conservancy expects to complete in June 2018, coincides exactly with the strategy area for the Yolo RCIS/LCP. The Yolo HCP/NCCP does not cover all species or natural communities in Yolo County, so the Yolo Habitat Conservancy developed the LCP to encourage additional voluntary, non-regulatory conservation. The Yolo Habitat Conservancy agreed to add the RCIS component to the LCP because it was consistent with existing efforts to develop a countywide conservation plan to complement the Yolo HCP/NCCP. The Yolo RCIS/LCP Steering Committee, consisting of the Yolo Habitat Conservancy, California Department of Water Resources, California Natural Resources Agency, Yolo County, American Rivers, and the Environmental Defense Fund, collaboratively updated the LCP into an RCIS/LCP. By using a science-based approach to identify conservation goals, objectives, and conservation actions for the region, the RCIS/LCP will aid the development of public infrastructure projects and implementation of local conservation goals by helping agencies identify priority conservation actions for compensatory mitigation, including as part of advance mitigation programs. Taken together, we believe the Yolo

HCP/NCCP and Yolo RCIS/LCP provide a comprehensive approach to conserve the biological resources in Yolo County.

On January 22, 2018, the Yolo Habitat Conservancy's Board of Directors authorized submittal of the Yolo RCIS/LCP to CDFW for review and subsequent release for public review and comment. (On January 23, 2018, the Yolo County Board of Supervisors also authorized submittal of the Yolo RCIS/LCP to CDFW.) In the same action, the Board of Directors approved provisionally identifying the Yolo Habitat Conservancy as the RCIS/LCP implementing sponsor. The Yolo Habitat Conservancy has several outstanding concerns regarding this role, but is willing to submit the draft RCIS/LCP to CDFW with the understanding these issues will be addressed to Yolo Habitat Conservancy's satisfaction prior to approval and submittal of the final Yolo RCIS/LCP. The remaining outstanding items are:

- Implementing sponsor. The Steering Committee has not formally identified an implementation sponsor. The Steering Committee has requested that the Yolo Habitat Conservancy provisionally accept the role of the Yolo RCIS/LCP implementing sponsor. The Yolo Habitat Conservancy does not wish to commit to serving in this capacity unless there is funding for implementation and agreement on the implementation responsibilities. The Yolo Habitat Conservancy will therefore wait to formally accept this role until the final Yolo RCIS/LCP and until funding for implementation is identified. Yolo Habitat Conservancy staff have suggested that MCA sponsors in the strategy area pay a fee to fund this work, a proposal that the Steering Committee is considering.

- Implementation costs. Yolo Habitat Conservancy staff believe that even a rough high and low cost estimate is important to include in the RCIS/LCP to provide the public and the Yolo Habitat Conservancy with an understanding of the potential magnitude of the work to implement the plan. Until these responsibilities are more clearly defined, it is impossible to estimate these costs.

- Public meetings and annual reports. Yolo Habitat Conservancy staff believe public meetings and annual reports are necessary to ensure accountability and transparency regarding the implementation of the Yolo RCIS/LCP, as well as other activities to ensure MCAs are coordinated and local agencies are aware of implementation efforts.

- Local coordination/review/approval of Mitigation Credit Agreements (MCAs). The Yolo Habitat Conservancy and Yolo County want to ensure they are part of the MCA review process: Yolo Habitat Conservancy as the RCIS/LCP implementing sponsor and Yolo HCP/NCCP implementing entity, and Yolo County as the land use authority in which most of the conservation is likely to occur. The language in the RCIS enabling statute related to MCA approval is as follows:

    > *The creation of mitigation credits pursuant to this section from a conservation action or habitat enhancement action, implemented within the plan area of an approved natural community conservation plan, shall not duplicate or replace mitigation requirements set forth in the natural community conservation plan and shall require the advance written approval of the plan's implementing entity.*

The Yolo Habitat Conservancy wants to see a process in place to ensure MCAs are consistent with the statute in this manner.

The Yolo Habitat Conservancy appreciates CDFW's efforts to review and approve this conservation strategy. We look forward to receiving your comments within the next 30 days. If you have questions, please contact Petrea Marchand at 916-505-7191 or petrea@yolohabitatconservancy.org.

Sincerely,

Petrea Marchand
Executive Director, Yolo Habitat Conservancy

March 19, 2018

Charlton Bonham
Director
California Department of Fish and Wildlife
1416 Ninth Street
Sacramento, CA 95814

Regarding: The Yolo Regional Conservation Investment Strategy / Local Conservation Plan.

Dear Director Bonham:

In accordance with California Fish and Game Code Section 1852(a), the California Natural Resources Agency (CNRA) requests that the California Department of Fish and Wildlife approve the Yolo Regional Conservation Investment Strategy / Local Conservation Plan (Yolo RCIS/LCP). The proposed Yolo RCIS/LCP encompasses all of Yolo County and has been developed by a collaborative group of state and local public agencies, non-profit organizations, and other stakeholders through a steering committee to help achieve improved conservation and public infrastructure outcomes in the County. CNRA and the California Department of Water Resources (DWR) believe that a successfully implemented Yolo RCIS/LCP could significantly further the State's regional conservation objectives and public infrastructure goals by facilitating meaningful stakeholder engagement, by creating a common vision for regional landscape-level and species-specific conservation, and by empowering and incentivizing the design of public infrastructure projects that produce significant and measurable conservation uplift.

The Yolo RCIS/LCP has been developed in partnership with Yolo County and the Yolo Habitat Conservancy and is consistent with and complements the Yolo Habitat Conservation Plan / Natural Community Conservation Plan (Yolo HCP/NCCP), in accordance with Fish and Game Code Section 1852(c)(10-11). The previously unfinished Yolo Local Conservation Plan – originally intended to complement the Yolo HCP/NCCP – served as a foundation for development of the Yolo RCIS/LCP. The State's 2017 Central Valley Flood Protection Plan and its corresponding Conservation Strategy also contributed significantly to the Yolo RCIS/LCP by incorporating the State's vision for both flood risk reduction infrastructure investments and habitat conservation priorities as part of multi-benefit projects. The Yolo RCIS/LCP also incorporates and seeks to further other State conservation and restoration goals and objectives, such as the EcoRestore initiative.

In accordance with California Streets and Highways Code Section 800.6(j), CNRA is requesting approval of the Yolo RCIS/LCP in part to facilitate mitigation for water infrastructure projects, including but not limited to flood risk reduction projects and fishery conservation projects. As such, the Yolo RCIS/LCP, if approved by the California Department of Fish and Wildlife, shall not count against the limit on the number of regional conservation investment strategies set in Section 1861 of the California Fish and Game Code.

Sincerely,

Kristopher Tjernell
Special Assistant for Water Policy
California Natural Resources Agency

Appendix B

Public Outreach

RECEIVED
AUG 1 5 2017
YOLO COUNTY
CLERK/RECORDER

NOTICE OF INTENT TO PREPARE YOLO REGIONAL CONSERVATION INVESTMENT STRATEGY/LOCAL CONSERVATION PLAN and NOTICE OF PUBLIC MEETING ABOUT YOLO REGIONAL CONSERVATION INVESTMENT STRATEGY/LOCAL CONSERVATION PLAN

Published August 15, 2017

Description of Proposed Regional Conservation Investment Strategy: A steering committee including the California Natural Resources Agency, Yolo County, the Yolo Habitat Conservancy, the Department of Water Resources, and other stakeholders is preparing a Regional Conservation Investment Strategy (RCIS) for Yolo County. Regional Conservation Investment Strategies are new, voluntary, landscape-scale conservation planning tools that will identify conservation priorities to guide public and private conservation actions and investment, such as habitat restoration and protection. Guided by state legislation signed by the Governor in 2016 (AB 2087). If the Yolo RCIS is approved by the California Department of Fish and Wildlife (Department) in 2018, conservation actions identified in the RCIS could be used by state or local agencies to develop mitigation credit agreements with the Department for water, transportation, and other projects not already covered by the Yolo Habitat Conservation Plan/Natural Community Conservation Plan (Yolo HCP/NCCP). The Yolo RCIS is part of a broader effort to implement regional advanced mitigation planning in the state to facilitate landscape-scale conservation and improve the delivery of water, transportation, and other public infrastructure projects.

The Yolo Habitat Conservancy is leading an effort in coordination with local stakeholders to develop a voluntary Local Conservation Plan (LCP) for the purpose of addressing conservation needs not addressed in the Yolo HCP/NCCP, which is currently out for public review (https://www.yolohabitatconservancy.org/documents).

Due to the overlap between the two conservation planning efforts, the involved parties have decided to combine the RCIS and LCP into a single document, the Yolo RCIS/LCP.

The Yolo RCIS/LCP:

- Is a voluntary, non-binding assessment of conservation priorities;
- Is being developed based on existing plans and other information, including the *Yolo HCP/NCCP* and the *Central Valley Flood Protection Plan*, among others;
- Is designed to be compatible with efforts to maintain and further conservation actions that support agricultural sustainability in coordination with willing landowners;

- Is designed to be compatible with efforts to maintain and further conservation actions that support agricultural sustainability in coordination with willing landowners;
- Coordinates various types of conservation investments, such as:
    - local, state, and federal government conservation projects;
    - private foundation and conservation organization (e.g. land trust) projects;
    - mitigation projects by private entities and public agencies;
- Considers the focal species listed in Table 1, below. For the LCP component, it also addresses multiple "conservation species" to be prioritized for conservation;
- Considers sensitive habitats, and addresses working lands, proposed infrastructure, and development projects;
- Is designed to be consistent with and complement the Yolo HCP/NCCP, a regional HCP/NCCP that covers Yolo County;
- Is being developed by a Steering Committee consisting of the California Resources Agency, the California Department of Water Resources, Yolo County, Yolo Habitat Conservancy, and partner organizations and agencies and with the assistance of a consultant team, through a planning process providing opportunities for public input; and
- Will be submitted to the California Department of Fish and Wildlife for their review and approval for the purposes of the RCIS portion of the document.

Table 1. Proposed Focal Species for Yolo RCIS/LCP

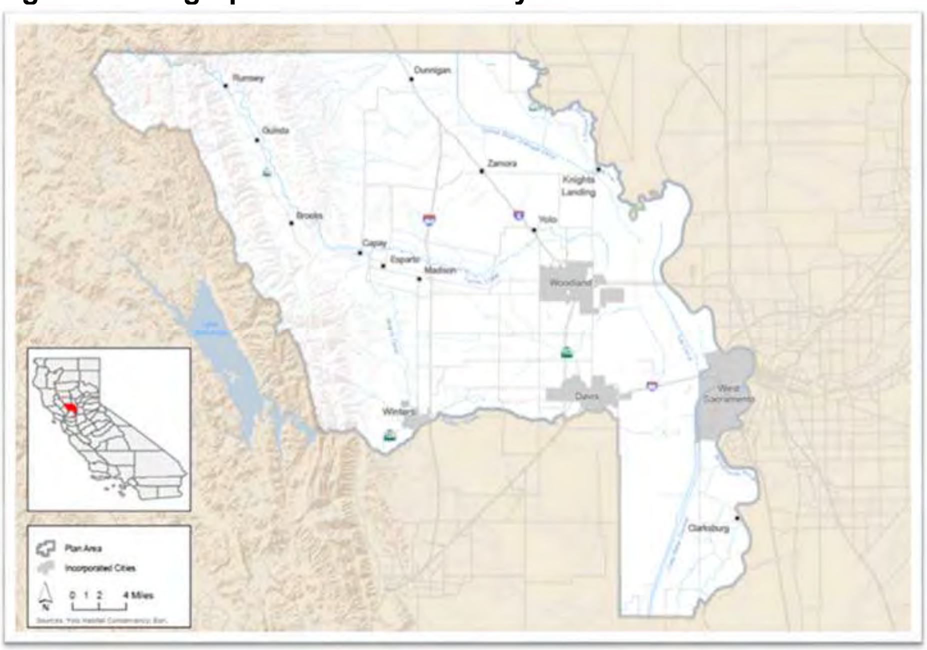
Common Name	*Scientific Name*	*Status (Federal/State/CNPS)*[a]
Plants		
alkali milk-vetch	*Astragalus tener* var. *tener*	-/-/1B
brittlescale	*Atriplex depressa*	-/-/1B
San Joaquin spearscale	*Atriplex joaquiniana*	-/-/1B
Heckard's pepper-grass	*Lepidium latipes* var. *heckardii*	-/-/1B
Baker's navarretia	*Navarretia leucocephala* ssp. *bakeri*	-/-/1B
Colusa grass	*Neostapfia colusana*	T/E/1B
Solano grass	*Tuctoria mucronata*	E/E/1B
Invertebrates		
Conservancy fairy shrimp	*Branchinecta conservatio*	E/-/-
vernal pool fairy shrimp	*Branchinecta lynchi*	T/-/-
midvalley fairy shrimp	*Branchinecta mesovallensis*	-/-/-
California linderiella	*Linderiella occidentalis*	-/-/-
Vernal pool tadpole shrimp	*Lepidurus packardi*	E/-/-
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	T/-/-
Fish		
white sturgeon	*Acipenser transmontanus*	-/-/-
green sturgeon	*Acipenser medirostris*	T/CSC/-
delta smelt	*Hypomesus transpacificus*	T/E/-

Common Name	*Scientific Name*	*Status (Federal/State/CNPS)[a]*
Central Valley steelhead	*Oncorhynchus mykiss*	T/CSC/-
Sacramento River winter-run Chinook salmon	*Oncorhynchus tshawytscha*	E/T/-
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	T/T/-
Central Valley fall- and late fall-run Chinook salmon	*Oncorhynchus tshawytscha*	-/CSC/-
Sacramento splittail	*Pogonichthys macrolepidotus*	-/CSC/-
Amphibians		
California tiger salamander	*Ambystoma californiense*	T/T/-
foothill yellow-legged frog	*Rana boylii*	-/CSC/-
western spadefoot	*Spea hammondii*	-/CSC/-
Reptiles		
western pond turtle	*Actinemys marmorata*	-/CSC/-
giant garter snake	*Thamnophis gigas*	T/T/-
Birds		
tricolored blackbird	*Agelaius tricolor*	-/T/-
grasshopper sparrow	*Ammodramus savannarum*	-/CSC/-
western burrowing owl	*Athene cunicularia hypugaea*	-/CSC/-
Swainson's hawk	*Buteo swaisonii*	-/T/-
greater sandhill crane	*Grus canadensis tabida*	-/T, FP/-
northern harrier	*Circus cyaneus*	-/CSC/-
black tern	*Chlidonias niger*	-/CSC/-
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	T/E/-
white-tailed kite	*Elanus leucurus*	-/FP/-
California black rail	*Laterallus jamaicensis coturniculus*	-/T, FP/-
loggerhead shrike	*Lanius ludovicianus*	-/CSC/-
yellow-breasted chat	*Icteria virens*	-/CSC/-
bank swallow	*Riparia riparia*	-/T/-
least Bell's vireo	*Vireo bellii pusillus*	E/E/-
Mammals		
Townsend's big-eared bat	*Corynorhinus townsendii*	-/CSC/-
Notes: a. Status: C = Candidate for listing under the FESA E = Listed as endangered under the FESA or CESA PT = Proposed as threatened under the FESA T = Listed as threatened under the FESA or CESA b. Formerly Cordylanthus palmatus.	FP = Fully Protected under California Fish and Game Code CSC = California Species of Special Concern - = No designation CESA = California Endangered Species Act FESA = Federal Endangered Species Act 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere 2B: Plants Rare, Threatened, or Endangered in California, But More Common Elsewhere 3: Plants About Which More Information is Needed - A Review List 4: Plants of Limited Distribution - A Watch List	

Once finalized, the RCIS aspect of the Yolo RCIS/LCP can help expedite delivery of public infrastructure projects by facilitating regional advance mitigation planning: a process in which the environmental mitigation for impacts from multiple projects is pooled and conducted in advance, resulting in larger conservation projects that have greater benefits, while expediting delivery of public infrastructure projects such as transportation or water supply projects and minimizing impacts on agriculture and other land uses. Conservation goals and objectives and conservation priorities described in the Yolo RCIS/LCP will guide and coordinate future conservation actions throughout Yolo County.

Location: The geographic area covered by the Yolo RCIS/LCP includes all of Yolo County (Figure 1)

Figure 1. Geographic Area Covered by the Yolo RCIS/LCP



Public Meeting: Pursuant to Fish and Game Code section 1854(c)(3), the Yolo Habitat Conservancy will hold a public meeting to provide information about the Yolo RCIS/LCP and to give the public an opportunity to provide written and oral comments for consideration in its development. Interested parties are invited to attend.

Meeting Date and Time: September 14, 2017, 5:30 to 7:00 PM

Meeting Location: Yolo County Department of Community Services, Cache Creek Conference Room (292 West Beamer Street, Woodland, CA 95695)

Contact Person: Chris Alford, Yolo Habitat Conservancy Deputy Director
Address: 611 North Street, Woodland, CA 95695
Phone: 530-723-5504
Email: chris@yolohabitatconservancy.org

* * *

Yolo Regional Conservation Investment Strategy / Local Conservation Plan

Public Meeting, September 14, 2017

Public Comments

Name/Organization (Optional):
DON SCHATZEL WEST SAC TRAIL RIDERS

Questions/Comments on the Content of the Presentation: Were there items that were unclear? Did any topics need more explanation? We would like feedback to inform future outreach.

HOW WOULD IT ACTUALLY WORK?

ACRONYMS HARD TO FOLLOW FOR NON PLANNERS.

Suggestions for Public Outreach/Engagement: How should the public best be informed about the development of the Yolo RCIS/LCP? HAVE MEETINGS IN EACH COMMUNITY.

Additional feedback about the Yolo RCIS/LCP: How do you foresee the RCIS/LCP being applicable to your interest/organization? What would you expect to see in a regional conservation document, such as an RCIS/LCP? EQUESTRIAN USE SEEMS TO BE COMPLETELY CONSISTANT WITH THIS REPORT.

How did you hear about the public meeting?
W SAC NEWSLETTER - PAPER

We welcome written comments on the material presented in this meeting by November 3, 2017 to:
Yolo Habitat Conservancy, Attn: Yolo Habitat Conservancy, 611 North Street, Woodland, CA 95695;
OR **info@yolohabitatconservancy.org**

DELTA PROTECTION COMMISSION
2101 Stone Blvd., Suite 210
West Sacramento, CA 95691
(916) 375-4800 / FAX (916) 376-3962
www.delta.ca.gov

September 14, 2017

Chris Alford
Deputy Director
Yolo Habitat Conservancy
611 North Street
Woodland, CA 95695

Re: Notice of Intent to Prepare Yolo Regional Conservation Investment Strategy/Local Conservation Plan (SCH# 2017082046)

Dear Ms. Alford:

Thank you for providing the Delta Protection Commission (Commission) the opportunity to review the Notice of Intent to Prepare Yolo Regional Conservation Investment Strategy/Local Conservation Plan (Project). The Project encompasses new, voluntary, landscape-scale conservation planning tools that will identify conservation priorities to guide public and private conservation actions and investment.

The Commission is a state agency charged with ensuring orderly, balanced conservation and development of Delta land resources and improved flood protection. The Project is subject to the Commission's land use jurisdiction because it is located in the Primary Zone of the Legal Delta and meets the definition of "development" as described in Public Resources Code Section 29723(a). State law requires local government general plans in the Primary Zone to be consistent with the Commission's Land Use and Resource Management Plan (LURMP). The Commission has found the Yolo County General Plan to be consistent with the LURMP. Local government actions concerning development projects in the Primary Zone can be appealed to the Commission.

We appreciate the Conservancy's efforts to promote agricultural sustainability and comprehensive habitat protection, restoration, and enhancement in Yolo County, which would be located on private as well as public lands. The Commission urges the Conservancy to review the Project for compliance with LURMP policies, particularly those related to conversion of agricultural lands to other uses, acquisition of agricultural conservation easements, protection of natural resources, and compatibility between agricultural and natural habitat uses.

Thank you for the opportunity to provide input. Please contact Blake Roberts, Senior Environmental Planner, at (916) 375-4237 for any questions regarding the comments provided.

Sincerely,

Erik Vink
Executive Director

cc: Oscar Villegas, Yolo County Board of Supervisors and Commission Vice Chair

Appendix C
Species Accounts

Appendix C
Species Accounts

C.1 Alkali Milk-Vetch (*Astragalus tener* var.*tener*)

© Carol W. Witham

C.1.1 Listing Status

Federal: None

State: None

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.2; 1B: Rare, threatened, or endangered in California and elsewhere. 0.2: Fairly endangered in California.

Recovery Plan: Alkali milk-vetch is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005).

C.1.2 Species Description and Life History

Alkali milk-vetch (*Astragalus tener* var. *tener*) is an herbaceous annual plant in the pea family (*Fabaceae*) that has been differentiated from Ferris's milk-vetch (*Astragalus tener* var. *ferrisiae*) based on the morphology of its fruits (Liston 1990, 1992) and grows from 4 to 40 centimeters (cm) (2 to 16 inches) tall. The leaves of alkali milk-vetch are 2 to 9 cm (1 to 3 inches) long, with seven to 17 pinnately compound, well-separated leaflets. Three to 12 pink-purple, pea-like flowers comprise a dense inflorescence.

A protein electrophoresis analysis of two populations, one from Jepson Prairie in Solano County and the other from northern Merced County, found very little genetic differentiation between the populations and high levels of genetic diversity within each population (Liston 1992). This technique uses allozymes or slight alterations in plant proteins as indicators or markers. Because small mutations in the genetic code result in markers that are generally invisible to the forces of natural selection, these allozyme markers are classified as neutral markers. Therefore, because the neutral markers used in the study have not been shown to be correlated with any traits that might provide an adaptive advantage, Liston's results provide no information concerning the extent of local adaptation or other measures of the "genetic health" of the populations and no information regarding the amount of variation for adaptive traits (McKay et al. 2001; McKay and Latta 2002; Latta and McKay 2002; Wayne and Morin 2004).

Based on Liston's crossing study, the species was found to be self-compatible, and the inbreeding coefficients for the two populations were not significantly different from the expected value for a randomly mating population. Therefore, Liston concluded that insect pollinators are responsible for maintaining high levels of outcrossing within the populations. Liston also concluded that the recent neutral marker differentiation might also be attributed to a seed bank, as milk-vetch species are known to produce long-lived seed banks. Liston indicated that the unique morphology of the plant's flower suggested that alkali milk-vetch is pollinated by butterflies, which is rare for a species in the pea family (Liston 1992).

It is not known when or under which environmental conditions germination of alkali milk-vetch seeds occurs (USFWS 2004). Skinner and Pavlik (1994) indicate the flowering period to be March through June. Witham (1990) observed that recruitment increased in a population near the Jepson Prairie Preserve after pipeline construction. Alkali milk-vetch was also observed in an artificially constructed vernal pool near Albrae at a site where no observations had been recorded since 1923 (USFWS 2004). These observations indicate the importance of a long-lived soil seed bank and suggest that viable seed may exist in the soil seed bank in areas where mature plants have not been observed for many years.

C.1.3 Habitat Requirements and Ecology

Very little is known about the ecology of alkali milk-vetch. In the Central Valley, it appears to be restricted to alkaline soils in areas that are, or were historically, subject to flooding and overland flows (Silveira 2000; Witham 2003; Environmental Science Associates [ESA] and Yolo County 2005). In the alkali sink area, this species occurs in areas that were converted to rice fields prior to 1937 and then abandoned.

At the Grasslands Regional Park and Davis Communications Facility site, it is found growing on the floodplains above the upper margins of vernal pools and swales that contain Solano grass (*Tuctoria mucronata*) and Colusa grass (*Neostapfia colusiana*) (ESA and Yolo County 2005). All individuals of the species encountered onsite were located in areas that had been subjected to a prescribed burn and which subsequently flooded briefly in February (ESA and Yolo County 2005). In two subsequent years, the same area burned due to uncontrolled fires and also flooded during the winter, but only a few individuals were detected during the following springs, in contrast to the large population that established after the prescribed burn (J. Gerlach unpublished data). At the California Department of Fish and Wildlife (DFW) Tule Ranch Unit of the Yolo Bypass Wildlife Area, it is found in vernally mesic grasslands associated with alkaline vernal pools (Witham 2003).

Historical occurrences and some recent occurrences have been identified on alkali soil patches within agricultural fields or along railroad rights-of-way and canal banks. It is found near the City of Woodland and along the Willow Slough Bypass in the Plan Area, in areas that were once alkali sinks but which were converted to rice fields and then fallowed for many years or which were converted into a levee system (Andrews 1970; Crampton 1979; Showers 1988, 1996; EIP Associates 1998; Foothill Associates 2002).

The populations southeast of the City of Woodland and north of the City of Davis are in a heavily human-impacted area of what historically was alkaline sink vegetation lying on along both sides of the northern channel of Putah Creek and Willow Slough and above the YoloBasin (U.S. Bureau of Soils 1909a, 1909b; Mann et al*.* 1911). The hydrology, salts, and clay soils that created and maintained the alkaline sink vegetation were deposited when floodwaters from Putah Creek flowed northward from the area near the City of Davis and empted into Willow Slough. That flow was also supplemented when the combined floodwaters of Putah Creek, Cache Creek, and all of the drainages of the Blue Ridge filled the Cache/Putah Basin, drained eastward through a gap in the Plainfield Ridge, and flowed into the Yolo Basin through Willow Slough (Graymer et al. 2002).

Laguna de Santos Callé, as Willow Slough was previously known, was a unique perennial stream (Eliason 1850; Anonymous 1870) that during the dry season originated from a series of pond-like springs approximately 9 miles southwest of Woodland on the eastern edge of the Plainfield Ridge. As the slough approached the area of Merritt, south of Woodland, it transformed into a 2.5-mile-long, gravel bottomed, linear lake, with an average width of 150 feet and a maximum depth of 75 feet. Approximately 1mile east of County Road 103, the stream flowing from the lake branched as it dropped over the edge of the alluvial deposits into the Yolo Basin, where it flowed another 2.5 miles northeastward until it emptied into a tule marsh. Large floods from Cache Creek and Putah Creek have flowed through Willow Slough as recently as 1942, but gravel mining in Cache Creek, dam building on both Cache and Putah Creeks, and the construction of the Willow Slough Bypass have drastically altered the hydrology, salt budgets, and clay deposition patterns in the area of the alkali sink vegetation. Aerial photographs show that all of the alkaline sink vegetation was converted into various kinds of agricultural fields, ditched for drainage (U.S. Department of Agriculture [USDA] 1952) or subsequently developed as the cities expanded.

C.1.4 Species Distribution and Population Trends

C.1.1.1 Distribution

Alkali milk-vetch was widely distributed around the San Francisco Bay region and in the Sacramento and northern San Joaquin Valleys 100 years ago (Barneby 1964), but by 1989, only a few populations remained (Liston 1992). A 2002 survey concluded that 25 of the 65 known occurrences should be considered extirpated (Witham 2002). Sixteen of the known extant occurrences are in the Solano-Colusa Vernal Pool Region of Solano County (Keeler-Wolf et al. 1998), and another five are located in an area between Newman, Merced, and Los Baños in the San Joaquin Vernal Pool Region of Merced County (Silveira 1996 in USFWS 2004; California Natural Diversity Database [CNDDB] 2012).

In the Plan Area, Crampton (1979) noted the presence of this species near Woodland on the Maupin property. A 1990 survey of historical collection sites in Yolo and Solano Counties found six plants at the City of Woodland Preserve and six small populations at the Jepson Prairie Preserve (Witham 1990). Currently, the Yolo County distribution of adult plants of this species includes the City of Woodland Preserve, the Woodland Regional Park site, the Brauner and Maupin properties (near the Road 25 and 103 intersection), the Grasslands Regional Park and Davis Communications Facility site, theTule Ranch Unit of the DFW Yolo Bypass Wildlife Area, and the Willow Slough Bypass (Showers 1996; EIP Associates 1998; Foothill Associates 2002; Witham 2003; ESA 2004a, 2004b; A. Shapiro pers. comm. 2005; University of California Davis Herbarium 2007; Dean 2009; CNDDB 2012).

C.1.1.2 Population Trends

There are no data documenting the population trends of alkali milk-vetch, but some populations in the Plan Area have been extirpated in the last 20 or so years as alkali scalds within agricultural fields have been converted to intensive agriculture. Because some of the recent observations of individuals have been at sites where it was considered extirpated, it appears that those individuals have established from pre-existing long-lived seed banks. An observation by Witham (CNDDB 2012) that recruitment increased in a population near the Jepson Prairie Preserve after pipeline construction appears to confirm the importance of the seed bank.

C.1.5 Threats to the Species

In the Plan Area, development, intensive agriculture, and nonnative invasive plant species are considered to be the primary threats to alkali milk-vetch in its alkali sink and vernal pool complex habitats (ESA and Yolo County 2005; Showers 1996; Witham 2003; Dawson et al. 2007). Threats to vernal pools and playa pools and species in general, including alkali milk-vetch, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005).

Habitat Loss and Fragmentation. Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (USFWS 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (USFWS 2005).

Agricultural Conversion. Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005).

Invasive Species. Perennial pepperweed is the most pervasive nonnative invasive species threat in the clay-bottom vernal pools and surrounding uplands in the Plan Area, and swamp timothy may pose a similar but less severe threat on the pool bottoms and sides (ESA and Yolo County 2005; J. Gerlach unpublished data). Italian ryegrass (*Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone and flood plains of clay-bottom vernal pools and saturated soil and ponding areas of Alkali Sink habitat and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

Altered Hydrology. Human disturbances can alter thehydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005).

C.1.6 Recovery Plan Goals

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) contains the following goals for alkali milk-vetch to be met within the Plan Area in the Solano-Colusa Core Area: protect 95 percent of suitable species habitat in the Davis Communications Annex and 85 percent of suitable species habitat in the Woodland area.

C.1.7 Species Model and Location Data

Geographic Information System (GIS) Map Data Sources. The alkali milk-vetch habitat model is map-based and not modeled and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Helm 2010; Gerlach 2011), and heads-up GIS digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset. Using these datasets, the habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat, as described in Section C.1.3, *Habitat Requirements and Ecology*.

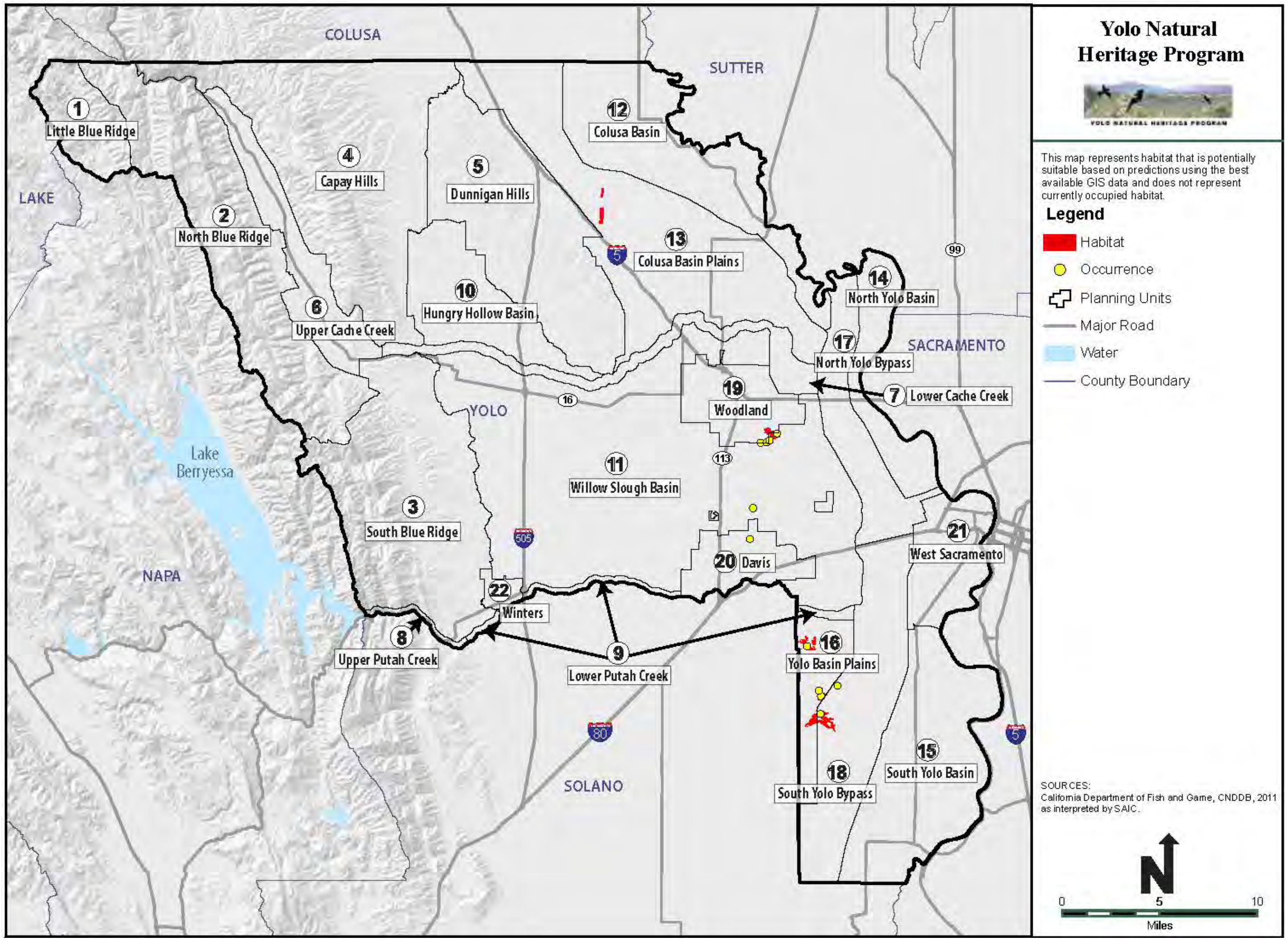
Vegetation types were assigned based on the species requirements as described above and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area (Figure A-1).

Mapped alkali milk-vetch habitat comprises the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site, with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit, based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Figure C-1. Alkali Milk-Vetch Modeled Habitat and Occurrences



Assumptions. Historical and current records of this species in the Plan Area indicate that it was widespread in the Plan Area as recently as the early 1990s on remnant alkali scalds in agricultural fields and on disturbed canal banks in areas with alkaline soils, but its known distribution on natural habitat is limited to the alkali sink habitat, the Grasslands Regional Park and Davis Communications Facility site, and the DFW Tule Ranch Unit (USFWS 2005; CNDDB 2012).

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Personal Communications

Arthur M. Shapiro. Professor of Evolution and Ecology, University of California, Davis. March 2005 – email correspondence.

C.2 Brittlescale (Atriplex depressa)


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C.2.1 Listing Status

Federal: None.

State: None.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.2; 1B: Rare, threatened, or endangered in California and elsewhere. 0.2: Fairly endangered in California.

Recovery Plan: None.

C.2.2 Species Description and Life History

Brittlescale (*Atriplex depressa*) is a grayish, annual herb in the goosefoot family (*Chenopodiaceae*) that grows up to 20 centimeters (8 inches) tall (U.S. Department of Agriculture [USDA] 2004). Its stems grow flat along the ground and may turn upwards near their tips. Its flowers are inconspicuous. The staminate (male) and pistillate (female) flowers are mixed and located within the leaf axils (Preston pers. comm.). Unlike many *Atriplex* species, the densely white-scaly leaves, 4 to 8 millimeters (mm) (0.2 to 0.3 inch) long and ovate to heart-shaped, may be opposite each other. Species of *Atriplex* are most easily identified when the plants are bearing fruit (Taylor and Wilken 1993). The seeds are approximately 1 to 1.5 mm (0.04 to 0.06 inch) in length and are reddish in color (Taylor and Wilken 1993).

This species was cited in Jepson (1925) and in Abrams and Ferris (1960) as a synonym of the Parish's brittlescale (*Atriplex parishii*); but it is treated in the current *Jepson Manual* as a distinct species, where it was separated from Parish's brittlescale by having stems merely glabrous (hairless and smooth) to densely scaly near the tips, versus woolly near the tips in the Parish's brittlescale (Taylor and Wilken 1993). Parish's brittlescale is presumed extinct (Taylor and Wilken 1993). Very little is known about the biology and germination patterns of the species; however, some annual *Atriplex* are known to produce long-lived seed banks that germinate in response to soil disturbances (EDAW 2004; Witham 2005; Witham unpublished data; Dean 2009).

C.2.3 Habitat Requirements and Ecology

Throughout California, brittlescale is found in shadscale scrub, valley grassland, and alkali sink plant communities (Calflora 2005). Brittlescale grows in relatively barren areas with alkaline clay soils within chenopod scrub, meadows, playas, vernal pools, and valley and foothill grassland. Occasionally it is found in riparian marshes. Brittlescale blooms from May through October, depending on local environmental conditions (California Natural Diversity Database [CNDDB] 2012; Munz and Keck 1973). In the Plan Area, brittlescale occurs with palmate-bracted bird's-beak (*Chloropyron palmatum*), San Joaquin spearscale (*Atriplex joaquinana*), saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and smooth tarplant (*Centromadia pungens)* (U.S. Fish and Wildlife Service [USFWS] 1998; CNDDB 2012).

C.2.4 Species Distribution and Population Trends

C.2.4.1 Distribution

Brittlescale is endemic to California (Calflora 2007). The range of brittlescale extends from Kern County in the south to Butte and Glenn Counties in the north and from Alameda County in the west to Madera and Tulare Counties in the east. It has been extirpated from Stanislaus County and has not been reported in Sacramento or San Joaquin Counties (CNPS 2005).

Historically, brittlescale has been collected in the Central Valley from Glenn and Butte Counties south to Fresno County (CNDDB 2012). It has also been collected in the inner North Coast Ranges in Glenn County and in the hills of Alameda and Contra Costa Counties (CNDDB 2012). In the Sacramento and San Joaquin delta, it has been collected in, or adjacent to, salt marshes in Solano County (CNDDB 2012). Brittlescale remains extant at many of these areas.

In the Plan Area, brittlescale is extant on the City of Woodland Preserve, on City Regional Park properties, and on a fallow agricultural field north of Davis (CNDDB 2012; EIP Associates 2003; Foothill Associates 2002; Showers 1996). In 1965, brittlescale was collected along Kentucky Avenue in Woodland and in two other locations east of Woodland; however, these sites no longer support this species (Witham pers. comm.).

According to the CNDDB (2012), brittlescale is found on a range of alkaline or saline soils in the Sacramento Valley and in the inner North Coast Ranges. Suitable saline or alkaline soils occur near springs and seeps in the Blue Ridge and the Capay Hills (Schaal et al. 1994) and may support populations of brittlescale.

C.2.4.2 Population Trends

Taylor and Wilken (1993) state that brittlescale is a rare species. However, data related to population trends of the species is lacking. According to the CNPS (2005), occurrences of brittlescale in California are limited and the species is at risk throughout its range.

C.2.5 Threats to the Species

Intensive agriculture, development, and invasive species are the primary threats. The creation of waterfowl habitat may also lead to habitat losses (CNDDB 2012; CNPS 2005; Showers 1996).

C.2.6 Species Model and Location Data

Geographic Information System (GIS) Map and Model Data Sources. Brittlescale habitat is comprised of map- and model-based components. The mapped component includes vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (Environmental Science Associates [ESA] and Yolo County 2005; Helm 2010; Gerlach 2011), heads-up digitization of the California Department of Fish and Wildlife (DFW) Tule Ranch Unit, and the alkali sink habitat in the Yolo NHP vegetation dataset. Modeled brittlescale salt spring habitat is based on known salt spring point localities (Schaal et al. 1994) and U.S. Geological Survey (USGS) data for springs on the appropriate geological formations (USGS 2007). Using these datasets, brittlescale habitat was determined according to the data layer vegetation/land cover types that support its habitat requirements as described in Section C.2.3, *Habitat Requirements and Ecology*. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area (Figure A-2).

Mapped and modeled brittlescale habitat is comprised of the following vegetation types.

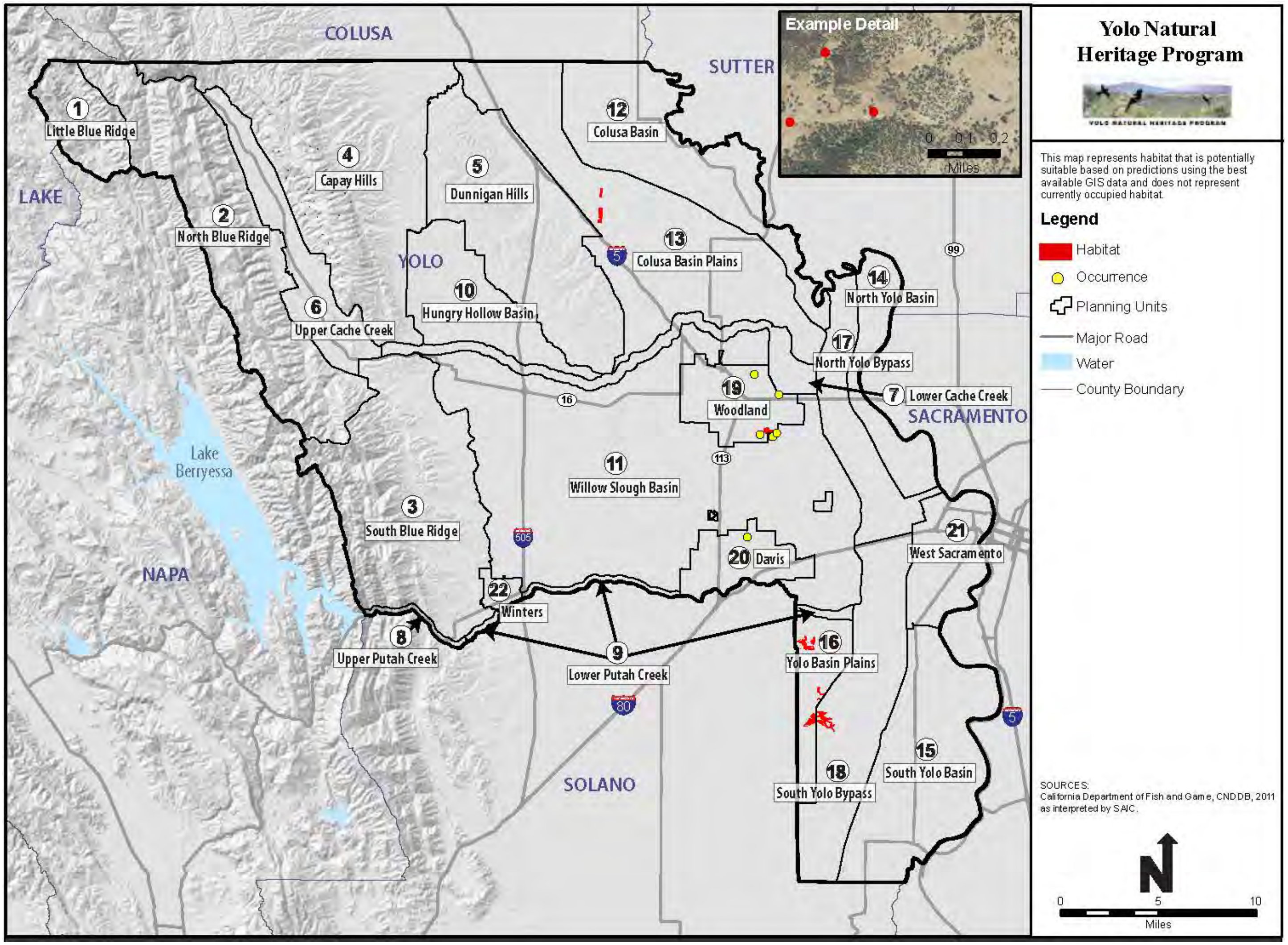
Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Salt Spring Habitat: Salt spring habitat was modeled using two methods. Point localities reported by in Schaal et al. (1994) in the Capay Hills were included with the addition of a 50 foot buffer. Other mapped springs (USGS National Hydrography Dataset [NHD] 2007) located in the Blue Ridge and Capay Hills were considered to be potential salt springs based on their underlying geologic formations. These potential salt spring locations were incorporated with the addition of a 50-foot buffer.

Assumptions. Historical and current records of this species in the Plan Area indicate that it was more widespread in the Plan Area as recently as the early 1990s on remnant alkali scalds, in agricultural fields, and along ditches, but that its known distribution on natural habitat in the Plan Area is limited to the alkali sink habitat.

Figure C-2. Brittlescale Modeled Habitat and Occurrences



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Carol Witham. President, California Native Plant Society. December 28, 2004 – email correspondence.

C.3 San Joaquin Spearscale (*Atriplex joaquinana*)

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C.3.1 Listing Status

Federal: None.

State: None.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.2; 1B: Rare, threatened, or endangered in California and elsewhere. 0.2: Fairly endangered in California.

Recovery Plan: None.

C.3.2 Species Description and Life History

San Joaquin spearscale was first described in 1904 by A. Nelson (Nelson 1904). San Joaquin spearscale (*Atriplex joaquinana*) is an herbaceous annual plant in the goosefoot family (*Chenopodiaceae*) (Taylor and Wilken 1993) that grows from 10 to 100 centimeters (cm) (4 to 30 inches) tall. The species is also known as San Joaquin saltbush and San Joaquin orache (Taylor and Wilken 1993; Calflora 2000). It has erect stems with many branches, which spread out as the plant ascends. The twigs are dense and finely scaled, becoming glabrous (hairless and smooth). The ovate to triangular-shaped leaves measure 10 to 70 millimeters (mm) (0.5 to 2.75 inches) (Taylor and Wilken 1993). The leaves are finely gray-scaled and may be green above. They are also generally irregularly wavy-toothed, with the base truncated and tapered in form (Taylor and Wilken 1993). The staminate inflorescence is spike- or panicle-like, which refers to branched clusters of flowers in which the branches are racemes. The seeds are approximately 1 to 1.5 mm (0.04 to 0.06 inch) in length and are dark brown (Taylor and Wilken 1993). Very little is known about the biology and germination patterns of the species; however, San Joaquin spearscale is known to produce a long-lived seed bank that germinates in response to soil disturbances and can exist in weedy grasslands dominated by exotic species (EDAW 2004; Witham 2005; Witham unpublished data).

C.3.3 Habitat Requirements and Ecology

San Joaquin spearscale occurs within chenopod scrub, meadows, playas, valley grassland, and foothill grassland habitats that include alkaline soils. In the Central Valley of California, it appears to be restricted to alkaline soils along the rims of alkaline basins and the edges of clay-bottom vernal pools (California Natural Diversity Database [CNDDB] 2012). It is also found in alkaline and saline soils near creeks and seeps of the eastern flank of the inner North Coast Ranges (CNDDB 2012; Taylor and Wilken 1993). Suitable saline or alkaline soils occur near springs and seeps in Blue Ridge and Capay Hills (Schaal et al. 1994) and may support populations of San Joaquin spearscale. In many instances, the species occurs with, or is found near, populations of brittlescale (*Atriplex depressa*) and palmate-bracted bird's-beak (*Chloropyron palmatum*) (CNDDB 2012).

C.3.4 Species Distribution and Population Trends

C.3.4.1 Distribution

Endemic to California, San Joaquin spearscale historically has been collected in the Central Valley from Glenn County south to Merced County (CNDDB 2012; Silveira 2000). Specimens have also been collected in the inner North Coast Ranges in Glenn County and in the ranges of Alameda, Contra Costa and San Benito Counties (CNDDB 2012; Silveira 2000). The species has been collected in, or adjacent to, salt marshes in Napa, Sacramento, San Luis Obispo, and Solano Counties and on the shore of a small lake in Solano County (CNDDB 2012). Populations remain extant at many of the collection sites.

In the Plan Area, San Joaquin spearscale has been collected on, and adjacent to, alkaline soils north of Davis, southeast of Woodland on the City of Woodland Regional Park site, at the Grasslands Regional Park and Davis Communications Facility site, at the Tule Ranch Unit of the California Department of Fish and Wildlife (DFW) Yolo Bypass Wildlife Area, and near Dunnigan (Showers 1996; EDAW 2004; CNDDB 2012; Environmental Science Associates [ESA] and Yolo County 2005; Dean 2007; Dean 2009) (Figure A-3).

C.3.4.2 Population Trends

Population trends of San Joaquin spearscale have not been suitably evaluated. According to the CNPS (2005), occurrences of San Joaquin spearscale in California are limited and at risk throughout its range, although it may have been more abundant historically.

C.3.4.3 Threats to the Species

Development, intensive agriculture, waterfowl management, and exotic plant species are considered to be the primary threats to the species (CNDDB 2012; EDAW 2004; Showers 1996). All of these impacts lead to loss of habitat and degradation of the specific soils the plant requires to survive. Research should be directed towards invasive species control methods and techniques for establishing the appropriate hydrological regime to maintain the saline and alkaline soils. Additional research on the pollination ecology, germination requirements, seed dispersal mechanisms and response to disturbance regimes would aid in formulating appropriate adaptive management strategies.

C.3.5 Species Habitat Model and Location Data

Geographic Information System (GIS) Map and Model Data Sources. San Joaquin spearscale habitat is comprised of map- and model-based components. The mapped component includes vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Helm 2010; Gerlach 2011), heads-up digitization of the DFW Tule Ranch Unit, and the alkali sink habitat in the Yolo NHP vegetation dataset. Modeled San Joaquin spearscale salt spring habitat is based on known salt spring point localities (Schaal et al. 1994) and U.S. Geological Survey (USGS) data for springs on the appropriate geological formations (USGS 2007). Using these datasets, San Joaquin spearscale habitat was determined according to the data layer vegetation/land cover types that support its habitat requirements as described in Section

C.3.3, *Habitat Requirements and Ecology*. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area (Figure A-3).

Mapped and modeled San Joaquin spearscale habitat is comprised of the following vegetation types.

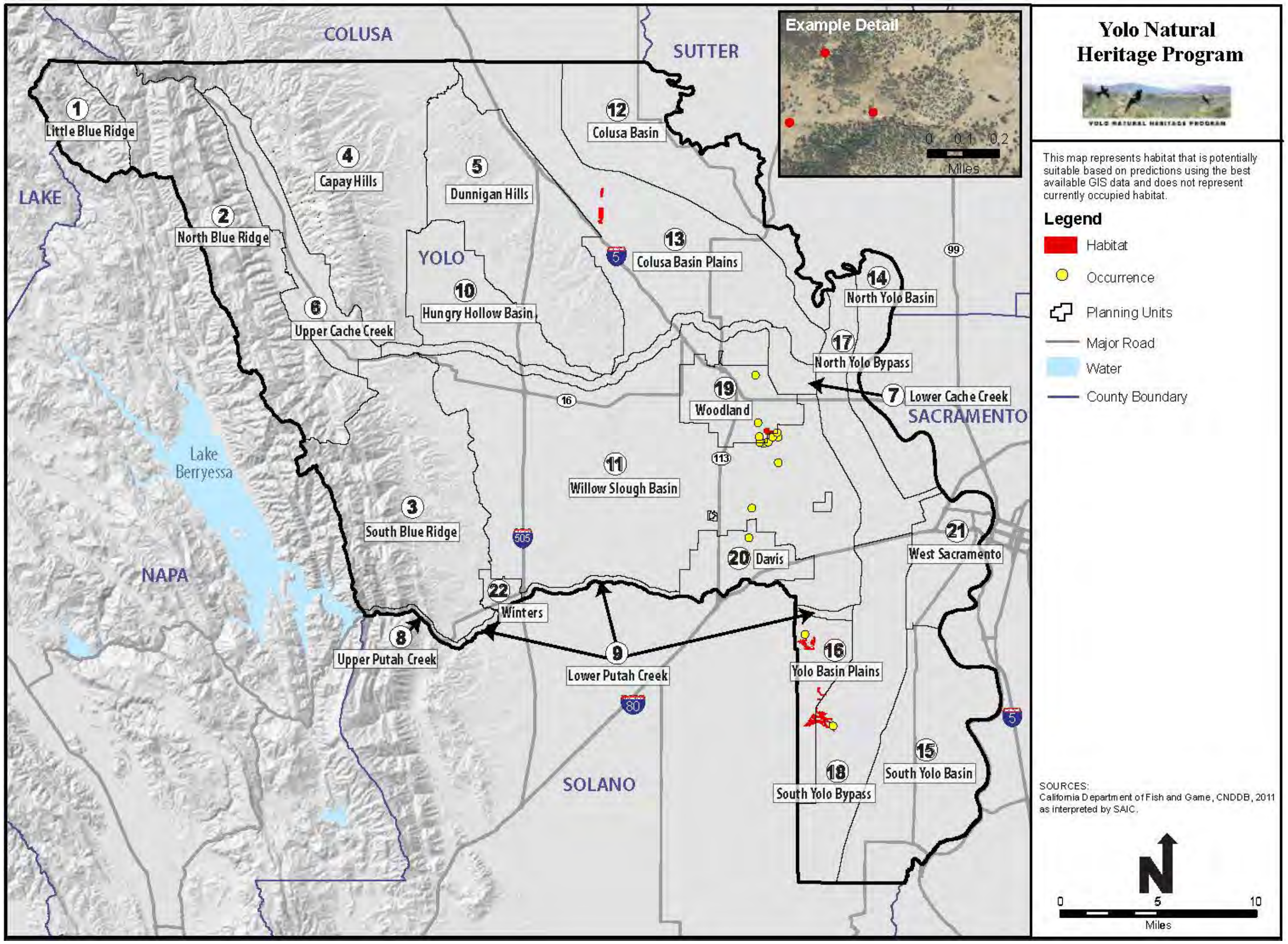
Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at theGrasslands Regional Park and Davis Communications Facility site, with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit, based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current GoogleEarth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Salt Spring Habitat: Salt spring habitat was mapped using two methods. Point localities reported in Schaal et al. (1994) in the Capay Hills were included with the addition of a 50-foot buffer. Other mapped springs (USGS National Hydrography Dataset [NHD] 2007) located in the Blue Ridge and Capay Hills were considered to be potential salt springs based on their underlying geologic formations. These potential salt spring locations were incorporated with the addition of a 50-foot buffer.

Assumptions. Historical and current records of this species in the Plan Area indicate that it was more widespread in the Plan Area as recently as the early 1990s on remnant alkali scalds in agricultural fields and along ditches, but that its known distribution on natural habitat is limited to alkali sink and vernal pool complex habitats.

Figure C-3. San Joaquin Spearscale Mapped Habitat and Occrrences



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C.4 Palmate-Bracted Bird's-Beak (*Chloropyron palmatum*)

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C.4.1 Listing Status

Federal: Endangered.

State: Endangered.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.1; 1B: Rare, threatened, or endangered in California and elsewhere. 0.1: Seriously endangered in California.

Recovery Plan: Palmate-bracted bird's-beak is included in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (U.S. Fish and Wildlife Service [USFWS] 1998).

C.4.2 Species Description and Life History

Palmate-bracted bird's-beak is a winter germinating, highly branched, herbaceous annual plant in the snapdragon family (Scrophulariaceae) that grows from 10 to 30 centimeters (cm) (4 to 12 inches) tall (Calflora 2008; Chuang and Heckard 1973; Hickman 1993). Formerly, it was classified as the morphologically and ecologically distinct subgenus *Hemistegia* of the genus *Cordylanthus* (Chuang and Heckard 1973) but has recently been assigned to a new family and genus as Orobanchaceae: *Chloropyron palmatum* (Tank et al. 2009). All members of *Chloropyron* develop mucilage containing cells in their leaf tissue, are covered with glandular salt-excreting hairs, and grow in saline soils (Chuang and Heckard 1986). Furthermore, all members of the genus are hemiparasitic and can obtain water and nutrients from the roots of other plants (Chuang and Heckard 1971).

Adult plants begin flowering in late May and continue flowering as late as October (L. C. Lee and Associates, and Center for Conservation Biology 2002). While palmate-bracted bird's-beak has a mixed mating system, it requires an insect pollinator to transfer pollen between its male and female reproductive structures in order to set viable seed. The primary pollinators at the Springtown population, near Livermore, Alameda County, are bumblebees (*Bombus vosnesenskii* and *B. californicus*) early in the season and small native bees (*Halictus tripartitus*, *Lasioglossum* [*Dialectus*], and *Lasioglossum* [*Evylaeus*]) later in the season (L. C. Lee and Associates, and Center for Conservation Biology 2002; Saul-Gershenz 2004). No pollinator studies have been conducted for any other populations. Pollinators are critically important for seed set. A study at the Springtown site found that *Lasioglossum* native bee species, which nest in bare soil areas adjacent to palmate-bracted bird's-beak plants, were particularly important, as 96 percent of the bees visiting palmate-bracted bird's-beak from June through July were of this genus (L. C. Lee and Associates, and Center for Conservation Biology 2002; Saul-Gershenz 2004). Those same species of small native bees also utilized nectar and pollen from common spikeweed (L. C. Lee and Associates, and Center for Conservation Biology 2002). Studies of the important pollinators of crop plants in Yolo County have found that populations of these same species of bees require bare ground and rodent burrows for nest sites and that the intensification of agriculture is eliminating their nesting habitat (Kremen

2001; Kremen et al. 2002a, 2002b; Kremen et al. 2004). Additionally, a shortage of pollinators has been reported in California as a result, at least partly, from the infestation of honeybees with the parasitic mite, *Varroa destructor* (Sousa 2005).

The timing of palmate-bracted bird's-beak seed germination has not been studied, but Fleishman et al. (1994) stated that the seed germinates in January and February. Observations that the seed can float for up to three weeks (Showers 1990) and that individuals are less densely aggregated during years of overland flows than during years of no overland flows (Showers 1988) also suggest that germination occurs during the winter months. Germination of previously buried seed may also be an important factor in the distribution and density of individuals in a population. While no studies have been conducted to determine the germination characteristics of seed under field conditions, seeds can remain viable for at least three years under laboratory conditions (Center for Conservation Biology 1994).

C.4.3 Habitat Requirements and Ecology

This species is restricted to seasonally flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet) (USFWS 1998). Small differences in soil topography are critical for seedling establishment, as seedlings establish on banks and sides of raised irrigation ditches and on small berms in areas subject to overland flows (Showers 1988). Extensive soil tests across mound and swale topography at the Springtown population have shown that soil salt concentrations are generally highest in the bottoms of swales and lowest on the tops of mounds (Coats et al. 1988, 1989, 1993). At Springtown, palmate-bracted bird's-beak was found to occur primarily on soils with intermediate salt content along the sides of the swales. The authors concluded that it was generally excluded from the scalds in the swales due to high soil salt content, and it was excluded from the tops of the mounds due to competition from exotic annual grasses (Coats et al. 1988, 1989, 1993). The descriptions of the Woodland population suggest that it also occurs on the sides of small topographic features and that the plants are shaded by dense populations of exotic annual grasses (Foothill Associates 2002; Showers 1988).

The extant population in the Plan Area is located southeast of the City of Woodland in a heavily human-impacted area of what historically was alkaline sink adapted vegetation occurring along both sides of Willow Slough and above the Yolo Basin (U.S. Bureau of Soils 1909a, 1909b; Mann et al. 1911). The hydrology, salts, and clay soils that created and maintained the alkaline sink vegetation were deposited when floodwaters from Putah Creek flowed northward from the area near the city of Davis and emptied into Willow Slough. That flow was supplemented when the combined floodwaters of Putah Creek, Cache Creek, and all of the drainages of the Blue Ridge filled the Cache/Putah Basin, drained eastward through a gap in the Plainfield Ridge, and flowed into the Yolo Basin through Willow Slough (Graymer et al. 2002).

Laguna de Santos Callé, as Willow Slough was previously known, was a unique perennial stream (Eliason 1850; Anonymous 1870) that during the dry season originated from a series of pond-like springs approximately 9 miles southwest of Woodland on the eastern edge of the Plainfield Ridge. As the slough approached the area of Merritt, south of Woodland, it transformed into a 2.5-mile-long, gravel bottomed, linear lake, with an average width of 150 feet and a maximum depth of 75 feet. Approximately 1 mile east of County Road 103, the stream flowing from the lake branched as it dropped over the edge of the alluvial deposits into the Yolo Basin, where it flowed another 2.5 miles northeastward until it emptied into a tule marsh. This perennial stream would have created a very shallow saline water table along Willow Slough that is comparable to the water table along Altamont Creek, which created and maintained the alkaline sink at Springtown. Recent studies show a localized trough in the underlying Tehama formation under this section of Willow Slough and a localized area of shallow groundwater (Wood Rodgers 2004; Lundorff and Scalmanini 2004). Large floods from Cache Creek and Putah Creek have flowed through Willow Slough as recently as 1942, but gravel mining in Cache Creek, dam building on both Cache and Putah Creeks, and the construction of the Willow Slough Bypass have drastically altered the hydrology, salt budgets, and clay deposition patterns in the area of the alkali sink vegetation. Aerial photographs show that all of the alkaline sink vegetation was either converted into rice fields or ditched for drainage, except for a single pool-meadow complex immediately along Willow Slough (U.S. Department of Agriculture [USDA] 1952). That pool has been disked multiple times (Showers 1990, 1996) but the southeastern upper margin of that pool still supports the largest number of plants in the area (Center for Natural Lands Management 2012). Given the intensity and extent of the agricultural impacts to the entire alkali sink area and the irreversible changes in hydrology, the area where palmate-bracted bird's-beak does not currently support alkali sink vegetation, and it would be very difficult to replicate the natural hydrological regimes that would allow that type of vegetation to be successfully restored in the area. However, the historical aerial photographs show that the disked pool-meadow complex did receive extensive amounts of supplemental summer water through ditches draining the upstream rice fields, so it may be possible to restore the appropriate hydrology artificially.

Monitoring studies have documented that populations of palmate-bracted bird's-beak experience significant mortality between early spring and early summer, and then low mortality rates through September (Center for Conservation Biology 1992; Fleishman et al. 1994; Cypher 1998). A positive correlation between high mortality rates and high seedling densities has been demonstrated at some research locations. However, because these data were obtained from field surveys where seedling density was not manipulated, density-independent causes of seedling mortality cannot be ruled out. Alternative explanations for high mortality rates include lack of appropriate hosts, drought stress, and competition with introduced annual grasses. Finally, there are no data describing the soil moisture requirements of palmate-bracted bird's-beak during the period of maximum mortality in spring, but studies have found that plants grow where they have access to adequate levels of soil moisture during the summer rainless period.

According to current data on the species, only perennial plants, such as saltgrass (*Distichlis spicata*), Mojave red sage (*Kochia californica*), and Torrey seepweed (*Suada moquinii*), are assumed to function as appropriate host plants for palmate-bracted bird's-beak (Coats et al. 1988; Cypher 1998; EIP Associates 1998). However, in a greenhouse host-preference experiment, Chuang and Heckard (1971) observed that palmate-bracted bird's-beak was vigorous and produced many flowers when grown with common sunflower (*Helianthus annuus*), which is a summer-flowering annual. This finding suggests that common spikeweed, a summer- and fall-flowering annual plant in the same plant family as common sunflower, and which is closely associated with palmate-bracted bird's-beak in its natural habitat, may be a suitable host. Because the roots of older perennials become increasingly lignified (woody) and resistant to parasitism, age and spatial distribution of the roots may also contribute to the suitability of a potential host plant for palmate-bracted bird's-beak parasitism (see Marvier and Smith 1997).

C.4.4 Species Distribution and Population Trends

C.4.4.1 Distribution

Palmate-bracted bird's-beak is endemic to the west side of the Sacramento Valley, the north side of the Sacramento National Wildlife Refuge (NWR) Complex, the San Joaquin Valley, and the Springtown area of the Livermore Valley. This species is currently known to exist at six locations outside of the Plan Area: Delevan NWR, Sacramento NWR (established from seed collected at the Delevan NWR), Colusa NWR, the Springtown area, western Madera County, and the combined Alkali Sink Ecological Reserve and Mendota Wildlife Management Area (USFWS 1998).

Very little information exists concerning the historical distribution of palmate-bracted bird's-beak in the Plan Area prior to extensive habitat conversion. The documented locations in the Plan Area consist of an extirpated population that was located northeast of the city of Woodland near the Cache Creek Settling Basin and an extant population located southeast of Woodland (California Natural Diversity Database [CNDDB] 2012; Center for Natural Lands Management 2012; Crampton 1979; Dean 2009). Within the last 25 years, the species has been observed in areas adjacent to the Woodland population in an alkali playa/meadow (Crampton 1979) and on Pescadero silty clay, saline-alkali, and Willows clay soil types (Showers 1988, 1996; EIP Associates 1998; Foothill Associates 2002).

Individuals in the existing Woodland population are generally found on small topographic features such as old irrigation checks, banks of shallow ditches, along the shoreline of a pond, and along the upper margin of a vernal pool. The entire population is limited to Pescadero silty clay, saline-alkali, and Willows clay soil types (Andrews 1970; Showers 1988, 1996; EIP Associates 1998).

C.4.4.2 Population Trends

Little is known about regional population trends of palmate-bracted bird's-beak. The conversion of land to farming and development is resulting in declines because of the destruction of extensive areas of potential habitat in the Sacramento and San Joaquin Valleys (USFWS 1998). However, populations are known to fluctuate. For instance, populations of palmate-bracted bird's-beak in the central San Joaquin Valley, in areas such as Mendota, have fluctuated between 0 and 800 flowering individuals from 1987 to 1993 (Fleishman et al. 2001).

The Colusa, Delevan, and Springtown populations appear to be robust with large populations of between 10,000 and 100,000 flowering individuals in 1991 and 1992, while the Mendota population is small and has fluctuated between 0 and 800 flowering individuals from 1987 to 1993 (Fleishman et al. 2001). Between 1983 and 1990, the Woodland population was restricted to a single property that is known as the City of Woodland Preserve. The size of this population ranged from 200 to 1,400 flowering individuals (EIP Associates 1990). In 1996 and 1998, special-status species surveys of the area discovered additional individuals on the adjoining Woodland Regional Park, Brauner, and Maupin properties (Showers 1996; EIP Associates 1998, Center for Natural Lands Management 2012, Dean 2009).

C.4.5 Threats to the Species

Natural threats to palmate-bracted bird's-beak populations include potential lack of appropriate hosts and pollinators, and competition with introduced annual grasses such as annual ryegrass (Dawson et al. 2007). A number of specific threats to the species were identified in the 1998 recovery plan but only urban expansion, altered hydrology, and limited genetic variation were identified as threats to the Woodland population (USFWS 1998). More recently, the Woodland site has been extensively invaded by annual ryegrass, which poses a severe threat to the species at this site (M. Showers pers. comm.)

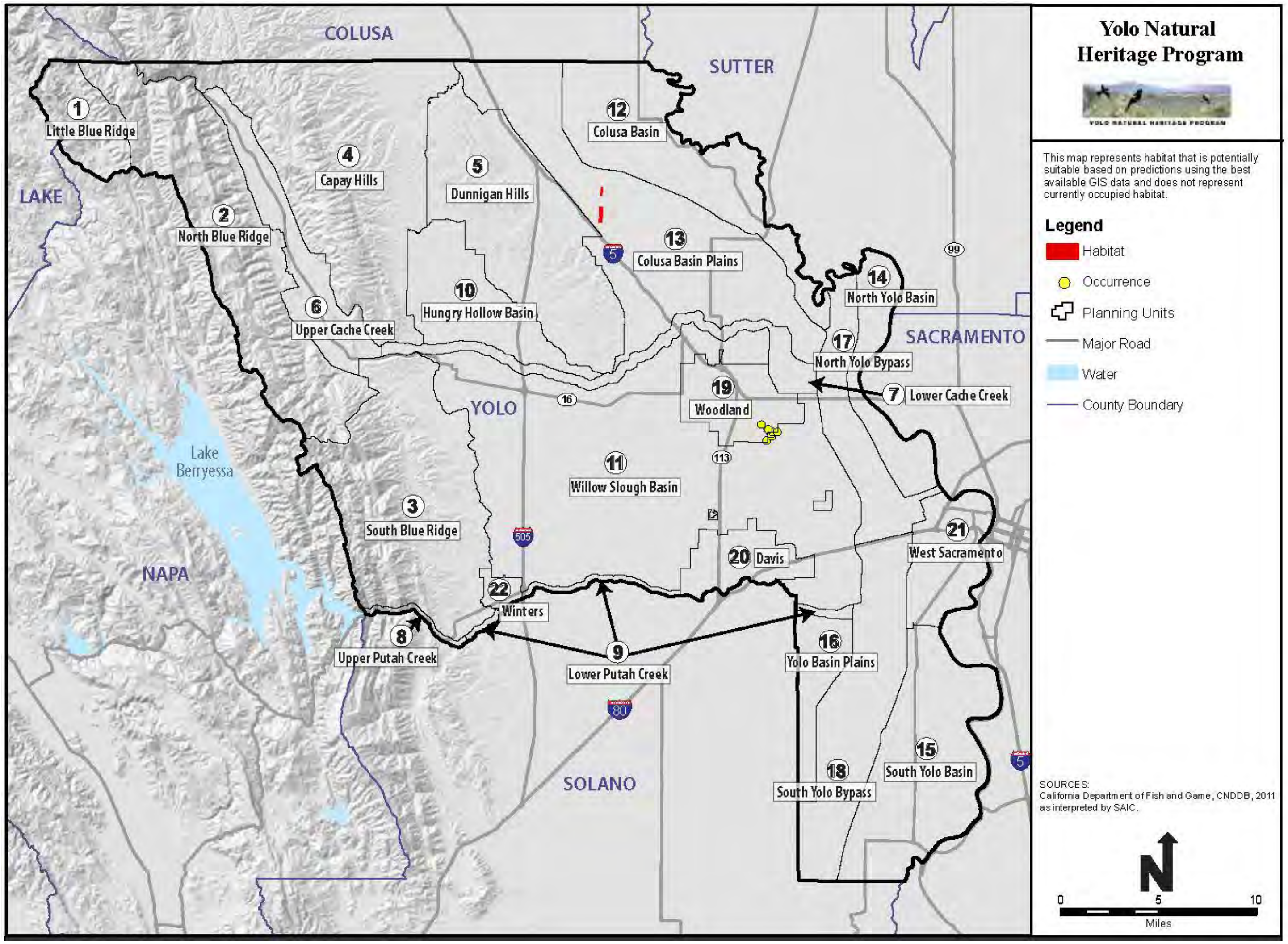
Finally, as previously mentioned, studies of the important pollinators of crop plants in Yolo County have found that intensification of agriculture is eliminating the nesting habitat of native bees, upon which the palmate-bracted bird's-beak depends for pollination (Kremen et al. 2001, 2002a, 2002b, 2004). Additionally, a shortage of pollinators has been reported in California as a result, at least partly, from the infestation of honeybees with the parasitic mite, *Varroa destructor* (Sousa 2005).

C.4.6 Species Habitat Model and Location Data

C.4.6.1 Geographic Information System (GIS) Map Data Sources

The palmate-bracted bird's-beak habitat is map based and uses the Yolo NHP vegetation dataset, which is based on a heads-up GIS digitization of the alkali sink habitat in the NHP Plan Area (Figure A-4). A habitat map of the distribution of palmate-bracted bird's-beak habitat in the Plan Area was then created. The habitat type was based on the species requirements as described in Section C.4.3, *Habitat Requirements and Ecology* above and the assumptions described below. Occurrences were mapped as the point at the center of any California Natural Diversity Database (CNDDB) polygons that fall within the Plan Area.

Figure C-4. Palmate-Bracted Bird's Beak Modeled Habitat and Occurrences



Mapped palmate-bracted bird's-beak habitat is comprised of the following vegetation type.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by the California Department of Fish and Wildlife (DFW).

Assumptions. Historical and current records of this species in the Plan Area indicate that it was present in the alkaline soil area between Willow Slough and Cache Creek, but that its known current distribution is limited to the mapped alkali sink habitat with some individuals present on adjacent severely disturbed sites.

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C.4.7.1 Personal Communications

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C.5 Heckard's Pepper-Grass (*Lepidium latipes* var. *heckardii*)

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C.5.1 Listing Status

Federal: None.

State: None.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.2; 1B: Rare, threatened, or endangered in California and elsewhere. 0.2: Fairly endangered in California.

Recovery Plan: None.

C.5.2 Species Description and Life History

Heckard's pepper-grass (*Lepidium latipes* var. *heckardii*) is an herbaceous annual plant in the mustard family (Brassicaceae) that grows from 3 to 25 centimeters (cm) (1 to 10 inches) tall. It is differentiated from dwarf pepper-grass (*L. latipes* var. *latipes*) based on height, distance between leaf nodes, and lack of a basal rosette (Hickman 1993; Rollins 1993). Heckard's pepper-grass has dense foliage with linear leaves 5 to 10 cm (2 to 4 inches) long. Small, greenish flowers with ciliate (edges having hair-like projections) petals occur in dense spikes and the flat, oval fruits are deeply notched at the top (Hickman 1993; Rollins 1993). Heckard's pepper-grass flowers March through May (CNPS 2012). The dispersal patterns and seed germination requirements of Heckard's pepper-grass are poorly understood.

C.5.3 Habitat Requirements and Ecology

Heckard's peppergrass generally occurs in alkaline flats and alkaline grasslands along the edges of vernal pools on Pescadero silty clay, Pescadero saline-alkali, Marvin soils, and Willows clay soil types across a range of disturbed sites near Woodland. In the Central Valley, it appears restricted to alkaline soils along the rims of basins in areas that are subject to periodic flooding (CNDDB 2012). On the Tule Ranch Unit of the California Department of Fish and Wildlife (DFW) Yolo Basin Wildlife Area it occurs on Capay silty clay and Clearlake clay, which are deeply cracked vertisols (Witham unpublished data). Data suggest that Heckard's pepper-grass is closely associated with Sacramento Valley populations of alkali milk-vetch (*Astragalus tener* var. *tener*), which is found on alkaline soils that are seasonally flooded or subjected to overland flows. Heckard's pepper-grass is ubiquitous in vernally mesic grasslands at the Tule Ranch Unit of the DFW Yolo Basin Wildlife Area in the Plan Area (Witham 2003). Very little is known about the biology and germination requirements of this taxon.

C.5.4 Species Distribution and Population Trends

C.5.4.1 Distribution

The distribution of Heckard's pepper-grass in California is based on 15 observations, as defined by Calflora (2007) and the California Natural Diversity Database (CNDDB) (2012). Heckard's pepper-grass has been collected in Glenn, Merced, Sacramento, Solano, and Yolo Counties (Calflora 2007; CNDDB 2012). Populations of Heckard's pepper-grass in Yolo and Glenn Counties range in size from 10 to 500 plants (CNDDB 2012). The distribution in the Plan Area includes the City of Woodland Preserve, the City of Woodland Regional Park/Mavis Henson Field, and the DFW Tule Ranch Unit (CNDDB 2012; Dean 2009; Showers 1996; Witham 2003).

C.5.4.2 Population Trends

Heckard's pepper-grass is extremely rare in California (Calflora 2007; CNPS 2012) and is expected to continue to decline, although data on population trends are lacking.

C.5.5 Threats to the Species

Development, waterfowl management, agricultural conversion, urban development, and exotic plant species are considered the primary threats to the subspecies in the Plan Area (Showers 1988, 1996; CNDDB 2012). All of these threats lead to loss of habitat or degradation of conditions the plant requires to survive.

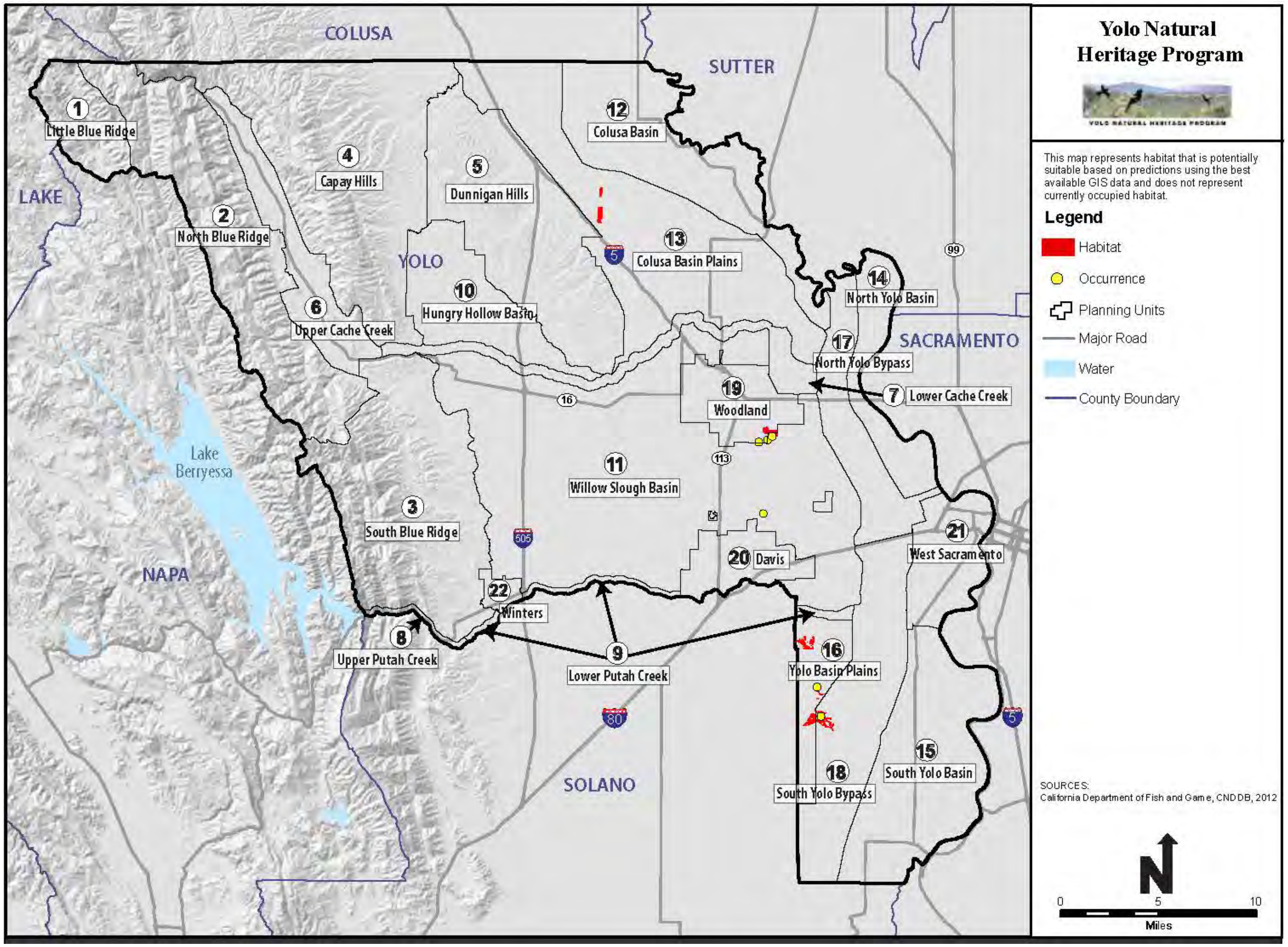
The species was more widely distributed in alkaline soils areas but known current occurrences on natural habitat in Plan Area are within alkali sink and vernal pool complex habitats.

C.5.6 Species Model and Location Data

C.5.6.1 Geographic Information System (GIS) Map Data Sources

The Heckard's pepper-grass habitat is map-based and not modeled and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (Environmental Science Associates [ESA] and Yolo County 2005; Helm 2010; Gerlach 2011), and heads-up GIS digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure A-5). Using these datasets, Heckard's pepper-grass habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat. Vegetation types were assigned based on the species requirements as described above in Section C.5.3, *Habitat Requirements and Ecology* and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

1 **Figure C-5. Heckard's Pepper Grass Mapped Habitat and Occurrences**



2

Mapped Heckard's pepper-grass habitat is comprised of the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current GoogleEarth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW

Assumptions. Historical and current records of this species in the Plan Area indicate that it was more widespread in the Plan Area remnant alkali scalds in disturbed areas but that its known distribution on natural habitat is limited to the alkali sink habitat and the Tule Ranch Unit of the DFW Yolo Basin Wildlife Area.

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C.6 Baker's Navarretia (*Navarretia leucocephala* ssp. *bakeri*)

C.6.1 Listing Status

Federal: None.

State: None.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.1; 1B: Rare, threatened, or endangered in California and elsewhere. 0.1: Seriously endangered in California.

Recovery Plan: None.

C.6.2 Species Description and Life History

Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*) is an annual herbaceous plant in the phlox family (Polemoniaceae) that grows to 2 to 10 centimeters (cm) tall erect (Hickman 1993). It has one to two pinnately compound leaves with linear leaflets, reflexed white hairs on the stem, and white five-petaled flowers (Hickman 1993). The flowers are in dense terminal clusters with leaf-like bracts (Hickman 1993). This subspecies is an intermediate between *leucocephala* and *plieantha* (Hickman 1993). Baker's navarretia is distinguished from those subspecies by bracts that are less than twice as long as the heads are wide, white flowers, an included floral tube, and an erect stem with ascending branches (Hickman 1993). White-headed navarretia (*Navarretia leucocephala* ssp. *leucocephala*) is a more common subspecies with bracts greater than twice as long as the heads are wide, white flowers, and an exserted floral tube (Hickman 1993). Many-flowered navarretia (*Navarretia leucocephala* ssp. *plieantha*) is another special-status subspecies that is distinguishable by its prostrate stem with spreading branches, blue flowers, and an included floral tube (Hickman 1993). Very little is known about the pollination ecology of this taxon, but various native and nonnative Hymenoptera (wasps and bees) and day-flying Lepidoptera (butterflies, skippers and moths) have been observed visiting this species (Witham 1993; Witham unpublished data). Seed dispersal is limited as members of this section of *Navarretia* hold their seeds until becoming wet (Hickman 1993).

C.6.3 Habitat Requirements and Ecology

Baker's navarretia occurs on clay texture or alkaline clay soils and is found in vernal pools and swales within cismontane woodland, lower montane coniferous forest, meadows and seeps, and valley and foothill grassland from 15 to 1,740 meters (49 to 5,709 feet) in elevation (CNPS 2001; California Natural Diversity Database [CNDDB] 2012). The species blooms from May to July (CNPS 2001).

C.6.4 Species Distribution and Population Trends

C.6.4.1 Distribution

Baker's navarretia is endemic to California and its distribution, as defined by Calflora 2007, is based on 88 recorded observations. The range of Baker's navarretia extends from Modoc and Lassen counties in the east; to San Joaquin, Merced, and Madera counties in the south; and to Humboldt, Trinity, Tehama, Mendocino, Glenn, Lake, Colusa, Sutter, Yolo, Napa, Solano, Sonoma, and Marin counties in the northwest (Calflora 2007; CNDDB 2012). The known occurrences in the Plan Area are located on the Tule Ranch Unit of the California Department of Fish and Wildlife (DFW) Yolo Basin Wildlife Area (CNDDB 2012; Witham 2003).

C.6.4.2 Population Trends

Population trends of Baker's navarretia have not been documented. Occurrences of Baker's navarretia in California are highly limited and the species is at risk throughout its range (CNPS 2001). Given the reductions in vernal pool area, this species is likely to be in decline, but according to the CNPS (2001) it may be more widespread than once thought.

C.6.5 Species Habitat Model and Location Data

C.6.5.1 Geographic Information System (GIS) Map Data Sources

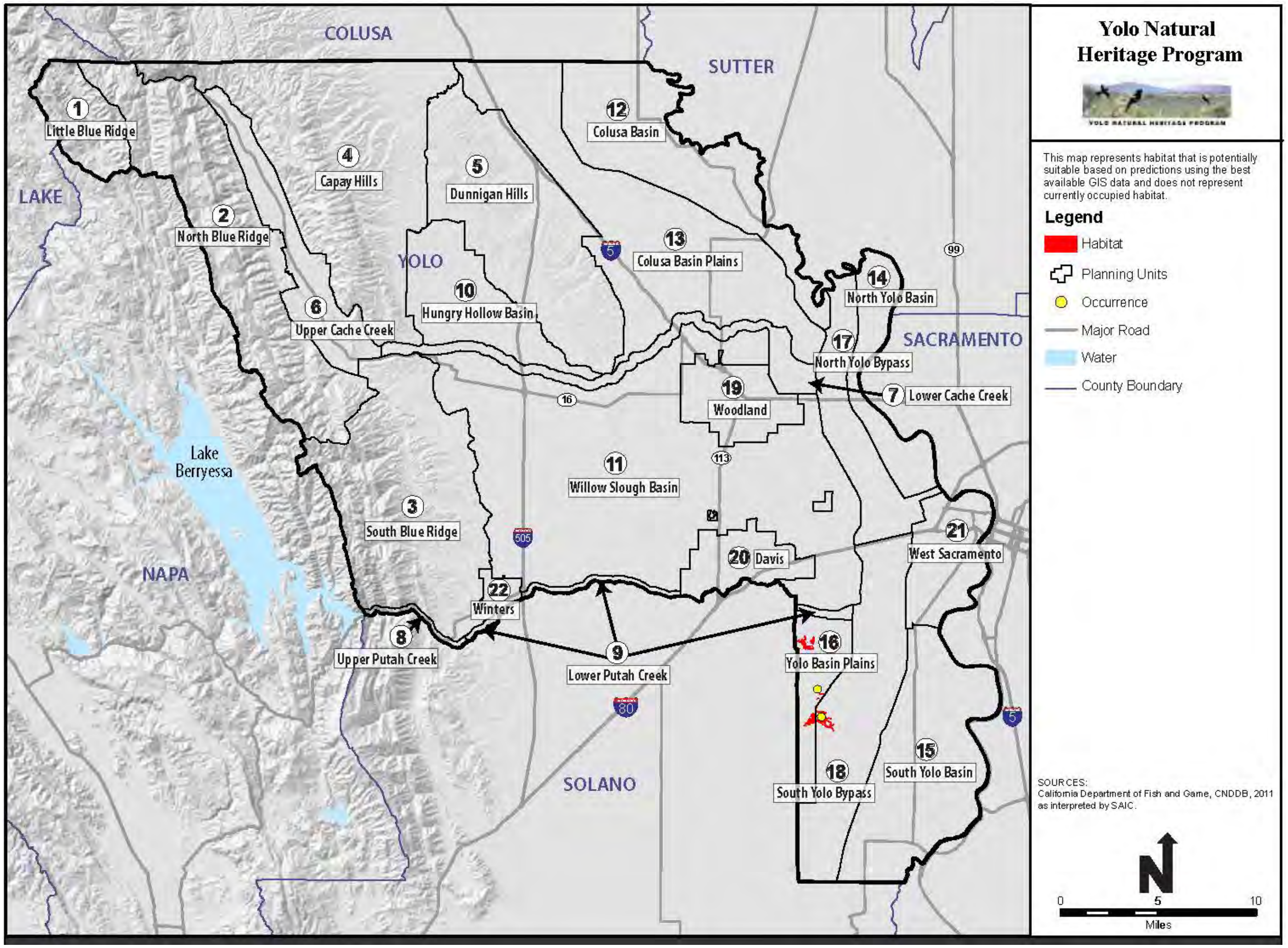
Baker's navarretia habitat is map-based and not modeled and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications facility site (Environmental Science Associates [ESA] and Yolo County 2005; Helm 2010; Gerlach 2011), and heads-up GIS digitization of the DFW Tule Ranch Unit (Figure A-6). Using these datasets, Baker's navarretia habitat was mapped in the Plan Area according to the species' vernal pool complex habitat. Vegetation types were assigned based on the species requirements as described above in Section A.6.3, *Habitat Requirements and Ecology* and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

Mapped Baker's navarretia habitat is comprised of the following vegetation type.

> **Vernal Pool Complex:** This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

> **Assumptions.** Occurrence records of this species in the Plan Area indicate that it is restricted to vernal pool complex habitat (CNDDB 2012).

Figure C-6. Baker's Navarretia Mapped Habitat and Occurrences



C.6.6 Threats to the Species

The primary threat to Baker's navarretia is the loss of vernal pool and swale habitat on alkaline clay soils. The predominant threats to this habitat include development and agriculture (CNPS 2001). The known locations in Yolo County are currently grazed; therefore, prior to any management recommendations to alter the grazing regime, research should be conducted to determine if the change in management would have a positive effect on Baker's navarretia.

C.6.7 References

Calflora: Information on California plants for education, research and conservation (web application). 2007. Berkeley, California: The Calflora Database (a nonprofit organization). http://www.calflora.org/.

CNDDB (California Natural Diversity Database). 2012. RareFind. Ver. 3.1.0 with data generated on July 01, 2012. California Department of Fish and Game, Sacramento, CA.

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C.8 Colusa Grass (Neostapfia colusana)

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C.8.1 Listing Status

Federal: Threatened (62 *Federal Register* [FR] 14338).

State: Endangered.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.1; 1B: Rare, threatened, or endangered in California and elsewhere. 0.1: Seriously endangered in California.

Recovery Plan: Colusa Grass in included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005) and Colusa Grass, *Neostapfia colusana* 5-Year Review (USFWS 2008).

Critical Habitat: Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule (71 FR 7118).

The only designated critical habitat in the Plan Area for Colusa grass is critical habitat subunit 1, which covers the Davis Communications Annex in southeast Yolo County.

C.8.2 Species Description and Life History

Colusa grass (*Neostapfia colusana*) is a robust, tufted annual, 10 to 30 centimeters (4 to 12 inches) tall, and is a member of the Orcuttieae tribe, which also includes *Orcuttia* and *Tuctoria* (Reeder 1965; Stone 1988; Hickman 1993). The lower portions of the stems of larger plants may lie on the ground while the upper portions are erect and terminate in dense cylindrical, spike-like inflorescences that superficially resemble small ears of corn. At the Grasslands Regional Park and Davis Communications Facility site, each spike each spike of relatively large plants produced an average of 89 seeds (n = 25) (Gerlach 2009). The number of spikes per individual varies depending on evapotranspiration (ET) rates during growth and location within the pool – higher ET results in lower spike production (Gerlach 2009, 2011). Plants begin flowering in May, June, or July, approximately one month after germinating, depending on seasonal growth conditions (Gerlach 2009, 2011). Seeds of Colusa grass germinate in very shallow water during late spring, the plants produce a long, strap-like floating leaf, and plants begin flowering in May, June, or July depending on seasonal conditions (Woodward 1985; Anonymous [S.J.B.] 1990; Environmental Science Associates [ESA] and Yolo County 2005; Gerlach 2009, 2011). The seeds can remain dormant for an undetermined length of time (but at least three to four years) and germinate underwater after they have been immersed for prolonged periods (Crampton 1976; Griggs 1980; Gerlach 2009, 2011). Gerlach (2009) conducted germination studies in controlled conditions that mimicked natural conditions and only one seed germinated in the entire experiment (Gerlach 2009). Seed collected in October 2008 and reintroduced into a restored vernal pool in December 2009 germinated in May 2009 unlike the seed of Solano grass that did not germinate until the third season (Gerlach 2011).

All plants in this tribe are wind-pollinated, but pollen probably is not carried long distances between populations (Griggs 1980; Griggs and Jain 1983). Local seed (i.e., caryopsis) dispersal is by water (Reeder 1965; Crampton 1976; Griggs 1980; Griggs 1981) and possibly by grazing animals when they walk in the mud of pools containing seed (Gerlach 2011). Despite numerous accounts in the literature to the contrary, seedlings at the Yolo Grasslands Park site produce long strap-like juvenile floating leaves, which casts doubt on its taxonomic characterization as a primitive relative of the *Orcuttia* genus (Gerlach 2009, 2011). Mature seeds are retained on the dead plants until the inflorescences disintegrate during the beginning of the wet season (Gerlach 2009, 2011).

C.8.3 Habitat Requirements and Ecology

Colusa grass is an annual plant that, in the Plan Area, grows in turbid vernal pools on infertile and highly salt-affected clay alluvium soils. Elsewhere, Colusa grass occurs in a wide variety of habitats that include the following: small alkaline vernal pools within alkali sinks (100 square meters [m^2]); large alkaline playa pools (250 hectares); small to large neutral to acidic vernal pools; depressions in intermittent drainages running on the Mehrten geological formation; and areas that pond due to human-modified hydrology (Crampton 1959, 1976; Woodward 1985; Stone 1988; Holland 2000; Cypher 2001; Hogle 2002).

Colusa grass apparently has the broadest environmental tolerances of any species in the Orcuttieae tribe (Stone 1988). At the Grasslands Regional Park and Davis Communications Facility site, Colusa grass grows on shrink/swell clay soils with high sodium and boron salt concentrations and a pH near 9 (Gerlach 2009, 2011). Despite published accounts to the contrary, all of the San Joaquin populations are found on a variety of non-saline soils with pH ranging from 5.8 to 7.5. None of the measured physical parameters accounted for its presence or absence in vernal pools, so its distribution is thought to be strongly correlated with seed dispersal dynamics (Hogle 2002). At the Grasslands Regional Park and Davis Communications Facility site, Colusa grass is found with Solano grass (*Tuctoria mucronata*) and swamp timothy (*Crypsis schoenoides*) (Gerlach 2009, 2011).

In high rainfall years, it is also found in flood plains above vernal pools (ESA and Yolo County 2005). In the San Joaquin Valley, populations are distributed in different areas of vernal pools, plants with the highest seed production were generally found in shallow depressions on the bottoms of the playas (Hogle 2002). According to historical aerial photographs, the population at the Grasslands Regional Park and Davis Communications Facility site currently exists in a series of shallow agricultural drainage ditches that were excavated through alkaline vernal pools and swales prior to 1937 (U.S. Department of Agriculture [USDA] 1937). These disturbed areas have not been re-excavated and are considered to be disturbed vernal pools.

Hydrology and soil materials, both rock and soil, are responsible for the unique patterns of species distributions in alkaline vernal pools and alkaline playa pools in the Plan Area (Gerlach 2009) and Solano County. Williamson et al. (2005) and Rains et al. (2008) summarized the situation well with regard to parent material: "The vernal pools on clay-rich soils formed on alluvium derived from sedimentary and metasedimentary rocks of marine origin. The soils that developed on these sediments are fine grained, saline, and sodic. These soils support vernal pools that are perched surface water systems, have relatively saline, sodic, and turbid surface water, and may be nitrogen and light limited." Other studies have confirmed the nitrogen and light limitations (Barclay and Knight 1981).

Because of its underlying and extremely unique geologic structure (Gerlach 2009), the Jepson Prairie alkaline vernal pools and alkaline playa pools are much older than the alkaline vernal pools and alkaline playa pools in the Plan Area (Graymer et al. 2002). Jepson Prairie owes its unique species assemblages and the continued existence of the alkaline playas and vernal pools to the presence of the underlying Montezuma Block (Band 1998). The inward-sloping sides of the block with increasing depth assure that the Montezuma Block pops up and floats like an iceberg among other crustal blocks without distorting. This unique characteristic has allowed this single flat piece of the earth's crust to persist in the same location since the oceanic plate and its accompanying archipelago of volcanoes first crashed into the North American continent and has maintained the only opening from the Central Valley to the Pacific Ocean through the rapidly rising Coast Ranges (Band 1998). After the Montezuma Block rose above the ocean, it was covered by eroded materials from the Coast Ranges that became deeply weathered infertile soils and which are clearly visible in aerial photographs (Band 1998). An ancient river channel cut across the northern edge of the block and apparently deposited the clays that underlie the Jepson Prairie alkaline vernal pools and alkaline playa pools. The Montezuma Block later tilted slightly to the north, which raised the Jepson Prairie area slightly above the surrounding area, preventing the non-saline floodwaters of the Sacramento River from flushing the salts present in its clays into the Delta.

In contrast, north of the Montezuma Block, the alkaline vernal pools and alkaline playa pools in Solano and Yolo Counties are located on a low alluvial terrace that formed above the Yolo Basin and Sacramento River Delta through the deposition of outwash clay materials when Putah Creek and Cache Creek flooded over their natural levees (Graymer et al. 2002; Gerlach 2009) (see Chapter 2). The spreading floodwaters deposited coarser alluvium near the channels and fine clays further away from the main channels in calmer water. As the floodwaters receded, the suspended clay and dissolved salts were deposited as a relatively thin surface coating across the lower portions of the alluvial terrace. Successive flood events deposited successive layers of clay and the flooding history of the terrace is recorded in the alternating bands of alluvial material (State of California 1987). Historically, these alkaline vernal pools and alkaline playa pools occurred on the terrace in a broad arc from the Montezuma Hills to Cache Creek and in the two basins in the Plan Area between the coast range and the Dunnigan Hills/Plainfield Ridge anticline (U.S. Bureau of Soils 1909a, 1909b; Mann et al. 1911). As described above, the salts (sodium, boron, magnesium) and the clay minerals were transported to the terrace by the creeks and did not develop in situ.

As noted above, the clays deposited in the Jepson Prairie Preserve area are older than 10,000 years, at least 30 feet thick near Olcott Lake, and thin to 6 feet thick near Jepson Prairie's northern edge (C. Witham pers. comm.). In contrast, the clay surface deposits at the Colusa grass location in the Plan Area could be as young as 60 years old and were periodically replenished by floodwaters from Putah Creek prior to the completion of Monticello Dam on Putah Creek, which altered the hydrology of the entire region. At the Grasslands Regional Park and Davis Communications Facility site, a former distributional branch of Putah Creek forms the largest drainage and the alkaline vernal pools or drainage ditches lie above the natural drainage (Department of the Air Force 1993; ESA and Yolo County 2005). Prior to the construction of the Monticello Dam, when Putah Creek routinely flooded, the site was submerged and the turbulent hydraulics of the floodwaters scoured basins and channels in the higher surfaces that became alkaline vernal pools and swales after the floodwaters receded. The Monticello Dam and other diversions have eliminated the natural floods that created and maintained the alkaline vernal pools and alkaline playa pools.

C.8.4 Species Distribution and Population Trends

C.8.4.1 Distribution

Currently, there are no more than 42 known extant occurrences scattered in Yolo, Solano, Merced, and Stanislaus counties (California Natural Diversity Database [CNDDB] 2012; Hogle 2002). The vast majority of these occurrences are in Stanislaus County (15 occurrences) and Merced County (22 occurrences).

Colusa grass was collected from Solano County in 1958 by Beecher Crampton from Olcott Lake, which is now within the Solano Land Trust's Jepson Prairie Preserve (Witham 2006). The Plan Area population was discovered by Bob Holland in 1993. Colusa grass may have been more broadly distributed prior to conversion of the Plan Area's alkaline vernal pools and alkaline playa pools to rice fields and drainage ditches, but its rarity in playa pools in the Jepson Prairie area suggests that it may have been limited to just a few alkaline pools or alkaline playa pools at both sites.

C.8.4.2 Population Trends

Hogle (2002) visited 24 occurrences (57 percent of all extant occurrences) in 2001 and reported that five of the 24 occurrences (20 percent) were extirpated since the 1980s. CNDDB (2012) indicates that five extant occurrences were declining and one was stable, and the status was reported as unknown for the remaining 36 extant occurrences.

The population at the Grasslands Regional Park and Davis Communications Facility site is distributed in five small sub-basins and two restored vernal pools; its population size has varied considerably over 11 years and no trend is apparent (Gerlach 2009, 2011). In drought years the species exists solely as a soil seed bank (Crampton 1959, 1976; Gerlach 2009, 2011). Approximately 40,000 plants were observed at this site in 2004 (ESA and Yolo County 2005) and zero reproductive plants were observed in 2007 (Gerlach 2009, 2011). The population in Olcott Lake is also similarly variable (Witham 1999). Due to the alternation of hydrologic processes by the construction of Monticello Dam and the cultivation of most of the formerly suitable habitat in the County, it is unlikely that Colusa grass will ever occur at other sites in Yolo County, except at this location at Yolo Grasslands Park. Therefore, conservation of the known occupied habitat in this area is essential to conserve this species in Yolo County.

C.8.5 Threats to the Species

Immediate threats to Colusa grass in the Plan Area are primarily due to the invasion of its habitat by perennial pepperweed (*Lepidium latifolium*) (ESA and Yolo County 2005; Gerlach 2009, 2011). In 2007 Yolo County began a long-term perennial pepperweed eradication program that has proved to be effective. Swamp timothy is considered to be a threat to the San Joaquin Valley populations (Stone 1988; Holland 2000; Hogle 2002). Interestingly, Crampton (1959, 1976) does not mention swamp timothy in either of his papers, so its invasion of vernal pools may be a relatively recent phenomenon. Lippia (*Phylla nodiflora*) is an invasive threat to the Olcott Lake population (Witham 1999). The extensively altered hydrology of the Plan Area site may pose an additional long-term threat to this occurrence of the species.

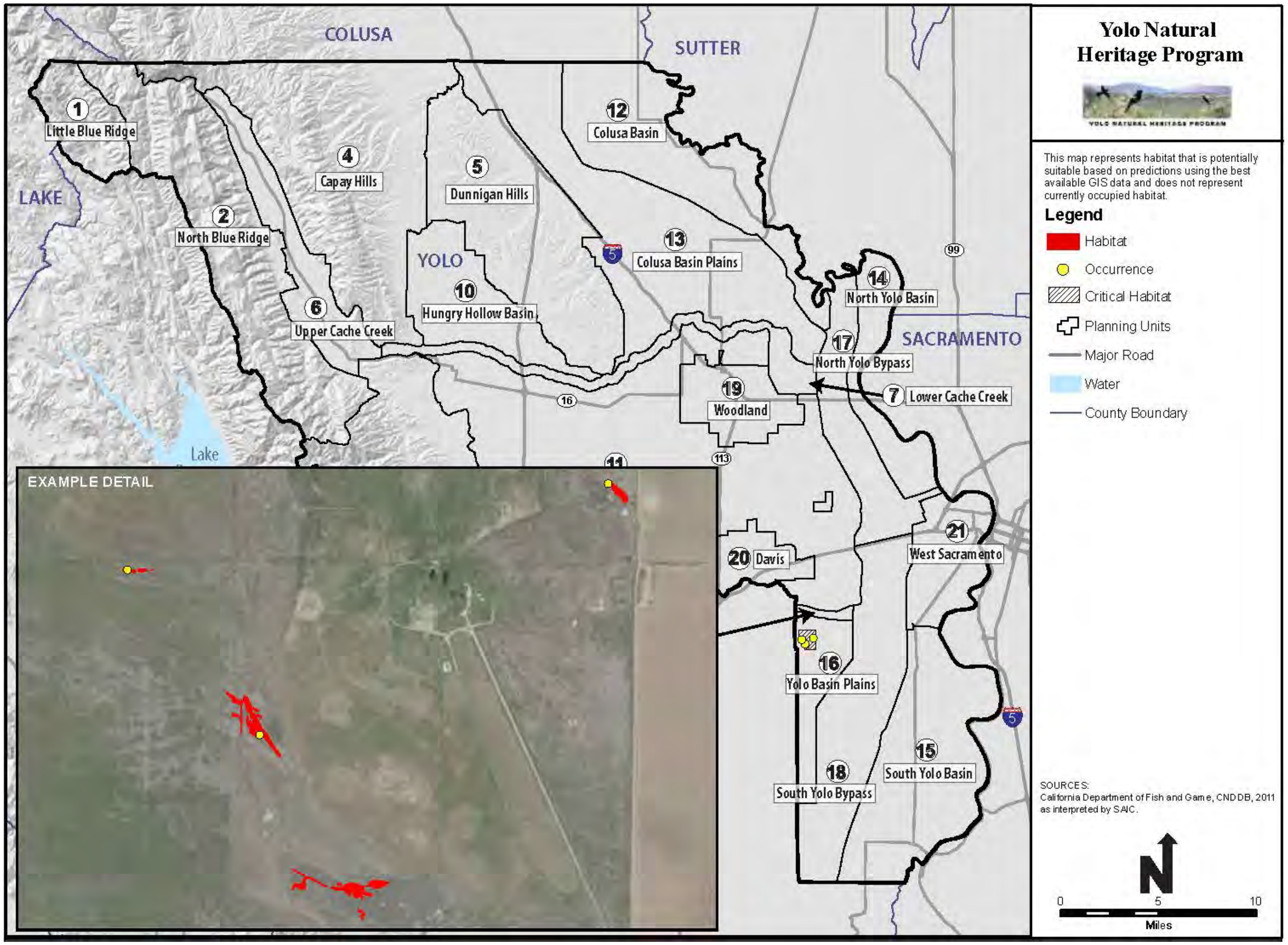
C.8.6 Recovery Plan Goals

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) contains the following goals for Colusa grass to be met within the Plan Area in the Solano-Colusa Core Area: protect 95 percent of suitable species habitat in the Davis Communications Annex.

C.8.7 Species Habitat Model and Location Data

This species only occurs in one small area of the County and the vernal pool basins that contain the population have been precisely mapped using the Global Positioning System (GPS) (Gerlach 2011) (Figure A-7). The GPS data from those surveys were used and no habitat model for this species was developed. Occurrences of the species are also based on those surveys.

1 **Figure C-7. Colusa Grass Mapped Habitat and Occurrences**

2 

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C.8.8.2 Personal Communications

Carol Witham. President, California Native Plant Society. December 28, 2004 – email correspondence.

C.9 Solano Grass (Tuctoria mucronata)


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C.9.1 Listing Status

Federal: Endangered (43 *Federal Register* [FR] 44810).

State: Endangered.

California Native Plant Society (CNPS) California Rare Plant Rank: 1B.1; 1B: Rare, threatened, or endangered in California and elsewhere. 0.1: Seriously endangered in California.

Recovery Plan: Solano grass is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005) and Solano Gras*s, Tuctoria mucronata 5-year Review* (USFWS 2009).

Critical Habitat: Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule. (71 FR 7118).

The only designated critical habitat in the Plan Area for Solano grass is critical habitat subunit 1, which covers the Davis Communications Annex in southeast Yolo County.

C.9.2 Species Description and Life History

Solano grass (*Tuctoria mucronata*) is an annual grass ranging from 2 to 12 centimeters (1 to 5 inches) tall (Hickman 1993). It is restricted to areas within alkaline vernal pools that have sodium and boron salt-affected soils and to similar salt-affected areas in alkaline playa pools (Crampton 1959; Environmental Science Associates [ESA] and Yolo County 2005; Gerlach 2009, 2011). Leaves are yellow-green and covered by a sticky aromatic secretion (Crampton 1959). In the extirpated population in Olcott Lake, each plant generally produced one stem (normal range was one to four), although herbarium specimens collected from the same site were generally much larger (Woodward 1985). Individuals at the Grasslands Regional Park and Davis Communications Facility site typically produce one stem when growing on the pool bottom and multiple stems when growing slightly above the bottoms of the pools (Gerlach 2011). The lower portions of the stems of large plants lie on the ground while the upper portions are erect (Hickman 1993; Gerlach 2009, 2011). The leaves lack ligules (membrane-like tissue where the leaf joins the stem) and there is no tissue differentiation between sheath and leaf. Seeds of Solano grass germinate in very shallow water as the vernal pools and playa pools dry rapidly during late spring and the seedlings produce one floating/emergent leaf (Gerlach 2011). At the Grasslands Regional Park and Davis Communications Facility site, each spike of a small plant produces an average of 19 seeds (n = 25; range from 3 to 56) while a spike from a large plant produced 80 seeds (Gerlach 2009). Individuals typically produce one spike when growing on the pool bottom and multiple spikes when growing slightly above the bottoms, but the number of spikes also varies depending on evapotranspiration (ET) rates during growth and position in the pool: higher ET results in less spike production (Gerlach 2011). Plants begin flowering in May, June, or July approximately one month after germinating, depending on seasonal growth conditions (Gerlach 2009, 2011).

Columbus and Porter (2003) conducted germination studies on Solano grass seed and found a 2.6 percent germination rate under both aerobic and anaerobic control conditions in a laboratory environment. This rate was increased to 6.0 percent and 8.5 percent by the introduction of fungicide (Dithane M-45) and fungicide plus soil extract, respectively, under anaerobic conditions, but the same treatments under aerobic conditions were not studied. Gerlach (2009) conducted germination studies in controlled conditions that mimicked natural conditions and no seeds germinated. Seed collected in October 2008 and reintroduced into a restored vernal pool in December 2009 did not germinate until May 2011 (Gerlach 2011).While Crampton (1976) states that mature seeds are retained on the flowering culms of the dead plants until they are dispersed by water as pools begin refilling in the fall, recent seed collections at the Grasslands Regional Park and Davis Communications Facility site found that the seeds are retained on the plants for a significantly longer period of time than Colusa grass, which, in contrast, begins to shed its seed immediately with the first significant fall rains (Gerlach 2009, 2011).

C.9.3 Habitat Requirements and Ecology

Solano grass is only found on clay soils in alkaline vernal pools or alkaline playa pools that are subject to long periods of inundation (Crampton 1959; ESA and Yolo County 2005; Gerlach 2009, 2011). It is also generally found immediately above or in the lowest areas of vernal pools and in shallow depressions on the otherwise flat bottoms of alkaline playa pools (Woodward 1985; ESA 2005; Gerlach 2009, 2011). When Crampton (1959) discovered the Solano County population in 1958, it was limited to three 3- to 8-meter-diameter patches in areas with cracked soil that were covered by a brownish film and was not growing on the smooth white areas that covered most of Olcott Lake. In contrast, the Plan Area population grows primarily in areas with a cracking white soil although in some years the dried remains of cyanobacteria blooms covers the soil in the pools with a brown coating that induces soil cupping (Gerlach 2009, 2011). According to historical aerial photographs, the population in the Plan Area currently exists in a series of shallow agricultural drainage ditches that were excavated in an area of alkaline vernal pools and alkaline playa pools prior to 1937 (U.S. Department of Agriculture [USDA] 1937).

Hydrology and the chemical and physical properties of soil parent materials are responsible for the unique patterns of species distributions in alkaline vernal pools and alkaline playa pools in the Plan Area and Solano County. Williamson et al. (2005) and Rains et al. (2008) summarized the situation well with regard to parent material: "The vernal pools on clay-rich soils formed on alluvium derived from sedimentary and metasedimentary rocks of marine origin. The soils that developed on these sediments are fine grained, saline, and sodic. These soils support vernal pools that are perched surface water systems, have relatively saline, sodic, and turbid surface water, and may be nitrogen and light limited." Other studies have confirmed the nitrogen and light limitations (Barclay and Knight 1981; J. Gerlach unpublished data)..

Because of its underlying and extremely unique geologic structure, the Jepson Prairie alkaline vernal pools and alkaline playa pools are much older than the alkaline vernal pools and alkaline playa pools in the Plan Area (Graymer et al. 2002). Jepson Prairie owes its unique species assemblages and the continued existence of the alkaline playa pools and vernal pools to the presence of the underlying Montezuma Block (Band 1998). The inward-sloping sides of the block with increasing depth assure that the Montezuma Block pops up and floats like an iceberg among other crustal blocks without distorting. This unique characteristic has allowed this single flat piece of the earth's crust to persist in the same location since the oceanic plate and its accompanying archipelago of volcanoes first crashed into the North American continent and has maintained the only opening from the Central Valley to the Pacific Ocean through the rapidly rising Coast Ranges (Band 1998). After the Montezuma Block rose above the ocean, it was covered by eroded materials from the Coast Ranges that became deeply weathered infertile soils and which are clearly visible in aerial photographs (Band 1998). An ancient river channel cut across the northern edge of the block and apparently deposited the clays that underlie the Jepson Prairie alkaline vernal pools and alkaline playa pools. The Montezuma Block later tilted slightly to the north, which raised the Jepson Prairie area slightly above the surrounding area, preventing the non-saline floodwaters of the Sacramento River from flushing the salts present in its clays into the Delta.

In contrast, north of the Montezuma Block, the alkaline vernal pools and alkaline playa pools in Solano and Yolo Counties are located on a low alluvial terrace that formed above the Yolo Basin and Sacramento River Delta through the deposition of outwash clay materials when Putah Creek and Cache Creek flooded over their natural levees (Graymer et al. 2002). The spreading floodwaters deposited coarser alluvium near the channels and fine clays further away from the main channels in calmer water. As the flood waters receded, the suspended clay and dissolved salts were deposited as a relatively thin surface coating across the lower portions of the alluvial terrace. Successive flood events deposited successive layers of clay and the flooding history of the terrace is recorded in the alternating bands of alluvial material (State of California 1987). Historically, these alkaline vernal pools and alkaline playa pools occurred on the terrace in a broad arc from the Montezuma Hills to Cache Creek and in the two basins in the Plan Area between the coast range and the Dunnigan Hills/Plainfield Ridge anticline (U.S. Bureau of Soils 1909a, 1909b; Mann et al. 1911). As described above, the salts (sodium, boron, magnesium) and the clay minerals were transported to the terrace by the creeks and did not develop in situ.

The clays deposited in the Jepson Prairie Preserve area are older than 10,000 years, at least 30 feet thick near Olcott Lake, and thin to 6 feet thick near Jepson Prairie's northern edge (C. Witham pers. comm.). In contrast, the clay surface deposits at the Solano grass location in the Plan Area could be as young as 60 years old and were periodically replenished by floodwaters from Putah Creek prior to the completion of Monticello Dam on Putah Creek, which altered the hydrology of the entire region. At the Grasslands Regional Park and Davis Communications Facility site, a former distributional branch of Putah Creek forms the largest drainage and the alkaline vernal pools or drainage ditches lie above the natural drainage (Department of the Air Force 1993; ESA and Yolo County 2005). Prior to the construction of the Monticello Dam, when Putah Creek routinely flooded, the site was submerged and the turbulent hydraulics of the floodwaters scoured basins and channels in the higher surfaces that became alkaline vernal pools and swales after the floodwaters receded. The Monticello Dam and other diversions have eliminated the natural floods that created and maintained the alkaline vernal pools and alkaline playa pools.

C.9.4 Species Distribution and Population Trends

C.9.4.1 Distribution

Solano grass was first discovered in 1958 by Beecher Crampton, who collected it from Olcott Lake, which is now within the Solano Land Trust's Jepson Prairie Preserve (Witham 2006). Solano grass was last observed in Olcott Lake in 1993 when four plants were present. A second population was discovered in Solano County on a private ranch in 1985 (Woodward 1985) and a third population was discovered by Bob Holland in 1993 on the Grasslands Regional Park and Davis Communications Facility site (Figure A-8). Solano grass may have been more broadly distributed prior to conversion of the Plan Area's alkaline vernal pools and alkaline playa pools to rice fields and drainage ditches. Its rarity in playa pools in the Jepson Prairie area suggests that it may have been limited to just a few alkaline pools or alkaline playa pools at both sites.

C.9.4.2 Population Trends

The population at the Grasslands Regional Park and Davis Communications Facility site is distributed in six small sub-basins and one restored vernal pool (J. Gerlach unpublished data). During drought years the species only exists as a soil seed bank. Approximately 20,000 plants were observed at this site in 2004 (ESA and Yolo County 2005) and zero reproductive plants were observed in 2007 (J. Gerlach unpublished data). The Olcott Lake population was also similarly variable (Holland 1986). The population on the private ranch is relatively small and has varied from a few hundred individuals to zero plants during drought years (C. Witham pers. comm.) As discussed above (see Habitat Requirements and Ecology), unique geologic and hydrologic conditions are necessary to support suitable habitat for Solano grass. Due to the alternation of hydrologic processes by the construction of Monticello Dam and the cultivation of most of the formerly suitable habitat in the County, it is unlikely that Solano grass will ever occur at other sites in the Plan Area. Therefore, conservation of the known occupied habitat in this area is essential to conserve this species in the Plan Area.

C.9.5 Threats to the Species

Immediate threats to Solano grass in the Plan Area are primarily due to the invasion of its habitat by swamp timothy (*Crypsis schoenoides*) and perennial pepperweed (*Lepidium latifolium*) (ESA and Yolo County 2005). There are no known effective management tools for reducing the impacts of swamp timothy, but in 2007 Yolo County began a long-term perennial pepperweed eradication program that has proved to be effective. Swamp timothy also occurs with Solano grass at the Solano County site (Woodward 1985) but in very small numbers as compared with the Plan Area site (Witham pers. comm.). This species is vulnerable to chance extinction as it only exists in a single large population and a single small population. The extensively altered hydrology of the Plan Area site may pose an additional long-term threat to this occurrence of the species.

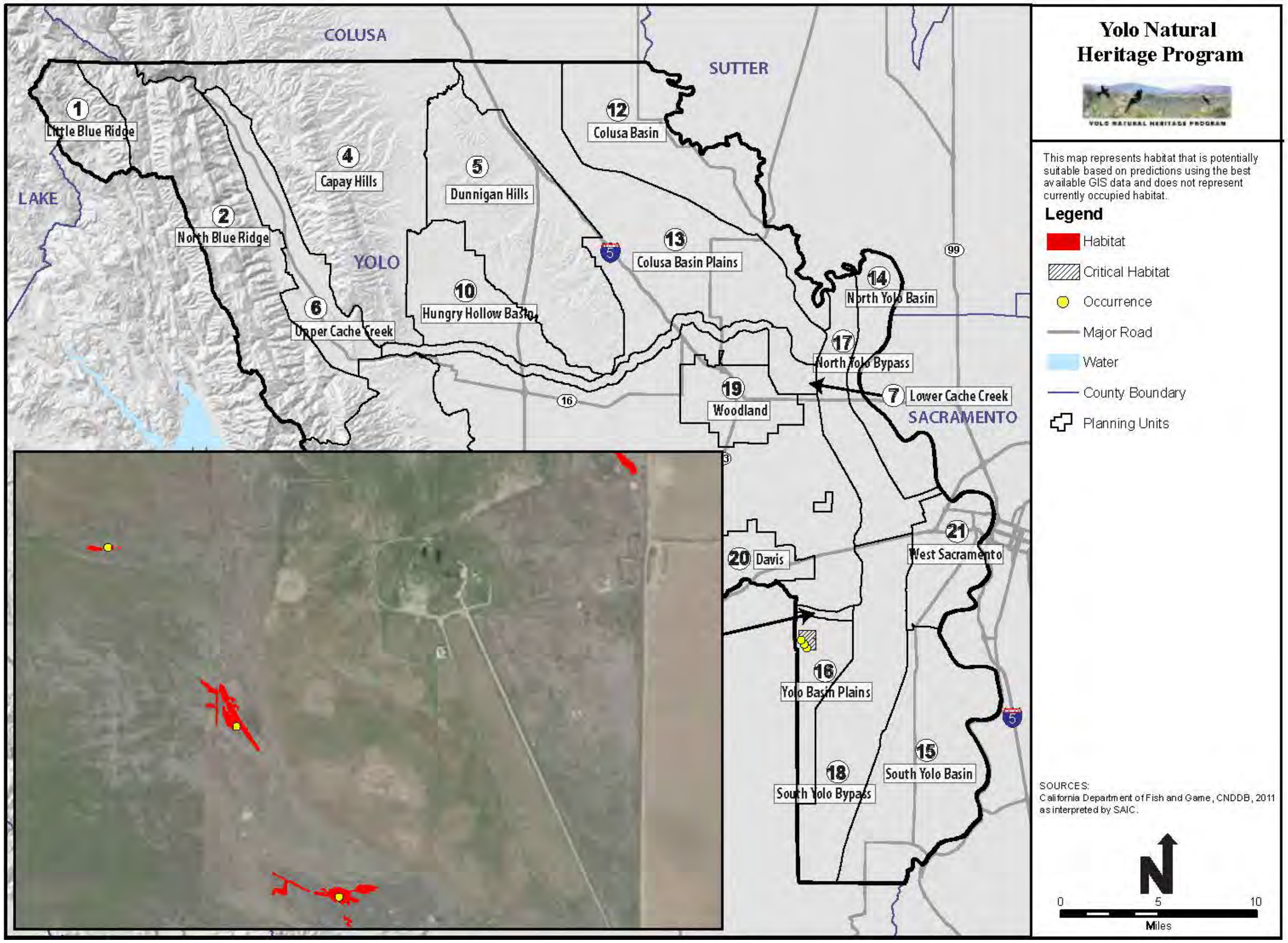
C.9.6 Recovery Plan Goals

The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005) contains the following goals for Solano grass to be met within the Plan Area in the Solano-Colusa Core Area: protect 95 percent of suitable species habitat in the Davis Communications Annex.

C.9.7 Species Habitat Model and Location Data

This species only occurs in one small area of the County and the vernal pool basins that contain the population have been precisely mapped using the Global Positioning System (GPS) (Gerlach 2009, 2011) (Figure A-8). GPS data from those surveys were used and no habitat model was developed for this species. Occurrences of the species are also based on those surveys.

Figure C-8. Solano Grass Mapped Habitat and Occurrences



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71 FR 7118. 2006. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule. *Federal Register* 71:7118.

C.9.8.2 Personal Communications

Carol Witham, California Native Plant Society. December 28, 2004 – email correspondence.

C.10 Conservancy Fairy Shrimp (*Branchinecta conservatio*)

© Doug Wirtz

C.10.1 Listing Status

Federal: Endangered (59 *Federal Register* [FR] 48136).

State: None.

Recovery Plan: Conservancy Fairy Shrimp is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005) and *Conservancy Fairy Shrimp,* Branchinecta conservatio *5-Year Review* (USFWS 2007).

Critical Habitat: Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule (71 FR 7118).

No critical habitat for Conservancy fairy shrimp has been designated in the Plan Area.

C.10.2 Species Description and Life History

C.10.2.1 Description

Conservancy fairy shrimp is a typical Branchinectid anostracan. It is typically off-white to grey, although the brood patch may be green or yellow. Depending on the rapidity of development, mature animals may vary in length from 3 to 38 millimeters (0.12 to 1.50 inches). Like other fairy shrimp, they are entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs. Males and females are generally differentiated on the basis of antennae development, thoracic projections, and brood pouch development.

C.10.2.2 Reproduction and Growth

Conservancy fairy shrimp is adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of Conservancy fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may comprise eggs from several years of breeding (USFWS 2005, 2007).

In a study using large plastic pools to simulate natural vernal pools, Helm found no difference in the time to reproduce among California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and vernal pool tadpole shrimp (46 days) (Helm 1998). However, results of that experiment supplemented by field data (Gallagher 1996; Alexander 2007) suggest that the average time to reproduce for California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, and vernal pool fairy shrimp is approximately eight weeks, while that for midvalley fairy shrimp is approximately two weeks. No data were reported regarding pool fertility or the impacts of predation on the time to reproduce. These reproduction periods may be shortened or lengthened by warmer or colder water temperatures (Helm 1998).

C.10.2.3 Feeding

Conservancy fairy shrimp is an omnivorous filter-feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do other crustacean groups (Eriksen and Belk 1999).

C.10.2.4 Predation and Dispersal

Planktonic Crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1996; Bogiatto and Karnegis 2006).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Eriksen and Belk 1999).

C.10.3 Habitat Requirements and Ecology

As with other vernal pool crustacean species, Conservancy fairy shrimp is sporadic in its distribution, often inhabiting only one or a few vernal pools in otherwise more widespread pool complexes. Pools within a complex typically are separated by distances on the order of 5 or more feet (1.5 meters) and may form dense mosaics of small pools or a sparser scattering of larger pools (USFWS 2005). Conservancy fairy shrimp have been found in vernal pools ranging in size from 323 square feet to 88 acres (30 square meters to 35.6 hectares) at elevations ranging from 16 to 5,577 feet (5 to 1,700 meters) (USFWS 2005, 2007).

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters Conservancy fairy shrimp inhabits fill in the fall and winter during the beginning of the wet season, dry in late spring at the beginning of the dry season and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from runoff from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons; the continuity and extent of hardpans and claypans underlying nonclay soils; the existence of a perched aquifer overlying the pans; slope; effects of vegetation on evapotranspiration rates; compaction of surface soils by grazing animals; and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

Typical turbid-water habitats for Conservancy fairy shrimp are large, playa-type vernal pools or long-inundation, smaller vernal pools (Eng et al. 1990; USFWS 2007). Common wetland plant species that co-occur with Conservancy fairy shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryringium* spp.), downingia (*Downingia ornatissma* or *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007).

C.10.4 Species Distribution and Population Trends

C.10.4.1 Distribution

The historical distribution of Conservancy fairy shrimp is not known, but the distribution of vernal pool habitats in the areas where the species is now known to occur was once more continuous and larger in area than today (USFWS 2005). The species is currently found in disjunct and fragmented habitats across the Central Valley of California from Tehama County to Merced County and at two Southern California locations on the Los Padres National Forest in Ventura County (USFWS 2005, 2007; California Natural Diversity Database [CNDDB] 2011).

Conservancy fairy shrimp is known to occur at the Tule Ranch Unit of the California Department of Fish and Wildlife (DFW) Yolo Bypass Wildlife Area within the Plan Area (Witham 2003; CNDDB 2011). In general, within the Plan Area, turbid-water playa pools and smaller vernal pools that may support the species occur on alkaline soils at the DFW Tule Ranch Unit, the Grasslands Regional Park and Davis Communications Facility site, and in the alkali sink area southeast of the City of Woodland.

C.10.4.2 Population Trends

The population trends of this species are unknown, but it is assumed that they have been reduced greatly in extent and density as their habitat has been reduced and fragmented (USFWS 2005).

C.10.5 Threats to the Species

Threats to vernal pools and playa pools and species in general, including Conservancy fairy shrimp, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005). In addition, the Recovery Plan identified several threats specific to the Conservancy fairy shrimp, which are discussed further below.

C.10.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (USFWS 2005, 2007). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (USFWS 2005, 2007).

C.10.5.2 Agricultural Conversion

Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005, 2007).

C.10.5.3 Invasive Species

Perennial pepperweed is the most pervasive nonnative invasive species threat in the clay-bottom vernal pools and surrounding uplands in the Plan Area, and swamp timothy may pose a similar but less severe threat on the pool bottoms and sides (Environmental Science Associates [ESA] and Yolo County 2005; J. Gerlach unpublished data). Italian ryegrass (*Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone and flood plains of clay-bottom vernal pools and saturated soil and ponding areas of alkali sink habitat, and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

C.10.5.4 Altered Hydrology

Human disturbances can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005, 2007).

C.10.6 Recovery Plan Goals

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) includes Conservancy fairy shrimp but does not contain goals to be met for the species in the Plan Area.

C.10.7 Species Habitat Model and Location Data

C.10.7.1 Geographic Information System (GIS) Map Data Sources

The Conservancy fairy shrimp habitat model is map based and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Brent Helm 2010 wetlands mapping for Yolo County; J. Gerlach unpublished data), and heads-up digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure A-9). Using these datasets, the habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat. Vegetation types were assigned based on the species requirements as described above in Section C.9.3, *Habitat Requirements and Ecology* and the assumptions described below.

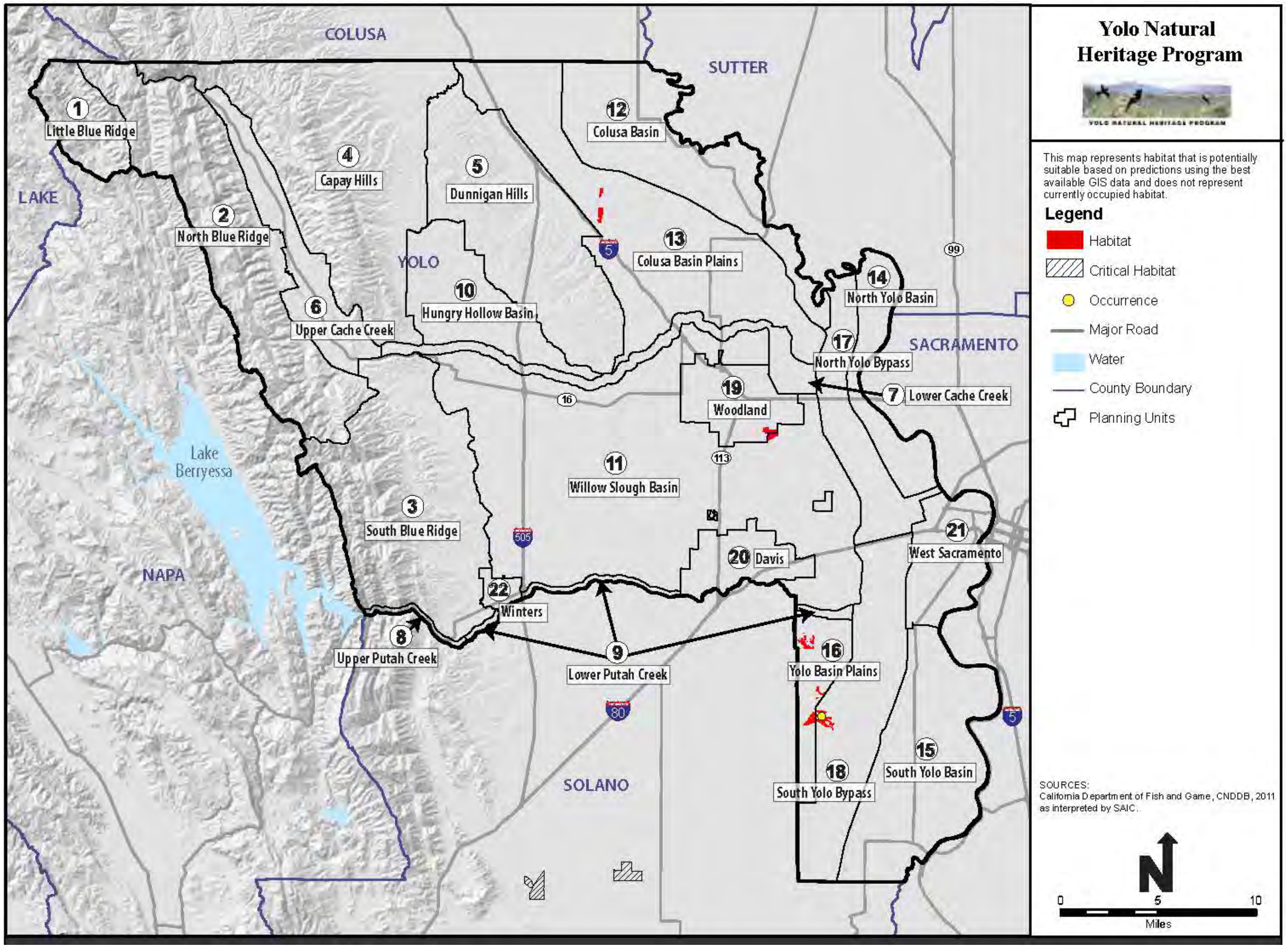
Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

Mapped Conservancy fairy shrimp habitat is comprised of the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

1 **Figure C-9. Conservancy Fairy Shrimp Modeled Habitat and Occurrences**



2

Assumptions. Historical and current records of this species in the Plan Area indicate that its known distribution is limited to the DFW Tule Ranch Unit of the Plan Area (Witham 2003; ESA and Yolo County 2005; CNDDB 2011). However, because the Plan Area has not been completely surveyed for this species, its potential distribution was increased to include the alkali sink habitat, which has a low density of small vernal pools and two potential playa pools. All other areas of alkaline clay soils in the county have been significantly altered by intensive agriculture and development. Ditches and isolated depressions in agricultural fields and vacant land in undeveloped areas may provide ephemeral anthropogenic habitat. Because these features are inundated during the wet season and may have historically been located in or near areas with natural vernal pools or playa pools, they may support individuals or small populations of this species. However, these features do not possess the full complement of ecosystem and community characteristics of natural habitat and are generally ephemeral features that are eliminated during the course of normal agricultural practices.

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71 FR 7118. 2006. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule. *Federal Register* 71:7118.

C.11 Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

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C.11.1 Listing Status

Federal: Threatened (59 *Federal Register* [FR] 48136).

State: None.

Recovery Plan: Vernal pool fairy shrimp is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005) and *Vernal Pool Fairy Shrimp,* Branchinecta lynchi *5-Year Review* (USFWS 2007).

Critical Habitat: Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule (71 *Federal Register* [FR] 7118).

No critical habitat for vernal pool fairy shrimp has been designated in the Plan Area.

C.11.2 Species Description and Life History

C.11.2.1 Description

Vernal pool fairy shrimp is a typical Branchinectid anostracan. They are typically off-white to grey. Depending on the rapidity of development, mature animals may vary in length from 3 to 38 millimeters (0.12 to 1.50 inch). Like other fairy shrimp, they are entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs. Males and females are generally differentiated on the basis of antennae development, thoracic projections, and brood pouch development.

C.11.2.2 Reproduction and Growth

Vernal pool fairy shrimp are adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of vernal pool fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may comprise eggs from several years of breeding (USFWS 2005, 2007). Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found no difference in the time to reproduce among California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and vernal pool tadpole shrimp (46 days) (Helm 1998). However, that experiment supplemented by field data (Gallagher 1996; Alexander 2007) suggests that the average time to reproduce for California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, and vernal pool fairy shrimp is approximately eight weeks, while that for midvalley fairy shrimp is approximately two weeks. No data were reported regarding pool fertility or the impacts of predation on the time to reproduce. These reproduction periods may be shortened or lengthened by warmer or colder water temperatures (Helm 1998).

C.11.2.3 Feeding

Vernal pool fairy shrimp is an omnivorous filter-feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999).

C.11.2.4 Predation and Dispersal

Planktonic Crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1996; Bogiatto and Karnegis 2006).

Predator consumption of vernal pool fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Erickson and Belk 1999).

C.11.3 Habitat Requirements and Ecology

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters vernal pool fairy shrimp inhabits fill in the fall and winter during the beginning of the wet season, dry in late spring at the beginning of the dry season, and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from runoff from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons; the continuity and extent of hardpans and claypans underlying nonclay soils; the existence of a perched aquifer overlying the pans; slope; effects of vegetation on evapotranspiration rates; compaction of surface soils by grazing animals; and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for vernal pool fairy shrimp are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999). Common wetland plant species that co-occur with vernal pool fairy shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryringium* spp.), downingia (*Downingia ornatissma* or *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007). Vernal pool fairy shrimp have also occasionally been found in degraded vernal pool habitats and artificially created seasonal pools (Helm 1998).

Vernal pool fairy shrimp commonly co-occur with the fairy shrimp (*Linderiella occidentalis, Branchinecta conservatio*, *B. lindahli*, *B. coloradensis*) and vernal pool tadpole shrimp (*Lepidurus packardi*). The midvalley shrimp (*B. mesovallensis*) and *B. longiantenna* both occur within the range of vernal pool fairy shrimp but are typically found in different habitats (USFWS 2005, 2007).

C.11.4 Species Distribution and Population Trends

C.11.4.1 Distribution

Vernal pool fairy shrimp was identified in 1990 (Eng et al. 1990) and there is little information on the historical range of the species. It has the largest geographical range of listed fairy shrimp in California, but is seldom abundant (Eng et al. 1990). The species is currently found in disjunct and fragmented habitats across the Central Valley of California from Shasta County to Tulare County and the central and southern Coast Ranges from northern Solano County to Ventura County, California (USFWS 2005, 2007; California Natural Diversity Database [CNDDB] 2011). Additional disjunct occurrences have been identified in Southern California and in Jackson County, Oregon. In California, it occurs in a wide range of vernal pools, and in the Altamont Pass area (Contra Costa and Alameda counties) it occurs in clear-water depression pools in sandstone outcrops (Eng et al. 1990; Eriksen and Belk 1999; CNDDB 2011).

Vernal pool fairy shrimp is present on the California Department of Fish and Wildlife (DFW) Tule Ranch Unit, an historical abandoned old channel of Putah Creek/Dry Slough in a vacant lot in the center of the City of Winters, and in a farmed channel of a tributary to Dry Slough on the D-Q University property east of the City of Winters (USFWS 2005, 2007; CNDDB 2011). The City of Winters and D-Q University sites are not considered to be natural habitat for this species. In general, within the Plan Area, turbid-water playa pools as well as smaller vernal pools that may support the species occur on alkaline soils at the DFW Tule Ranch Unit, the Grasslands Regional Park and Davis Communications Facility site. Areas that pond in the alkali sink area southeast of the City of Woodland are also potential habitat.

C.11.4.2 Population Trends

The population trends of this species are unknown, but it is assumed that they have been reduced greatly in extent and density as their habitat has been reduced and fragmented (USFWS 2005).

C.11.5 Threats to the Species

Threats to vernal pools and playa pools and species in general, including vernal pool fairy shrimp, were identified in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005). In addition, the Recovery Plan identified several threats specific to the vernal pool fairy shrimp.

C.11.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (USFWS 2005, 2007). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (USFWS 2005, 2007).

C.11.5.2 Agricultural Conversion

Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005, 2007).

C.11.5.3 Invasive Species

Perennial pepperweed is the most pervasive non-native invasive species threat in the clay-bottom vernal pools and surrounding uplands in the Plan Area, and swamp timothy may pose a similar but less severe threat on the pool bottoms and sides (Environmental Science Associates [ESA] and Yolo County 2005; J. Gerlach unpublished data). Italian ryegrass (*Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone and flood plains of clay-bottom vernal pools and saturated soil and ponding areas of alkali sink habitat, and it appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

C.11.5.4 Altered Hydrology

Human disturbances can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005, 2007).

C.11.6 Recovery Plan Goals

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) includes vernal pool fairy shrimp but does not contain goals to be met for the species in the Plan Area.

C.11.7 Species Habitat Model and Location Data

C.11.7.1 Geographic Information System (GIS) Map Data Sources

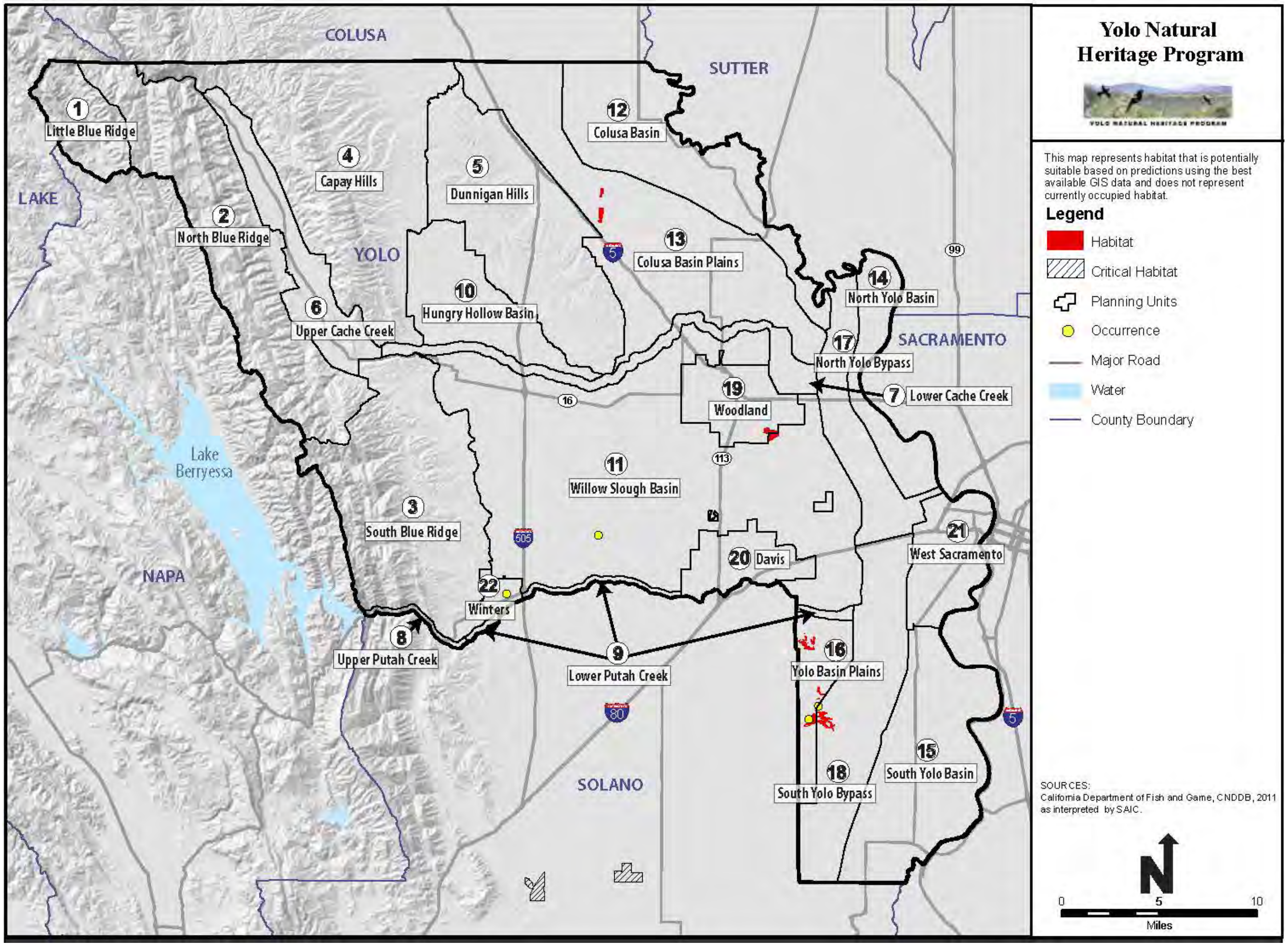
The vernal pool fairy shrimp habitat model is map based and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Helm 2010; J. Gerlach unpublished data), and heads-up digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure A-10). Using these datasets, the habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat. Vegetation types were assigned based on the species requirements as described above in Section C.10.3, *Habitat Requirements and Ecology* and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

C.11.7.2 Mapped vernal pool fairy shrimp habitat is comprised of the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Figure C-10. Vernal Pool Fairy Shrimp Mapped Habitat and Occurrences



Assumptions. Historical and current records of this species in the Plan Area indicate that its known distribution is limited to DFW Tule Ranch Unit, a low spot in a vacant lot in the center of the City of Winters, and in abandoned and farmed channels of a channelized slough on the D-Q University property east of the City of Winters within the Plan Area (USFWS 2005, 2007; CNDDB 2011). The City of Winters and D-Q University sites are not considered to be natural habitat for this species. However, because the Plan Area has not been completely surveyed for this species, its potential distribution was increased to include the alkali sink habitat, which has a low density of small vernal pools and two potential playa pools. All other areas of alkaline clay soils in the county have been significantly altered by intensive agriculture and development. As noted above, ditches and isolated depressions in agricultural fields and vacant land in may provide ephemeral anthropogenic habitat. Because these features are inundated during the wet season and may have historically been located in or near areas with natural vernal pools or playa pools, they may support individuals or small populations of this species. However, these features do not possess the full complement of ecosystem and community characteristics of natural habitat and are generally ephemeral features that are eliminated during the course of normal agricultural practices.

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71 FR 7118. 2006. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule. *Federal Register* 71:7118.

C.12 Midvalley Fairy Shrimp (*Branchinecta mesovallensis*)

C.12.1 Listing Status

Federal: None.

State: None.

Recovery Plan: Midvalley fairy shrimp is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005).

C.12.2 Species Description and Life History

C.12.2.1 Description

Midvalley fairy shrimp is a typical branchinectid anostracan. Live animals are typically off-white to grey, although the brood pouch may be green or yellow. Depending upon the rapidity of development, mature animals may vary in length from 3 to 38 millimeters (0.12 to 1.5 inch). Like other fairy shrimp, they are entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and 11 pairs of swimming legs. Males and females are generally differentiated on the basis of antennae development, thoracic projections, and brood pouch development.

C.12.2.2 Reproduction and Growth

During the dry phase of their habitat, the anostracans survive as diapausing cysts (resting eggs) in and on the substrate (Sars 1896, 1898; Eriksen and Belk 1999; Rogers and Fugate 2001). When the habitat inundates from seasonal rainfall, some of the cysts hatch, and the nauplii (early larval form of anostraca) swim into the upper water column (Eriksen and Belk 1999). The cysts lie dormant in the substrate until the pool dries and re-inundates during the subsequent rains. Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found no difference in the time to reproduce among California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and vernal pool tadpole shrimp (46 days) (Helm 1998). However, that experiment supplemented by field data (Gallagher 1996; Alexander 2007) suggests that the average time to reproduce for California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, and vernal pool fairy shrimp is approximately eight weeks, while that for midvalley fairy shrimp is approximately two weeks. No data were reported regarding pool fertility or the impacts of predation on the time to reproduce. These reproduction periods may be shortened or lengthened by warmer or colder water temperatures (Helm 1998).

C.12.2.3 Predation and Dispersal

Planktonic Crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1996; Bogiatto and Karnegis 2006).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Eriksen and Belk 1999).

C.12.3 Habitat Requirements and Ecology

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters midvalley fairy shrimp inhabits fill in the fall and winter during the beginning of the wet season, dry in late spring at the beginning of the dry season, and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from runoff from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons; the continuity and extent of hardpans and claypans underlying nonclay soils; the existence of a perched aquifer overlying the pans; slope; effects of vegetation on evapotranspiration rates; compaction of surface soils by grazing animals; and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for midvalley fairy shrimp are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999).

Common wetland plant species that co-occur with midvalley shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryringium* spp.), downingia (*Downingia ornatissma* or *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007).

Vernal pools that support these fairy shrimp are often grass or mud-bottomed, with clear to tea-colored water, and are often in basalt flow depression pools in grasslands (Eriksen and Belk 1999). Midvalley fairy shrimp have been found in habitats ranging from 0.0004 to 0.2 hectare (0.001 to 0.5 acre) and typically are found in smaller, short-lived pools and other seasonal wetlands compared with other species within the same genus (Eriksen and Belk 1999).

Midvalley fairy shrimp commonly co-occur with California fairy shrimp (*Linderiella occidentalis*) (Eriksen and Belk 1999; Rogers in prep.). This species has also been reported co-occurring with the vernal pool fairy shrimp (*Branchinecta lynchi*) (Eng et al. 1990) on three occasions, where midvalley fairy shrimp was probably washed into the vernal pool fairy shrimp habitat by abnormally high rainfall (Eriksen and Belk 1999).

C.12.4 Species Distribution and Population Trends

C.12.4.1 Distribution

Midvalley fairy shrimp is endemic to California Central Valley grassland vernal pools (Belk and Fugate 2000). All known occurrences are between central Sacramento County and northern Fresno County. Reported occurrences include scattered occurrences from the Mather Field area of Sacramento, south through Galt from Sacramento County; two locations in the Yolo Bypass southwest of Saxon in Yolo County; Jepson Prairie, Travis Air Force Base, and Vacaville areas in Solano County; from Lodi, north to the county border in San Joaquin County; the Byron Airport in Contra Costa County; the Virginia Smith Trust (Haystack Mountain), and Arena Plains National Wildlife Reserve (NWR) in Merced County; one location in central Madera County; and one in northern Fresno County (Eriksen and Belk 1999; Belk and Fugate 2000).

Midvalley fairy shrimp has been reported from the California Department of Fish and Wildlife (DFW) Tule Ranch Unit within the Plan Area (USFWS 2005; California Natural Diversity Database [CNDDB] 2011). In general, within the Plan Area, turbid-water playa pools as well as smaller vernal pools that may support the species occur on alkaline soils at the DFW Tule Ranch Unit, the Grasslands Regional Park and Davis Communications Facility site. Areas that pond in the alkali sink area southeast of the City of Woodland are also potential habitat.

C.12.4.2 Population Trends

The population trends of this species are unknown but it is assumed that they have been reduced greatly in extent and density as their habitat has been reduced and fragmented (USFWS 2005).

C.12.5 Threats to the Species

Threats to vernal pools and playa pools and species in general, including midvalley fairy shrimp, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005).

C.12.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (USFWS 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (USFWS 2005).

C.12.5.2 Agricultural Conversion

Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005).

C.12.5.3 Invasive Species

Perennial pepperweed is the most pervasive nonnative invasive species threat in the clay-bottom vernal pools and surrounding uplands in the Plan Area and swamp timothy may pose a similar but less severe threat on the pool bottoms and sides (Environmental Science Associates [ESA] 2005; J. Gerlach unpublished data). Italian ryegrass (*Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone and flood plains of clay-bottom vernal pools and saturated soil and ponding areas of alkali sink habitat and appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

C.12.5.4 Altered Hydrology

Human disturbances can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005).

C.12.6 Species Habitat Model and Location Data

C.12.6.1 Geographic Information System (GIS) Map Data Sources

The midvalley fairy shrimp habitat model is map based and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Helm 2010; J. Gerlach unpublished data), and heads-up digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure A-11). Using these datasets, the habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat. Vegetation types were assigned based on the species requirements as described above in Section C.11.3, *Habitat Requirements and Ecology* and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

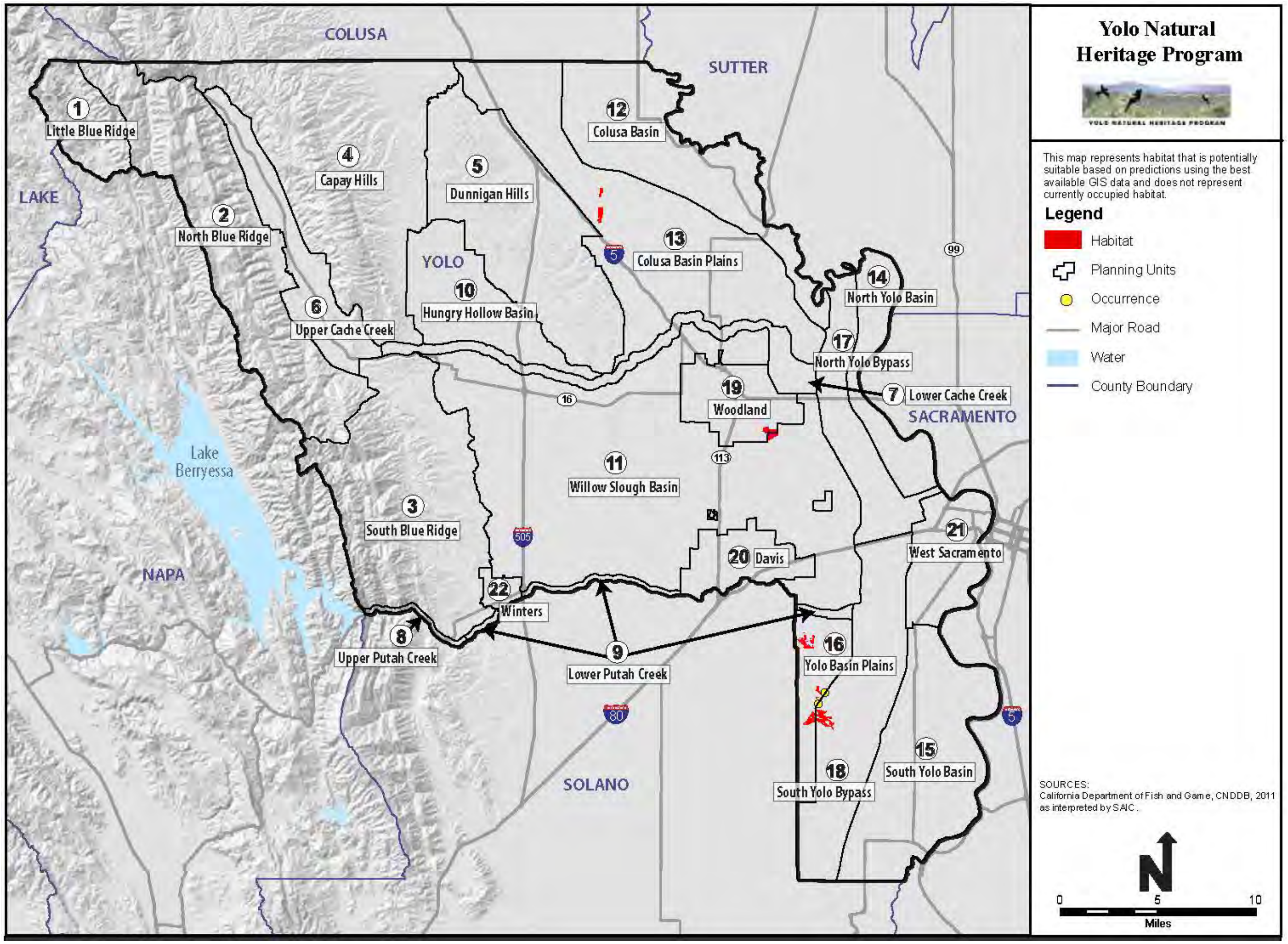
Mapped midvalley fairy shrimp habitat is comprised of the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Assumptions. Historical and current records of this species in the Plan Area indicate that its known distribution is limited to DFW Tule Ranch Unit within the Plan Area (USFWS 2005; CNDDB 2011). However, because the Plan Area has not been completely surveyed for this species, its potential distribution was increased to include the alkali sink habitat, which has a low density of small vernal pools and two potential playa pools. All other areas of alkaline clay soils in the county have been significantly altered by intensive agriculture and development. As noted above, ditches and isolated depressions in agricultural fields and vacant land may provide ephemeral anthropogenic habitat. Because these features are inundated during the wet season and may have historically been located in or near areas with natural vernal pools or playa pools, they may support individuals or small populations of this species. However, these features do not possess the full complement of ecosystem and community characteristics of natural habitat and are generally ephemeral features that are eliminated during the course of normal agricultural practices.

Figure C-11. Midvalley Fairy Shrimp Mapped Habitat and Occurrences



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C.13 California Linderiella Fairy Shrimp (*Linderiella occidentalis*)

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C.13.1 Listing Status

Federal: None.

State: None.

Recovery Plan: California linderiella fairy shrimp is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005).

C.13.2 Species Description and Life History

C.13.2.1 Description

Like other fairy shrimp, California linderiella is entirely aquatic with delicate elongate bodies, large stalked compound eyes, no carapaces, and eleven pairs of swimming legs. Males and females are generally differentiated on the basis of antennae development, thoracic projections, and brood pouch development. Live animals are off-white to grayish in color and are translucent, but unlike fairy shrimp in the genus Branchinecta, California linderiella tend to be slightly smaller and have distinctive red eyes (Eriksen and Belk 1999).

C.13.2.2 Reproduction and Growth

California linderiella is adapted to the environmental conditions of its ephemeral habitats. One adaptation is the ability of the eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cool, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons, some but not all of the eggs may hatch. The egg bank in the soil may include eggs from several years of breeding (USFWS 2005).

Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found no difference in the time to reproduce among California linderiella, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and vernal pool tadpole shrimp (Helm 1998). However, that experiment supplemented by field data (Gallagher 1996; Alexander 2007) suggests that the average time to reproduce for California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, and vernal pool fairy shrimp is approximately eight weeks, while that for midvalley fairy shrimp is approximately two weeks. No data were reported regarding pool fertility or the impacts of predation on the time to reproduce. These reproduction periods may be shortened or lengthened by warmer or colder water temperatures as the minimum time to reproduce for California linderiella is in the range of two to four weeks (Helm 1998).

C.13.2.3 Feeding

California linderiella is an omnivorous filter-feeder. In general, all fairy shrimp species indiscriminately filter particles that include bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp species will attempt to consume whatever material they can fit into their feeding groove and apparently do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999).

C.13.2.4 Predation and Dispersal

Planktonic Crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1996; Bogiatto and Karnegis 2006).

Predator consumption of fairy shrimp cysts aids in distributing populations of fairy shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through fairy shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Eriksen and Belk 1999).

C.13.3 Habitat Requirements and Ecology

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters California linderiella inhabits fill in the fall and winter during the beginning of the wet season and dry in late spring at the beginning of the dry season and remain desiccated throughout the summer (Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from runoff from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent that is necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons, the continuity and extent of hardpans and claypans underlying nonclay soils, the existence of a perched aquifer overlying the pans; slope; effects of vegetation on evapotranspiration rates; compaction of surface soils by grazing animals; and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for California linderiella are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999; California Natural Diversity Database [CNDDB] 2010). Common wetland plant species that co-occur with California linderiella include toad rush

(*Juncus bufonius*), coyote thistle (*Eryringium* spp.), downingia (*Downingia ornatissma* or *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007).

California linderiella is a component of a larger invertebrate community (King et al. 1996; Rogers 1998; Eriksen and Belk 1999). This invertebrate community includes mostly planktonic Crustacea dependent on temporary waters, including copepods, cladocerans, and ostracodes, as well as flatworms and a suite of insect species, including vernal pool haliplid beetle (*Apterliplus parvulus*), scimitar backswimmers (*Buenoa scimitra*), Ricksecker's hydrochara (*Hydrochara rickseckeri*), and many others (Rogers 1998). These habitats are usually low in opportunistic species that include mosquitoes and chironomid midges in the genus *Chironomus* (Rogers 1998).

C.13.4 Species Distribution and Population Trends

C.13.4.1 Distribution

California linderiella is the most common fairy shrimp in California and is endemic to the state (Eriksen and Belk 1999). It has been reported in the Central Valley from Shasta County south to Fresno County and in the Coast and Transverse ranges from Mendocino County south to Ventura County (Eriksen and Belk 1999; CNDDB 2010) and has been collected at elevations from near sea level to 1,159 meters (3,800 feet) (Eriksen and Belk 1999). California linderiella co-occurs with 19 other large branchiopods including conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*B. longiantenna*), vernal pool fairy shrimp (*B. lynchi*), midvalley fairy shrimp (*B. mesovallensis*), and vernal pool tadpole shrimp (*Lepidurus packardi*) (Helm 1998; Eriksen and Belk 1999). It most often co-occurs in pools also inhabited by vernal pool fairy shrimp, in which case California linderiella is generally more numerous (Eriksen and Belk 1999).

California linderiella has been reported from the California Department of Fish and Wildlife (DFW) Tule Ranch Unit and east of the City of Davis in borrow pits and ditches along Interstate 80 within the Plan Area (USFWS 2005; CNDDB 2011). In general, within the Plan Area, turbid-water playa pools as well as smaller vernal pools that may support the species occur on alkaline soils at the DFW Tule Ranch Unit, the Grasslands Regional Park and Davis Communications facility site. Areas that pond in the alkali sink area southeast of the City of Woodland are also potential habitat.

C.13.4.2 Population Trends

The population trends of this species are unknown, but it is assumed that they have been reduced greatly in extent and density as their habitat has been reduced and fragmented (USFWS 2005).

C.13.5 Threats to the Species

Threats to vernal pools and playa pools and species in general, including California linderiella, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005). In addition, the Recovery Plan identified several threats specific to the vernal pool fairy shrimp.

C.13.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (USFWS 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (USFWS 2005).

C.13.5.2 Agricultural Conversion

Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005).

C.13.5.3 Invasive Species

Perennial pepperweed is the most pervasive nonnative invasive species threat in the clay-bottom vernal pools and surrounding uplands in the Plan Area and swamp timothy may pose a similar but less severe threat on the pool bottoms and sides (Environmental Science Associates [ESA] and Yolo County 2005; J. Gerlach unpublished data). Italian ryegrass (*Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone and flood plains of clay-bottom vernal pools and saturated soil and ponding areas of alkali sink habitat, and it appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

C.13.5.4 Altered Hydrology

Human disturbances can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005).

C.13.6 Species Habitat Model and Location Data

C.13.6.1 Geographic Information System (GIS) Map Data Sources

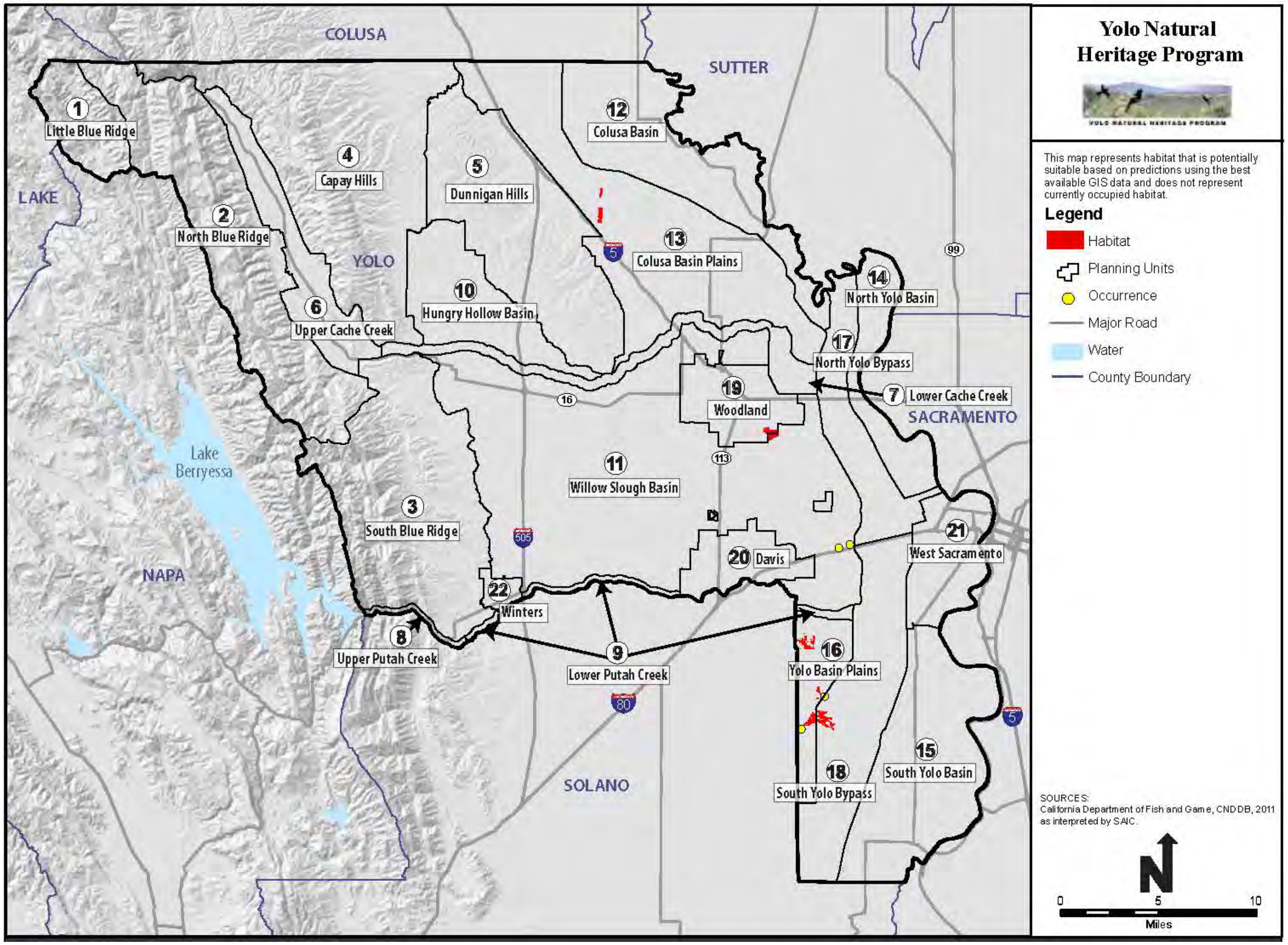
The California linderiella habitat model is map based and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Helm 2010; J. Gerlach unpublished data), and heads-up digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure A-12). Using these datasets, the habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat. Vegetation types were assigned based on the species requirements as described in Section C.12.3, *Habitat Requirements and Ecology* above and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

Mapped California linderiella habitat is comprised of the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Figure C-12. California Linderiella Fairy Shrimp Mapped Habitat and Occurrences



Assumptions. Historical and current records of this species in the Plan Area indicate that its known distribution is limited to DFW Tule Ranch Unit, and borrow pits and ditches along Interstate 80 (USFWS 2005, CNDDB 2011). The Interstate 80 sites are not considered to be natural habitat for this species. However, because the Plan Area has not been completely surveyed for this species, its potential distribution was increased to include the alkali sink habitat, which has a low density of small vernal pools and two potential playa pools. All other areas of alkaline clay soils in the county have been significantly altered by intensive agriculture and development. As noted above, ditches and isolated depressions in agricultural fields and vacant land may provide ephemeral anthropogenic habitat. Because these features are inundated during the wet season and may have historically been located in or near areas with natural vernal pools or playa pools, they may support individuals or small populations of this species. However, these features do not possess the full complement of ecosystem and community characteristics of natural habitat and are generally ephemeral features that are eliminated during the course of normal agricultural practices.

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C.14 Vernal Pool Tadpole Shrimp (*Lepidurus packardi*)

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C.14.1 Listing Status

Federal: Endangered (59 *Federal Register* [FR] 48136).

State: None.

Recovery Plan: Vernal pool tadpole shrimp is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005) and *Vernal Pool Tadpole Shrimp,* Lepidurus packardi *5-Year Review* (USFWS 2007).

Critical Habitat: Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants; Final Rule (71 FR 7118).

The only designated critical habitat in the Plan Area for vernal pool tadpole shrimp is critical habitat subunit 10B, which covers the Davis Communications Annex in southeast Yolo County.

C.14.2 Species Description and Life History

C.14.2.1 Description

Vernal pool tadpole shrimp is characterized by a smooth protective concave shell or carapace that protects its head and thorax. A pair of eyes is centered at the anterior end of its shell. Its segmented abdomen is visible (posterior), and the last segment produces a caudal lamina (tail plate), which is diagnostic for the genus, and a pair of whip-like appendages called cercopods. At full maturity, vernal pool tadpole shrimp has 30–35 pairs of appendages called phyllopods (leaf-feet) that propel it through the water and through which it exchanges oxygen (Rogers 2001). Vernal pool tadpole shrimp may vary in coloration, depending on habitat, although it is most commonly green. In highly turbid water, this species may be nearly translucent to buff-colored with brown mottles. In slightly turbid to clear water, vernal pool tadpole shrimp shows greater variety; coloration may be light green, dark green, dark green mottled with brown, chocolate brown, brown with green mottles, and black.

C.14.2.2 Reproduction and Growth

Vernal pool tadpole shrimp are adapted to the environmental conditions of their ephemeral habitats. One adaptation is the ability of vernal pool tadpole shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry. The cysts survive the hot, dry summers and cold, wet winters that follow until the vernal pools and swales fill with rainwater and conditions are right for hatching. When the pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may comprise eggs from several years of breeding (USFWS 2005, 2007). Beyond inundation of the habitat, the specific cues for hatching are unknown, although temperature and conductivity (solute concentration) are believed to play a large role (Helm 1998; Eriksen and Belk 1999).

In a study using large plastic pools to simulate natural vernal pools, Helm found no difference in the time to reproduce among California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and vernal pool tadpole shrimp (46 days) (Helm 1998). However, that experiment supplemented by field data (Gallagher 1996; Alexander 2007) suggests that the average time to reproduce for California linderiella, Conservancy fairy shrimp, longhorn fairy shrimp, and vernal pool fairy shrimp is approximately eight weeks, while that for midvalley fairy shrimp is approximately two weeks. No data were reported regarding pool fertility or the impacts of predation on the time to reproduce. These reproduction periods may be shortened or lengthened by warmer or colder water temperatures (Helm 1998).

Vernal pool tadpole shrimp have relatively high reproductive rates and may be hermaphroditic. Sex ratios can vary, perhaps in response to changes in water temperature (Ahl 1991). Genetic variation among vernal pool tadpole shrimp was studied in populations at 20 different sites in the Central Valley (King 1996). The results found that 96 percent of the genetic variation measured was due to differences between sites. This result corresponds with the findings of other researchers that vernal pool crustaceans have low rates of gene flow between separated sites. The low rate of exchange between vernal pool tadpole shrimp populations is probably a result of the spatial isolation of their habitats and their reliance on passive dispersal mechanisms. However, the studies also found that gene flow between pools within the same vernal pool complex is much higher. This indicates that vernal pool tadpole shrimp populations, like most vernal pool crustacean populations, are defined by vernal pool complexes and not by individual vernal pools (USFWS 2005).

C.14.2.3 Feeding

Vernal pool tadpole shrimp are omnivorous, with a strong preference for animal matter, and will capture and consume live invertebrates including fairy shrimp and other vernal pool tadpole shrimp, amphibian larvae, or carrion, and they also filter detritus for micrometazoa (USFWS 2005, 2007).

C.14.2.4 Predation and Dispersal

Planktonic Crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard (*Anas platyrhynchos*), green-winged teal (*A. crecca*), bufflehead (*Bucephala albeola*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferus*) all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months (Silveira 1996; Bogiatto and Karnegis 2006).

Predator consumption of tadpole shrimp cysts aids in distributing populations of tadpole shrimp. Predators (e.g., birds and amphibians) expel viable cysts in their excrement, often at locations other than where they were consumed. If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also transported by wind and in mud carried on the feet of animals, including livestock that may wade through vernal pool tadpole shrimp habitat. This type of dispersal aids ephemeral pool crustaceans in exploiting a wide variety of ephemeral habitats (Eriksen and Belk 1999).

C.14.3 Habitat Requirements and Ecology

This species is entirely dependent on the aquatic environment provided by the temporary waters of natural vernal pool and playa pool ecosystems as well as the artificial environments of ditches and tire ruts (King et al. 1996; Helm 1998; Eriksen and Belk 1999). The temporary waters vernal pool tadpole shrimp inhabits fill in the fall and winter during the beginning of the wet season and dry in late spring at the beginning of the dry season and remain desiccated throughout the summer (Helm 1998; Eriksen and Belk 1999). The temporary waters fill directly from precipitation as well as from runoff from their watersheds (Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008). The watershed extent necessary for maintaining the hydrological functions of the temporary waters depends on a number of complex factors, including the hydrologic conductivity of the surface soil horizons; the continuity and extent of hardpans and claypans underlying non-clay soils; the existence of a perched aquifer overlying the pans; slope; effects of vegetation on evapotranspiration rates; compaction of surface soils by grazing animals; and other factors (Marty 2004; Pyke and Marty 2005; Williamson et al. 2005; Rains et al. 2006, 2008; O'Geen et al. 2008).

The temporary waters that are habitat for vernal pool tadpole shrimp are extremely variable and range from clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999). Common wetland plant species that co-occur with vernal pool tadpole shrimp include toad rush (*Juncus bufonius*), coyote thistle (*Eryringium* spp.), downingia (*Downingia ornatissma* or *D. bicornuta*), goldfields (*Lasthenia* spp.), woolly marbles (*Psilocarphus* spp.), and hair grass (*Deschampsia* spp.) (King et al. 1996; Alexander and Schlising 1997, 1998; Helm 1998; Plattencamp 1998; Eriksen and Belk 1999; Alexander 2007).

Vernal pool tadpole shrimp commonly co-occur with the fairy shrimp (*Linderiella occidentalis, Branchinecta conservatio, B. lindahli, B. coloradensis*) and vernal pool fairy shrimp (*B. lynchi*). The midvalley shrimp (*B. mesovallensis*) and *B. longiantenna* both occur within the range of vernal pool tadpole shrimp but are typically found in different habitats (USFWS 2005, 2007).

C.14.4 Species Distribution and Population Trends

C.14.4.1 Distribution

Vernal pool tadpole shrimp is distributed across the Central Valley of California and in the San Francisco Bay area. Populations are found at 18 vernal pool complexes in the Sacramento Valley from east of Redding in Shasta County south through the Central Valley to the San Luis National Wildlife Refuge in Merced County. It also occurs in a single vernal pool complex located on the San Francisco Bay National Wildlife Refuge in the City of Fremont, Alameda County. The easternmost known location is around 3,500 feet (1,067 meters) in elevation in the central Sierra Nevada foothills (Merced County) and the westernmost known location is in the San Francisco Bay Area (Alameda County). The Bay Area location is the only known population of vernal pool tadpole shrimp outside of the Central Valley (USFWS 2005, 2007). The largest concentration of vernal pool tadpole shrimp occurrences is found in the Southeastern Sacramento Vernal Pool Region, where the species occurs on a number of public and private lands in Sacramento County (USFWS 2005, 2007).

Vernal pool tadpole shrimp has been reported from the Grasslands Regional Park and Davis Communications Facility site, the Department of Fish and Wildlife (DFW) Tule Ranch Unit, and in the City of Davis within the Plan Area (USFWS 2005, 2007; California Natural Diversity Database

[CNDDB] 2011). In general, within the Plan Area, turbid-water playa pools as well as smaller vernal pools that may support the species occur on alkaline soils at the DFW Tule Ranch Unit, the Grasslands Regional Park and Davis Communications Facility site. Areas that pond in the alkali sink area southeast of the City of Woodland are also potential habitat.

C.14.4.2 Population Trends

The population trends of this species are unknown, but it is assumed that they have been reduced greatly in extent and density as their habitat has been reduced and fragmented (USFWS 2005).

C.14.5 Threats to the Species

Threats to vernal pools and playa pools and species in general, including vernal pool tadpole shrimp, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005). In addition, the Recovery Plan identified several threats specific to the vernal pool tadpole shrimp.

C.14.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (USFWS 2005, 2007). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other as a result of activities such as road development and other infrastructure projects (USFWS 2005, 2007).

C.14.5.2 Agricultural Conversion

Conversion of land use, such as from grasslands or pastures to more intensive agricultural uses (e.g., croplands) or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general (USFWS 2005, 2007).

C.14.5.3 Invasive Species

Perennial pepperweed is the most pervasive nonnative invasive species threat in the clay-bottom vernal pools and surrounding uplands in the Plan Area, and swamp timothy may pose a similar but less severe threat on the pool bottoms and sides (Environmental Science Associates [ESA] and Yolo County 2005; J. Gerlach unpublished data). Italian ryegrass (*Lolium multiflorum*) has rapidly become a dominant invasive species of the uppermost zone and flood plains of clay-bottom vernal pools and saturated soil and ponding areas of alkali sink habitat, and it appears to have undergone rapid adaptation to alkaline clay soils (Dawson et al. 2007).

C.14.5.4 Altered Hydrology

Human disturbances can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005, 2007).

C.14.6 Recovery Plan Goals

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) contains the following goals for vernal pool tadpole shrimp to be met within the Plan Area in the Solano-Colusa Core Area: protect 95 percent of suitable species habitat in the Davis Communications Annex.

C.14.7 Species Habitat Model and Location Data

C.14.7.1 Geographic Information System (GIS) Map Data Sources

The vernal pool tadpole shrimp habitat model is map-based and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Brent Helm 2010 wetlands mapping for Yolo County; and J. Gerlach unpublished data), and heads-up GIS digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure A-13). Using these datasets, the habitat was mapped in the Plan Area according to the species' two habitat types, vernal pool complex and alkali sink habitat. Vegetation types were assigned based on the species requirements as described above in Section C.13.3, *Habitat Requirements and Ecology* and the assumptions described below. Occurrences were mapped as the point at the center of any CNDDB polygons that fall within the Plan Area.

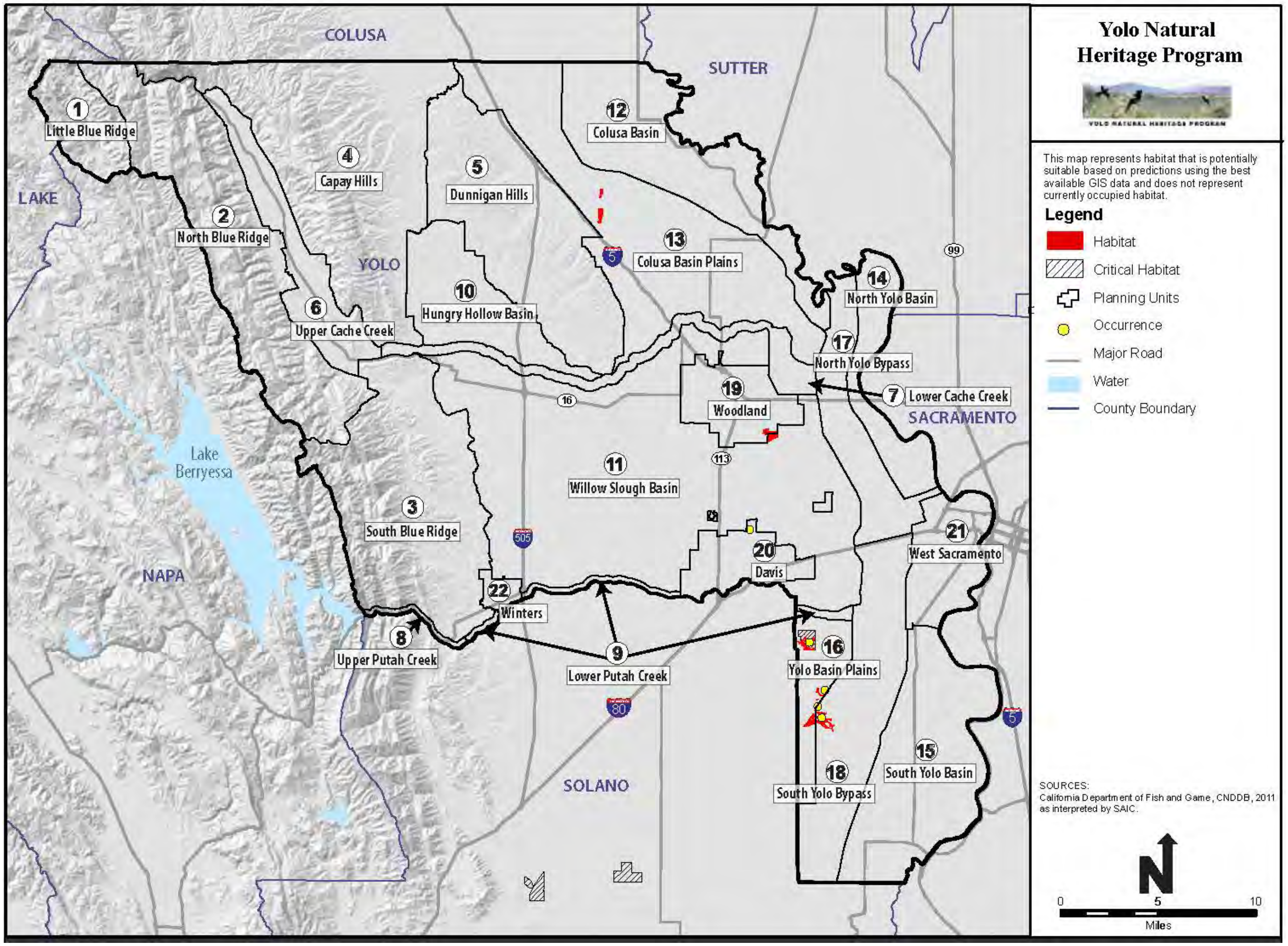
Mapped vernal pool tadpole shrimp habitat is comprised of the following vegetation types.

Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the visual signature of the characteristic yellow bloom of goldfields.

Alkali Sink: This habitat was mapped based on current and historical soils maps, aerial imagery from 1933 and 1952, and current Google Earth imagery to determine existing land use. Additional habitat was mapped in Planning Unit 13 using polygons supplied by DFW.

Assumptions. Historical and current records of this species in the Plan Area indicate that its known distribution is limited to the Grasslands Regional Park and Davis Communications Facility site, the DFW Tule Ranch Unit, and in the City of Davis within the Plan Area (USFWS 2005, 2007; CNDDB 2011). However, because the Plan Area has not been completely surveyed for this species, its potential distribution was increased to include the alkali sink habitat, which has a low density of small vernal pools and two potential playa pools. All other areas of alkaline clay soils in the county have been significantly altered by intensive agriculture and development. Ditches and isolated depressions in agricultural fields and vacant land in undeveloped areas may provide ephemeral anthropogenic habitat. Because these features are inundated during the wet season and may have historically been located in or near areas with natural vernal pools or playa pools, they may support individuals or small populations of this species. However, these features do not possess the full complement of ecosystem and community characteristics of natural habitat and are generally ephemeral features eliminated during the course of normal agricultural practices.

1 **Figure C-13. Vernal Pool Tadpole Shrimp Mapped Habitat and Occurrences**

2 

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C.15 Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)


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C.15.1 Listing Status

Federal: Threatened.

State: None.

Recovery Plan: None.

C.15.2 Species Description and Life History

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) is an atypical lepturine; the Lepturinae is a subfamily of the Cerambycidae (longhorn beetle family). Elderberry beetles are separated from all other lepturines by the form of the mandibles, which are broad and short, without internal pubescence (Linsley and Chemsak 1972). Originally described by Horn (1881), valley elderberry longhorn beetle is black in color, with red to orange margins on the elytra (wing covers), which fades to yellow after death. The pronotum (plate behind the head) is smooth, with confluent punctuations. The elytra are densely punctate or rugose. Adult beetles range from 14 to 25 millimeters (mm) (0.55 to 0.98 inch) in length (Linsley and Chemsak 1972).

The valley elderberry longhorn beetle was described as a separate species by Fisher (1921) and was reduced to subspecific status by Doane et al.(1936). The majority of male valley elderberry longhorn beetles can be separated from other subspecies by the short, suberect, pale setae (bristle or hair-like structures) on the antennae (as opposed to dark setae) and the black markings on each forewing (Linsley and Chemsak 1972). The female valley elderberry longhorn beetle cannot be separated morphologically from other subspecies.

Female valley elderberry longhorn beetles lay between eight and 20 eggs in bark crevices on the host plant and produce only one generation per year (Burke 1921; Barr 1991). The host plant is the elderberry (*Sambucus mexicana, S. caerulea, S. racemosa, S. glauca*) (Burke 1921; Linsley and Chemsak 1972, 1997; Barr 1991). The eggs, which are white initially then darken to a reddish brown, are 3.5 to 1.25 mm (0.14 to 0.05 inch) in diameter; oblong with a small knob at each end; and have wavy, longitudinal ridges (Burke 1921; Barr 1991). The egg is attached to the shrub by a thin secretion, and the larva encloses within 30 to 40 days (Burke 1921).

The newly emerged larvae bore into the wood of the host plant (Linsley and Chemsak 1972; Barr 1991). Burke (1921) and Eya (1976) reported that the larvae take two years to mature; however, Halstead (1991) believes that one year is the norm. The larva typically bores into the central pith of stems and feeds there; however, on large trunks, the larvae feed on the wood (Burke 1921). The larvae create an elongated, longitudinal gallery through the heart of the stems, filling it with debris and shredded wood (Barr 1991). When the larva is ready to pupate, it chews a circular to slightly oval exit hole (7 to 10 mm [0.28 to 0.39 inch] in diameter) to the outside, which it plugs with frass. Then the larva backs up into the gallery and constructs a pupal chamber out of shredded wood and frass (Barr 1991). Jones & Stokes (1985, 1986, 1987a, 1987b) and Halstead (1991) reported that 70 percent of exit holes are within 1.2 meters (3.9 feet) of the ground in stems greater than 13 mm (0.51 inch) in diameter; however, holes may be as high as 3 meters (10 feet) above the ground (Barr 1991). Pupae can be found between January and April, and the pupal stage lasts about one month (Burke 1921).

After pupation, the adult remains in the pupal cell for several weeks prior to emergence (Burke 1921). The adult eventually emerges from the pupal chamber through the exit hole (Barr 1991). The adults readily fly from shrub to shrub. Valley elderberry longhorn beetle is most often seen on, in, or immediately under the host plant's flowers. However, copulation occurs on the lower parts of the stems (Barr 1991). The adults feed on the leaves (Linsley and Chemsak 1972; Barr 1991; Talley et al. 2006) and are active from March to early June.

C.15.3 Habitat Requirements and Ecology

The valley elderberry longhorn beetle is completely dependent on its host plant, the elderberry (Linsley and Chemsak 1972, 1997; Eng 1984; Barr 1991; Collinge et al. 2001). This shrub is a component of riparian forests throughout the Central Valley. Although this shrub occasionally occurs outside riparian areas, shrubs supporting the greatest beetle densities are located in areas where the shrubs are abundant and interspersed among dense riparian forest, including Fremont cottonwood (*Populus fremontii*), box elder (*Acer negundo*), California sycamore (*Platanus racemosa*), California walnut (*Juglans californica*), white alder (*Alnus rhombifolia*), willow (*Salix* spp.), button willow (*Cephalanthus occidentalis*), Oregon ash (*Fraxinus latifolia*), wild grape (*Vitis californica*), California hibiscus (*Hibiscus californica*), and poison oak (*Toxicodendron diversilobum*) (Barr 1991; USFWS 1999; Collinge et al. 2001). There is also a strong association between blue elderberries and valley oaks which historically extended beyond riparian zones. Isolated elderberry shrubs separated from contiguous habitat by extensive development are not typically considered to provide viable habitat for valley elderberry longhorn beetle (USFWS 1998; Collinge et al. 2001).

Elderberry savannah was a habitat type that was previously more extensive in the California Central Valley but now is limited to the confluence area of the American River, which is outside the Plan Area (Jones & Stokes 1985, 1986, 1987a, 1987b; Barr 1991; USFWS 1984, 1999), and the valley elderberry longhorn beetle was probably a component of this habitat. Therefore, potential valley elderberry longhorn beetle habitat is defined as stands of elderberry shrubs that are adjacent to, or contiguous with, riparian forest, floodplains, or relict elderberry savannah.

There are no known diseases that are considered a source of mortality for valley elderberry longhorn beetle. Numerous species of Cleridae (checkered beetles), Cucujidae (flat bark beetles), Ostomatidae (bark-gnawing beetles), Elateridae (click beetles), Asilidae (robber flies), Phymatidae (ambush bugs), Reduviidae (assassin bugs), and some Thysanoptera (thrips) are known predators of Cerambycid beetles (Linsley 1961). All are common in the Central Valley, but none have been reported feeding on valley elderberry longhorn beetle.

Birds that hunt insect larvae in wood, such as woodpeckers, creepers, and nuthatches, may also predate upon valley elderberry longhorn beetle but no observations of this have been reported. Due to the valley elderberry longhorn beetle's warning colors, birds may not take adult beetles. Whether these warning colors are genuine or represent Batesian mimicry is unknown.

C.15.4 Species Distribution and Population Trends

C.15.4.1 Distribution

Desmocerus californicus is one of three species of *Desmocerus* in North America. Valley elderberry longhorn beetle is one of two subspecies of *D. californicus*. One subspecies is widespread in coastal California, ranging from Mendocino County southward to western Riverside and northern San Diego Counties, and into the southern Sierra Nevada range (Kern and Tulare Counties).

The valley elderberry longhorn beetle subspecies is a narrowly defined, endemic taxon, limited to portions of the Central Valley (USFWS 1999; USFWS 2006). Studies to assess the distribution and extent of the valley subspecies began in the late 1970s (Eya 1976), and the USFWS proposed the species for listing in 1978. Since valley elderberry longhorn beetle was listed in 1980 (45 FR 52803), numerous distributional studies have been conducted (summarized in Talley et al*.* 2006). This subspecies is endemic to California, occurring below 900 meters (2,953 feet) elevation (USFWS 1999).

In the Central Valley of California, valley elderberry longhorn beetle was first collected from "Sacramento, CA," the precise location unknown (Fisher 1921). Additional material was identified from Putah Creek in Solano and Yolo Counties and from along the Lower American River in Sacramento County (Linsley and Chemsak 1972). Linsley and Chemsak (1972) also reported a single female from the Merced River; however, since the females cannot be separated to subspecific level, the identification is unverified.

Subsequent to various surveys throughout the California Central Valley, the USFWS (1999) prepared a map of the presumed range of valley elderberry longhorn beetle. This map encompasses the entire California Central Valley and the Sacramento River Delta below 900 meters (2,953 feet) elevation.

In Yolo County, numerous records of occupied and potential valley elderberry longhorn beetle habitat occur throughout the Sacramento River corridor (Eya 1976; Jones & Stokes 1985, 1986, 1987a, 1987b; USFWS 1984; Barr 1991; Collinge et al. 2001; California Natural Diversity Database [CNDDB] 2000), as well as along Putah Creek from Monticello Dam east to Davis (Eya 1976; USFWS 1984; Barr 1991; Collinge et al. 2001; CNDDB 2005) and along Cache Creek (Barr 1991; CNDDB 2005). However, because comprehensive surveys for valley elderberry longhorn beetle in Yolo County have not been conducted and because known occurrences throughout the species' range are based mostly on incidental observations (e.g., CNDDB), the population size and locations of this species in the Yolo Natural Community Conservation Plan (NCCP) study area are not fully known. Few surveys focused on valley elderberry longhorn beetle have been conducted within and adjacent to Yolo County, and the total extent of potential habitat is unknown. Within and adjacent to Yolo County exist several preserves, parks, and mitigation banks that support valley elderberry longhorn beetle occurrences, including the Lake Solano Park and the American River Parkway.

C.15.4.2 Population Trends

Habitat occupied by valley elderberry longhorn beetle tends to form and exist in riparian corridors and on the level, open ground of periodically flooded river and stream terraces and floodplains. This geomorphic setting historically has been desirable for agricultural, urban, or industrial development. As a result, much of this habitat type has been converted through dams and levees for use as developable land. Although it has been estimated that 90 percent of California riparian habitat has been lost over the last century and a half (Smith 1980; Barr 1991; Naiman et al. 1993; Naiman and Décamps 1997), these losses are difficult to accurately quantify in terms of direct valley elderberry longhorn beetle habitat losses (Talley et al. 2006). Therefore, an unknown amount of riparian forest and elderberry savannah habitat has been lost and an unknown number of valley elderberry longhorn beetle populations as well (Collinge et al. 2001). Due to current pressures from increasing human populations in California, more valley elderberry longhorn beetle habitat is being encroached on and affected throughout the species' range.

C.15.5 Threats to the Species

The greatest historical threat to valley elderberry longhorn beetle has been the elimination, loss, or modification of its habitat by urban, agricultural, or industrial development and other activities that reduce or eliminate its host plants (Talley et al. 2006). While mitigation and restoration actions do not come close to restoring the enormous amount of habitat lost in the more remote past they appear to be adequate for current levels of impact (Talley et al. 2006). However, Talley et al. (2006) observed that the quality and persistence of mitigation and restoration efforts are uncertain and that there have been declines in the total number of valley elderberry longhorn beetle–occupied sites and in the number of riparian sites. Talley et al. (2006) also noted that the information included in reports is often unusable, making assessments of mitigation and restoration success difficult.

The greatest current threat to valley elderberry longhorn beetle is from the invasive nonnative Argentine ant (*Linepithema humile*) and European earwig (*Forficula auricularia*) (Talley et al*.* 2006). The nonnative invasive Argentine ant has been observed attacking and killing valley elderberry longhorn beetle larvae. The ants enter the exit hole that the beetle makes prior to pupation and remove the larva (Huxel 2000; Huxel et al. 2003). Given that the invasion of riparian systems by Argentine ant in the Central Valley is continuing to spread, it is unclear how the invasion will impact valley elderberry longhorn beetle, but it appears that the Argentine ant may have caused the disappearance of some populations (Talley et al. 2006). Field bait and trapping experiments have determined that Argentine ant has been introduced widely through mitigation plantings and irrigation (Klasson et al. 2005). Irrigation plays a major role in Argentine ant's rate and distance of dispersal in other ecosystems (Menke and Holway 2006). Those data also suggest that there may be a threshold of Argentine ant density above which valley elderberry longhorn beetle is extirpated from a site (Klasson et al. 2005). If confirmed, this would be a serious threat to valley elderberry longhorn beetle's recovery because once valley elderberry longhorn beetle is extirpated from a site, recolonization is unlikely (Talley et al. 2006). The nonnative invasive European earwig is also considered to be a threat to valley elderberry longhorn beetle through direct predation or by supporting higher populations of predators of insects (Talley et al. 2006), and earwig populations are also significantly larger in mitigation plantings and irrigated areas (Klasson et al. 2005).

Nonnative invasive plant species such as black locust (*Robinia pseudoacacia*), giant reed (*Arundo donax*), red sesbania (*Sesbania punicea*), Himalaya blackberry (*Rubus armeniacus*), tree of heaven (*Ailanthus altissima*), Spanish broom (*Spartium junceum*), Russian olive (*Eleagnus angustifolia*), edible fig (*Ficus carica*), and Chinese tallowtree (*Sapium sebiferum*), may have significant indirect impacts on valley elderberry longhorn beetle by impacting elderberry shrub vigor and recruitment (Talley et al. 2006). It is also predicted that ripgut brome (*Bromus diandrus*), foxtail barley (*Hordeum murinum*), *Lolium multiflorum*, and yellow starthistle (*Centaurea solstitialis*) may increase seedling mortality through competition for light and water or through increased fire return intervals (Talley et al. 2006).

The taxonomic status of valley elderberry longhorn beetle was questioned by Halstead (1991) and Halstead and Oldham (2000). However, in a reanalysis of that data in support of the five-year status review, Talley et al. (2006) found that it supported a distinct biomodal distribution separation between California elderberry longhorn beetle and valley elderberry longhorn beetle. That analysis also found that there appeared to be some interbreeding where there is contact between the two subspecies, and molecular genetic study would be required to completely describe their distributions (Talley et al. 2006).

Long-term data regarding site persistence, population size and dynamics, extirpation, and recolonization are also lacking, as are estimates regarding the minimum self-sustaining population size, riparian forest corridor size, or habitat complex size for valley elderberry longhorn beetle or other riparian forest organisms.

C.15.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.14.3, *Habitat Requirements and Ecology* (Figure A-14).

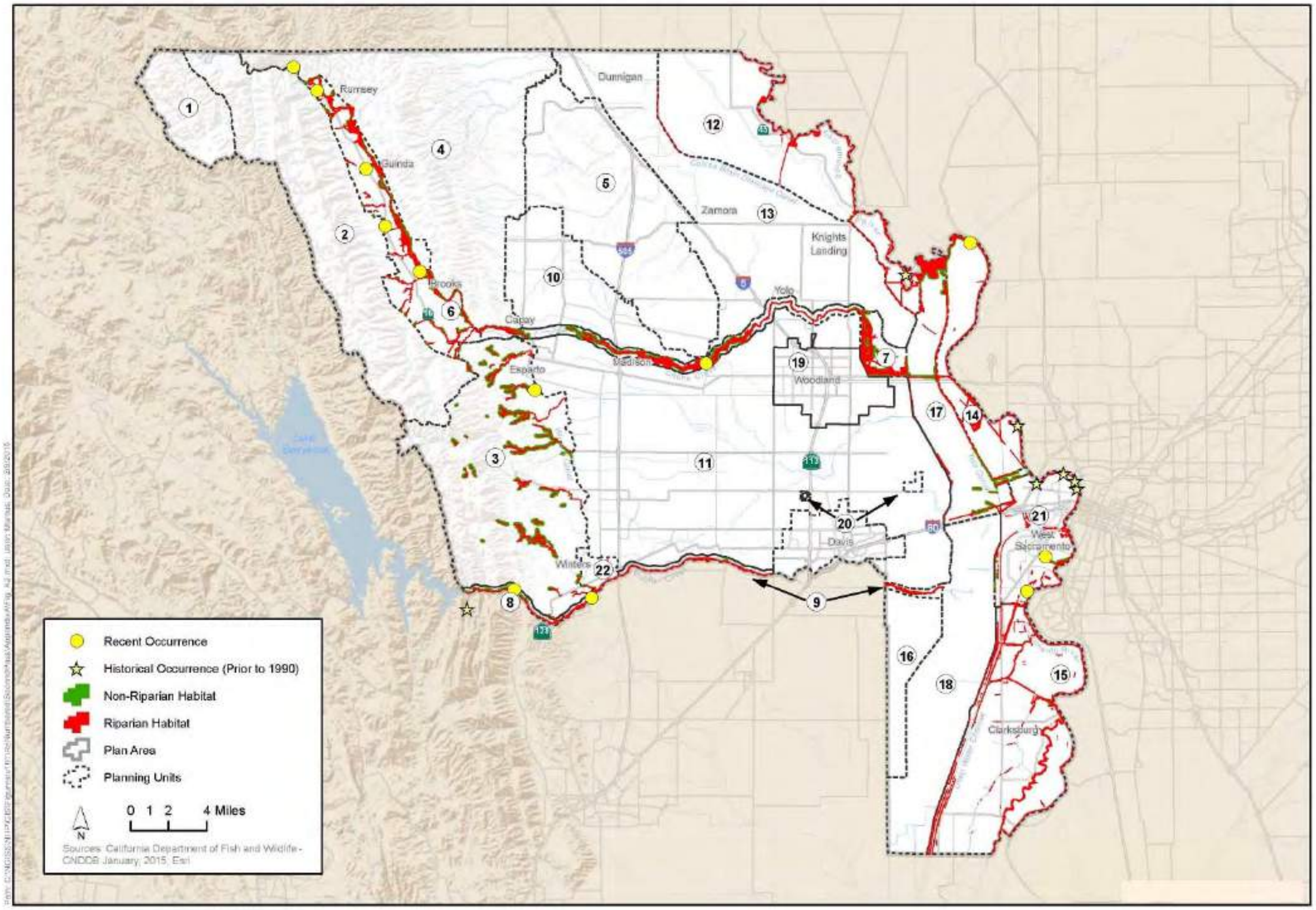
The model parameters include the following:

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: This is the location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB, University of California, Davis).
- Riparian Habitat: This habitat includes all potentially suitable riparian habitat where elderberry shrubs (the species host plant) are most likely to occur. This habitat was modeled by selecting all mapped Valley Foothill Riparian vegetation types.
- Nonriparian Habitat: This habitat includes all potentially suitable areas adjacent to the riparian zone that are likely to also include elderberry shrubs. This habitat was modeled by creating a buffer zone of 250 feet from modeled riparian habitat and selecting the vegetation types listed below.
- Limited modeling to the following Planning Units: 3, 6, 7, 8, 9, 12, 14, 15, 17, 20, 21, 22

C.15.6.1 Nonriparian Habitat–Vegetation Types

- All Annual Grassland
- All Barren
- Carex spp. – *Juncus* spp. – Wet Meadow Grasses Not Formally Defined (NFD) Super Alliance
- *Crypsis* spp. – Wetland Grasses – Wetland Forbs NFD Super Alliance

Figure C-14. Valley Elderberry Longhorn Beetle Occurrences



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C.16 White Sturgeon (Acipenser transmontanus)

C.16.1 Listing Status

The white sturgeon is not listed under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA).

C.16.2 Species Description and Life History

White sturgeon spend most of their lives in the brackish portions of the upper estuary, although a small number of individuals move extensively in the ocean (Moyle 2002; Surface Water Resources, Inc. 2004; Welch et al. 2006). Individuals can live over 100 years and can grow to over 19.7 feet (6 meters), but sturgeon greater than 27 years old and over 6.6 feet (2 meters) are rare (Moyle 2002).

Male white sturgeon reach sexual maturity at 10 to 12 years of age, and females reach sexual maturity at 12 to 16 years (Moyle 2002). Maturation is thought to be a function of both photoperiod and temperature (Birstein et al. 1997). White sturgeon can spawn multiple times throughout their lives. Males are believed to spawn every 1 to 2 years, whereas females spawn every 2 to 4 years (Moyle 2002). Chapman et al. (1996) found that female white sturgeon on the Sacramento River produced on average 203,328 eggs. However, Skinner (1962) described a 9.2-foot (280-centimeter), 460-pound (206-kilogram) female white sturgeon that was estimated to yield 4.7 million eggs, a value that greatly exceeds the expected upper limit of the fecundity-weight relationship described by Chapman et al. (1996) (Israel et al. 2009). Other studies indicate that females can produce 100,000 to several million eggs (Pacific States Marine Fisheries Council 1996), with typical females producing approximately 200,000 eggs (Moyle 2002).

Spawning typically occurs between February and June when temperatures are 46 to 66°F (8 to 19°C) (Moyle 2002). Maximum spawning occurs at 58°F (14.4°C) in the Sacramento River (Kohlhorst 1976). It is thought that adults broadcast spawn in the water column in areas with swift current. Spawning success varies from year to year, but is most likely related to temperature and Delta outflow. Spring flows in wet years may be the single most significant factor for white sturgeon year class strength (Beamesderfer et al. 2005). Although the mechanism is unknown, it is hypothesized that higher flows may help disperse young sturgeon downstream, provide increased freshwater rearing habitat, increase spawning activity cued by higher upstream flows, increase nutrients in nursery areas, or increase downstream migration rate and survival through reduced exposure time to predators (Anadromous Fish Restoration Program 1995).

Fertilized eggs sink and attach to the gravel bottom, where they hatch after 4 days at 61°F (16°C) (Beer 1981), though hatching may take up to 2 weeks at lower water temperatures (Pacific States Marine Fisheries Council 1996). Newly hatched larvae are 7.5 to 19.5 millimeters (0.3 to 0.77 inch) long (Kohlhorst 1976) and generally remain in the gravel for 7 to 10 days before emergence into the water column (Moyle 2002). Newly emerged larvae are pelagic for approximately 7 to 10 days until the yolk-sac is absorbed, at which time they begin actively feeding on amphipods and other small benthic macroinvertebrates (Wang 1986). Juvenile white sturgeon feed primarily on algae, aquatic insects, small clams, fish eggs, and crustaceans, but their diet becomes more varied with age (Wang 1986; Pacific States Marine Fisheries Council 1996; Moyle 2002). Since the invasion by the overbite clam (*Potamocorbula amurensis*) in the western Delta and Suisun Bay during the late 1980s, *Potamocorbula* has become a major component of the diet of juvenile and adult white sturgeon

C.16.3 Habitat Requirements and Ecology

As a diadromous fish, white sturgeon inhabit riverine, estuarine, and occasionally marine habitats at various stages during their long life. White sturgeon are adapted for living close to the bottom of large, cold rivers. Adult fish tend to occur in deeper, faster waters of large river mainstems, where they spend most of their time on or near the bottom of the riverbed. Juveniles prefer slow moving sloughs and backwaters. Spawning habitat is usually in turbulent fast water, but locations can range from shallow murky side channels with pebbly and sandy bottoms to deeper, less murky main channels with larger boulders and cobble.

C.16.4 Species Distribution and Population Trends

C.16.4.1 Distribution

Historically, white sturgeon ranged from Ensenada, Mexico to the Gulf of Alaska. Currently, spawning populations are found in the Sacramento–San Joaquin, Columbia, Snake, and Fraser River systems (Moyle 2002; Israel et al. 2009). In California, white sturgeon are most abundant in the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) and Sacramento River (Figure 2A.9 1) (Moyle 2002), but they have also been observed in the San Joaquin River system, particularly in wet years (California Department of Fish and Game 2002; Beamesderfer et al. 2004).

C.16.4.2 Population Trends

The abundance and age structure of the population fluctuates substantially in response to highly variable annual reproductive success. In recent decades the population tends to be dominated by strong year classes produced in years with high spring flows. High spring flows were the norm prior to the major dam building effort on the rim of the Central Valley (Moyle 2002). Recent analyses of the abundance of white sturgeon 117 to 168 centimeters based on harvest data from 2007 to 2009 indicate current populations between about 43,000 and 57,000 fish (DuBois and Gingras 2011). From 2000 to 2009 the abundance of age 15 white sturgeon ranged from 3,252 to 6,539 (DuBois et al. 2011).

C.16.5 Threats to the Species

C.16.5.1 Operational Changes in River Flows

Operational changes that have reduced river flows, including spring peak flows, have affected white sturgeon spawning, habitat availability, and prey resources (Israel et al. 2009). Sturgeon recruitment is correlated to flow (Kohlhorst et al. 1991; Beamesderfer and Farr 1997), and the most successful spawning generally occurs in wet and above-normal water years (Fish 2010). Low flows reduce larval dispersal and increase vulnerability to predation (Israel et al. 2009).

C.16.5.2 Water Exports

There is little evidence that the overall population of white sturgeon is influenced by entrainment. Adults are not likely to be entrained due to their large size and benthic habits. Larval sturgeon are more susceptible to entrainment as a result of their migratory behavior in the water column and reduced swimming ability. Herren and Kawasaki (2001) documented 431 water diversions on the Sacramento River between Sacramento and the Shasta Dam. In the Feather River, there are eight diversions greater than 10 cubic feet per second (cfs) and approximately 60 small diversions between 1 and 10 cfs between the Thermalito Afterbay outlet and the confluence with the Sacramento River (U.S. Fish and Wildlife Service 1995).

C.16.5.3 Habitat Loss

Spawning Habitat

Access to historical spawning habitat has been reduced by construction of barriers to upstream migration that block or impede access to spawning and juvenile rearing habitat. Major dams include Keswick Dam on the Sacramento River and Oroville Dam on the Feather River (Lindley et al. 2004; National Marine Fisheries Service 2005). White sturgeon adults have been observed periodically in the Feather River (U.S. Fish and Wildlife Service 1995; Beamesderfer et al. 2004). Habitat modeling by Mora et al. (20062009) suggests there is suitable habitat for sturgeon in the upstream reaches of the Feather River that have been blocked by Oroville Dam. This modeling also suggests that suitable conditions are present in the San Joaquin River upstream of Friant Dam, and in the tributaries such as Stanislaus, Tuolumne, and Merced Rivers upstream to their respective dams.

The Red Bluff Diversion Dam is an important migration barrier for sturgeon on the Sacramento River (U.S. Fish and Wildlife Service 1995). Adult sturgeon can migrate past the Red Bluff Diversion Dam when gates are raised between mid-September and mid-May to allow passage of winter-run Chinook salmon. However, tagging studies by Heublein et al. (20062009) found that, when the gates were closed, a substantial portion of tagged adult green sturgeon failed to use the fish ladders at the dam and were, therefore, unable to access upstream spawning habitats. The same behavioral response may be true for white sturgeon. Recent changes to water operations at the Red Bluff Diversion Dam, including placing dam gates in a permanent open position and constructing a new pumping facility with a state-of-the-art fish screen, are expected to eliminate passage issues at the dam for white sturgeon and other migratory fish species.

The Fremont Weir is located at the upstream end of the Yolo Bypass, a 40-mile (64 kilometer)-long basin that functions as a flood control facility on the Sacramento River. When the Yolo Bypass is inundated by flood water, white sturgeon are attracted into the bypass and become trapped behind the Fremont Weir, which acts as a barrier and impediment to upstream migration (California Department of Water Resources 2005). Sturgeon that are trapped by the weir are then subject to heavy legal and illegal fishing pressure, or become stranded behind the flashboards when the flows recede. The current Fremont and Sacramento weirs create stranding and poaching problems for white sturgeon and green sturgeon (Israel et al. 2009; Israel and Klimley 2008). Sturgeon can also be attracted to small pulse flows and trapped during the descending hydrograph (Harrell and Sommer 2003). Efforts to improve passage and redesign weirs would reduce poaching and stranding. Methods to reduce stranding and increase passage have been investigated by the California Department of Water Resources (DWR) and the California Department of Fish and Wildlife (CDFW). Between 2002 and 2006, approximately 50 sturgeon (no species identification given) were rescued over the course of four rescue operations at the Fremont Weir. In 2011, 14 green sturgeon and 19 white sturgeon were rescued at the Fremont Weir (Healey and Vincik 2011).

Exact white sturgeon spawning locations in the Feather River are unknown; however, based on angler catches, most spawning is believed to occur downstream of Thermalito Afterbay and upstream of Cox's Spillway, just downstream of Gridley Bridge. Potential physical barriers to upstream migration include the rock dam associated with Sutter Extension Water District's sunrise pumps, shallow water caused by a head cut at Shanghai Bend, and several shallow riffles between the confluence of Honcut Creek upstream to the Thermalito Afterbay outlet (U.S. Fish and Wildlife Service 1995). These structures are likely to present barriers or impediments during low-flow periods that block and or delay upstream sturgeon migration to spawning habitat.

Rearing Habitat

Historical reclamation of wetlands and islands has reduced and degraded suitable in- and off-channel rearing habitat for white sturgeon. Furthermore, the channelization and hardening of levees with riprap has reduced in- and off-channel intertidal and subtidal rearing habitat as well as seasonal inundation of floodplains. The resulting changes to river hydraulics, riparian cover, and geomorphology affect important ecosystem functions (Sweeney et al. 2004). Because juvenile and adult white sturgeon feed primarily on benthic organisms such as clams and shrimp, habitat-related impacts of reclamation, channelization, and riprapping would be expected to contribute to ecosystem related impacts, such as changes in the availability of food sources and altered predator densities. The impacts of channelization and riprapping are thought to affect larval, post-larval, juvenile, and adult stages of sturgeon, as these life stages are dependent on the freshwater and estuarine foodwebs in the rivers and Delta.

C.16.5.4 Dredging

Hydraulic dredging to allow commercial and recreational vessel traffic is a common practice in the navigational channels of the Sacramento and San Joaquin Rivers. White sturgeon are at risk of entrainment from dredging, with young-of-the-year fish at greatest risk (Boysen and Hoover 2009). Studies by Buell (1992) reported approximately 2,000 sturgeon entrained in the removal of one million tons of sand from the bottom of the Columbia River at depths of 60 to 80 feet (18 to 24 meters). In addition, dredging operations can result in the resuspension of toxics such as ammonia , hydrogen sulfide, and copper as a result of both dredging and dredge spoil disposal, and alter channel bathymetry and current patterns (National Marine Fisheries Service 2006).

C.16.5.5 Water Temperature

Water temperatures in the upper Sacramento River near the Red Bluff Diversion Dam historically occurred within optimum ranges for sturgeon reproduction; however, temperatures downstream, especially later in the spawning season, were reported to be frequently above 63°F (17.2°C) (U.S. Fish and Wildlife Service 1995). Concern regarding exposure to high temperatures in the Sacramento River during the February to June period has been reduced in recent years because temperatures in the upper Sacramento River are actively managed for Sacramento River winter-run Chinook salmon. The Shasta temperature control device, which was installed at Shasta Dam in 1998, cold water pool management in Lake Shasta, and management to maintain higher reservoir storage have all contributed to improving cool water temperature conditions in the upper Sacramento River where white sturgeon spawning and juvenile rearing are thought to occur.

Water temperatures in the lower Feather River may be inadequate for sturgeon spawning and egg incubation as the result of releases of warmed water from Thermalito Afterbay (Surface Water Resources, Inc. 2003). The warmed water may be one reason that neither green nor white sturgeon are found in the river in low-flow years (California Department of Fish and Game 2002). Exposure to elevated water temperatures in the Feather River downstream of Thermalito Afterbay is thought to be a factor affecting habitat value and availability for sturgeon spawning and juvenile rearing on the lower Feather River (California Department of Fish and Game 2002).

Reduced flow on the San Joaquin River resulting from dam and diversion operations contributes to seasonally elevated water temperatures in the mainstem San Joaquin River, particularly during late summer and fall. Although these effects are difficult to measure, water temperatures in the lower San Joaquin River during spring months continually exceed preferred temperatures for sturgeon migration and development. Temperatures at Stevenson on the San Joaquin River near the Merced River confluence as recorded on May 31 (spawning typically occurs February to June) between 2000 and 2004 ranged from 77 to 82°F (25 to 27.8°C) (California Department of Water Resources 2007). Juvenile sturgeon are also exposed to increased water temperatures in the Delta during the late spring and summer, in part as a result of the loss of riparian shading and by thermal inputs from municipal, industrial, and agricultural discharges. Seasonally elevated water temperature in the San Joaquin River has been identified as a factor affecting habitat value and availability for sturgeon migration, spawning, and juvenile rearing.

C.16.5.6 Turbidity

The relationship between turbidity and the vulnerability of various life stages of white sturgeon to predation has not been established in the Strategy Area. The dense colonization of local areas by introduced species of submerged aquatic vegetation (SAV) such as Brazilian waterweed (Egeria densa) has been shown to be associated with increased water clarity (e.g., resulting from trapping and settlement of suspended sediments). Increased water clarity may contribute to increased vulnerability of sturgeon to predation. However, juvenile white sturgeon are expected to be less vulnerable to predation than other estuarine fish due to their scutes and protective armoring. In addition, the large size of subadult and adult white sturgeon further reduces their vulnerability to predation. As a result of these factors, the potential increase in vulnerability to predation due to localized reductions in turbidity is expected to be minor relative to other focal fish species.

C.16.5.7 Exposure to Toxins

Water quality in the Strategy Area is influenced by a variety of point and nonpoint source pollutants from urban, industrial, and agricultural land uses. Runoff from residential, agricultural, and industrial areas introduces pesticides, oil, grease, heavy metals, other organics, and nutrients that contaminate drainage waters and deteriorate the quality of aquatic habitats necessary for white sturgeon survival (National Marine Fisheries Service 1996; California Regional Water Quality Control Board 1998).

Organic contaminants from agricultural returns, urban and agricultural runoff from storm events, and high concentrations of trace elements, such as boron, selenium, and molybdenum, have been identified as factors that decrease sturgeon early life stage survival, causing abnormal development and high mortality in yolk-sac fry sturgeon at concentrations of only a few parts per billion (ppb) (U.S. Fish and Wildlife Service 1995; California Regional Water Quality Control Board 2004). Principal sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (U.S. Fish and Wildlife Service 1995).

In recent years, changes have been made in the composition of herbicides and pesticides used on agricultural crops in an effort to reduce potential toxicity to aquatic and terrestrial species. Modifications have also been made to water system operations and discharges related to agricultural wastewater (e.g., agricultural drainage water system lock-up and holding prior to discharge) and municipal wastewater treatment and discharges. Concerns remain, however, regarding the toxicity to sturgeon of contaminants absorbed by sediments, such as pyrethroids and other chemicals including selenium and mercury.

Potamocorbula and other introduced clams that are now prominent in the diet of sturgeon are benthic filter feeders that can accumulate various toxic substances, such as selenium, mercury, and other compounds, in their tissue. *Potamocorbula*, due to its high filtration efficiency, accumulates selenium in high concentrations and loses it slowly (Luoma and Presser 2000; Linville et al. 2002). As a result, concentrations of selenium in white sturgeon have been observed at greater than threshold levels at which toxic effects have been observed in other fish species (Lemly 2002). Dietary selenium in high concentrations can adversely affect white sturgeon survival, activity, and growth (Tashjian et al. 2006).

The extent to which toxic pollution has affected the population of white sturgeon is unknown. White sturgeon is a long-lived species that feeds on invertebrates, such as clams and shrimp, and is vulnerable to the effects of toxicant bioaccumulation on the health and condition of sub-adult and adult sturgeon and their reproductive success in the estuary. However, sturgeon do not readily concentrate lipid-soluble toxins such as polychlorinated biphenyls (PCBs). Greenfield et al. (2003) found that dichlorodiphenyltrichloroethane (DDT) and chlordane concentrations in white sturgeon tissues have declined since the 1980s, while selenium concentrations have remained elevated. High levels of selenium can also be found in some white sturgeon prey (Johns and Luoma 1988), including *Potamocorbula* (Urquhart and Regalado 1991), as well as in sturgeon muscle, liver, and eggs (White et al. 1987, 1989; Kroll and Doroshov 1991; Urquhart and Regalado 1991).

C.16.5.8 Invasive Aquatic Vegetation

Introductions of nonnative invasive plant species such as water hyacinth (*Eichhornia crassipes*) and *Egeria* have altered habitat and have affected local assemblages of fish in the Strategy Area (Nobriga et al. 2005). *Egeria* forms thick “walls” along the margins of channels and shallow water habitat. This growth may prevent juvenile sturgeon from accessing shallow water habitat along channel edges. By reducing water velocities near plants, these species reduce turbidity in the water column, potentially exposing sturgeon to higher predation risk. Dissolved oxygen levels beneath the mats often drop below suitable levels for fish due to the increased amount of decaying vegetative matter produced from the overlying mat and diel respiration by aquatic plants.

C.16.5.9 Harvest

White sturgeon is a popular game species in the Strategy Area and supports a commercial fishery in estuaries in Oregon and Washington. In California, the recreational fishery for white sturgeon is open all year, but anglers are limited to three fish per year between 46 inches and 66 inches total length, and CDFW has established large closure areas (Section 27.90, Title 14 California Code of Regulations). Nevertheless, some illegal harvest occurs, particularly in areas where sturgeon have been stranded (e.g., Fremont Weir).

The effects of legal and illegal harvest on the population dynamics and abundance of white sturgeon are largely unknown. The small population of white sturgeon inhabiting the San Joaquin River experiences heavy fishing pressure, particularly from illegal fishing (U.S. Fish and Wildlife Service 1995). In addition, areas just downstream of Thermalito Afterbay outlet, Cox's Spillway, and several barriers impeding sturgeon migration on the Feather River, may be areas of high adult mortality from fishing and poaching. Poaching of white sturgeon females is a type of poaching that could be particularly detrimental to the white sturgeon population because it targets the oldest and largest adults with the highest fecundity, which affects both current and future stocks.

C.16.6 Recovery Plan Goals

No recovery plan has been prepared for white sturgeon because the species is not listed under the ESA or CESA.

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C.17 Green Sturgeon (Acipenser medirostris)

C.17.1 Listing Status

Federal: Threatened

State: Species of Special Concern

Recovery Plan: On November 12, 2009, NMFS announced its intent to develop a recovery plan. An outline for the recovery plan was prepared December 2010 (National Marine Fisheries Service 2010), but the plan itself has not yet been completed.

Critical Habitat: Critical habitat was designated for the Southern DPS by NMFS on October 9, 2009 (74 FR 52300). Designated areas in California include the Sacramento River, lower Feather River, and lower Yuba River; the Delta; and Suisun, San Pablo, and San Francisco Bays (National Marine Fisheries Service 2012).

C.17.2 Species Description and Life History

There is relatively little known about the North American green sturgeon, particularly for those that spawn in the Sacramento River (The Nature Conservancy et al. 2008). Adult North American green sturgeon are believed to spawn every 3 to 5 years, but can spawn as frequently as every 2 years (National Marine Fisheries Service 2005) and reach sexual maturity at an age of 15 to 20 years, with males maturing earlier than females. Adult green sturgeon begin their upstream spawning migrations into the San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein et al. 2009). Based on the distribution of sturgeon eggs, larvae, and juveniles in the Sacramento River, CDFW (California Department of Fish and Game 2002) concluded that green sturgeon spawn in late spring and early summer upstream of Hamilton City, and possibly to Keswick Dam. Peak spawning is believed to occur between April and June. Adult female green sturgeon produce between 59,000 and 242,000 eggs, depending on body size, with a mean egg diameter of 4.3 millimeters (0.17 inch) (Moyle et al. 1992; Van Eenennaam et al. 2006).

Newly hatched green sturgeon are approximately 12.5 to 14.5 millimeters (0.5 to 0.57 inch) long. Green sturgeon are strongly oriented to the river bottom and exhibit nocturnal activity patterns (Cech et al. 2000). After six days, the larvae exhibit nocturnal swim-up activity (Deng et al. 2002). After about 10 days they begin nocturnal downstream migrational movements (Kynard et al. 2005). Juvenile green sturgeon continue to exhibit nocturnal behavior beyond the metamorphosis from larval to juvenile stages. After approximately 10 days, larvae begin feeding and growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the upper Sacramento River between Keswick Dam and Hamilton City (California Department of Fish and Game 2002). Length measurements estimate juveniles to be 2 weeks old (24 to 34 millimeters [0.95 to 1.34 inch] fork length) when they are captured at the Red Bluff Diversion Dam (California Department of Fish and Game 2002), and three weeks old when captured further downstream at the Glenn-Colusa facility (Van Eenennaam et al. 2001). Growth is rapid as juveniles reach up to 30 centimeters (11.8 inches) the first year and over 60 centimeters (24 inches) in the first 2 to 3 years (Nakamoto et al. 1995).

Juveniles spend 1 to 4 years in freshwater and estuarine habitats before they enter the ocean (Nakamoto et al. 1995). According to Heublein (2006), all adults leave the Sacramento River prior to

September. Lindley et al. (2008) found frequent large-scale migrations of green sturgeon along the Pacific Coast. Kelly et al. (2007) reported that green sturgeon enter the San Francisco Estuary during the spring and remain until fall. Juvenile and adult green sturgeon enter coastal marine waters after making significant long-distance migrations with distinct directionality thought to be related to resource availability.

Green sturgeon are long-lived (up to 60 to 70 years) and late maturing (sexual maturity is reached at approximately 15 years of age) (Van Eenennaam et al. 2006). They have a low fecundity rate (59,000 to 242,000 eggs per female) due to a larger egg size and smaller adult size relative to white sturgeon (180,000 to 590,000 eggs per female). They may spawn every 3 to 5 years (California Fish Tracking Consortium 2009; National Marine Fisheries Service 2010). These characteristics make green sturgeon particularly susceptible to habitat degradation and overharvest (Musick 1999). With only one population in the Central Valley, a lack of spatial and geographic diversity make the viability of the Southern DPS vulnerable to changes in the environment and catastrophic events. As a result of low abundance, the population has limited genetic diversity, which decreases the ability of individuals in the green sturgeon population to withstand environmental variation.

C.17.3 Habitat Requirements and Ecology

As anadromous fish, North American green sturgeon rely on riverine, estuarine, and marine habitats during their long life. On October 9, 2009, NMFS (74 FR 52300) designated critical habitat for the green sturgeon Southern DPS. In fresh water, critical habitat includes the mainstem Sacramento River downstream of Keswick Dam (including the Yolo and Sutter Bypasses), the Feather River below Fish Barrier Dam, and the Yuba River below Daguerre Point Dam. The essential physical and biological habitat features identified for the Southern DPS include prey resources (benthic invertebrates and small fish), water quality, water flow (particularly in freshwater rivers), water depth, substrate type/size (i.e., appropriate spawning substrates in freshwater rivers), sediment quality, and migratory corridors.

Freshwater habitat of green sturgeon of the Southern DPS varies in function, depending on location in the Sacramento River watershed. Spawning areas currently are limited to accessible reaches of the Sacramento River upstream of Hamilton City and downstream of Keswick Dam (California Department of Fish and Game 2002). Preferred spawning habitats are thought to contain large cobble in deep and cool pools with turbulent water (California Department of Fish and Game 2002; Moyle 2002; Adams et al. 2002). Sufficient flows are needed to oxygenate and limit disease and fungal infection of recently laid eggs (Deng et al. 2002; Parsley et al. 2002). In the Sacramento River, spawning appears to be triggered by large increases in water flow during spawning (Brown and Michniuk 2007). However, in the Rogue River, Erickson et al. (2002) found that green sturgeon were most often found at depths greater than 5 meters (16 feet) with low or no currents during summer and fall months.

Habitats for migration are downstream of spawning areas and include the mainstem Sacramento River, Delta, and San Francisco Bay Estuary. These corridors allow the upstream passage of adults and the downstream emigration of juveniles (71 FR 17757). Migratory habitat conditions are strongly affected by the presence of barriers and impediments to migration (e.g., dams), unscreened or poorly screened diversions, and degraded water quality. Heublein et al. (2009) found two different patterns of spawning migration and out-migration for green sturgeon in the Sacramento River.

C.17.4 Species Distribution and Population Trends

C.17.4.1 Distribution

Green sturgeon ranges from Ensenada, Mexico to the Bering Sea, Alaska (Colway and Stevenson 2007; Moyle 2002). Green sturgeon spawn in two California basins: the Sacramento and Klamath Rivers (Figure 2A.8-1). These reproducing populations are genetically distinct and occupy the Southern and Northern DPS, respectively (Adams et al. 2002; Israel et al. 2004). Adult populations in the less-altered Klamath and Rogue Rivers are fairly constant, with a few hundred spawning adults typically harvested annually by tribal fisheries. In the Sacramento River, the green sturgeon population is believed to have declined over the last two decades, with less than 50 spawning green sturgeon sighted annually in the best spawning habitat an estimated 18 to 42 annual spawners above Red Bluff Diversion Dam, based on genetic analysis of tissue samples taken from juveniles during 2002–2005 (Corwin pers. comm. Klimley 2008). In the Umpqua, Feather, Yuba, and Eel Rivers, green sturgeon sightings are extremely limited and spawning has not been recently recorded. In the San Joaquin and South Fork Trinity Rivers, the green sturgeon population appears extirpated (Figure 2A.8-1).

Green sturgeon have been recorded in the Feather River as larvae caught in screw traps (Beamesderfer et al. 2004). Spawning has recently been recorded with eggs from three different sturgeon females (Van Eenenaam 2011). In spring 2011, many sturgeon adults were spotted while DIDSON surveys were being conducted (Seesholtz 2011). No juvenile green sturgeon have been documented in the San Joaquin River. Moyle (2002) suggested that reproduction may have taken place in the San Joaquin River because adults have been captured at Santa Clara Shoal and Brannan Island. However, given the conditions that exist in the San Joaquin River today, they are probably extirpated (Israel and Klimley 2008).

Adults migrate upstream primarily through the western edge of the Delta into the lower Sacramento River between March and June (Adams et al. 2002). The only confirmed spawning site for Southern DPS green sturgeon is a short stretch of the upper mainstem Sacramento River below Keswick Dam (National Marine Fisheries Service 2010). Larvae and post-larvae are present in the lower Sacramento and North Delta between May and October, primarily in June and July (California Department of Fish and Game 2002). Juvenile green sturgeon have been captured in the Delta during all months of the year (Borthwick et al. 1999; California Department of Fish and Game 2002). Adult green sturgeon have been documented in the Yolo Bypass, but these individuals usually end up stranded against the Freemont Weir (U.S. Bureau of Reclamation and California Department of Water Resources 2012) and rear in Suisun Bay and Suisun Marsh.

C.17.4.2 Population Trends

Musick et al. (2000) noted that the abundance of North American green sturgeon populations has declined by 88% throughout much of its range. The California Department of Fish and Wildlife (CDFW) (California Department of Fish and Game 2002) estimated that green sturgeon abundance in the Bay-Delta estuary (generally defined as the San Francisco Bay and the Sacramento River-San Joaquin River Delta) ranged from 175 to more than 8,000 adults between 1954 and 2001 with an annual average of 1,509 adults. Fish monitoring efforts at Red Bluff Diversion Dam and the Glenn-Colusa Irrigation District pumping facility on the upper Sacramento River have recorded between zero and 2,068 juvenile North American green sturgeon per year (Adams et al. 2002). Using CDFW angler report card reports, the number of green sturgeon caught from 2006 to 2011 ranged from 311 to 389 (Gleason et al. 2007; DuBois et al. 2009, 2010, 2011, 2012). Because these fish were primarily captured in San Pablo Bay, where both northern and Southern DPSs exist, the proportion of fish captured in sampling from the Southern DPS is unknown.

C.17.5 Threats to the Species

C.17.5.1 Reduced Spawning Habitat

Access to historical spawning habitat has been reduced by construction of migration barriers, such as major dams, that block or impede access to the spawning habitat. Major dams include Keswick Dam on the Sacramento River and Oroville Dam on the Feather River (Lindley et al. 2004; National Marine Fisheries Service 2005). The Feather River is likely to have supported significant spawning habitat for the green sturgeon population in the Central Valley before dam construction (California Department of Fish and Game 2002). Green sturgeon adults have been observed periodically in the lower Feather River (U.S. Fish and Wildlife Service 1995; Beamesderfer et al. 2004). Results of habitat modeling by Mora et al. (2009) suggested there is potential habitat on the Feather River upstream of Oroville Dam that would have been suitable for sturgeon spawning and rearing prior to construction of the dam. This modeling also suggested sufficient conditions are present in the San Joaquin River to Friant Dam, and in the tributaries such as Stanislaus, Tuolumne, and Merced Rivers upstream to their respective dams, although it is unknown whether green sturgeon ever inhabited the San Joaquin River or its tributaries (Beamesderfer et al. 2004).

C.17.5.2 Reduced Rearing Habitat

Historical reclamation of wetlands and islands have reduced and degraded the availability of suitable in- and off-channel rearing habitat for green sturgeon. Further, channelization and hardening of levees with riprap has reduced in- and off-channel intertidal and subtidal rearing habitat. The resulting changes to river hydraulics, riparian cover, seasonal floodplain inundation, and geomorphology affect important ecoystem functions (Sweeney et al. 2004). The impacts of channelization and riprapping are thought to affect larval, post-larval, juvenile, and adult stages of sturgeon, as these life stages are dependent on the food web in freshwater and low-salinity regions of the Delta.

C.17.5.3 Migration Barriers

In the Central Valley, approximately 4.6% of the total river kilometers have spawning habitat characteristics similar to where Northern DPS green sturgeon spawn, with only 12% of this habitat currently occupied by sturgeon (Neuman et al. 2007). Of the 88% that is unoccupied (approx. 4,000 kilometers [2,485 miles]), 44.2% is currently inaccessible due to dams (Neuman et al. 2007).

The Red Bluff Diversion Dam has been identified as a major barrier and impediment to sturgeon migration on the Sacramento River (U.S. Fish and Wildlife Service 1995). Adult sturgeon can migrate past the dam when gates are raised between mid-September and mid-May to allow passage for winter-run Chinook salmon. However, tagging studies by Heublein (2006) found that when the gates were closed, a substantial portion of tagged adult green sturgeon failed to use fish ladders at the dam and were, therefore, unable to access upstream spawning habitats. Recent changes to water operations at the Red Bluff Diversion Dam, including placing dam gates in a permanent open position and construction of a new pumping facility with a state-of-the-art fish screen, are expected to eliminate passage issues at the dam for green sturgeon and other migratory fish species.

The Fremont Weir is located at the upstream end of the Yolo Bypass, a 40-mile (64-kilometer) long basin that functions as a flood control project on the Sacramento River. Green sturgeon are attracted by high floodwater flows into the Yolo Bypass basin and then concentrate behind Fremont Weir, which they cannot effectively pass (California Department of Water Resources 2005). Green sturgeon that concentrate behind the weir are subject to heavy illegal fishing pressure or become stranded behind the flashboards when high flood flows recede (Marshall pers. comm. U.S. Bureau of Reclamation and California Department of Water Resources 2012). Sturgeon can also be attracted to small pulse flows and trapped during the descending hydrograph (Harrell and Sommer 2003:88–93). Methods to reduce stranding and increase passage have been investigated by the California Department of Water Resources (DWR) and CDFW (California Department of Water Resources 2007; Navicky pers. comm. U.S. Bureau of Reclamation and California Department of Water Resources 2012).

C.17.5.4 Exposure to Toxins

Exposure of green sturgeon to toxins has been identified as a factor that can lower reproductive success, decrease early life stage survival, and cause abnormal development, even at low concentrations (U.S. Fish and Wildlife Service 1995; Environmental Protection Information Center et al. 2001; Klimley 2002). Water discharges containing metals from Iron Mountain Mine, located adjacent to the Sacramento River, have been identified as a factor affecting survival of sturgeon downstream of Keswick Dam. In addition, storage limitations and limited availability of dilution flows cause downstream copper and zinc levels to exceed salmonid tolerances. Treatment processes and improved drainage management in recent years have reduced the toxicity of runoff from Iron Mountain Mine to acceptable levels. Although the impact of trace elements on green sturgeon reproduction is not completely understood, negative impacts similar to those of salmonids are suspected (U.S. Fish and Wildlife Service 1995; Environmental Protection Information Center et al. 2001; Klimley 2002).

C.17.5.5 Harvest

As a long-lived, late maturing fish with relatively low fecundity and periodic spawning, the green sturgeon is particularly susceptible to threats from overfishing (Musick 1999). Total captures of green sturgeon in the Columbia River Estuary in commercial fisheries between 1985 and 2003 ranged from 46 fish per year to 6,000 (Adams et al. 2007). However, a high proportion of green sturgeon present in the Columbia River, Willapa Bay, and Grays Harbor (as high as 80% in the Columbia River) may be from the Southern DPS (California Department of Fish and Game 2002; Israel et al. 20062009). Long-term data indicate that harvest for green sturgeon occurs primarily in the Columbia River (51%), coastal trawl fisheries (28%), the Oregon fishery (8%), and the California tribal fishery (8%). Harvest of green sturgeon dropped substantially from over 6,000 from 1985 to 1989 to 512 in 2003 (Adams et al. 2007). Much of the reduction results from progressively more restrictive regulation in the Columbia River. Coastal trawl fisheries have declined to low levels, thereby lowering the by-catch of green sturgeon. In 2003, Klamath and Columbia River tribal fisheries accounted for 65% of total catch (Adams et al. 2007).Green sturgeon are also vulnerable to recreational sport fishing in the Bay-Delta estuary and Sacramento River, as well as other estuaries located in Oregon and Washington. Green sturgeon are primarily captured incidentally in California by sport fishermen targeting the more desirable white sturgeon, particularly in San Pablo and Suisun Bays (Emmett et al. 1991).

To protect spawning Southern DPS green sturgeon, new federal and state regulations, including the June 2, 2010 NMFS take prohibition (75 FR 30714), mandate that no green sturgeon can be taken or possessed in California (California Department of Fish and Game 2007a). If green sturgeon are caught incidentally and released while fishing for white sturgeon, anglers are asked to report it to CDFW on their white sturgeon report card. The level of hooking mortality that results following release of green sturgeon by anglers is unknown. Sport fishing captures have declined through time, but the factors leading to the decline are unknown. CDFW (California Department of Fish and Game 2002) indicates that sturgeon are highly vulnerable to the fishery in areas where sturgeon are concentrated, such as the Delta and Suisun and San Pablo Bays in late winter, and the upper Sacramento River during spawning migration. Because many sturgeon in the Columbia River, Willapa Bay, and Grays Harbor are likely from the Southern DPS, additional harvest closures in these areas would likely benefit the Southern DPS.

Poaching (illegal harvest) of sturgeon is known to occur in the Sacramento River, particularly in areas where sturgeon have been stranded (e.g., Fremont Weir) (Marshall pers. comm.), as well as throughout the Bay-Delta (U.S. Bureau of Reclamation and California Department of Water Resources 2012Schwall pers. comm.). Catches of sturgeon are thought to occur during all years, especially during wet years. Green sturgeon inhabiting the San Joaquin River portion of the Delta experience heavy fishing pressure, particularly from illegal fishing (U.S. Fish and Wildlife Service 1995). Areas just downstream of Thermalito Afterbay outlet, Cox's Spillway, and several barriers impeding migration on the Feather River may be areas of high adult mortality from increased fishing effort and poaching. Poaching rates in the rivers and estuary and the impact of poaching on green sturgeon abundance and population dynamics are unknown.

C.17.5.6 Increased Water Temperature

Exposure to water temperatures greater than 63°F (17.2°F) can increase mortality of sturgeon eggs and larvae (Pacific States Marine Fisheries Commission 1992) and temperatures above 69°F (20.6°C) are lethal to embryos (Cech et al. 2000). Temperatures near the Red Bluff Diversion Dam on the Sacramento River historically occur within optimum ranges for sturgeon reproduction; however, temperatures downstream, especially later in the spawning season, were reported to be frequently above 63°F (17.2°F) (U.S. Fish and Wildlife Service 1995). High temperatures in the Sacramento River during the February to June period no longer appear to be a major concern for green sturgeon spawning, egg incubation, and juvenile rearing, as temperatures in the upper Sacramento River are actively managed for Sacramento River winter-run Chinook salmon. The Shasta temperature control device, installed at Shasta Dam in 1998, in combination with improved cold-water pool management and storage in Lake Shasta, have resulted in improved cool water stream conditions in the upper Sacramento River.

Water temperatures in the Feather River may be inadequate for spawning and egg incubation as the result of releases of warmed water from Thermalito Afterbay (Surface Water Resources, Inc. 2003). Warmed water may be one reason why neither green nor white sturgeon are found in the river during low-flow years (California Department of Fish and Game 2002). It is not expected that water temperatures will become more favorable in the near future and this temperature problem will continue to be a factor affecting habitat value for green sturgeon on the lower Feather River (California Department of Fish and Game 2002).

The lack of flow in the San Joaquin River from dam and diversion operations and agricultural return flows contribute to higher temperatures in the mainstem San Joaquin River, offering less water to keep temperatures cool for sturgeon, particularly during late summer and fall. Though these effects are difficult to measure, temperatures in the lower San Joaquin River continually exceed preferred temperatures for sturgeon migration and development during spring months. Temperatures at Stevenson on the San Joaquin River near the Merced River confluence recorded on May 31 (spawning typically occurs from April to June; Table 2A.8-1) between 2000 and 2004 ranged from 77 to 82°F (25 to 27.8°C) (California Department of Water Resources 2007). Juvenile sturgeon are also exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading and by thermal inputs from municipal, industrial, and agricultural discharges.

C.17.5.7 Dredging

Hydraulic dredging to allow commercial and recreational vessel traffic is a common practice in the Sacramento and San Joaquin Rivers. Such dredging operations pose risks to bottom-oriented fish such as green sturgeon. Studies by Buell (1992) reported approximately 2,000 sturgeon entrained in the removal of one million tons of sand from the bottom of the Columbia River at depths of 60 to 80 feet (18 to 24 meters). In addition, dredging operations can decrease the abundance of locally available prey species, and contribute to resuspension of toxics such as ammonia[1], hydrogen sulfide, and copper during dredging and dredge spoil disposal, and alter bathymetry and water movement patterns (National Marine Fisheries Service 2006).

C.17.5.8 Entrainment

Larval sturgeon are susceptible to entrainment from nonproject water diversion facilities because of their migratory behavior and habitat selection in the rivers and Delta. The overall impact of entrainment of fish populations is typically unknown (Moyle and Israel 2005); however, there is enough descriptive information to predict where green sturgeon may be entrained. Herren and Kawasaki (2001) documented 431 nonproject diversions on the Sacramento River between Sacramento and Shasta Dam. Entrainment information regarding larval and post-larval individual green sturgeon is unreliable because entrainment at these diversions has not been monitored and field identification of green sturgeon larvae is difficult. USFWS staff are working on identification techniques and are optimistic that green sturgeon greater than 40 millimeters (1.6 inch) can be identified in the field (Poytress 2006).

Presumably, juvenile green sturgeon become less susceptible to entrainment as they grow and their swimming ability and capacity to escape diversions improves. Green sturgeon that are attracted by high flows in the Yolo Bypass move onto the floodplain and eventually concentrate behind Fremont Weir and in various ponds and pools, where they are blocked from further upstream migration (California Department of Water Resources 2005). As the bypass recedes, these sturgeon become stranded behind the flashboards of the weir and can be subjected to heavy illegal fishing pressure (U.S. Bureau of Reclamation and California Department of Water Resources 2012 Marshall pers.

[1] Ammonia in water generally forms some amount of ammonium. Therefore, the use of the term *ammonia* implies that both ammonia and ammonium may be present.

comm.). Sturgeon can also be attracted to small pulse flows and trapped during the descending hydrograph (Harrell and Sommer 2003:88–93). Methods to reduce stranding and increase passage have been investigated (U.S. Bureau of Reclamation and California Department of Water Resources 2012Navicky pers. comm.).

C.17.6 Recovery Plan Goals

On November 12, 2009, NMFS announced its intent to develop a recovery plan for the Southern DPS of North American green sturgeon (Acipenser medirostris) and has requested information from the public (74 FR 58245). An outline for the recovery plan was prepared December 2010 (National Marine Fisheries Service 2010), but the plan itself has not yet been completed.

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C.17.8 Federal Register Notices

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C.18 Delta Smelt (Hypomesus transpacificus)

C.18.1 Listing Status

Federal: Threatened

State: Threatened

Recovery Plan: Delta smelt is included in the *Sacramento-San Joaquin Delta Native Fishes Recovery Plan,* which was completed in 1996 (U.S. Fish and Wildlife Service 1996).

Critical Habitat: Critical habitat was designated by USFWS for the delta smelt under the ESA effective January 18, 1995 (59 FR 65256). The designated critical habitat extends throughout Suisun Bay (including Grizzly and Honker Bays), the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch) and Montezuma Sloughs, and the contiguous waters of the legal Delta (59 FR 65256).

C.18.2 Species Description and Life History

Delta smelt are a small, translucent fish endemic to the Sacramento–San Joaquin River Delta (Delta) (Moyle 2002). They inhabit open surface waters, where they form loose aggregations. Their life history has been described as semi anadromous by Bennett (2005), reflecting a cycle of spawning in freshwater areas generally followed by juvenile migration to shallow, open-water areas of the West Delta and Suisun Bay subregions to feed and mature. More recent analyses suggest that year-round populations of delta smelt may exist in central locations (Lower Sacramento River to Suisun Marsh and in the Cache Slough and Deep Water Ship Channel regions) suggesting that they are not 100% obligatorily semi-anadromous or migratory, but may show several life history strategies (Merz et al. 2011; Baxter et al. 2010; Murphy et al. in press and Hamilton 2012). Delta smelt populations have shown a long-term decline in the upper estuary (the Delta and Suisun Bay), although the Fall Mid-Water Trawl index has fluctuated greatly from year to year, with change points detected in 1975–76, 1980–81 and 1998–99 by Manly and Chotkowski (2006). Using a different analytical method, a trend change was identified in 2000–2002, and a step decline in 2004 (Thomson et al. 2010).There has been extremely low abundance in recent years as part of the pelagic organism decline (POD) (Sommer et al. 2007; Baxter et al. 2010).

The low abundance of delta smelt since the early 1980s is hypothesized to relate to a number of interacting factors. These factors include larval advection during high flows in the winter and spring of 1982 and 1983 (Kimmerer 2002a); the prolonged drought from 1987 to 1992 (Baxter et al. 2010); entrainment in water diversions (although a small effect at population level) (Kimmerer 2008); increases in salinity, water clarity, and temperature constricting habitat for juveniles (Nobriga et al. 2008) and maturing individuals (Feyrer et al. 2007; Thomson et al. 2010); predation and competition from introduced species (Bennett 2005); a decline in food resources (Maunder and Deriso 2011, Miller et al. 2012); and changes in the foodweb due to changes in nutrients (Glibert et al. 2011; Dugdale et al. 2012; Parker et al. 2012a; Parker et al. 2012b). In its most recent review of the factors potentially threatening the delta smelt, the U.S. Fish and Wildlife Service (USFWS) determined that operation of upstream reservoirs, increased water exports, and upstream water diversions has altered the location and extent of the low-salinity zone. Upstream reservoirs and the increased presence of Egeria densa have reduced turbidity levels in rearing habitat, which may reduce foraging efficiency. Predation, deficiency of current regulatory processes, entrainment into water diversions, the presence of nonnative plant and animal species, contaminants, and the potential for effects related to small population size all are likely having an effect on the abundance of the delta smelt. The delta smelt is also highly vulnerable to climate change (Brown et al. 2013).

C.18.3 Habitat Requirements and Ecology

Distribution of delta smelt life appears to be based largely on salinity and temperature (Bennett 2005). Larvae, in particular, distribute themselves in relation to the two-parts-per-thousand (2 ppt) salinity isohaline, usually about 10 km upstream of it (Dege and Brown 2004). The Summer Tow-Net Survey and the Fall Midwater Trawl survey indicate that over 70% of juveniles and 60% of preadults are collected at salinities less than 2 practical salinity units (psu), with over 90% occurring at salinities less than 7 psu (Bennett 2005). Abundance is centered near or slightly upstream of 2 psu in the entrapment or low-salinity zone (LSZ) (Dege and Brown 2004). Water temperatures above 25°C are above delta smelt tolerance and can constrain available habitat especially in late summer and fall (Swanson et al. 2000). The LSZ, or the entrapment zone, is an area just seaward of the extent of salinity intrusion and is an area of high retention of fishes and zooplankton. It is determined by the interaction of Delta outflow and tidal inflow of marine water from San Francisco and San Pablo Bays. The downstream location of the LSZ typically is in Suisun Bay, extending farther to the west in response to higher Delta outflows and farther to the east in response to lower Delta outflows. Delta smelt have been collected in Carquinez Strait, the Napa River, and even as far downstream as the East Bay Shoreline in wet years (Bennett 2005; Merz et al. 2011). Smaller larvae and spawning activity are distributed away from the LSZ, while prespawning adults and juveniles are distributed along the edge of the LSZ, as indicated by the position of X2 (i.e., the location of the 2-psu bottom salinity isohaline; Jassby et al. 1995). Juvenile delta smelt are most abundant at the upstream edge of the LSZ where salinity is less than 3 psu, water transparency is low (Secchi disk depth less than 0.5 meter), and water temperatures are cool (less than 24°C) (Feyrer et al. 2007; Nobriga et al. 2008). The association with the LSZ may be related to distribution of food as well as abiotic factors such as salinity.

Migrating, staging, and spawning delta smelt reportedly require low-salinity and freshwater habitats, turbidity, and water temperatures less than 20°C (68°F) (Sommer et al. 2011; Grimaldo et al. 2009). Subadult and adult delta smelt densities are positively correlated with turbidity (Feyrer et al. 2007; Nobriga et al. 2008).

Turbidity has declined in the Delta in the past few decades in part due to trapping of sediment in reservoirs and depletion of the erodible sediment pool from hydraulic mining in the late 1800s, and to increases of submerged aquatic vegetation that traps sediment (Wright and Shoellhamer 2004; Shoellhamer 2011; Hestir et al. 2008). Declining turbidity has been hypothesized as one factor in the long-term decline of delta smelt (Baxter et al. 2010).

Sommer et al. 2011 suggest that, from December to March, mature delta smelt move upstream from brackish rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin Rivers). Murphy and Hamilton (2012) propose that the observed change in distribution is an expansion of smelt distribution using fresher waters throughout their range. The initiation of migration is associated with pulses of freshwater inflow, which are turbid, cool, and less saline (Grimaldo et al. 2009). Spawning has not been observed in the wild; timing and locations may be inferred from the collection of gravid females and larvae. Preferred substrates have been inferred from laboratory observations and other smelt species. From collection of larval smelt, it appears that delta smelt spawn from February to June at water temperatures ranging from approximately 10°C to 20°C, with most spawning in mid-April and May (California Department of Fish and Game 2007; Bennett 2005; Moyle 2002).

Mager (1996) reported a length/fecundity range spanning 1,196 eggs for a 56-millimeter female to 1,856 eggs for a 66-millimeter female. Captive-reared females may be more fecund than a wild female of the same size; however, the variability in the length-fecundity relationship also appears to be greater for captive females (Bennett 2005). The abrupt change from a single-age, adult cohort during spawning in spring to a population dominated by juveniles in summer suggests strongly that most adults die after they spawn (Radtke 1966; Moyle 2002).

Larvae emerge near where they are spawned, and mainly inhabit tidal fresh water at temperatures between 10°C to 20°C (Bennett 2005). The center of distribution (1995 to 2001) for delta smelt larvae less than 20 millimeters is usually 5 to 20 kilometers upstream of X2, but most larvae move closer to X2 as the spring progresses into summer (Dege and Brown 2004). Survival during the larval period is linked to the minimum density of zooplankton prey (Maunder and Deriso 2011; Miller et al. 2012). The effects of outflow are complex, affecting not only abundance, but also patterns of distribution, and possibly the timing of spawning events (Moyle 2002). The lowest numbers of smelt generally occur in years of either low or extremely high outflow, but outflow and smelt numbers show no relationship at intermediate flows where abundance is highly variable (Moyle 2002; Bennett 2005).

Feeding success is highly dependent upon prey densities (Nobriga 2002) and turbidity (Baskerville-Bridges et al. 2004; Mager et al. 2004). Juveniles grow to 40 to 50 millimeters total length by early August (Erkkila et al. 1950; Ganssle 1966; Radtke 1966). Delta smelt reach 55 to 70 millimeters standard length in 7 to 9 months (Moyle 2002). Growth during the next 3 months slows down considerably (only 3 to 9 millimeters total), presumably because most of the energy ingested is directed toward gonadal development (Erkkila et al. 1950; Radtke 1966).

In a near-annual fish like delta smelt, maximizing recruitment success is vital to the long-term persistence of the population. There is some evidence that density-dependent (preferred food resources) and density-independent (turbidity, salinity and temperature) factors may affect the population (Bennett 2005; Maunder and Deriso 2011; Miller et al. 2012).

C.18.4 Species Distribution and Population Trends

C.18.4.1 Distribution

The geographic distribution of delta smelt occurs primarily downstream of Isleton on the Sacramento River, in the Cache Slough subregion (Cache Slough-Liberty Island and the Deep Water Ship Channel), downstream of Mossdale on the San Joaquin River, and Suisun Bay and Suisun Marsh (Moyle 2002; Kimmerer 2004). Delta smelt also have been collected in the Petaluma and Napa Rivers (Bennett 2005). A delta smelt was caught just below Knights Landing on the Sacramento River, representing the highest known point of the distribution (Vincik and Julienne 2012). Over the last two decades, the center of the adult delta smelt abundance in the fall (September through December) has been the West Delta and Suisun Bay subregions (Sommer et al. 2011).

There is evidence that delta smelt may remain in the Cache Slough subregion throughout their lives (Nobriga et al. 2008; Sommer et al. 2011; Lehman et al., possibly because turbidity and prey abundance are sufficient to support them (Sommer et al. 2004; Lehman et al. 2010). Merz et al. (2011) examined the recent (1995 to 2009) frequency of occurrence of delta smelt in various surveys in the species' range. They found that larval delta smelt (less than 15 millimeters) were most frequently found in the West Delta subregion (confluence of the Sacramento/San Joaquin Rivers and the lower San Joaquin River) and the Suisun Marsh subregion. Subjuveniles (15 to 30 millimeters) were most commonly found in the Cache Slough subregion, West Delta subregion (confluence and lower Sacramento River), and Suisun Marsh and Suisun Bay subregions. Juveniles (30 to 55 millimeters) were most frequently found in the Suisun Bay, Cache Slough, and West Delta subregions. Subadults (larger than 55 millimeters) were most commonly found in the West Delta and Suisun Bay subregions. Mature adults had their highest frequency of occurrence in the Suisun Bay subregion, whereas prespawning adults were most frequently collected in the Suisun Marsh, West Delta, and Suisun Bay subregions. Adults in spawning condition were most frequently sampled in the Suisun Marsh and Cache Slough subregions.

C.18.4.2 Population Trends

Although an unbiased estimate of the abundance of delta smelt is not presently available, indices of relative abundance have been developed using catch data from surveys conducted by the Interagency Ecological Program. Several of the program's surveys provide annual delta smelt abundance information, including the Spring Kodiak Trawl, the larva survey, the 20-millimeter survey, the Summer Townet Survey, and the Fall Midwater Trawl. Relative abundance information can also be obtained from count data on delta smelt entrained into the federal and state water export facilities. The Fall Midwater Trawl provides the best available long-term index of the relative abundance of delta smelt (Moyle et al. 1992; Sweetnam 1999). The indices derived from the Fall Midwater Trawl closely mirror trends in catch per unit effort (Kimmerer and Nobriga 2005), but do not, at present, support statistically reliable population abundance estimates, though substantial progress has recently been made (Newman 2008). Fall Midwater Trawl-derived data are generally accepted as providing a reasonable basis for detecting and roughly scaling interannual trends in delta smelt abundance. The Fall Midwater Trawl-derived indices have ranged from a low of 17 in 2009 to 1,673 in 1970. For comparison, Summer Townet Survey -derived indices have ranged from a low of 0.3 in 2005 and 2009 to a high of 62.5 in 1978.

Although the peak high and low values have occurred in different years, the Fall Midwater Trawl and Summer Townet Survey indices show a similar pattern of delta smelt relative abundance that is higher prior to the mid-1980s and very low in the past decade. Smelt abundance is indexed from surveys at different locations and times that sample various life-history stages of delta smelt. Multiple permanent sites sampled by CDFW and USFWS using many different collection methods intended to sample various life history stages of delta smelt provide a basis for examining trends in abundance of delta smelt under different hydrologic conditions, as well as the temporal and geographic distribution of the species within and among years.

C.18.5 Threats to the Species

C.18.5.1 Water Exports

The risk of entrainment to delta smelt varies seasonally and among years. The most important entrainment risk has been hypothesized to occur during winter, when prespawning adults migrate into the Delta in preparation for spawning (Moyle 2002; Sommer et al. 2007). Bennett (2005) has hypothesized that delta smelt that spawn earlier in the winter are more vulnerable to entrainment. Fish that hatch earlier can grow larger prior to spawning than fish that hatch later. Larger females may be more fecund, spawn repeatedly, and produce more offspring with higher fitness than smaller females. As a result, Bennett hypothesized that entrainment during winter months may have a disproportionately large impact on the overall population dynamics of delta smelt than entrainment during other periods of the year.

Delta smelt are not believed to be threatened by small agriculture diversions. Nobriga and Matica (2000) and Nobriga et al. (2004) found low and inconsistent entrainment of juvenile delta smelt by small agricultural diversions near Sherman Island; the low entrainment rates were hypothesized to be the result of juvenile delta smelt occurring offshore of the intake location and in the upper portions of the water column. Cook and Buffaloe (1998) also reported that unscreened agricultural diversions entrained low numbers of delta smelt. Larvae may have higher entrainment losses than juveniles and adults because they are planktonic, with poor swimming ability.

C.18.6 Habitat Loss

C.18.6.1 Reduced Spawning Habitat

It is generally thought that spawning occurs in shallow, low-salinity areas with sand or gravel substrate on which to deposit adhesive egg sacs (Bennett 2005). The extent of these areas is dependent on the spatial distribution of fresh water in the estuary (Hobbs et al. 2005; 2007). Such habitat could occur in Cache Slough or in shallow shoals located in the Deep Water Ship Channel (Bennett 2007) and may be reduced because of land reclamation, channelization, and riprapping of historical intertidal and shallow subtidal wetlands. The extent to which such habitat loss may be limiting the population is unknown (Bennett 2005; Miller et al. 2012); however, spawning substrates are not thought to be a limiting factor for delta smelt.

C.18.6.2 Reduced Rearing Habitat

There is evidence that the availability and suitability of delta smelt rearing habitat varies with salinity and the location of the LSZ (Moyle et al. 1992; Hobbs et al. 2006; Feyrer et al. 2007; Kimmerer et al 2009). The Suisun Marsh salinity control gates function to decrease salinity in managed wetlands of Suisun Marsh to support crops that attract waterfowl to duck clubs located throughout the marsh. When in operation, generally from October through May, the control gates near Collinsville divert up to 2,500 cubic feet per square inch (cfs) of fresh water from upstream flows into the marsh. Because the minimum outflow standard during fall months is 5,000 cfs, a significant proportion of total Delta outflow (up to 50%) does not flow through the eastern Suisun Bay region. This diversion moves the LSZ upstream resulting in a measurable increase in salinity in eastern Suisun Bay, which may correspond to a decrease in low salinity habitat for delta smelt.

C.18.6.3 Water Temperature

Delta smelt are members of the cold water fish family (Osmeridae) and it is adapted to cold to cool water temperatures like many other California fish species (Moyle 2002). Delta smelt are sensitive to exposure to elevated water temperatures (Swanson and Cech 1995), and high temperatures are known to reduce delta smelt survival (Swanson et al. 2000) and interfere with spawning (Bennett 2005). During the late spring, summer, and early fall months water temperatures in the central and southern regions of the Delta typically exceed 25°C (77°F), which has been found to be close to the incipient lethal temperature for delta smelt. During these warmer periods, results of fishery sampling have shown that delta smelt avoid inhabiting the central and south Delta and are typically located downstream in Suisun Bay and Suisun Marsh. Although water temperatures are cooler in Suisun Bay during the summer months, water temperatures in excess of 20°C (68°F) are typical in July (Nobriga et al. 2008). Under these warm summer conditions, delta smelt rearing in Suisun Bay and Suisun Marsh would be stressed by exposure to elevated water temperatures and would experience higher metabolic demands and a greater demand for food supplies to maintain individual health and a positive growth rate. Stresses experienced by rearing delta smelt during the warmer summer months, which include the synergistic effects of salinity and seasonally elevated water temperatures, have been hypothesized to be a potentially significant factor affecting delta smelt survival, abundance, and subsequent reproductive success (Baxter et al. 2010; Mac Nally et al. 2010; Miller et al. 2012).

Recent climate change analyses have examined the potential implications of climate warming for delta smelt (Wagner et al. 2011; Brown et al. 2013). Modeling results projected increases in the number of days with lethal and stressful water temperatures (especially along the Sacramento River) and a shift in thermal conditions for spawning to earlier in the year, upstream movement of the LSZ, and decreasing habitat suitability.

C.18.6.4 Turbidity

Turbidity is a significant predictor of delta smelt occurrence in the Delta (Feyrer et al. 2007; Resources Agency 2007; Nobriga et al. 2008; Grimaldo et al. 2009). Delta smelt require turbidity for both successful foraging (Feyrer et al. 2007; Nobriga et al. 2008) and predator escape (Feyrer et al. 2007), and turbidity is an important cue for delta smelt spawning movements (Grimaldo et al. 2009). Thompson et al. (2010) found fall water clarity to be a significant covariate associated with changes in delta smelt abundance over time.

C.18.6.5 Food Resources

Reduced food availability in the Bay-Delta estuary has been identified as a major stressor on delta smelt. Recent analyses by Maunder and Deriso (2011) and Miller et al. (2012) indicated that prey density was the most important environmental factor explaining variations in delta smelt abundance from 1972 to 2006 and over the recent period of decline. Delta smelt feed primarily on calanoid copepods, cladocerans, amphipods, and, to a lesser extent, on insect larvae (Moyle et al. 1992; Lott 1998; Nobriga 2002). Larger delta smelt may also feed on the mysid shrimp, *Neomysis* (Moyle et al. 1992). Mac Nally et al. (2010) found evidence for a relationship between summer calanoid copepod biomass and changes in delta smelt abundance. The most important food organism for all sizes of delta smelt appears to be the euryhaline copepod, *Eurytemora*, although the nonnative *Pseudodiaptomus* has become a major part of the diet since its introduction in 1988 (Kimmerer and Orsi 1996; Nobriga 2002; Hobbs et al. 2006).

C.18.6.6 Contaminants and Exposure to Toxins

Exposure of delta smelt to toxic substances can result from point and nonpoint sources associated with agricultural, urban, and industrial land uses. Toxics such as pesticides may affect delta smelt indirectly by reducing food resources (Luoma 2007; Werner 2007; Teh et al 2011), but the short life span (1 to 2 years) and location of their food sources in the food web (zooplankton are primary consumers) reduce the ability of toxic chemicals to bioaccumulate in the tissue of delta smelt (Moyle 2002). Exposure to environmentally relevant pyrethroid concentrations resulted in significant swimming abnormalities in delta smelt. Kuivila and Moon (2004) found that the exposure to multiple pesticides for an extended period could pose potential lethal or sublethal effects on delta smelt, particularly during the larval development stage. This scenario occurred at the confluence of the Sacramento and San Joaquin Rivers with pesticide concentrations and fish densities coinciding for several weeks.

C.18.6.7 Predation and Competition

The importance of predation on delta smelt relative to others is uncertain. Statistical analyses have shown some evidence for links between delta smelt abundance or survival and predation (Mac Nally et al. 2010; Maunder and Deriso 2011). Silversides may consume delta smelt eggs and larvae (Bennett 2005). In a pilot study, genetic testing found that 41% of 37 silversides caught in the channel of Cache Slough contained delta smelt DNA in their guts, while none of 614 silversides from nearshore areas contained delta smelt DNA (Baerwald et al. 2012). Silversides are highly abundant throughout the delta smelt geographic range, their diet range encompasses that of delta smelt, and because they spawn repeatedly throughout late spring, summer, and fall, they have a competitive advantage over delta smelt (Bennett 1998, 2005).

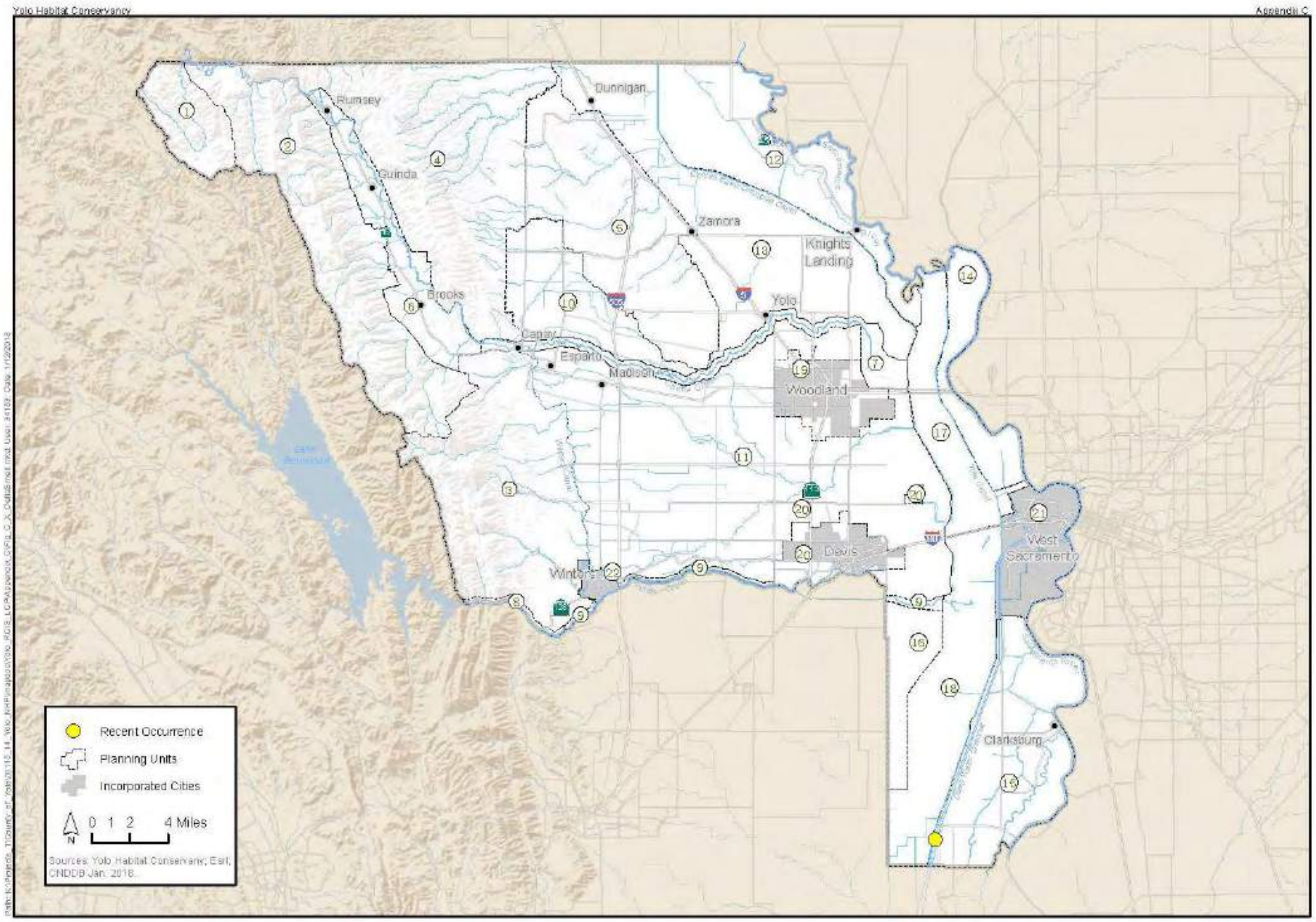
C.18.6.8 Invasive Aquatic Vegetation

Egeria and water hyacinth are fast-growing and abundant aquatic plants that have had detrimental effects on the Bay-Delta aquatic ecosystem, including competition with native vegetation and reducing dissolved oxygen concentrations and turbidity within their immediate vicinity (Grimaldo and Hymanson 1999; Brown and Michniuk 2007; Feyrer et al. 2007). These nonnative plant species grow in dense aggregations and can indirectly affect delta smelt by reducing dissolved oxygen levels and nearby flow rates, thus reducing suspended sediment concentrations and turbidity within the water column. Furthermore, because of the three-dimensional structure and shade they provide, these aquatic plants likely create excellent habitat for nonnative predators of delta smelt, primarily centrarchids (Nobriga et al. 2005). Mac Nally et al. (2010) found some evidence for a negative association between delta smelt abundance and the abundance of largemouth bass.

C.18.7 Recovery Plan Goals

The USFWS recovery strategy for delta smelt is contained in the Sacramento-San Joaquin Delta Native Fishes Recovery Plan (U.S. Fish and Wildlife Service 1996). The basic strategy for recovery is to manage the estuary in such a way that it provides better habitat for native fish in general and delta smelt in particular. Since 1996, new significant findings regarding the status and biology of and threats to delta smelt have emerged, prompting development of an updated recovery plan.

Figure C-15. Delta Smelt Mapped Habitat and Occurrences



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C.19 Central Valley Steelhead (*Oncorhynchus mykiss*)

Listing Status

Federal: Threatened

State: No listing.

Recovery Plan: The draft recovery plan for Central Valley salmonids, including Central Valley steelhead, was released on October 19, 2009 (National Marine Fisheries Service 2009a).

Critical Habitat: Critical habitat for the Central Valley steelhead DPS was designated by NMFS on September 2, 2005 (70 FR 52488) with an effective date of January 2, 2006, and includes 2,308 miles of stream habitat in the Central Valley and an additional 254 square miles of estuarine habitat in the San Francisco-San Pablo-Suisun Bay complex.

C.19.1 Species Description and Life History

Steelhead can be divided into two life history types based on their state of sexual maturity at the time of river entry and the duration of their spawning migration: stream-maturing and ocean-maturing. Stream-maturing steelhead enter fresh water in a sexually immature condition and require several months to mature prior to spawning, whereas ocean-maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. These two life history types are more commonly referred to by their season of freshwater entry (i.e., summer [stream-maturing] and winter [ocean-maturing] steelhead). A variation of the two forms occurs in the Central Valley and primarily migrates into the system in the fall, then spawns during the winter and early spring, although this form is referred to as winter run (McEwan and Jackson 1996). There are, however, indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program Steelhead Project Work Team 1999; McEwan 2001). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

There is high polymorphism among steelhead/rainbow trout populations with respect to a continuum from anadromy to permanent freshwater residency (Behnke 1992 as cited in McEwan 2001). Furthermore, there is plasticity in an individual from a specific life history form to assume a different life history strategy if conditions necessitate it (McEwan 2001). For example, if emigrating smolts show reduced survival, an individual may choose not to emigrate to the ocean (Satterthwaite et al. 2010). This polymorphic life history structure provides the flexibility for steelhead to remain persistent in highly variable conditions, particularly near the edges of their range (McEwan 2001).

Central Valley steelhead generally leave the ocean and migrate upstream from August through March (Busby et al. 1996; Hallock et al. 1957; National Marine Fisheries Service 2009a), and spawn from December through April (Newton and Stafford 2011; Bureau of Reclamation 2008). Peak immigration seems to have occurred historically in the fall from late September to late October, with some creeks such as Mill Creek showing a small run in mid-February (Hallock 1989). Peak spawning typically occurs from January through March in small streams and tributaries where cold, well-oxygenated water is available year-round (Table 2A.6 1) (Hallock et al. 1961; McEwan and Jackson 1996). Timing of upstream migration corresponds with higher flow events (e.g., freshets), associated lower water temperatures, and increased turbidity. The peak period of adult immigration appears to be during fall months with fewer immigrants in the winter (as reviewed in McEwan 2001). Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby et al. 1996). It is, however, rare for steelhead to spawn more than twice before dying; individuals that do spawn more than twice tend to be females (Busby et al. 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby et al. 1996).

After reaching a suitable spawning area, the female steelhead selects a site with good intergravel flow, digs a redd, and deposits eggs while an attendant male fertilizes them. Eggs in the redd are covered with gravel dislodged just upstream. The length of time it takes for eggs to hatch varies in response to water temperature. Optimal spawning temperatures range between from 4°C and 11°C (39°F to 52°F), with egg mortality beginning at about 13°C (55°F) (McEwan and Jackson 1996). Hatching of steelhead eggs in hatcheries takes about 30 days at 10.6°C (51°F). Fry generally emerge from the gravel 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and water temperature can speed or retard the time to emergence (Shapovalov and Taft 1954, as cited in McEwan and Jackson 1996). Newly emerged fry move to shallow, protected areas with lower water velocities associated with the stream margin, and soon establish feeding locations in the juvenile rearing habitat (Shapovalov and Taft 1954, as cited in McEwan and Jackson 1996).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although young-of-the-year also are abundant in glides and riffles. Productive steelhead habitat is characterized by habitat complexity, primarily in the form of large and small woody debris and boulders. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (McEwan and Jackson 1996).

About 70% of Central Valley steelhead spend 2 years within their natal streams before migrating out of the Sacramento-San Joaquin system as smolts, with small percentages (29%) and (1%) spending 1 or 3 years, respectively (Hallock et al. 1961). Juvenile steelhead emigrate primarily from natal streams in the spring in response to the first heavy runoff, and again in the fall (Hallock et al. 1961). Emigrating Central Valley steelhead use the lower reaches of the Sacramento and San Joaquin Rivers as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects, and will take active bottom invertebrates (Moyle 2002).

C.19.2 Habitat Requirements and Ecology

C.19.2.1 Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, egg incubation, and larval development. Spawning habitat for Central Valley steelhead primarily occurs in mid to upper elevation reaches or immediately downstream of dams located throughout the Central Valley that contain suitable environmental conditions (e.g., seasonal water temperatures, substrate, dissolved oxygen) for spawning and egg incubation. Spawning habitat has a high conservation value because its function directly affects the spawning success and reproductive potential of steelhead.

C.19.2.2 Freshwater Rearing Habitat

Freshwater steelhead rearing sites contain suitable instream flows, water quantity and quality (e.g., water temperatures), and floodplain connectivity to form and maintain physical habitat conditions that support juvenile growth and mobility, provide forage species, and include cover such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Spawning areas and migratory corridors may also function as rearing habitat for juveniles, which feed and grow before and during their out-migration. Rearing habitat value is strongly affected by habitat complexity, food supply, and the presence of predators. Some of these more complex and productive habitats with floodplain connectivity are still present in the Central Valley (e.g., Sacramento River reaches with set-back levees The channeled, leveed, and riprapped river reaches and sloughs common in the lower Sacramento and San Joaquin Rivers and throughout the Delta, however, typically have low habitat complexity and low abundance of food organisms, and offer little protection from predation by fish and birds. Freshwater rearing habitat has a high conservation value because juvenile steelhead are dependent on the function of this habitat for successful survival and recruitment to the adult population.

C.19.2.3 Freshwater Migration Corridors

Optimal freshwater steelhead migration corridors (including river channels) support mobility, survival, and food supply for juveniles and adults. Migration corridors should be free from obstructions (passage barriers and impediments to migration), provide favorable water quantity (instream flows) and quality conditions (seasonal water temperatures), and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Migratory corridors are typically downstream of the spawning area and include the lower Sacramento and San Joaquin Rivers, and the San Francisco Bay complex extending to coastal marine waters. These corridors allow the upstream passage of adults and the downstream emigration of juvenile steelhead. Migratory corridor conditions are strongly affected by the presence of passage barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality. For freshwater migration corridors to function properly, they must provide adequate passage, provide suitable migration cues, reduce false attraction, avoid areas where vulnerability to predation is increased, and avoid impediments and delays in both upstream and downstream migration. For this reason, freshwater migration corridors are considered to have a high conservation value.

C.19.2.4 Ocean Habitats

Most juvenile steelhead rear in coastal marine waters for a period of approximately 1 to2 years before returning to the Central Valley rivers as adults to spawn (Burgner et al. 1992 as cited in McEwan and Jackson 1996). During their marine residence, steelhead forage on krill and other marine organisms. Offshore marine areas with water quality conditions and food, including squid, crustaceans, and fish (fish become a larger component in the steelhead diet later in life [Moyle 2002]) that support growth and maturation are important habitat elements. These features are essential for conservation because, without them, juveniles cannot forage and grow to adulthood.

C.19.3 Species Distribution and Population Trends

C.19.3.1 Distribution

Central Valley steelhead were widely distributed historically throughout the Sacramento and San Joaquin Rivers (Busby et al. 1996; McEwan 2001). Steelhead inhabited waterways from the upper Sacramento and Pit River systems (now inaccessible because of Shasta and Keswick Dams) south to the Kings River and possibly the Kern River systems, and in both east- and west-side Sacramento River tributaries (Yoshiyama et al. 1996). Lindley et al. (2006) estimated that there were historically at least 81 independent Central Valley steelhead populations distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin Rivers.

The geographic distribution of spawning and juvenile rearing habitat for Central Valley steelhead has been greatly reduced by the construction of dams (McEwan and Jackson 1996; McEwan 2001). Presently, impassable dams block access to 80% of historically available habitat and all spawning habitat for approximately 38% of historic populations (Lindley et al. 2006). Existing wild steelhead stocks in the Central Valley inhabit the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks, and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

C.19.3.2 Population Trends

Historical Central Valley steelhead run sizes are difficult to estimate given the paucity of data but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, steelhead run size had declined to approximately 40,000 adults (McEwan 2001). Over the past 30 years, naturally spawned steelhead populations in the upper Sacramento River have declined substantially (Figure 2A.6 2). Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, recent monitoring has detected small self-sustaining populations in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001; Zimmerman et al. 2009; National Marine Fisheries Service 2011). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good et al. 2005). Some of these fish, however, may have been resident rainbow trout, which are the same species but have not found it advantageous to choose anadromy. Nonhatchery stocks of rainbow trout that have anadromous components within them are found in the Upper Sacramento River and its tributaries; Mill, Deer, and Butte Creeks; and the Feather, Yuba, Mokelumne, and Calaveras Rivers (McEwan 2001).

Along with the decline in accessible habitat, there has been a substantial decline in steelhead returning to the upper Sacramento River . The reduction in numbers from an average of 6,574 fish from 1967 to 1991, to an average of 1,282 fish from 1992 to 2006, represents a significant drop in the upper Sacramento River populations. Although data are limited, similar population reductions are expected to have occurred throughout the Sacramento–San Joaquin system.

The most recent status review of the Central Valley steelhead DPS (National Marine Fisheries Service 2011) found that the status of the population appears to have worsened since the 2005 status review (Good et al. 2005), when it was considered to be in danger of extinction.

C.19.4 Threats to the Species

C.19.4.1 Reduced Staging and Spawning Habitat

Adult steelhead historically migrated upstream into higher gradient reaches of rivers and tributaries where water temperatures were cooler, turbidity was lower, and gravel substrate size was suitable for spawning and egg incubation (McEwan 2001). Steelhead are known to migrate upstream into higher gradient and elevation reaches of the rivers and streams than fall-run Chinook salmon, which predominantly spawn at lower elevations in the valley floor. Most historical adult staging/holding and spawning habitat for Central Valley steelhead is no longer accessible to upstream migrating steelhead. Habitat has been eliminated or degraded by artificial structures (e.g., dams and weirs) associated with water storage and conveyance; diversions; flood control; and municipal, industrial, agricultural, and hydropower purposes (Figure 2A.6-1) (McEwan and Jackson 1996; McEwan 2001; Bureau of Reclamation 2004; Lindley et al. 2006; National Marine Fisheries Service 2007). These impediments and barriers to upstream passage limit the geographic distribution of steelhead to lower elevation habitats in the Central Valley.

Steelhead in the Central Valley migrate upstream into the mainstem Sacramento River and major tributaries (e.g., American and Feather Rivers; Clear and Battle Creeks), and are also known to occur in tributaries to the San Joaquin River, where they spawn and rear. Steelhead do not currently spawn in the mainstem San Joaquin River. The majority of current steelhead spawning habitat exists upstream of the Red Bluff Diversion Dam on the Sacramento River and its tributaries. Although the overall effect of operations of the dam on the Central Valley steelhead populations is not well understood, concerns have been expressed regarding the effect of gate operations on upstream and downstream migration by steelhead. Additional concerns include the potential for increased vulnerability of juvenile steelhead to predation by Sacramento pikeminnow, striped bass, and other predators that pass through the Red Bluff Diversion Dam gates or fish ladder.

Reduced flows from dams and upstream water diversions can lower attraction cues for adult spawners, causing straying and delays in spawning or the inability to spawn (California Department of Water Resources 2005). Adult steelhead migration delays can reduce fecundity and egg viability and increase susceptibility to disease and harvest.

C.19.4.2 Reduced Rearing and Out-Migration Habitat

Juvenile steelhead prefer to utilize natural stream banks, floodplains, marshes, and shallow water habitats for rearing during out-migration. Modification of natural flow regimes from upstream reservoir operations has resulted in dampening of the hydrograph in most Central Valley rivers, reducing the extent and duration of inundation of floodplains and other flow-dependent habitat used by migrating juvenile steelhead (California Department of Water Resources 2005; 70 FR 52488). Changes in river hydrology that have affected floodplain inundation may have affected areas thought to provide significant growth benefits to rearing fish (Sommer et al. 2001).

C.19.4.3 Predation by Nonnative Species

Native species such as the Sacramento pikeminnow are a potentially significant source of mortality in the Sacramento River at locations such as the Red Bluff Diversion Dam. However, predation by nonnative species is of particular concern. In general, the effect of nonnative predation on the Central Valley steelhead DPS is unknown but predation is most likely a threat in areas with high densities of nonnative fish (e.g., small and large mouth bass, striped bass, and catfish), which are thought to prey on out-migrating juvenile steelhead. Predation risk may covary with increased temperatures. Metabolic rates of nonnative, predatory fish increase with increasing water temperatures based on bioenergetic studies (Loboschefsky et al. 2012; Miranda et al. 2010). Upstream gravel pits and flooded ponds, such as those that occur on the San Joaquin River and its tributaries, attract nonnative predators because of their depth and lack of cover for juvenile steelhead (California Department of Water Resources 2005). Nonnative aquatic vegetation, such as Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), provide suitable habitat for nonnative predators (Brown and Michniuk 2007).

C.19.4.4 Harvest

Steelhead have been, and continue to be, an important recreational fishery in inland rivers throughout the Central Valley. Although there are no commercial fisheries for steelhead, inland steelhead fisheries include tribal and recreational fisheries. In the Central Valley, recreational fishing for steelhead of hatchery origin is popular, but harvest is restricted to only visibly marked fish of hatchery origin (adipose fin clipped). Unmarked steelhead (adipose fin intact) must be released, reducing the take of naturally spawned wild fish. The level of illegal harvest of Chinook salmon and steelhead in the Delta and bays is unknown.The effects of recreational fishing and this unknown level of illegal harvest on the abundance and population dynamics of wild Central Valley steelhead have not been quantified.

C.19.4.5 Reduced Genetic Diversity and Integrity

Artificial propagation programs for steelhead in Central Valley hatcheries present multiple threats to the wild steelhead population, including mortality of natural steelhead in fisheries targeting hatchery origin steelhead, competition for prey and habitat, predation by hatchery origin fish on younger natural fish, disease transmission, and impediments to fish passage imposed by hatchery facilities. It is now recognized that Central Valley hatcheries are a significant and persistent threat to wild Chinook salmon and steelhead populations and fisheries (National Marine Fisheries Service 2009b). One major concern with hatchery operations is the genetic introgression by hatchery origin fish that spawn naturally and interbreed with local natural populations (U.S. Fish and Wildlife Service 2001; Bureau of Reclamation 2004; Goodman 2005). Such introgression introduces maladaptive genetic changes to the wild steelhead stocks (McEwan and Jackson 1996; Myers et al. 2004). Hatchery operations have been found to decrease Chinook salmon fitness (Araki et al. 2007). Taking eggs and sperm from a large pool of individuals is one method for ameliorating genetic introgression, but artificial selection for traits that assure individual success in a hatchery setting (e.g., rapid growth and tolerance to crowding) are unavoidable (Bureau of Reclamation 2004).

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88% naturally produced fish in the 1950s (McEwan 2001) to an estimated 23% to 37% naturally produced fish by 2000 (Nobriga and Cadrett 2003), and less than 10% currently

(National Marine Fisheries Service 2011). The increase production of in hatchery steelhead has reduced the viability of the wild steelhead populations (National Marine Fisheries Service 2012).

C.19.4.6 Entrainment

The risk of entrainment is a function of the size of juvenile fish and the slot opening of the screen mesh (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987). Although entrainment/salvage of steelhead at the SWP/CVP export facilities is well documented, it is unclear how many juvenile steelhead are entrained at other unscreened Delta diversions. Because steelhead are moderately large (greater than 200-millimeter fork length) and relatively strong swimmers when out-migrating, the effects on steelhead of small in agricultural water diversions are thought to be lower than those on other Central Valley salmonids. In addition, many of the juvenile steelhead migrate downstream during the late winter or early spring before many of the agricultural irrigation diversions are operating.

Power plants have the ability to impinge juvenile steelhead on the existing intake screens. However, use of cooling water is currently low with the retirement of older units. Furthermore, newer units are equipped with a closed-cycle cooling system that virtually eliminates the risk of impingement of juvenile steelhead.

C.19.4.7 Exposure to Toxins

Toxic chemicals are widespread and may occur on a more localized scale in response to episodic events (e.g., stormwater runoff, point source discharges, etc.). These toxic substances include mercury, selenium, copper, pyrethroids, and endocrine disruptors with the potential to affect fish health and condition, and negatively affect steelhead distribution and abundance directly or indirectly. Some loads of toxics, such as selenium, are much higher in the San Joaquin River than the Sacramento River because they are naturally occurring in the alluvial soils and have been leached by irrigation water and concentrated by evapotranspiration (Nichols et al. 1986). This may indicate that the potential effects of chronic exposure could be greater for steelhead of San Joaquin River origin. Additionally, agricultural return flows that may contain toxic chemicals are widely distributed throughout the Sacramento and San Joaquin Rivers.

Iron Mountain Mine, located adjacent to the upper Sacramento River, has been a source of trace elements that are known to adversely affect aquatic organisms (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989). Storage limitations and limited availability of dilution flows have caused downstream copper and zinc levels to exceed salmonid tolerances and resulted in documented fish kills in the 1960s and 1970s (Bureau of Reclamation 2004). The U.S. Environmental Protection Agency's Iron Mountain Mine remediation program has removed toxic metals in acidic mine drainage from the Spring Creek watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s.

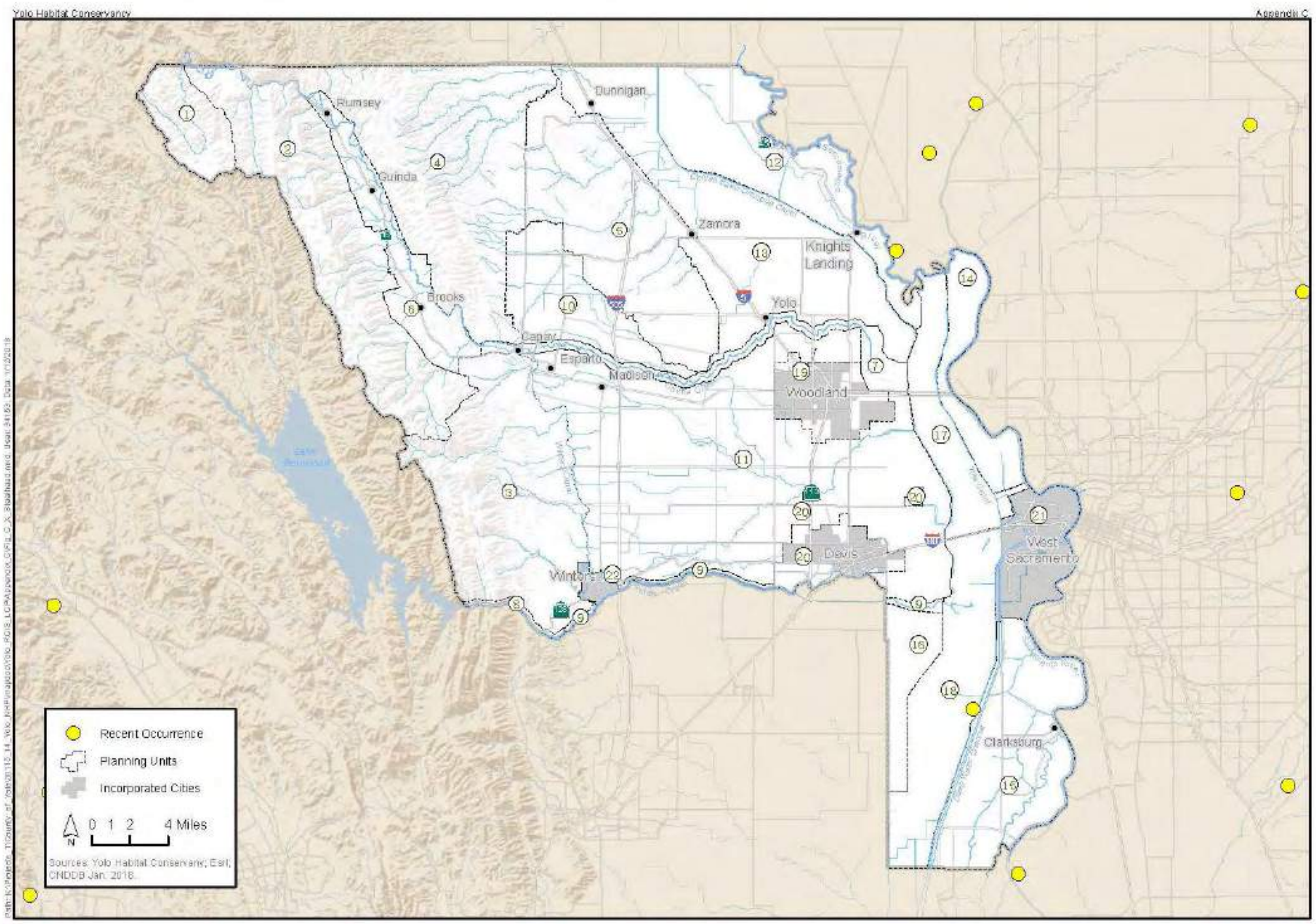
C.19.4.8 Increased Water Temperature

Water temperature is among the physical factors that affect the value of habitat for salmonid adult holding, spawning and egg incubation, juvenile rearing, and migration. Adverse sublethal and lethal effects can result from exposure to elevated water temperatures at sensitive life stages, such as during incubation or rearing. Water temperature criteria for various life stages of salmonids in the Central Valley have been developed by the NMFS (2009a). The tolerance of steelhead water temperatures depends on life stage, acclimation history, food availability, duration of exposure, health of the individual, and other factors such as predator avoidance (Myrick and Cech 2004; Bureau of Reclamation 2004). Higher water temperatures can lead to physiological stress, reduced growth rate, reduced spawning success, and increased mortality of steelhead (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). Exposure to seasonally elevated water temperatures may occur from reductions in flow because of upstream reservoir operations, reductions in riparian vegetation, channel shading, local climate, and solar radiation.

C.19.5 Recovery Plan Goals

The draft recovery plan for Central Valley salmonids, including steelhead, was released on October 19, 2009 (National Marine Fisheries Service 2009b). Although not final, the overarching goal in the public draft is the removal of, among other listed salmonids, the Central Valley steelhead DPS from the federal List of Endangered and Threatened Wildlife (National Marine Fisheries Service 2009b). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations in each historical diversity group, as well as other measurable biological criteria.

Figure C-16. Steelhead Mapped Habitat and Occurrences



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C.20 Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*)

C.20.1 Listing Status

Federal: Endangered

State: Endangered

Recovery Plan: The draft recovery plan for Central Valley salmonids, including Sacramento River winter-run Chinook salmon, was released on October 19, 2009 (National Marine Fisheries Service 2009a).

Critical Habitat: Critical habitat for the winter-run Chinook ESU was designated under the ESA on June 16, 1993 (58 FR 33212).

C.20.2 Species Description and Life History

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). Stream-type adults enter fresh water months before spawning and juveniles reside in fresh water for a year or more following emergence, whereas ocean-type adults spawn soon after entering fresh water and juveniles migrate to the ocean as fry or parr in their first year. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter fresh water in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July; the peak occurring in March (Yoshiyama et al. 1998; Moyle 2002). Spawning occurs from mid-April to mid-August, peaking in May and June, in the Sacramento River reach between Keswick Dam and Red Bluff Diversion Dam (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old. Adult winter-run Chinook salmon tend to enter fresh water as sexually immature fish, migrate far upriver, and delay spawning for weeks or months. Prespawning activity requires an area of 200 to 650 square feet. The female digs a nest, called a redd, with an average size of 165 square feet, in which she buries her eggs after they are fertilized by the male (Resources Agency et al. California Department of Fish and Game 1998).

Sacramento River winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994), with emergence generally occurring at night. Fry then seek lower velocity nearshore habitats with riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (National Marine Fisheries Service 1996). Emigrating juvenile Sacramento River winter-run Chinook salmon pass the Red Bluff Diversion Dam beginning as early as mid-July, typically peaking in September, and can continue through March in dry years (Vogel and Marine 1991; National Marine Fisheries Service 1997). Many juveniles apparently rear in the Sacramento

River below Red Bluff Diversion Dam for several months before they reach the Delta (Williams 2006). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed the Red Bluff Diversion Dam by October, and all outmigrating presmolts and smolts passed the Red Bluff Diversion Dam by March (Martin et al. 2001).

C.20.3 Habitat Requirements and Ecology

C.20.3.1 Spawning Habitat

Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between Red Bluff Diversion Dam and Keswick Dam. Spawning sites include those stream reaches with water movement, velocity, depth, temperature, and substrate composition that support spawning, egg incubation, and larval development. Water velocity and substrate conditions are more critical to the viability of spawning habitat than depth. Incubating eggs and embryos buried in gravel require sufficient water flow through the gravel to supply oxygen and remove metabolic wastes (California Department of Fish and Game 1998). Spawning occurs in gravel substrate in relatively fast-moving, moderately shallow riffles or along banks with relatively high water velocities. The gravel must be clean and loose, yet stable for the duration of egg incubation and the larval development.

Substrate composition has other key implications to spawning success. The embryos and alevins (newly hatched fish with the yolk sac still attached) require adequate water movement through the substrate; however, this movement can be inhibited by the accumulation of fines and sand. Generally, the redd should contain less than 5% fines (California Department of Fish and Game 1998).

Water velocity in Chinook salmon spawning areas typically ranges from 1.0 to 3.5 feet per second and optimum velocity is 1.5 feet per second (California Department of Fish and Game 1998). Spawning occurs at depths between 1 to 5 feet with a maximum observed depth of 20 feet. A depth of less than 6 inches can be restrictive to Chinook salmon movement.

C.20.3.2 Freshwater Rearing Habitat

Freshwater salmon rearing habitats contain sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions that support juvenile growth and mobility; suitable water quality; availability of suitable forage species that support juvenile salmon growth and development; and cover such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors also function as rearing habitat for juveniles, which feed and grow before and during their outmigration. Nonnatal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat value is strongly affected by habitat diversity and complexity, food supply, and fish and avian predators. Some of these more complex and productive habitats with floodplains are still found in the system (e.g., Sacramento River reaches with setback levees). The channeled, leveed, and riprapped river reaches and sloughs are common along the Sacramento River; however, they typically have low habitat complexity, have low abundance of food organisms, and offer little protection from predation by fish and birds. Freshwater rearing habitat has a high conservation value as the juvenile life stage of salmonids is dependent on the function of this habitat for successful survival and recruitment into the adult population.

C.20.3.3 Freshwater Migration Corridors

Freshwater migration corridors for winter-run Chinook salmon, including river channels, floodplains, support mobility, survival, and food supplies for juveniles and adults. Migration corridors should be free from obstructions (passage barriers and impediments to migration), provide favorable water quantity (instream flows) and quality conditions (seasonal water temperatures), and contain natural cover such as submerged and overhanging large wood, native aquatic vegetation, large woody debris, rocks and boulders, side channels, and undercut banks. Migratory corridors for winter-run Chinook salmon are located downstream of the spawning areas and include the Yolo Bypass. These corridors allow the upstream passage of adults and the downstream emigration of juvenile salmon. Migratory corridor conditions are strongly affected by the presence of passage barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality. For freshwater migration corridors to function properly, they must provide adequate passage, provide suitable migration cues, limit false attraction, provide low vulnerability to predation, and not contain impediments and delays in both upstream and downstream migration.

Results of mark-recapture studies conducted using juvenile Chinook salmon (typically hatchery-reared late fall-run Chinook salmon that are considered to be representative of juvenile winter-run salmon) released into the Sacramento River have shown high mortality during passage downstream through the rivers and Delta (Brandes and McLain 2001; Newman and Rice 2002; Hanson 2008). Mortality is typically greater in years when spring flows are reduced and water temperatures are increased.

C.20.3.4 Estuarine Habitat

Estuarine migration and juvenile rearing habitats should be free of obstructions (i.e., dams and other barriers) and provide suitable water quality, water quantity (river and tidal flows), and salinity conditions to support juvenile and adult physiological transitions between fresh and salt water. Natural cover, such as submerged and overhanging large wood, native aquatic vegetation, and side channels, provide juvenile foraging habitat and cover from predators. Tidal wetlands and seasonally inundated floodplains have also been identified as high-value foraging and rearing habitats for juvenile salmon migrating downstream through the estuary. Estuarine areas contain a high conservation value because they function to support juvenile Chinook salmon growth, smolting, and avoidance of predators, as well as provide a transition to the ocean environment.

C.20.3.5 Marine Habitats

Although ocean habitats are not part of the critical habitat listings for Sacramento River winter-run Chinook salmon, biologically productive coastal waters are an important habitat component for the species. Juvenile Chinook salmon inhabit near-shore coastal marine waters for a period of typically 2 to 4 years before adults return to Central Valley rivers to spawn. During their marine residence, Chinook salmon forage on krill, squid, and other marine invertebrates and a variety of fish such as northern anchovy, sardines, and Pacific herring. These features are essential for conservation because, without them, juveniles cannot forage and grow to adulthood.

C.20.4 Species Distribution and Population Trends

C.20.4.1 Distribution

The distribution of winter-run Chinook salmon spawning and rearing was limited historically to the upper Sacramento River and tributaries, where cool spring-fed streams supported successful adult holding, spawning, egg incubation, and juvenile rearing (Slater 1963; Yoshiyama et al. 1998). The headwaters of the McCloud, Pit, and Little Sacramento Rivers and Hat and Battle Creeks, provided clean, loose gravel, cold, well-oxygenated water, and year-round flow in riffle habitats for spawning and incubation (Figure 2A.3 1). These areas also provided the cold, productive waters necessary for egg and fry survival and juvenile rearing over summer. Construction of Shasta Dam in 1943 and Keswick Dam in 1950 blocked access to all of these upstream waters except Battle Creek, which is blocked by a weir at the Coleman National Fish Hatchery and other small hydroelectric facilities (Moyle et al. 1989; National Marine Fisheries Service 1997). Approximately 299 miles of tributary spawning habitat in the upper Sacramento River are inaccessible to winter-run Chinook salmon (National Marine Fisheries Service 2012).

Primary spawning and rearing habitats for winter-run Chinook salmon are now confined to the cold water areas between Keswick Dam and Red Bluff Diversion Dam. The lower reaches of the Sacramento River, Sacramento–San Joaquin River Delta (Delta), and San Francisco Bay serve as migration corridors for the upstream migration of adult and downstream migration of juvenile winter-run Chinook salmon.

C.20.4.2 Population Trends

Estimates of the Sacramento River winter-run Chinook salmon population (including both male and female salmon) reached nearly 100,000 fish in the 1960s before declining to under 200 fish in the 1990s (Good et al. 2005). Although the abundance of the Sacramento River winter-run Chinook salmon population has, on average, been growing since the 1990s (despite recent declines since 2007), there is only one population and it depends heavily on coldwater releases from Shasta Dam (Good et al. 2005). Lindley et al. (2007) consider the Sacramento River winter-run Chinook salmon population at a moderate risk of extinction primarily because of the risks associated with only one existing population. The viability of an ESU that is represented by a single population is vulnerable to changes in the environment through a lack of spatial geographic and genetic diversity. A single catastrophic event with effects persisting for 4 or more years could extirpate the entire Sacramento River winter-run Chinook salmon ESU, which puts the population at a high risk of extinction over the long term (Lindley et al. 2007). Such potential catastrophes include volcanic eruption of Mount Lassen; prolonged drought, which depletes the coldwater pool in Lake Shasta or some related failure to manage coldwater storage; a spill of toxic materials with effects that persist for 4 years; regional declines in upwelling and productivity of near-shore coastal marine waters resulting in reduced food supplies for juvenile and sub-adult salmon, reduced growth, and/or increased mortality; or a disease outbreak. Another vulnerability to an ESU that is represented by a single population is the limitation in life history and genetic diversity that would otherwise increase the ability of individuals in the population to withstand environmental variation.

Although NMFS proposed that this ESU be downgraded from endangered to threatened status, NMFS decided in its Final Listing Determination (June 28, 2005; 70 FR 37160) to continue to list the Sacramento River winter-run Chinook salmon ESU as endangered because the population remains below the draft recovery goals established for the run (National Marine Fisheries Service 1997) and the naturally spawned component of the ESU is dependent on one extant population in the Sacramento River. NMFS reconfirmed this listing status in 2011, based on a 10-year negative trend in abundance and the continued influence of hatchery fish on the single spawning population in the ESU (National Marine Fisheries Service 2011).

C.20.5 Threats to the Species

C.20.5.1 Reduced Staging and Spawning Habitat

Access to much of the historical upstream spawning habitat for winter-run Chinook salmon has been eliminated or degraded by artificial structures (e.g., dams and weirs) associated with water storage and conveyance, flood control, and diversions and exports for municipal, industrial, agricultural, and hydropower purposes (Yoshiyama et al. 1998). The construction and operation of Shasta Dam reduced the winter-run Chinook salmon ESU from four independent populations to just one. The remaining available habitat for natural spawners is currently maintained with cool water releases from Shasta and Keswick dams, thereby significantly limiting spatial distribution of this ESU in the reach of the mainstem Sacramento River immediately downstream of the dam.

The Red Bluff Diversion Dam, located on the Sacramento River, has been identified as a barrier and impediment to adult winter-run Chinook salmon upstream migration. Although the Red Bluff Diversion Dam is equipped with fish ladders, migration delays occur when the dam gates are closed. Mortality, as a result of increased predation by Sacramento pikeminnow on juvenile salmon passing downstream through the fish ladder, has also been identified as a factor affecting abundance of salmon produced on the Sacramento River (Hallock 1991). The construction and operation of the Red Bluff Diversion Dam has been identified as one of the primary factors contributing to the decline in winter-run Chinook salmon abundance that led to listing of the species under the ESA. However, the dam gates were placed in a permanent open position in September 2011, and a new pump facility with a state-of-the-art fish screen was subsequently constructed. The project is expected to benefit both upstream and downstream migration and contribute to a reduction in juvenile predation mortality.

C.20.5.2 Reduced Rearing and Out-Migration Habitat

Juvenile winter-run Chinook salmon prefer natural stream banks, floodplains, marshes, and shallow water habitats for rearing during out-migration. Channel margins throughout the Delta have been leveed, channelized, and fortified with riprap for flood protection and island reclamation, reducing and degrading the value of natural habitat available for juvenile Chinook salmon rearing (Brandes and McLain 2001). Artificial barriers further reduce and degrade rearing and migration habitat and delay juvenile out-migration. Juvenile out-migration delays can reduce fitness and increase susceptibility to diversion screen impingement, entrainment, disease, and predation. Modification of natural flow regimes from upstream reservoir operations has resulted in dampening and altering the seasonal timing of the hydrograph, reducing the extent and duration of seasonal floodplain inundation and other flow-dependent habitat used by migrating juvenile Chinook salmon (70 FR 52488; Sommer et al. 2001; California Department of Water Resources 2005).

Recovery of floodplain habitat in the Central Valley has been found to contribute to increased production in fall-run Chinook salmon (Sommer et al. 2001), but little is known about the potential benefits of recovered floodplains during the migration period for winter-run fish, although Sommer et al. (2001) noted that the reduction of floodplain habitat might have significant negative impacts on winter-run Chinook salmon. Reductions in flow rates have resulted in increased seasonal water temperatures. The potential adverse effects of dam operations and reductions in seasonal river flows, such as delays in juvenile emigration and exposure to a higher proportion of agricultural return flows, have all been identified as factors that could affect the survival and success of winter-run Chinook salmon inhabiting the Sacramento River in the future.

Channel margins have been considerably reduced because of the construction of levees and the armoring of their banks with riprap (Williams 2009). These shallow-water habitat areas provide refuge from unfavorable hydraulic conditions and predation, as well as foraging habitat for out-migrating juvenile salmonids. Recent research has focused on the use of channel margin habitat by Chinook salmon fry (McLain and Castillo 2009; H.T. Harvey & Associates with PRBO Conservation Science 2011). Benefits for larger Chinook salmon migrant juveniles and steelhead may be somewhat less than for foraging Chinook salmon fry, although the habitat may serve an important function as holding areas during downstream migration (Burau et al. 2007), thereby improving connectivity along the migration route.

C.20.5.3 Predation by Nonnative Species

Predation on juvenile salmon by nonnative fish has been identified as an important threat to winter-run Chinook salmon in areas with high densities of nonnative fish (e.g., smallmouth and largemouth bass, striped bass, and catfish) that prey on out-migrating juveniles (Lindley and Mohr 2003). On the main stem Sacramento River, high rates of predation are known to occur at the Anderson-Cottonwood and Glenn Colusa Irrigation District diversion facilities, areas where rock revetment has replaced natural river bank vegetation, and at South Delta water diversion structures (e.g., Clifton Court Forebay) (California Department of Fish and Game 1998).

Water temperatures are generally lower during out-migration of winter-run compared to other salmonids, and may ameliorate predation pressures that can increase with increasing water temperature. In addition, nonnative aquatic vegetation, such as Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), provide suitable habitat for nonnative predators (Nobriga et al. 2005; Brown and Michniuk 2007). Predation risk may also vary with increased temperatures. Metabolic rates of nonnative, predatory fish increase with increasing water temperatures based on bioenergetic studies (Loboschefsky et al. 2012; Miranda et al. 2010). The low spatial complexity and reduced habitat diversity (e.g., lack of cover) of channelized waterways in the Sacramento River reduces refuge space of salmon from predators (Raleigh et al. 1984; Missildine et al. 2001; 70 FR 52488).

C.20.5.4 Harvest

Commercial and recreational harvest of winter-run Chinook salmon in the ocean and inland fisheries has been a subject of management actions by the California Fish and Game Commission and the Pacific Fishery Management Council. The primary concerns focus on the effects of harvest on wild Chinook salmon produced in the Central Valley, as well as the incidental harvest of winter-run Chinook salmon as part of the fall- and late fall-run salmon fisheries. Naturally reproducing winter-run Chinook salmon are less able to withstand high harvest rates when compared to hatchery-based stocks. This intolerance is attributed to differences in survival rates for incubating eggs and rearing and emigrating juvenile salmon produced in streams and rivers (relatively low survival rates) compared to Central Valley salmon hatcheries (relatively high survival rates) (Knudsen et al. 1999).

Commercial fishing for salmon in west coast ocean waters is managed by the Fishery Management Council and is constrained by time and area closures to meet the Sacramento River winter-run ESA consultation standard and restrictions that require minimum size limits and the use of circle hooks by anglers. Ocean harvest restrictions since 1995 have led to reduced ocean harvest of winter-run Chinook salmon (i.e., Central Valley Chinook salmon ocean harvest index, ranged from 0.55 to nearly 0.80 from 1970 to 1995, and was reduced to 0.27 in 2001). Major restrictions in the commercial fishing industry in California and Oregon were enforced to protect Klamath River coho salmon stocks. Because the fishery is mixed, these restrictions have likely reduced harvest of winter-run Chinook salmon as well. The California Department of Fish and Wildlife (CDFW), NMFS, and Pacific Fishery Management Council continually monitor and assess the effects of the harvest of winter-run Chinook salmon, such that regulations can be refined and modified as new information becomes available. However, previous harvest practices are the likely cause of the predominance of 3-year-old spawners, with few (if any) 4- and 5-year-old fish surviving the additional years in the ocean to return as spawners (National Marine Fisheries Service 2012).

Because adult winter-run Chinook salmon hold in the mainstem Sacramento River until spawning during the summer months, they are particularly vulnerable to illegal (poaching) harvest. Various watershed groups have established public outreach and educational programs in an effort to reduce poaching. In addition, CDFW wardens have increased enforcement against illegal harvest of winter-run Chinook salmon. The level and effect of illegal harvest on adult winter-run Chinook salmon abundance and population reproduction is unknown.

C.20.5.5 Reduced Genetic Diversity and Integrity

Artificial propagation programs conducted for winter-run Chinook salmon conservation purposes (i.e., Livingston Stone National Fish Hatchery) were developed to increase the abundance and diversity of winter-run Chinook salmon and to protect the species from extinction in the event of a catastrophic failure of the wild population. It is unclear what the effects of the hatchery propagation program are on the productivity and spatial structure of the winter-run Chinook salmon ESU (i.e., genetic fitness and productivity). One of the primary concerns with hatchery operations is the genetic introgression by hatchery origin fish that spawn naturally and interbreed with local natural populations (U.S. Fish and Wildlife Service 2001; Bureau of Reclamation 2004; Goodman 2005). It is now recognized that Central Valley hatcheries are a significant and persistent threat to wild Chinook salmon and steelhead populations and fisheries (National Marine Fisheries Service 2009a). Such introgression introduces maladaptive genetic changes to the wild winter-run stocks and may reduce overall fitness (Myers et al. 2004; Araki et al. 2007). Taking egg and sperm from a large number of individuals is one method to ameliorate genetic introgression, but artificial selection for traits that assure individual success in a hatchery setting (e.g., rapid growth and tolerance to crowding) are unavoidable (Bureau of Reclamation 2004).

Hatchery-origin winter-run Chinook salmon from Livingston Stone National Fish Hatchery represent more than 5% of the natural spawning run in recent years and as high as 18% in 2005 (National Marine Fisheries Service 2012). Lindley et al. (2007) recommended reclassifying the winter-run Chinook population extinction risk as moderate, rather than low, if hatchery introgression exceeds about 15% over multiple generations of spawners. Since 2005, however, the percentage of hatchery fish has been consistently below 15% of the spawning run (National Marine Fisheries Service 2012).

C.20.5.6 Entrainment

The risk of entrainment is a function of the size of juvenile fish and the slot opening of the screen mesh (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987). Many juvenile winter-run Chinook salmon migrate downstream during the late winter or early spring when many of the agricultural irrigation diversions are not operating or are only operating at low levels. Juvenile winter-run Chinook salmon also migrate primarily in the upper part of the water column, reducing their vulnerability to unscreened diversions located near the channel bottom. No quantitative estimates have been developed to assess the potential magnitude of entrainment losses for juveniles migrating through the rivers and Delta, or the effects of these losses on the overall population abundance of returning adult Chinook salmon. The effect of entrainment mortality on the population dynamics and overall adult abundance of winter-run Chinook salmon is not well understood.

Power plants also have the ability to impinge and entrain juvenile Chinook salmon on the existing cooling water system intake screens. However, use of cooling water is currently low with the retirement of older units. Furthermore, newer units are being equipped with a closed-cycle cooling system that virtually eliminates the risk of impingement of juvenile salmon.

C.20.5.7 Exposure to Toxins

Inputs of toxins into the Delta watershed include agricultural drainage and return flows, municipal wastewater treatment facilities, and other point and nonpoint discharges (Moyle 2002). These toxic substances include mercury, selenium, copper, pyrethroids, and endocrine disruptors with the potential to affect fish health and condition, and adversely affect salmon distribution and abundance. Toxic chemicals have the potential to be widespread throughout the Sacramento River and Delta, or may occur on a more localized scale in response to episodic events (e.g., stormwater runoff and point source discharges). Agricultural return flows are widely distributed throughout the Sacramento River, although dilution flows from the rivers may reduce chemical concentrations to sublethal levels. Toxic algae (e.g., Microcystis) have also been identified as a potential factor adversely affecting salmon and other fish. Exposure to these toxic materials has the potential to directly and indirectly adversely affect salmon distribution and abundance.

Concern regarding exposure to toxic substances for Chinook salmon includes both waterborne chronic and acute exposure, but also bioaccumulation and chronic dietary exposure. Exposure to selenium in the diet of juvenile Chinook salmon has been shown to result in toxic effects (Hamilton et al. 1986, 1990; Hamilton and Buhl 1990). Selenium exposure has been associated with agricultural and natural drainage in the San Joaquin River basin and petroleum refining operations adjacent to San Pablo and San Francisco Bays.

Other contaminants of concern for Chinook salmon include, but are not limited to, mercury, copper, oil and grease, pesticides, herbicides, ammonia, and localized areas of depressed dissolved oxygen. As a result of the extensive agricultural development in the Central Valley, exposure to pesticides and herbicides has been identified as a significant concern for salmon and other fish species in the Strategy Area (Bennett et al. 2001). In recent years, changes have been made in the composition of herbicides and pesticides used on agricultural crops in an effort to reduce potential toxicity to aquatic and terrestrial species. Modifications have also been made to water system operations and discharges related to agricultural wastewater discharges (e.g., agricultural drainage water system lock-up and holding prior to discharge) and municipal wastewater treatment and discharges.

Mercury and other metals such as copper have also been identified as contaminants of concern for salmon and other fish, as a result of direct toxicity and impacts related to acid mine runoff from sites such as Iron Mountain Mine (U.S. Environmental Protection Agency 2006). The potential problems include tissue bioaccumulation that may adversely affect the fish, but also represent a human health concern (Gassel et al. 2008). These materials originate from a variety of sources including mining operations, municipal wastewater treatment, agricultural drainage in the tributary rivers, nonpoint runoff, natural runoff and drainage in the Central Valley, agricultural spraying, and a number of other sources.

In the final listing determination of the ESU, acid mine runoff from Iron Mountain Mine, located adjacent to the upper Sacramento River, was identified as one of the main threats to winter-run Chinook salmon (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989). Acid mine drainage, including elevated concentrations of metals, produced from the abandoned mine degraded spawning habitat of winter-run Chinook salmon and resulted in high mortality. Storage limitations and limited availability of dilution flows have caused downstream copper and zinc levels to exceed salmonid tolerances and resulted in documented fish kills in the 1960s and 1970s (Bureau of Reclamation 2004). EPA's Iron Mountain Mine remediation program and 2002 restoration plan has removed toxic metals in acidic mine drainage from the Spring Creek watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s. Pollution from Iron Mountain Mine is no longer considered to be a main factor threatening the winter-run Chinook salmon ESU.

Concern has been expressed regarding the potential to resuspend toxic materials into the water column where they may adversely affect salmon through seasonal floodplain inundation, habitat construction projects, channel and harbor maintenance dredging, and other means. For example, mercury deposits exist at a number of locations in the Central Valley, including the Yolo Bypass. Seasonal inundation of floodplain areas, such as in the Yolo Bypass, has the potential to create anaerobic conditions that contribute to the methylation of mercury, which increases toxicity. Additionally, there are problems with scour and erosion of these mercury deposits by increased seasonal flows. Similar concerns exist regarding creating aquatic habitat by flooding Delta islands or disturbance created by levee setback construction or other habitat enhancement measures. The potential to increase toxicity as a result of habitat modifications designed to benefit aquatic species is one of the factors that needs to be considered when evaluating the feasibility of habitat enhancement projects in the Central Valley.

Sublethal concentrations of toxics may interact with other stressors on salmonids, such as increasing their vulnerability to mortality as a result of exposure to seasonally elevated water temperatures, predation or disease (Werner 2007). For example, Clifford et al. (2005) found in a laboratory setting that juvenile fall-run Chinook salmon exposed to sublethal levels of a common pyrethroid, esfenvalerate, were more susceptible to the infectious hematopoietic necrosis virus than those not exposed to esfenvalerate. Although not tested on winter-run Chinook salmon, a similar response is likely.

C.20.5.8 Increased Water Temperature

Water temperature is among the physical factors that affect the value of habitat for salmonid adult holding, spawning and egg incubation, juvenile rearing, and migration. Adverse sublethal and lethal effects can result from exposure to elevated water temperatures at sensitive life stages, such as during incubation or rearing. The Central Valley is the southern limit of Chinook salmon geographic distribution and increased water temperatures are often recognized as an important stressor to California populations. Water temperature criteria for various life stages of salmonids in the Central Valley have been developed by NMFS (2009a).

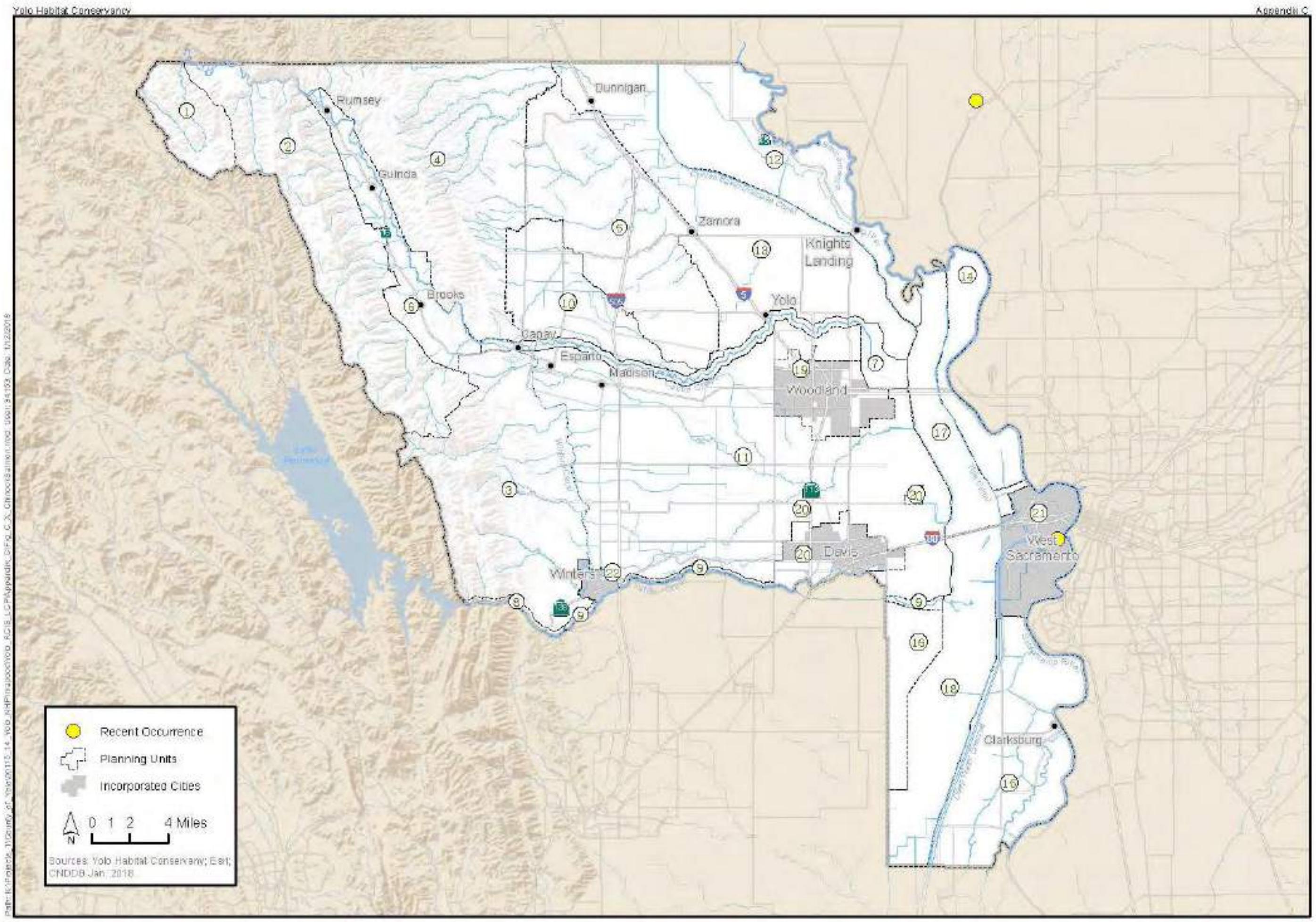
The tolerance of winter-run Chinook salmon to water temperatures depends on life stage, acclimation history, food availability, duration of exposure, health of the individual, and other factors, such as predator avoidance (Myrick and Cech 2004; Bureau of Reclamation 2004). Higher water temperatures can lead to physiological stress, reduced growth rates, prespawning mortality, reduced spawning success, and increased mortality of salmon (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). Exposure to seasonally elevated water temperatures may occur as a result of reductions in flow, as a result of upstream reservoir operations, reductions in riparian vegetation, channel shading, local climate and solar radiation.

The effects of climate change and global warming patterns, in combination with changes in precipitation and seasonal hydrology in the future, have been identified as important factors that may adversely affect the health and long-term viability of Sacramento River winter-run Chinook salmon (Crozier et al. 2008). The rate and magnitude of these potential future environmental changes, and their effect of habitat value and availability for winter-run Chinook salmon, however, are subject to a high degree of uncertainty.

C.20.6 Recovery Plan Goals

The draft recovery plan for Central Valley salmonids, including Sacramento River winter-run Chinook salmon, was released on October 19, 2009 (National Marine Fisheries Service 2009a). Although not final, the overarching goal in the public draft is the removal of Sacramento River winter-run Chinook salmon, among other listed salmonids, from the federal list of Endangered and Threatened Wildlife (National Marine Fisheries Service 2009a). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations in each historical diversity group, as well as other measurable biological criteria.

Figure C-17. Chinook Salmon Mapped Habitat and Occurrences



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C.21 Central Valley Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*)

C.21.1 Listing Status

Federal: Threatened

State: Threatened

Recovery Plan: The draft recovery plan for Central Valley salmonids, including Central Valley-run Chinook salmon, was released on October 19, 2009 (National Marine Fisheries Service 2009a).

Critical Habitat: Critical habitat for spring run Chinook salmon ESU was updated on September 2, 2005, with an effective date of January 2, 2006 (70 FR 52488) and includes 1,158 miles of stream habitat in the Sacramento River basin and 254 square miles of estuarine habitat in the San Francisco-San Pablo-Suisun Bay complex

C.21.2 Species Description and Life History

Chinook salmon typically mature between 2 and 6 years of age, although more commonly from 2 to 4 years (Myers et al. 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated based on adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime, and flow characteristics of their spawning site, and the actual time of spawning (Myers et al. 1998). Spring-run Chinook salmon tend to enter fresh water as immature fish, migrate far upriver, hold in cool-water pools for a period of months during the spring and summer, and delay spawning until the early fall.

Adult Central Valley spring-run Chinook salmon begin their upstream migration in late January and early February (California Department of Fish and Game 1998) and enter the Sacramento River between February and September, primarily in May and June (Yoshiyama et al. 1998; Moyle 2002). Lindley et al. (2006) reported that adult Central Valley spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid-April and mid-June. Typically, spring-run Chinook salmon use mid- to high-elevation streams that provide appropriate seasonal water temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama et al. 1998).

Chinook salmon spawn in clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper reaches where suitable water temperature, depth, and velocity favor redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds located at the tails of holding pools (U.S. Fish and Wildlife Service 1995). Fry emergence generally occurs at night. Upon emergence, fry swim or are displaced downstream (Healey 1991). The daily migration of juvenile spring-run Chinook salmon passing Red Bluff Diversion Dam is highest in the 4-hour period prior to sunrise (Martin et al. 2001).

Fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period from weeks to a year (Healey 1991). Fry seek streamside habitats containing beneficial characteristics such as riparian vegetation and associated substrates that provide aquatic and terrestrial invertebrates, predator avoidance cover, and slower water velocities for resting (National Marine Fisheries Service 1996).

Spring-run Chinook salmon fry emerge from the gravel from September to April (Moyle 2002; Harvey 1995; Bilski and Kindopp 2009) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year or as juveniles or yearlings. The modal size of fry migrants at approximately 40 millimeters between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley et al. 2006). Studies found that the majority of Central Valley spring-run Chinook salmon migrants are fry occurring primarily during December, January, and February, and that fry movements appeared to be influenced by flow (Ward et al. 2002, 2003; McReynolds et al. 2005). Small numbers of Central Valley spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that juveniles from Mill and Deer creeks typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley et al. 2006).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also disperse downstream during high-flow events. As is the case with other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster water as they grow. Microhabitat use can be influenced by the presence of predators, which can force juvenile salmon to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of yearling Central Valley spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and young-of-the-year juveniles occur in March and April; however, juveniles were also observed between November and the end of May (Snider and Titus 2000).

As juvenile Chinook salmon grow, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento by the U.S. Fish and Wildlife Service (USFWS) (1997) showed that larger juvenile salmon were captured in the main channel and smaller fry were typically captured along the channel margins. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit surface waters (Healey 1980). Stream flow changes and/or turbidity increases in the upper Sacramento River watershed are thought to stimulate juvenile emigration (Kjelson et al. 1982; Brandes and McLain 2001).

C.21.3 Habitat Requirements and Ecology

C.21.3.1 Freshwater Spawning Habitat

Freshwater spawning sites are those stream reaches with water quantity (instream flows) and quality conditions (e.g., water temperature and dissolved oxygen) and substrate suitable to support spawning, egg incubation, and larval development. Most spawning habitat in the Central Valley for spring-run Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Historically, spring-run Chinook salmon migrated upstream into high-elevation steep gradient reaches of the rivers and tributaries for spawning. Access to the majority of these historical spawning areas has been blocked by construction of major Central Valley dams and reservoirs. Currently, Central Valley spring-run Chinook salmon spawn on the mainstem Sacramento River between the Red Bluff Diversion Dam and Keswick Dam, and in tributaries such as the Feather River, Mill, Deer, Clear, Battle and Butte Creeks. There is currently an effort under way to reestablish a self-sustaining population of spring-run Chinook salmon on the San Joaquin River downstream of Friant Dam. Spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

C.21.3.2 Freshwater Rearing Habitat

Freshwater rearing sites have sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; suitable water quality; availability of suitable prey and forage to support juvenile growth and development; and natural cover such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large woody debris, rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration.

Juveniles also rear in nonnatal, intermittent tributaries. Rearing habitat condition is strongly affected by habitat diversity and complexity, food supply, and presence of predators. Some of these more complex, productive habitats with floodplain connectivity are still present in limited amounts in the Central Valley. However, the channeled, leveed, and riprapped river reaches and sloughs that are common along the Sacramento and San Joaquin Rivers typically have low habitat complexity, low abundance of food organisms, and offer little protection from predatory fish and birds. Freshwater rearing habitat also has a high conservation value, as the juvenile life stage of salmonids is dependent on the function of this habitat for successful survival and recruitment to the adult population.

C.21.3.3 Freshwater Migration Corridors

Freshwater migration corridors for spring-run Chinook salmon support mobility, survival, and food supplies for juveniles and adults. Migration corridors should be free from obstructions (passage barriers and impediments to migration), have favorable water quantity (instream flows) and quality conditions (seasonal water temperatures), and contain natural cover such as submerged and overhanging large wood, native aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Migratory corridors for spring-run Chinook salmon are located downstream of the spawning areas and include the lower Sacramento River, lower Feather River, tributaries providing suitable adult holding and spawning habitat. These corridors allow the upstream passage of adults and the downstream emigration of juvenile salmon. Migratory corridor conditions are strongly affected by the presence of passage barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality. For freshwater migration corridors to function properly, they must provide adequate passage, provide suitable migration cues, reduce false attraction, avoid areas where vulnerability to predation is increased, and avoid impediments and delays in both upstream and downstream migration. For this reason, freshwater migration corridors are considered to have a high conservation value.

Results of mark-recapture studies conducted using juvenile Chinook salmon (typically fall-run or late fall-run Chinook salmon, which are considered to be representative of juvenile spring-run salmon) released into both the Sacramento and San Joaquin Rivers have shown high mortality during passage downstream through the rivers (Brandes and McLain 2001; Newman and Rice 2002;

Manly 2004; San Joaquin River Group Authority 2007; Hanson 2008; Low and White undated). Mortality for juvenile salmon is typically greater in the San Joaquin River than in the Sacramento River (Brandes and McLain 2001).

C.21.3.4 Estuarine Habitat

Estuarine migration and juvenile rearing habitats should be free of obstructions (i.e., dams and other barriers) and provide suitable water quality, water quantity (river and tidal flows), and salinity conditions to support juvenile and adult physiological transitions between fresh and salt water. Natural cover, such as submerged and overhanging large wood, native aquatic vegetation, and side channels provide juvenile foraging habitat and cover from predators. Tidal wetlands and seasonally inundated floodplains are identified as high-value foraging and rearing habitats for juvenile salmon migrating downstream through the estuary. Estuarine areas have a high conservation value as they support juvenile Chinook salmon growth, smolting, avoidance of predators, and the transition to the ocean environment.

C.21.3.5 Marine Habitats

Although ocean habitats are not part of the critical habitat listing for Central Valley spring-run Chinook salmon, biologically productive coastal waters are an important habitat component for the ESU. Juvenile Chinook salmon inhabit near-shore coastal marine waters for a period of typically 2 to 4 years before adults return to Central Valley rivers to spawn. During their marine residence, Chinook salmon forage on krill, squid, and other marine invertebrates as well as a variety of fish such as northern anchovy and Pacific herring. These features are essential for conservation because, without them, juveniles cannot forage and grow to adulthood.

Although the effects of ocean conditions on Chinook salmon growth and survival have not been investigated extensively, recent observations since 2007 have shown a significant decline in the abundance of adult Chinook salmon and coho salmon returning to California rivers and streams (Pacific Fishery Management Council 2008). These declines are believed to be the result of decreases in ocean productivity and associated high mortality rates during the period when these fish were rearing in nearshore coastal waters (MacFarlane et al. 2008b; Pacific Fishery Management Council 2008). The importance of changes in ocean conditions on growth, survival, and population abundance of Central Valley Chinook salmon is currently undergoing further investigation.

C.21.4 Species Distribution and Population Trends

C.21.4.1 Distribution

Historically, spring-run Chinook salmon were predominant throughout the Central Valley occupying the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit Rivers, with smaller populations in most tributaries with sufficient habitat for adult salmon holding over the summer months (Stone 1874; Rutter 1904; Clark 1929). Completion of Friant Dam extirpated the native spring-run Chinook salmon population from the San Joaquin River and its tributaries. Naturally spawning populations of Central Valley spring-run Chinook salmon with consistent spawning returns are currently restricted to Butte Creek, Deer Creek, and Mill Creek (Good et al. 2005). However, a small spawning population has been documented in Clear Creek (Newton and Brown 2004). In addition, the upper Sacramento River and

Yuba River support small populations, but their status is not well documented. The Feather River Hatchery produces spring-run Chinook salmon on the Feather River.

Adult Central Valley spring-run Chinook salmon migrate primarily along the western edge of the Sacramento–San Joaquin River Delta (Delta) through the Sacramento River corridor, and juvenile spring-run Chinook salmon use the Delta, Suisun Marsh, and Yolo Bypass for migration and rearing. With the goal of returning spring-run Chinook salmon to the San Joaquin River, the San Joaquin corridor will presumably become an important migration route, with juveniles also using the south, central and west Delta areas as migration and rearing corridors.

C.21.4.2 Population Trends

Central Valley spring-run Chinook salmon were once the most abundant run of salmon in the Central Valley (Campbell and Moyle 1992). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (California Department of Fish and Game 1998). More than 500,000 Central Valley spring-run Chinook salmon were caught in the Sacramento-San Joaquin commercial fishery in 1883 (Yoshiyama et al. 1998). There were occasional records of returning spring-run Chinook salmon during the 1950s and 1960s in wet years. The San Joaquin River population was essentially extirpated by the late 1940s. Populations in the upper Sacramento, Feather, and Yuba Rivers were eliminated with the construction of major dams from the 1940s through the 1960s.

Although recent Central Valley spring-run Chinook salmon population trends are negative, annual abundance estimates display a high level of variation. The overall number of Central Valley spring-run Chinook salmon remains well below estimates of historical abundance. Central Valley spring-run Chinook salmon have some of the highest population growth rates in the Central Valley, but other than Butte Creek and the hatchery-influenced Feather River, population sizes are very small relative to fall-run Chinook salmon populations (Good et al. 2005).

C.21.5 Threats to the Species

C.21.5.1 Reduced Staging and Spawning Habitat

Access to most of the historical upstream spawning habitat for spring-run Chinook salmon has been eliminated or degraded by artificial structures (e.g., dams and weirs) associated with water storage and conveyance, flood control, and diversions and exports for municipal, industrial, agricultural, and hydropower purposes (Yoshiyama et al. 1998). Current spawning and juvenile rearing habitat is restricted to the mainstem and a few tributaries to the Sacramento River. Suitable summer water temperatures for adult and juvenile spring-run Chinook salmon holding and rearing are thought to occur at elevations from 492 to 1,640 feet (150 to 500 meters), most of which are now blocked by impassible dams. Habitat loss has resulted in a reduction in the number of natural spawning populations from an estimated 17 to 3 (Good et al. 2005).

Upstream diversions and dams have decreased downstream flows and altered the seasonal hydrologic patterns. These factors have been identified as resulting in delayed upstream migration by adults, increased mortality of outmigrating juveniles, and are responsible for making some streams uninhabitable by spring-run salmon (Yoshiyama et al. 1998; California Department of Water Resources 2005). Dams and reservoir impoundments and associated reductions in peak flows have blocked gravel recruitment and reduced flushing of sediments from existing gravel beds, thereby reducing and degrading natal spawning grounds. Further, reduced flows may decrease attraction cues for adult spawners, causing migration delays and increases in straying (California Department of Water Resources 2005). Adult salmon migration delays can reduce fecundity and increase susceptibility to disease and harvest (McCullough 1999).

Dams and other passage barriers also limit the geographic locations where spring-run Chinook salmon can spawn. In the Sacramento and Feather Rivers, restrictions to upstream movement and spawning site selection for spring-run salmon may increase the risk of hybridization with fall-run salmon, as co-occurrence contributes to an increased risk of redd superimposition. In creeks that are not affected by large dams, such as Deer and Mill Creeks, adult spring-run Chinook salmon have a greater opportunity to migrate upstream into areas where geographic separation from fall-run salmon reduces the risk of hybridization.

The Red Bluff Diversion Dam, located on the Sacramento River, is a barrier and impediment to adult spring-run Chinook salmon upstream migration. Although the dam is equipped with fish ladders, migration delays were reported when the dam gates are closed. Mortality from increased predation by Sacramento pikeminnow on juvenile salmon passing downstream through the fish ladder also affects abundance of salmon produced on the Sacramento River (Hallock 1991). The dam gates were placed in a permanent open position beginning in September 2011, and a new pump facility with a state-of-the-art fish screen was subsequently constructed. The elimination of dam operations is expected to benefit both upstream and downstream migration and contribute to a reduction in juvenile predation mortality.

C.21.5.2 Reduced Rearing and Out-Migration Habitat

Juvenile spring-run Chinook salmon prefer natural stream banks, floodplains, marshes, and shallow water habitats as rearing habitat during out-migration. Channel margins throughout the Delta have been leveed, channelized, and fortified with riprap for flood protection and island reclamation, reducing and degrading the quality of natural habitat available for juvenile Chinook salmon rearing (Brandes and McLain 2001). Artificial barriers further reduce and degrade rearing and migration habitat and delay juvenile out-migration. Juvenile out-migration delays can reduce fitness and increase susceptibility to diversion screen impingement, entrainment, disease, and predation. Modification of natural flow regimes from upstream reservoir operations has resulted in dampening and altering the seasonal timing of the hydrograph, reducing the extent and duration of seasonal floodplain inundation and other flow-dependent habitat used by migrating juvenile Chinook salmon (70 FR 52488) (Sommer et al. 2001a; California Department of Water Resources 2005). Recovery of floodplain habitat in the Central Valley has been found to contribute to increases in production in Chinook salmon (Sommer et al. 2001b), but little is known about the potential benefit available to migrating spring-run salmon.

The potential adverse effects of dam operations include reductions in seasonal river flows, delays in juvenile emigration, and increased seasonal water temperature.

C.21.5.3 Predation by Nonnative Species

Predation on juvenile salmon by nonnative fish has been identified as an important threat to spring-run Chinook salmon in areas with high densities of nonnative fish (e.g., small and largemouth bass, striped bass, and catfish) that prey on out-migrating juveniles (Lindley and Mohr 2003). Nonnative aquatic vegetation, such as Brazilian waterweed (*Egeria dense*) and water hyacinth (*Eichhornia crassipes*), provide suitable habitat for nonnative predators (Nobriga et al. 2005; Brown and Michniuk 2007). Predation risk may covary with increased temperatures. Metabolic rates of nonnative, predatory fish increase with increasing water temperatures based on bioenergetic studies (Loboschefsky et al. 2012; Miranda et al. 2010). The low spatial complexity and reduced habitat diversity (e.g., lack of cover) of channelized waterways in the rivers and Delta reduces refugia from predators (70 FR 52488) (Raleigh et al. 1984; Missildine et al. 2001; California Department of Water Resources 2005).

Increased predation mortality by native fish species, such as Sacramento pikeminnow at the Red Bluff Diversion Dam, is a factor affecting the survival of juvenile salmon in the rivers. Predation at the dam should decrease as the dam gates are in for shorter periods of time, and particularly in 2012 when the dam gates will be out year-round (National Marine Fisheries Service 2011). Although reducing predation at the Red Bluff Diversion Dam will benefit spring-run Chinook salmon at that location, it is unclear whether the reduction will substantially decrease the overall level of predation throughout the Sacramento River.

C.21.5.4 Harvest

Commercial and recreational harvest of spring-run Chinook salmon in the ocean and inland fisheries has been a subject of management actions by the California Fish and Game Commission and Pacific Fishery Management Council. The primary concerns focus on the effects of harvest on wild Chinook salmon produced in the Central Valley as well as the incidental harvest of listed salmon as part of the fall-run and late fall-run salmon fisheries. Because survivorship has been reduced in incubating eggs and rearing and emigrating wild salmon relative to hatchery-reared individuals, naturally reproducing populations are less able to withstand high harvest rates compared to hatchery-based stocks (Knudsen et al. 1999). National Marine Fisheries Service (2011) reports that ocean harvest had not changed appreciably since the 2005 status review (Good et al. 2005), except for extreme reductions in 2008 through 2010. The ocean salmon fisheries were closed in 2008 and 2009 and substantially restricted in 2010.

Because adult spring-run Chinook salmon hold in a pool habitat in a stream during the summer months, they are vulnerable to illegal harvest (poaching). Various watershed groups have established public outreach and educational programs in an effort to reduce poaching. In addition, CDFW wardens have increased enforcement against illegal harvest of spring-run Chinook salmon. The level and effect of illegal harvest on adult spring-run Chinook salmon abundance and population reproduction is unknown.

C.21.5.5 Reduced Genetic Diversity and Integrity

Interbreeding of wild spring-run Chinook salmon with both wild and hatchery fall-run Chinook salmon has the potential to dilute and eventually eliminate the adaptive genetic distinctiveness and diversity of the few remaining naturally reproducing spring-run Chinook salmon populations (California Department of Fish and Game 1995; Sommer et al. 2001b; Araki et al. 2007). Central Valley spring- and fall-run Chinook salmon spawning areas were historically isolated in time and space (Yoshiyama et al. 1998). However, the construction of dams has eliminated access to historical upstream spawning areas of spring-run salmon in the upper tributaries and streams of many river systems. Restrictions to upstream access, particularly on the Sacramento and Feather Rivers, has forced spring-run individuals to spawn in lower elevation areas also used by fall-run individuals, potentially resulting in hybridization of the two races. Hybridization between spring- and fall-run salmon is a particular concern on the Feather River, where both runs co-occur, and is a potential concern for restoration of salmon on the San Joaquin River downstream of Friant Dam.

Management of the Feather River hatchery and brood stock selection practices have been modified in recent years (e.g., tagging early returning adult salmon showing phenotypic and run timing characteristics of spring-run Chinook salmon for subsequent use as selected brood stock and genetic testing of potential brood stock) in an effort to reduce potential hybridization as a result of hatchery operations. Consideration has also been given to using a physical weir to help segregate and isolate adults showing spring-run characteristics and later-arriving fish showing characteristics of fall-run fish to reduce the risk of hybridization and redd superimposition in spawning areas of the river.

C.21.5.6 Entrainment

The risk of entrainment is a function of the size of juvenile fish and the slot opening of the screen mesh (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987). Many of the juvenile salmon migrate downstream during the late winter or early spring when many of the agricultural irrigation diversions are not operating or are only operating at low levels. Juvenile salmon also migrate primarily in the upper part of the water column and are less vulnerable to an unscreened diversion located near the channel bottom. While unscreened diversions used to flood agricultural fields (e.g., rice fields) during the winter have the potential to divert and strand juvenile salmonids, there are no quantitative estimates of the potential magnitude of entrainment losses for juvenile Chinook salmon migrating through the rivers. Draining these fields can also provide flow attractions to upstream migrating adult salmon, resulting in migration delays or stranding losses, although the loss of adult fish and the effects of these losses on the overall population abundance of returning adult Chinook salmon are also unknown. Despite these potential detrimental effects, flooding agricultural fields can increase nutrient loading to downstream habitats and increase productivity, and increase base flows during low stream flow periods. Many of the larger water diversions located in the Central Valley have been equipped with positive barrier fish screens to reduce and avoid the loss of juvenile Chinook salmon and other fish species.

Power plants may impinge juvenile Chinook salmon on the existing cooling water system intake screens. However, use of cooling water is currently low with the retirement of older units. Newer units are equipped with a closed-cycle cooling system that virtually eliminates the risk of impingement of juvenile salmon.

Besides mortality, salmon fitness may be affected by entrainment at these diversions and delays in out-migration of smolts caused by reduced or reverse flows. Delays in migration can make juvenile salmonids more susceptible to many of the threats and stressors, such as predation, entrainment, angling, exposure to poor water quality and toxics, and disease. The quantitative relationships among changes in hydrodynamics, the behavioral and physiological response of juvenile salmon, and the increase or decrease in risk associated with other threats are unknown, but are the subject of a number of investigations and analyses.

C.21.5.7 Exposure to Toxins

Toxic chemicals have the potential to be widespread throughout the Delta, or may occur on a more localized scale in response to episodic events (stormwater runoff, point source discharges). These toxic substances include mercury, selenium, copper, pyrethroids, and endocrine disruptors with the potential to affect fish health and condition, and adversely affect salmon distribution and abundance. Chinook salmon may experience both waterborne chronic and acute exposure, but also bioaccumulation and chronic dietary exposure.

As a result of the extensive agricultural development in the Central Valley, exposure to pesticides and herbicides is a significant concern for salmon and other fish species in the Plan Area (Bennett et al. 2001). In recent years, changes have been made in the composition of herbicides and pesticides used on agricultural crops in an effort to reduce potential toxicity to aquatic and terrestrial species. Modifications have also been made to water system operations and agricultural wastewater discharges (e.g., agricultural drainage water system lock-up and holding prior to discharge) and municipal wastewater treatment and discharges. Concerns remain, however, regarding the toxicity of contaminants such as pyrethroids that adsorbed to sediments and other chemicals (selenium and mercury, as well as other contaminants) on salmon.

Mercury and other metals such as copper have also been identified as contaminants of concern for salmon and other fish as a result of direct toxicity and impacts such as those related to acid mine runoff from sites such as Iron Mountain Mine (U.S. Environmental Protection Agency 2006). Tissue bioaccumulation may adversely affect the fish, but also represents a human health concern (Gassel et al. 2008). These materials originate from a variety of sources, including mining operations, municipal wastewater treatment, agricultural drainage in the tributary rivers and Delta, nonpoint runoff, natural runoff and drainage in the Central Valley, agricultural spraying, and a number of other sources. The State Water Resources Control Board (State Water Board), Central Valley Regional Water Quality Control Board, U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), California Department of Water Resources (DWR), and others have ongoing monitoring programs designed to characterize water quality conditions and identify potential toxicants and contaminant exposure to Chinook salmon and other aquatic resources in the Strategy Area. Programs are in place to regulate point source discharges as part of the National Pollutant Discharge Elimination System (NPDES) program as well as efforts to establish and reduce total daily maximum loads (TMDL) of various constituents entering the waterways. Regulations have been updated to help reduce chemical exposure and adverse effects on aquatic resources and habitat conditions in the Strategy Area.

Iron Mountain Mine, located adjacent to the upper Sacramento River, has been a source of trace elements and metals that are known to adversely affect aquatic organisms (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989). Storage limitations and limited availability of dilution flows have caused downstream copper and zinc levels to exceed salmonid tolerances and resulted in documented fish kills in the 1960s and 1970s (Bureau of Reclamation 2004). The EPA's Iron Mountain Mine remediation program has removed toxic metals in acidic mine drainage from the Spring Creek watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s.

C.21.5.8 Increased Water Temperature

Water temperature is among the physical factors that affect the value of habitat for salmonid adult holding, spawning and egg incubation, juvenile rearing, and migration. Adverse sublethal and lethal effects can result from exposure to elevated water temperatures at sensitive life stages, such as during incubation or rearing. The Central Valley is the southern limit of spring-run Chinook salmon geographic distribution, so increased water temperatures are often recognized as an important stressor to California populations. Water temperature criteria for various life stages of salmonids in the Central Valley have been developed (National Marine Fisheries Service 2009a). The tolerance of spring-run Chinook salmon to water temperatures depends on life stage, acclimation history, food availability, duration of exposure, health of the individual, and other factors such as predator avoidance (Myrick and Cech 2004; Bureau of Reclamation 2004). Higher water temperatures can lead to physiological stress, reduced growth rate, prespawning mortality, reduced spawning success, and increased mortality of salmon (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). Exposure to seasonally elevated water temperatures may occur because of reductions in flow, upstream reservoir operations, reductions in riparian vegetation, channel shading, local climate and solar radiation. The installation of the Shasta Temperature Control Device in 1998, in combination with reservoir management to maintain the cold water pool, has reduced many of the temperature issues on the Sacramento River.

Adult and juvenile spring-run Chinook salmon hold and rear in pools at higher elevations in the watershed. On several tributaries, prespawning adult mortality has been reported for adults that accumulate in high densities in a pool and are then exposed to elevated summer water temperatures. Flow reductions, resulting from natural hydrologic conditions during the summer, evapotranspiration, or surface and groundwater extractions may all contribute to exposure to elevated temperatures and increased levels of stress or mortality. In some areas, groundwater wells have been used to pump cooler water into the stream to reduce summer temperatures. Dense riparian vegetation, streams incised into canyons that provide shading, cool water springs, and availability of deep holding pools are factors that affect summer holding and rearing conditions for spring-run Chinook salmon.

The effects of climate change and global warming patterns, in combination with changes in precipitation and seasonal hydrology in the future are important factors that may adversely affect the health and long-term viability of Central Valley spring-run Chinook salmon (Crozier et al. 2008). The rate and magnitude of these potential future environmental changes, and their effect on habitat value and availability for spring-run Chinook salmon, however, are subject to a high degree of uncertainty.

C.21.6 Recovery Plan Goals

The draft recovery plan for Central Valley salmonids, including spring-run Chinook salmon, was released by NMFS on October 19, 2009. Although not final, the overarching goal is the removal of, among other listed salmonids, spring-run Chinook salmon from the federal list of endangered and threatened wildlife (National Marine Fisheries Service 2009b). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations in each historical diversity group, as well as other measurable biological criteria.

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C.22 Central Valley Fall- and Late Fall–Run Chinook Salmon (*Oncorhynchus tshawytscha*)

C.22.1 Listing Status

Federal: Species of Concern

State: Not listed.

C.22.2 Species Description and Life History

The Central Valley fall- and late fall–run Chinook salmon evolutionary significant unit (ESU) includes all naturally spawned populations of fall- and late fall–run Chinook salmon in the Sacramento and San Joaquin River basins and their tributaries east of Carquinez Strait, California (64 *Federal Register* [FR] 50394).

Chinook salmon exhibit two characteristic freshwater life history types (Healey 1991). Stream-type adult Chinook salmon enter fresh water months before spawning, and their offspring reside in fresh water 1 or more years following emergence. In contrast, ocean-type Chinook salmon spend significantly less time in fresh water, spawning soon after entering fresh water as adults and migrating to the ocean as juvenile fry or parr in their first year. Adequate stream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting the stream-type life history behaviors because of their residence in fresh water both as adults and juveniles over the warmer summer months.

Central Valley fall-run Chinook salmon exhibit an ocean-type life history. Adult fall-run Chinook salmon migrate through the Delta and into Central Valley rivers from June through December and spawn from September through December. Peak spawning activity usually occurs in October and November. The life history characteristics of late fall–run Chinook salmon are not well understood; however, they are thought to exhibit a stream-type life history. Adult late fall–run Chinook salmon migrate through the Delta and into the Sacramento River from October through April and may wait 1 to 3 months before spawning from December through April. Peak spawning activity occurs in February and March. Chinook salmon typically mature between 2 and 6 years of age (Myers et al. 1998). The majority of Central Valley fall-run Chinook salmon spawn at age 3.

Information on the migration rates of Chinook salmon in fresh water is scant, and is mostly taken from the Columbia River basin where migration behavior information is used to assess the effects of dams on salmon travel times and passage (Matter et al. 2003). Adult Chinook salmon upstream migration rates ranged from 29 to 32 kilometers per day in the Snake River, a Columbia River tributary (Matter et al. 2003). Keefer et al. (2004) found migration rates of adult Chinook salmon in the Columbia River to range between approximately 10 kilometers per day to greater than 35 kilometers per day. Adult Chinook salmon with sonic tags have been tracked throughout the Delta and the lower Sacramento and San Joaquin Rivers (CALFED Bay-Delta Program 2001).

C.22.3 Habitat Requirements and Ecology

C.22.3.1 Spawning Habitat

Chinook salmon spawning sites include those stream reaches with instream flows, water quality, and substrate conditions suitable to support spawning, egg incubation, and larval development. Central Valley fall-run Chinook salmon currently spawn downstream of dams on every major tributary in the Sacramento and San Joaquin River systems (with the exception of the San Joaquin River downstream of Friant Dam, which is currently the subject of a settlement agreement and salmonid restoration program) in areas containing suitable environmental conditions for spawning and egg incubation.

Late fall–run Chinook salmon spawning is limited to the mainstem and tributaries of the Sacramento River.

C.22.3.2 Freshwater Rearing Habitat

Fall- and late fall–run Chinook salmon rear in streams and rivers with sufficient water flow and floodplain connectivity. They rear in these areas to form and maintain physical habitat conditions that support growth and mobility and provide suitable water quality (e.g., seasonal water temperatures) and forage species that support juvenile salmon growth and cover such as shade, submerged and overhanging large wood, logjams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors might also function as rearing habitat for juveniles, which feed and grow before and during their out-migration.

Nonnatal, intermittent tributaries and seasonally inundated flood-control bypasses such as the Yolo Bypass in the strategy area also support juvenile rearing (Sommer et al. 2001). Rearing habitat value is strongly affected by habitat complexity, food supply, and predators. Some of these more complex and productive habitats with floodplains are still present in limited amounts in the Central Valley, for example, the lower Cosumnes River, Sacramento River reaches with setback levees (i.e., primarily located upstream of the City of Colusa). The channeled, leveed, and riprapped river reaches and sloughs common in the Sacramento and San Joaquin Rivers and throughout the Delta typically have low habitat diversity and complexity, have low abundance of food organisms, and offer little protection from predation by fish and birds. Freshwater rearing habitat has a high conservation value because the juvenile life stage of salmonids is dependent on the function of this habitat for successful growth, survival, and recruitment to the adult population.

C.22.3.3 Freshwater Migration Corridors

Freshwater migration corridors for fall- and late fall–run Chinook salmon, including river channels, support mobility, survival, and food supply for juveniles and adults. Migration corridors should be free from obstructions (passage barriers and impediments to migration), have favorable water quantity (instream flows) and quality conditions (seasonal water temperatures), and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Migratory corridors are typically downstream of the spawning area and include the lower Sacramento and San Joaquin Rivers, the Delta, and the San Francisco Bay complex extending to coastal marine waters. These corridors allow the upstream passage of adults and the downstream emigration of juvenile salmon. Migratory corridor conditions are strongly affected by the presence of passage barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality. For freshwater migration corridors to function properly, they must provide adequate passage, provide suitable migration cues, reduce false attraction, avoid areas where vulnerability to predation is increased, and avoid impediments and delays in both upstream and downstream migration. For this reason, freshwater migration corridors are considered to have a high conservation value.

C.22.3.4 Estuarine Areas

Estuarine migration and juvenile rearing habitats should be free of obstructions (i.e., dams and other barriers) and provide suitable water quality, water quantity (river and tidal flows), and salinity conditions to support juvenile and adult physiological transitions between fresh- and saltwater. Natural cover, such as submerged and overhanging large wood, aquatic vegetation, and side channels, provides juvenile and adult foraging. Estuarine areas contain a high conservation value because they support juvenile Chinook salmon growth, smolting, and the avoidance of predators, as well as provide a transition to the ocean environment.

C.22.3.5 Ocean Habitats

Biologically productive coastal waters are an important habitat component for Central Valley fall- and late fall–run Chinook salmon. Juvenile fall-run and late fall–run Chinook salmon inhabit near-shore coastal marine waters for typically 2 to 4 years before adults return to Central Valley rivers to spawn. During their marine residence Chinook salmon forage on krill, squid, and other marine invertebrates, as well as a variety of fish such as northern anchovy and Pacific herring. These features are essential for conservation because without them juveniles cannot forage and grow to adulthood.

Results of oceanographic studies have shown the variation in ocean productivity off the West Coast within and among years. Changes in ocean currents and upwelling have been identified as significant factors affecting ocean-derived nutrient availability, phytoplankton and zooplankton production, and the availability of other forage species in near-shore surface waters (Wells et al. 2012). Ocean conditions at the end of the salmon's ocean residency period can be important, as indicated by the effect of the 1983 El Niño on the size and fecundity of Central Valley fall-run Chinook salmon (Wells et al. 2006). Although the effects of ocean conditions on Chinook salmon growth and survival have not been investigated extensively, recent observations since 2007 have shown a significant decline in the abundance of adult Chinook salmon and coho salmon returning to California rivers and streams (fall-run adult returns to the Sacramento and San Joaquin Rivers were the lowest on record [Pacific Fishery Management Council 2008]). This drop has been hypothesized to be the result of declines in ocean productivity and associated high mortality rates during the period when these fish were rearing in near-shore coastal waters (MacFarlane et al. 2008). The importance of changes in ocean conditions to growth, survival, and population abundance of Central Valley Chinook salmon is undergoing further investigation, although relatively rapid changes in ocean conditions would act on top of the long-term, steady degradation of the freshwater and estuarine environment (Lindley et al. 2009).

C.22.4 Species Distribution and Population Trends

C.22.4.1 Distribution

Central Valley fall-run Chinook salmon historically spawned in all major tributaries, as well as the mainstem of the Sacramento and San Joaquin Rivers. The historical geographic distribution of Central Valley late fall–run Chinook salmon is not well understood, but is thought to be less extensive than that of fall-run. The late fall–run fish most likely spawned in the upper Sacramento and McCloud Rivers in reaches now blocked by Shasta Dam, as well as in sections of major tributaries where there was adequate cold water in summer. There is also some evidence they once spawned in the San Joaquin River in the Friant region and in other large San Joaquin tributaries (Yoshiyama et al. 1998). A large percentage of fall-run Chinook spawning areas in the Sacramento and San Joaquin Rivers historically inhabited the lower gradient reaches of the rivers downstream of sites now occupied by major dams, such as Shasta and Friant Dams.

As a result of the geographic distribution of spawning and juvenile rearing areas, fall-run Chinook salmon populations in the Central Valley were not as severely affected by early water projects that blocked access to upstream areas, as were spring and winter runs of Chinook salmon and steelhead that used higher elevation habitat for spawning and rearing (Reynolds et al. 1993; McEwan 2001). Changes in seasonal hydrologic patterns resulting from operation of upstream reservoirs for water supplies, flood control, and hydroelectric power generation have altered instream flows and habitat conditions for fall-run Chinook salmon and other species downstream of the dams (Williams 2006).

C.22.4.2 Population Trends

The abundance of Central Valley fall- and late fall–run Chinook salmon escapement before 1952 is poorly documented. Reynolds et al. (1993) estimated that production of fall- and late fall–run Chinook salmon on the San Joaquin River historically approached 300,000 adults and probably averaged approximately 150,000 adults. Calkins et al. (1940) estimated fall- and late fall–run Chinook salmon abundance at 55,595 adults in the Sacramento River basin from 1931 to 1939. In the early 1960s, adult fall- and late fall–run Chinook salmon escapement was estimated to be 327,000 fish in the Sacramento River basin (California Department of Fish and Game 1965). In the mid-1960s, fall- and late fall–run Chinook salmon escapement to the San Joaquin River basin was estimated to be about 2,400 fish, which spawned in the San Joaquin River tributaries—the Stanislaus, Tuolumne, and Merced Rivers.

Long-term trends in adult fall-run Chinook salmon escapement indicate that abundance in the Sacramento River has been consistently higher than abundance in the San Joaquin River (Figure 2A.5 3). Escapement on the Sacramento River has been characterized by relatively high interannual variability ranging from approximately 100,000 to over 800,000 fish. Sacramento River escapement showed a marked increase in abundance between 1990 and 2003 followed by a decline in abundance from 2004 to present. In 2009, adult fall-run Chinook salmon returns to the Central Valley rivers showed a substantial decline in both the Sacramento and San Joaquin River systems. Similar declines in adult escapement were also observed for coho salmon and Chinook salmon returning to other river systems in California (MacFarlane et al. 2008).

A variety of factors are thought to have influenced adult escapement on both rivers, including hydrological conditions for migration, spawning, and juvenile rearing; ocean conditions; and management actions. Measures have been implemented since the early 1990s to improve seasonal water temperatures, streamflows, modifications to Red Bluff Diversion Dam gate operations, fish passage, construction of positive barrier fish screens on larger diversions, and improved habitat conditions.

Trends in adult fall-run Chinook salmon escapement on the San Joaquin River and tributaries has been relatively low since the 1950s, ranging from several hundred to approximately 100,000 adults. Results of escapement estimates have shown a relationship between adult escapement in a cohort year and spring flows on the San Joaquin River 2.5 years earlier when the juvenile in the cohort were rearing and migrating downstream through the Sacramento–San Joaquin River Delta (Delta). Adult escapement appears to be cyclical and may be related to hydrology during the juvenile rearing and migration period, among other factors (San Joaquin River Group Authority 2010; California Department of Fish and Game 2008).

Population estimates for late fall–run Chinook salmon on the San Joaquin River system are not available, but it is thought that late fall–run Chinook salmon do not regularly spawn in the tributaries of the San Joaquin River (Moyle et al. 1995). Adult escapement estimates for late fall–run Chinook salmon returning to the Sacramento River from 1971 through 2009 have ranged from several hundred to over 40,000 adults. Adult escapement showed a general trend of declining abundance between 1971 and 1997. During the late 1990s and continuing through 2006, escapement has increased substantially but is characterized by high interannual variability. The 2008 and 2009 escapement estimates were lower than the previous 4 years, but were not characterized by the massive decline observed for fall-run Chinook salmon. Many factors have been identified that may be contributing to the observed trends and patterns in late fall–run Chinook salmon escapement to the upper Sacramento River and its tributaries.

C.22.5 Threats to the Species

C.22.5.1 Reduced Staging and Spawning Habitat

Access to the upper extent of the historical upstream spawning habitat for fall- and late fall–run Chinook salmon has been eliminated or degraded by artificial structures (e.g., dams and weirs) associated with water storage and conveyance, flood control, and diversions and exports for municipal, industrial, agricultural, and hydropower purposes (Yoshiyama et al. 1998). Because spawning locations of fall- and late fall–run Chinook salmon are typically in the lower reaches of rivers, fall- and late fall–run Chinook salmon have been less affected by dam construction relative to other Central Valley salmonids. Spawning habitat for fall- and late fall–run Chinook salmon is still widely distributed in the Sacramento River basin, but more limited in the San Joaquin River basin.

Upstream diversions and dams have decreased downstream flows and altered the seasonal hydrologic patterns. These factors have been identified as contributing to delays in upstream migration by adults, contributing to increased mortality of out-migrating juveniles, and responsible for making some streams uninhabitable for fall- and late fall–run salmon (Yoshiyama et al. 1998; California Department of Water Resources 2005). Dams and reservoir impoundments and associated reductions in peak flows have blocked gravel recruitment and reduced flushing of sediments from existing gravel beds, reducing and degrading natal spawning grounds. Further, reduced flows can lower attraction cues for adult spawners, causing straying and delays in spawning (California Department of Water Resources 2005). Adult salmon migration delays can reduce fecundity and increase susceptibility to disease and harvest (McCullough 1999) Because fall-run Chinook salmon spawn shortly after entering fresh water, a delay in migration can have substantial impacts on prespawning mortality and spawning success relative to other races of Chinook salmon.

The Red Bluff Diversion Dam located on the Sacramento River has been identified as a barrier and impediment to adult upstream migration. Although the Red Bluff Diversion Dam is equipped with fish ladders, migration delays have been reported when the dam gates are closed. Mortality as a result of increased predation by Sacramento pikeminnow on juvenile salmon passing downstream through the fish ladder has also been identified as a factor affecting abundance of salmon produced on the Sacramento River (Hallock 1991). The dam gates were placed in a permanent open position in September 2011, and a new pump facility with a state-of-the-art fish screen was subsequently constructed. The project is expected to benefit both upstream and downstream migration and contribute to a reduction in juvenile predation mortality.

C.22.5.2 Reduced Rearing and Outmigration Habitat

Natural migration corridors for juvenile fall- and late fall–run Chinook salmon consist of complex habitat types, including stream banks, floodplains, marshes, and shallow water areas used as rearing habitat during out-migration. Much of the Sacramento and San Joaquin River corridors have been leveed, channelized, and modified with riprap for flood protection, thereby reducing and degrading the value and availability of natural habitat for rearing and emigrating juvenile Chinook salmon (Brandes and McLain 2001). Juvenile out-migration delays associated with artificial passage impediments can reduce fitness and increase susceptibility to diversion screen impingement, entrainment, disease, and predation. Modification of natural flow regimes from upstream reservoir operations has resulted in dampening of the hydrograph, reducing the extent and duration of seasonal floodplain inundation and other flow-dependent habitat used by migrating juvenile Chinook salmon (70 FR 52488; Sommer et al. 2001; California Department of Water Resources 2005). Recovery of floodplain habitat in the Central Valley has been found to contribute to increases in production in Chinook salmon (Sommer et al. 2001).]

Floodplain habitat areas provide important rearing habitat for foraging juvenile salmonids, including fall-run Chinook salmon. Studies have shown that these salmonids may spend 2 to 3 months rearing in these habitat areas, and losses resulting from land reclamation and levee construction are considered to be major stressors on juvenile salmonids (Williams 2009). Similarly, channel margins provide valuable rearing and connectivity habitat along migration corridors, particularly for smaller juvenile fry, such as fall-run Chinook salmon. However, these habitats are expected to provide less benefit to larger stream-type juvenile migrants, such as late fall–run Chinook salmon, which tend to spend less time rearing and foraging in the lower river reaches and the Delta.

C.22.5.3 Predation by Nonnative Species

Predation on juvenile salmon by nonnative fish has been identified as an important threat to fall- and late fall–run Chinook salmon in areas with high densities of nonnative fish (e.g., small and large mouth bass, striped bass, and catfish) that prey on out-migrating juvenile salmon (Lindley and Mohr 2003). Nonnative aquatic vegetation, such as Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), provide suitable habitat for nonnative predators (Nobriga et al. 2005; Brown and Michniuk 2007). Predation risk may also vary with increased temperatures.

Metabolic rates of nonnative, predatory fish increase with increasing water temperatures based on bioenergetic studies (Loboschefsky et al. 2012; Miranda et al. 2010). Upstream gravel pits and flooded ponds attract nonnative predators because of their depth and lack of cover for juvenile salmon (California Department of Water Resources 2005). The low spatial complexity and reduced habitat diversity (e.g., lack of cover) of channelized waterways in the rivers and Delta reduce refugia from predators (Raleigh et al. 1984; Missildine et al. 2001; 70 FR 52488).

Predation by native species, such as the Sacramento pikeminnow in the Sacramento River at the Red Bluff Diversion Dam has also been identified as a potentially significant source of mortality on juvenile salmonids.

C.22.5.4 Harvest

Fall-run Chinook salmon have been the most abundant species in the Central Valley for many years and have supported much of the California commercial and sport fishery (Lindley et al. 2004). However, a sharp decline in returning fall-run Chinook salmon in recent years, and the influence of large-scale hatchery production on the genetics of the species (Barnett-Johnson et al. 2007) have prompted concern for the fall-run stock.

Commercial or recreational harvest of fall- and late fall–run Chinook salmon populations in the ocean and inland fisheries has been a subject of management actions by the California Fish and Game Commission and the Pacific Fishery Management Council. Coastal marine waters offshore of San Francisco Bay are a mixed stock fishery comprised of both wild and hatchery produced salmon. As a result of differences in survival rates for egg incubation, rearing, and emigration, juvenile salmon produced in streams and rivers have relatively low survival rates compared to Central Valley salmon hatcheries, which have relatively high survival rates. Therefore, naturally reproducing Chinook salmon populations are less able to withstand high harvest rates compared to hatchery-based stocks (Knudsen et al. 1999). The ocean fishery for fall- and late fall–run Chinook salmon is supplemented by hatchery enhancement programs (U.S. Fish and Wildlife Service 1999; Williams 2006). The Coleman National Fish Hatchery produces approximately 12 million fall-run and 1 million late fall–run Chinook salmon juveniles each year to mitigate for habitat loss from construction of Shasta and Keswick Dams (Williams 2006). Fall-run Chinook salmon are also produced at hatcheries on the Feather, American, Mokelumne, and Merced Rivers (Williams 2006). Harvest as a result of the commercial and recreational fisheries may ultimately be having detrimental effects on wild spawners in this mixed stock fishery, but few data are available. Commercial fishing for salmon is managed by the Pacific Fishery Management Council and is constrained by time and area to meet the Sacramento River winter-run ESA consultation standard and restrictions that require minimum size limits and use of circle hooks by anglers.

Beginning in 2007, Central Valley hatcheries implemented a proportional marking program (tagging a set percentage of salmon produced in each hatchery) that is designed to provide improved information on the effects of harvest on various stocks of Chinook salmon. The program also provides information on ocean migration patterns, growth and survival for fish released at various life stages and locations, the contribution of hatcheries to the adult population, straying among hatcheries and watersheds, the relative contribution of in-river versus hatchery production, and other data that will assist managers in refining harvest regulations. Results of coded wire tag mark-recapture studies and data from the proportional marking program are continually being reviewed and analyzed each year, and used to modify harvest regulations and Central Valley salmon management.

C.22.5.5 Reduced Genetic Diversity and Integrity

Artificial propagation programs (hatchery production) for fall- and late fall–run Chinook salmon in the Central Valley present multiple threats to wild (in-river spawning) Chinook salmon populations, including genetic introgression by hatchery origin fish that spawn naturally and interbreed with local wild populations (U.S. Fish and Wildlife Service 2001a; Bureau of Reclamation 2004; Goodman 2005). Central Valley hatcheries are recognized as a significant and persistent threat to wild Chinook salmon and steelhead populations and fisheries (National Marine Fisheries Service 2009a). Interbreeding with hatchery fish contributes directly to reduced genetic diversity and introduces maladaptive genetic changes to the wild population (California Department of Fish and Game 1995; CALFED Bay-Delta Program 2004; Myers et al. 2004; Araki et al. 2007). In addition, releasing hatchery smolts downstream of hatcheries has resulted in an increase in straying rates, further reducing genetic diversity among populations (Williamson and May 2005). Central Valley hatcheries are currently undergoing a detailed review by NMFS and the California Department of Fish and Wildlife (CDFW) as part of a comprehensive hatchery master plan process. Various techniques and actions for reducing the effects of hatchery production on the genetic characteristics of Chinook salmon have been identified as part of the hatchery review. These include, but are not limited to, the following practices.

- Seasonally selecting brood stock for hatchery use in proportion to adult escapement to the river.
- Selecting brood stock from various age classes (including grilse) that represents the age structure of the wild population.
- Selecting brood stock by tagging and conducting genetic testing.
- Increasing the number of adults used as brood stock to increase genetic diversity.
- Reducing the interbasin transfer of eggs and fry.
- Imprinting juveniles to reduce straying among watersheds.

These and other hatchery management methods (e.g., reducing the use of antibiotics and implementing juvenile release strategies to reduce effects on wild rearing juveniles, and planning volitional releases) are expected to reduce the potential risk of hatchery production on the genetics and success of wild populations. However, artificial selection for traits that assure individual success in a hatchery setting (e.g., rapid growth and tolerance to crowding) are difficult to avoid (Bureau of Reclamation 2004).

The potential for inter-breeding between Central Valley spring- and fall-run salmon stocks is generally identified as a genetic concern (Yoshiyama et al. 1998). However, some studies indicate no evidence of natural hybridization among Chinook salmon runs despite the spatial and temporal overlap (Banks et al. 2000). Spring- and fall-run Chinook salmon were historically isolated in time and space during spawning; however, the construction of dams and reduction in flows haveeliminated access to historical spawning areas of spring-run salmon in the upper tributaries and streams, forcing spring-run salmon to spawn in lower elevation areas also used by fall-run salmon (Yoshiyama et al. 1998).

C.22.5.6 Entrainment

The losses of fish to entrainment mortality has been identified as an impact on Chinook salmon populations (Kjelson and Brandes 1989). Kimmerer (2008) estimated that losses of Chinook salmon may have been up to 10% at high rates of south Delta export pumping but noted considerable uncertainty in the estimates because prescreen losses due to predation and other factors are difficult to quantify.

The risk of entrainment is a function of the size of juvenile fish and the slot opening of the screen mesh (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987). Many of the juvenile salmon migrate downstream through the strategy area during the late winter or early spring when many of the agricultural irrigation diversions are not operating or are only operating at low levels. Juvenile salmon also migrate primarily in the upper part of the water column and, as a result, their vulnerability to an unscreened diversion located near the channel bottom is reduced. No quantitative estimates have been developed to assess the potential magnitude of entrainment losses for juvenile Chinook salmon migration through the rivers or the effects of these losses on the overall population abundance of returning adult fall- and late fall–run Chinook salmon. Many of the larger water diversions located in the Central Valley have been equipped with positive barrier fish screens to reduce and avoid the loss of juvenile Chinook salmon and other fish species.

Power plants have the ability to impinge juvenile Chinook salmon on the existing cooling water system intake screens. However, as older units are retired, the use of cooling water has declined. Newer units are equipped with a closed-cycle cooling system that virtually eliminates the risk of impingement of juvenile salmon.

C.22.5.7 Exposure to Toxins

Toxic chemicals have the potential to be widespread throughout the Delta, or may occur on a more localized scale in response to episodic events (stormwater runoff, point source discharges, etc.). These toxic substances include mercury, selenium, copper, pyrethroids, and endocrine disruptors with the potential to affect fish health and condition, and adversely affect salmon distribution and abundance. The concerns regarding exposure to toxic substances for Chinook salmon include waterborne chronic and acute exposure, as well as bioaccumulation and chronic dietary exposure. For example, selenium is a naturally occurring constituent in agricultural drainage water return flows from the San Joaquin River that is subsequently dispersed downstream into the Delta (Nichols et al. 1986). Exposure to selenium in the diet of juvenile Chinook salmon has been shown to result in toxic effects (Hamilton et al. 1986, 1990; Hamilton and Buhl 1990). Selenium exposure has been associated with agricultural and natural drainage in the San Joaquin River basin. Other contaminants of concern for Chinook salmon include, but are not limited to, mercury, copper, oil and grease, pesticides, herbicides, and ammonia[2].

As a result of the extensive agricultural development in the Central Valley, exposure to pesticides and herbicides has been identified as a significant concern for salmon and other fish species in the

[2] Ammonia in water generally forms some amount of ammonium. Therefore, the use of the term *ammonia* implies that both ammonia and ammonium may be present.

strategy area (Bennett et al. 2001). Mercury and other metals such as copper have also been identified as contaminants of concern for salmon and other fish as a result of toxicity and tissue bioaccumulation adversely affecting fish (U.S. Environmental Protection Agency 2006), as well as representing a human health concern (Gassel et al. 2008). These materials originate from a variety of sources including mining operations, municipal wastewater treatment, agricultural drainage in the tributary rivers throughout the strategy area, nonpoint runoff, natural runoff and drainage in the Central Valley, agricultural spraying, and a number of other sources.

The State Water Resources Control Board (State Water Board), Central Valley Regional Water Quality Control Board, U.S. EPA, U.S. Geological Survey (USGS), California Department of Water Resources (DWR), and others have ongoing monitoring programs designed to characterize water quality and identify potential toxicants and contaminant exposure to Chinook salmon and other aquatic resources in the strategy area. Programs are in place to regulate point source discharges as part of the National Pollutant Discharge Elimination System (NPDES) as well as programs to establish and reduce total maximum daily loads (TMDL) of various constituents entering the waterways. Changes in regulations have also been made to help reduce chemical exposure and reduce the adverse impacts on aquatic resources and habitat conditions in the Plan Area. These monitoring and regulatory programs are ongoing.

Iron Mountain Mine, located adjacent to the upper Sacramento River, has been a source of trace elements and metals that are known to adversely affect aquatic organisms (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989). Storage limitations and limited availability of dilution flows have caused downstream copper and zinc levels to exceed salmonid tolerances and resulted in documented fish kills in the 1960s and 1970s (Bureau of Reclamation 2004). EPA's Iron Mountain Mine remediation program has removed toxic metals in acidic mine drainage from the Spring Creek watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s.

C.22.5.8 Increased Water Temperature

Water temperature is among the physical factors that affect the value of habitat for salmonid adult holding, spawning and egg incubation, juvenile rearing, and migration. Adverse sublethal and lethal effects can result from exposure to elevated water temperatures at sensitive life stages, such as during incubation or rearing. The Central Valley is the southern limit of Chinook salmon geographic distribution. As a result, increased water temperatures are often recognized as a particularly important stressor to California populations. Water temperature criteria for various life stages of salmonids in the Central Valley have been developed by NMFS (2009a). The tolerance of fall-run and late fall–run Chinook salmon to water temperatures depends on life stage, acclimation history, food availability, duration of exposure, health of the individual, and other factors such as predator avoidance (Myrick and Cech 2004; Bureau of Reclamation 2004). Higher water temperatures can lead to physiological stress, reduced growth rate, delayed passage, in vivo egg mortality of spawning adults, prespawning mortality, reduced spawning success, and increased mortality of salmon (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). Exposure to seasonally elevated water temperatures may occur because of reductions in flow as a result of upstream reservoir operations, reductions in riparian vegetation, channel shading, local climate, and solar radiation. The installation of the Shasta Temperature Control Device in 1998, in combination with reservoir management to maintain the cold water pool, has reduced many of the temperature issues on the Sacramento River. During dry years, however, the release of cold water from Shasta Dam is still limited. As the river flows further downstream, particularly during the warm spring, summer, and early fall months, water temperatures continue to increase until they reach thermal equilibrium with atmospheric conditions. As a result of the longitudinal gradient of seasonal water temperatures, the coldest water—and, therefore, the best areas for salmon spawning and rearing—are typically located immediately downstream of the dam.

The effects of climate change and global warming patterns, in combination with changes in precipitation and seasonal hydrology in the future have been identified as important factors that may adversely affect the health and long-term viability of Central Valley spring-run Chinook salmon (Crozier et al. 2008). The rate and magnitude of these potential environmental changes, and their effect on habitat value and availability for fall- and late fall–run Chinook salmon, however, are subject to a high degree of uncertainty.

C.22.6 Recovery Plan Goals

Because fall- and late fall–run Chinook salmon are not listed for protection under either the federal or CESA, formal recovery goals will not be established. As part of other fishery management programs, such as the Central Valley Project Improvement Act and the State Water Board salmon doubling goal, goals and objectives have been established for Central Valley Chinook salmon.

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C.23 Sacramento Splittail (Pogonichthys macrolepidotus)

C.23.1 Listing Status

Federal: No listing

State: Species of Special Concern

C.23.2 Species Description and Life History

The Sacramento splittail, a cyprinid fish, is endemic to the San Francisco Estuary and watershed (Moyle 2002). Mature splittail begin a gradual upstream migration towards spawning areas sometime between late November and late January, with larger splittail migrating earlier (Caywood 1974; Moyle et al. 2004). The relationship between migrations and river flows is poorly understood, but it is likely that splittail have a positive behavioral response to increases in flows and turbidity. Feeding in flooded riparian areas in the weeks just prior to spawning may be important for later spawning success and for postspawning survival. Not all splittail make significant movements prior to spawning, as indicated by evidence of spawning in Suisun Marsh (Meng and Matern 2001) and the Petaluma River.

Two early life history strategies occur in juvenile splittail produced in the Sacramento River system. The dominant strategy is characterized by juveniles migrating downstream in late spring and early summer; a less well-studied strategy is to remain upstream through the summer into the next fall or spring and migrate downstream as a subadult (Baxter 1999; Moyle et al. 2004). This latter strategy occurs in the mainstem of the Sacramento River. As water recedes further, juveniles remaining in upstream riverine habitats and congregate in large eddies for feeding.

Splittail spawning occurs between late February and early July (Wang 1986). Females lay between 5,000 and 150,000 eggs, but fecundity is size-dependent and highly variable, probably related to food availability and selenium content in bivalves (Feyrer and Baxter 1998; Moyle et al. 2004). Egg incubation lasts for 3 to 7 days depending on water temperature (Moyle 2002). Newly hatched larvae are typically 6.5 to 8 millimeters [0.26 to 0.32 inches] fork length (Wang 1986). Larvae remain in shallow weedy areas near spawning areas for 10 to 14 days (Meng and Moyle 1995). In the case of floodplains, larvae are found in shallow water associated with flooded terrestrial vegetation (Crain et al. 2004).

Splittail grow to a typical length of 110 to 120 millimeters [4.3 to 4.7 inches] during their first year, 140 to 160 millimeters [5.5 to 6.3 inches] during their second year, 200 to 215 millimeters [7.9 to 8.5 inches] during their third year, and grow 25 to 35 millimeters/year during remaining years, reaching up to 400 millimeters [15.75 inches], but fish over 300 millimeters [11.8 inches] are rare, as growth has decreased since the introduction of the overbite clam (*Potamocorbula amurensis*) (Moyle et al. 2004). Maturity is typically reached at the end of their second year (Daniels and Moyle 1983).

C.23.3 Habitat Requirements and Ecology

The upstream movement of splittail is closely linked with flow events from February to April that inundate floodplains and riparian areas (Garman and Baxter 1999; Harrell and Sommer 2003). Seasonal inundation of shallow floodplains provides both spawning and foraging habitat for splittail (Caywood 1974; Daniels and Moyle 1983; Baxter et al. 1996; Sommer et al. 1997). Evidence of splittail spawning on floodplains has been found on both the San Joaquin and Sacramento Rivers (Sommer et al. 2006). In the San Joaquin River drainage, spawning has apparently taken place in wet years in the region where the San Joaquin River is joined by the Tuolumne and Merced Rivers (Sommer et al. 2006). In the StrategyArea, splittail spawn on inundated floodplains in the Yolo Bypass (Sommer et al. 1997, 2001, 2002; Crain et al. 2004; Moyle et al. 2004). When floodplain inundation does not occur in the Yolo Bypass, adult splittail migrate farther upstream to suitable habitat along channel margins or flood terraces; spawning in such locations occurs in all water year types (Feyrer et al. 2005). Although spawning is typically greatest in wet years, CDFW surveys demonstrate spawning takes place every year along the river edges and backwaters created by small increases in flow.

Limited collections of ripe adults and early stage larvae indicate splittail spawn in shallow water (less than 2 meters [6.6 feet] deep) over flooded vegetated habitat with a detectable water flow in association with cool temperatures (less than 15°C [59°F]) (Moyle et al. 2004). Turbidity is typically high under these conditions, but decreases rapidly as flows diminish. On floodplains, complex topography slows water velocities, creating eddies and increasing hydraulic residence time. Increased hydraulic residence time promotes phytoplankton and zooplankton production on seasonally inundated floodplains.

When juveniles reach a length of approximately 29 millimeters fork length, they move into deeper habitats (Sommer et al. 2002).Although some larval and juvenile splittail are swept off floodplains and downstream by flood currents (Baxter et al. 1996), many larvae and juveniles remain in riparian or annual vegetation along shallow edges on floodplains as long as water temperatures remain cool (Sommer et al. 2002; Moyle et al. 2004). Most late-stage juveniles and nonreproductive adults inhabit moderately shallow (less than 4 meters [13 feet]) brackish and freshwater tidal sloughs and shoals, such as those found in the margins of the lower Sacramento River (Moyle et al. 2004; Feyrer et al. 2005).

Channel margins and backwater habitats can be critical to the survival of young-of-year splittail, as well as the population as a whole (Moyle et al. 2004; Feyrer et al. 2005). Such habitats provide refugia from predatory fishes and feeding sites as fish grow in upstream regions before and during downstream migration. Many backwater habitats are associated with the complex topography of remnant riparian habitats and are created ephemerally in response to increases in river stage (water surface elevation); others are synthetic creations such as cut channels, boat ramps, or agricultural pump intakes. This contrasts with major floodplain inundation typically associated with large splittail year classes (Meng and Moyle 1995; Baxter et al. 1996; Sommer et al. 1997), which may require an 8- to 10 meter [26- to 33-foot] increase in river stage (typically associated with flood flow events).

Splittail regularly inhabit the Sacramento River upstream to the Red Bluff Diversion Dam at River Mile 243 and the San Joaquin River into Salt Slough (River Mile 135) (Moyle 2002) and Mud Slough at River Mile 125 (plus an additional 10.5 miles into Mud Slough). Splittail also inhabit the Napa and Petaluma River drainages (upper documented range: River Miles 18 and 17, respectively) and marshes. Splittail inhabiting these drainages have been found to be genetically distinct from splittail inhabiting the Sacramento and San Joaquin Rivers (Baerwald et al. 2007). Splittail from the Petaluma River exhibited a higher degree of differentiation from the Sacramento–San Joaquin population than did Napa River splittail, suggesting high salinities in San Pablo Bay and Carquinez Strait isolated these populations to differing degrees from the larger Sacramento–San Joaquin population. Spawning occurs in the Petaluma and Napa Rivers, but spawning locations within these rivers remain unknown (Moyle et al. 2004; Feyrer et al. 2005). No populations of splittail exist outside of the Central Valley rivers and the San Francisco/Sacramento–San Joaquin River Delta (Bay-Delta) estuary.

C.23.4 Species Distribution and Population Trends

C.23.4.1 Distribution

The splittail range includes the Sacramento River up to the Red Bluff Diversion Dam and the San Joaquin River to River Mile 135. Selected observations in the lower portions of Sacramento River and tributaries include the American River to River Mile 12, in the Feather River to River Mile 58 and from just below the Thermalito Afterbay outlet (Oppenheim pers. comm.; Seesholtz pers. comm. Resources Agency and California Department of Water Resources 2004), and in Butte Creek/Sutter Bypass to vicinity of Colusa State Park (U.S. Fish and Wildlife Service 1995; Moyle 2002; California Department of Water Resources 2004; Sommer et al. 2006).

Long-term beach seine sampling data for age 0 splittail (less than or equal to 50-millimeter fork length) in the Sacramento River spanning 32 years (1976 to 2008) indicates that the farthest location upstream where juvenile splittail have been collected was 144 to 184 miles upstream of the confluence of the Sacramento and San Joaquin Rivers. The consistency in the upstream range of juvenile splittail found in these long-term studies supports a finding that there was no decrease in distribution during this period (Feyrer et al. 2005; Sommer et al. 2006). This distribution also includes the lower reaches of the Cosumnes, Mokelumne, Feather, American, Napa and Petaluma Rivers (U.S. Fish and Wildlife Service 1995; U.S. Fish and Wildlife Service 1996; Moyle 2002; Sommer et al. 2006; Sommer et al. 2007).

Near Mud and Salt Sloughs, splittail can access historical valley floodplains and apparently use them for spawning in wet years (e.g., 1995 and 1998) (Baxter 1999; Moyle et al. 2004). Splittail occasionally extend their range farther southward into central and southern San Francisco Bays using freshwater and low-salinity habitats created during high-outflow years (Moyle et al. 2004). After high-outflow years in the early 1980s and mid-1990s, splittail were captured in the estuary of Coyote Creek, South San Francisco Bay (Stevenson pers. comm. Sommer et al. 2007). In a study by researchers at the University of California, Davis, that started in August of 2010 and samples monthly, no splittail have been caught in Coyote Creek (Hobbs and Buckmaster 2012pers. comm.).

C.23.4.2 Population Trends

No population-level estimates currently exist for Sacramento splittail. The abundance of juvenile splittail (young-of-the-year) is highly variable from one year to the next and positively correlated with hydrologic conditions within the rivers and Delta during the late-winter and spring spawning period and the magnitude and duration of floodplain inundation (Sommer et al. 1997). Because splittail are a long-lived species (5 to 7 years) (Moyle 2002; Grimaldo pers. comm.), the abundance of juveniles in a given year may not be a good predictor of adult splittail abundance. Results of CDFW fall midwater trawl surveys indicate a marked decline in overall splittail abundance and consistently low population levels since 2002.

C.23.5 Threats to the Species

C.23.5.1 Water Exports

Results of surveys at unscreened diversions (Nobriga et al. 2004) have shown that a variety of fish species (e.g., threadfin shad, silversides, striped bass), primarily larval and juvenile life stages, are vulnerable to entrainment. Based on results of this and similar studies conducted on unscreened diversions, it has been hypothesized that early juvenile splittail would be vulnerable to entrainment from these smaller diversions. However, water velocities at these relatively small agricultural pumps and siphons are low enough that larger fish are able to avoid entrainment. The potential magnitude of the entrainment risk, risk variations across seasons and areas, and the cumulative effect of entrainment losses on the population dynamics of splittail cannot be determined. No comprehensive, quantitative estimates have been developed for the level of potential entrainment mortality that may occur because of diversions from the rivers.

Power plants have the ability to entrain large numbers of fish. However, with the retirement of older units, use of cooling water is currently low. Furthermore, recent State Water Resources Control Board regulations require that units at these plants be equipped with a closed cycle cooling system by 2017.

C.23.5.2 Habitat-Changing Structures

In the Sacramento River, levees constrain river meander from River Mile 194 at Chico Landing downstream to Collinsville (River Mile 0) and restrict the riparian zone accessible via the river channel. Levee configuration differs through three reaches downstream of Chico Landing and has important implications in terms of splittail spawning and rearing habitat (Feyrer et al. 2005).

C.23.6 Habitat Loss

Maintaining and increasing seasonally inundated floodplain habitat suitable for splittail spawning and juvenile rearing throughout the species range has been identified as a factor that will help maintain successful reproduction and increase juvenile abundance and genetic diversity during prolonged drought events and avoid a genetic “bottleneck.”

Reclamation of Delta islands and wetlands during the 19th and early 20th centuries removed or degraded large areas of high-value juvenile/adult rearing habitat. This habitat consisted of shallow, low-velocity areas throughout the Delta, and particularly in the western Delta and Suisun Marsh (Moyle et al. 2004). In the 1960s and 1970s, the U.S. Army Corps of Engineers increased downstream water conveyance and reinforced levees by clearing and riprapping levees along the lower Sacramento River. These actions further reduced or eliminated suitable rearing habitat for splittail from the City of Sacramento downstream by removing large areas of shallow channel margins. Current efforts are underway to improve flood protection for communities along much of the lower Sacramento River and several other valley rivers. Actions being proposed and conducted include removal of trees and riparian vegetation and armoring with riprap. The current policy is for removal of all large trees and brush from levees to improve detection of weak points and potential levee failures.

Reclamation and levee construction along the majority of riverine habitats has degraded or eliminated large areas of seasonally inundated floodplains that once served as spawning and larval rearing habitat for splittail. Although some spawning occurs on shallow margins of the main channels every year, floodplains are highly productive and, when inundated, are used by splittail for spawning and larval rearing more heavily than channel margins.

Changes in river stage resulting from upstream diversions and reservoir storage have not been well studied, but during low- and moderate-runoff years, water management may affect splittails' access to floodplains and their ability to emigrate successfully after spawning and early rearing (Moyle et al. 2004). Reservoir operations are designed to reduce peak flows during winter and spring months that historically would have resulted in seasonal inundation of floodplains.

C.23.6.1 Food Resources

Reductions in productivity within have been attributed to changes in hydrology associated with water diversions, upstream reservoir operations, and ammonia[3] from wastewater treatment plants. Upstream reservoir operations have reduced seasonal variability in river hydrology, resulting in fewer and shorter high-flow events and, therefore, reduced frequency and duration of floodplain inundation (Sommer et al. 1997, 2002; Meng and Matern 2001; Feyrer et al. 2005, 2006). Floodplains are an important source of food for splittail (Sommer et al. 2001; Schemel et al. 2004; Lehman et al. 2008). High concentrations of ammonium from municipal wastewater treatment plants may inhibit diatom production, reducing the food available for the prey of splittail prey and other fish species (Wilkerson et al. 2006; Dugdale et al. 2007; Glibert 2010; Cloern et al. 2011; Glibert et al. 2011).

C.23.7 Exposure to Toxins

Although there is strong support from laboratory studies that toxics can be lethal to splittail (Teh et al. 2002, 2004a, 2004b, 2005), there is little information about the chronic or acute toxicity of contaminants within the Delta (Greenfield et al. 2008). The longevity of splittail relative to most other covered fish species (5 to 7 years) (Moyle 2002) enables their tissue to bioaccumulate toxicants to higher concentrations than those other species. This makes splittail particularly vulnerable to heavy metals such as mercury, and other fat-soluble chemicals. Perhaps the greatest concern among the impacts of contaminants on splittail relates to selenium. Tissues of splittail collected in Suisun Bay had sufficiently high selenium concentrations to cause physiological impacts, in particular, reproductive abnormalities (Stewart et al. 2004). Adult splittail feed on the Potamocorbula, which bioaccumulates and transfers selenium in high concentrations (Luoma and Presser 2000). With the decline of the mysid shrimp, Neomysis, in the estuary, juvenile and adult splittail have increased foraging on benthic macroinvertebrates such as clams (Feyrer et al. 2003).

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[3] Ammonia in water generally forms some amount of ammonium. Therefore, the use of the term *ammonia* implies that both ammonia and ammonium may be present.

Teh et al. (2004b) found that young splittail that were fed a diet high in selenium grew significantly slower and had higher liver and muscle selenium concentrations after nine months of testing.

Pesticide use on row crops (including rice) commonly grown in the Yolo Bypass and their proclivity to adhere to sediment particles suspended in water and deposited on the bottom provide a dietary pathway to splittail ingestion along with detritus during feeding (Werner 2007). Exposure to pesticides and other chemical contaminants may occur while splittail forage on inundated floodplains or in the estuary after the pesticides have entered stream and river channels through agricultural drainage.

C.23.7.1 Predation

Major nonnative predatory fish introduced into the waterways of the Strategy Area, such as striped bass and largemouth bass, have resided in the area for over a century (Dill and Cordone 1997), and splittail have persisted. However, reduced turbidity and increased habitat for nonnative predatory species provided by Brazilian waterweed (Egeria densa) and water hyacinth (Eichhornia crassipes) have enhanced both largemouth bass abundance and their ability to visually forage, thus increasing predation risk to splittail (Toft et al. 2003; Brown and Michniuk 2007).

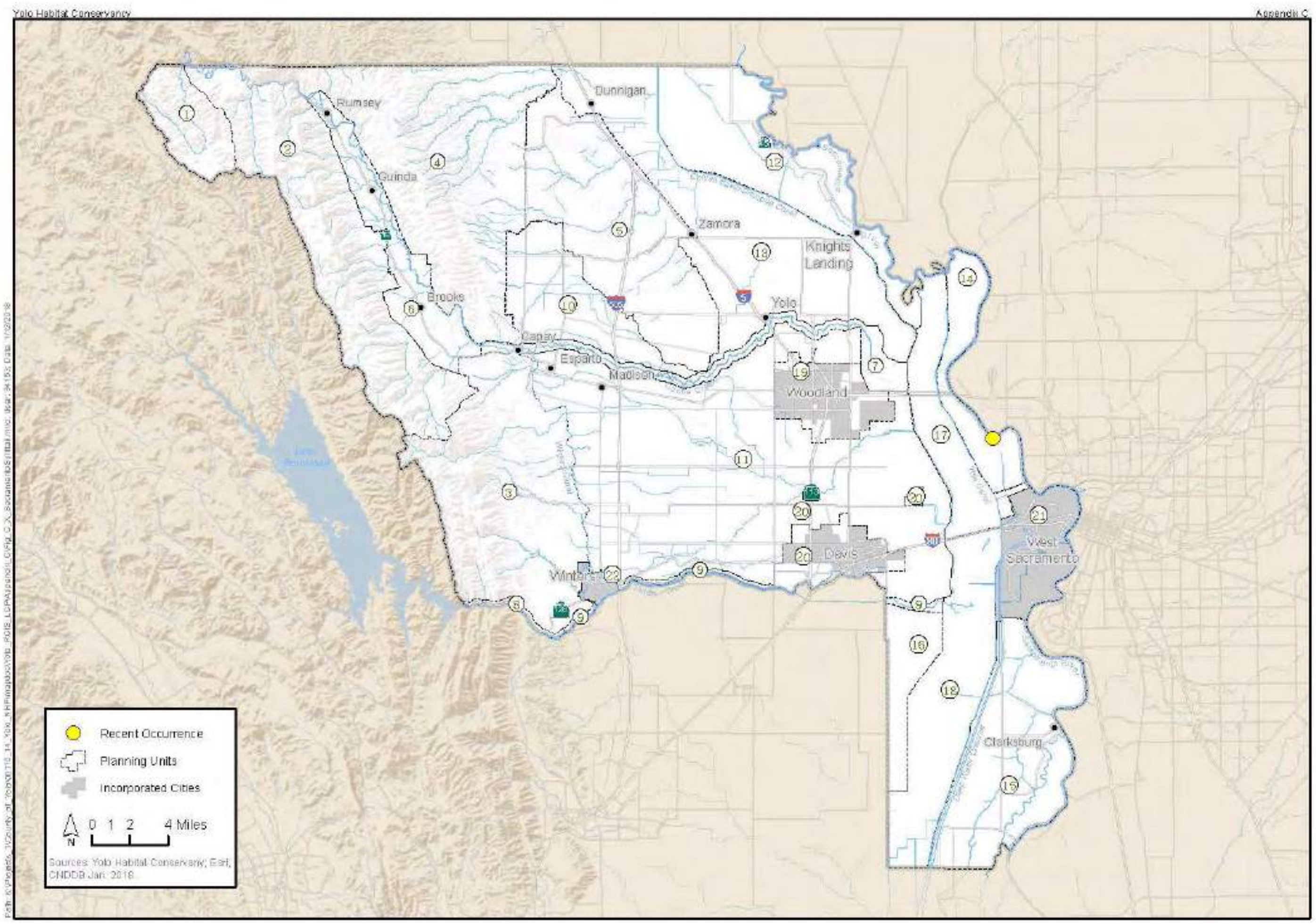
C.23.7.2 Harvest

The legal fishery for splittail is thought to be substantial, despite poor documentation (Moyle et al. 2004). Subadult and adult splittail are harvested by recreational anglers for consumption, as well as for use as bait by striped bass anglers. There is no evidence that splittail are affected at a population level by the fishery, but there is insufficient evidence to conclude this with confidence. CDFW now regulates the take of splittail to two fish per day, which may only be taken by angling (California Code of Regulations 14(2):4,5.70).

C.23.8 Recovery Plan Goals

Although splittail is not listed, it is included in the *Sacramento–San Joaquin Delta Native Fishes Recovery Plan* (U.S. Fish and Wildlife Service 1996), which also includes the delta smelt, longfin smelt, green sturgeon, Sacramento perch, and three races of Chinook salmon. USFWS has the responsibility to review and update the recovery plan for these species. To accomplish this task, USFWS has formed a new Delta Native Fishes Recovery Team to assist in the preparation of this updated plan.

Figure C-18. Sacramento Splittail Mapped Habitat and Occurrences



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C.24 California Tiger Salamander (*Ambystoma californiense*)

C.24.1 Listing Status

Federal: Threatened range-wide (69 *Federal Register* [FR] 47212); Endangered Sonoma County (65 FR 57242); Endangered Santa Barbara County (68 FR 13498); critical habitat designated (70 FR 49380).

State: Candidate Endangered; Species of Special Concern.

Critical Habitat: Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for California Tiger Salamander; Central Population: Final Rule (70 FR 49380–49458).

The Dunnigan Creek Unit (Central Valley Region Unit 1) of designated critical habitat, comprising 1,105 hectares (2,730 acres), located just west of Interstate 5 and the town of Dunnigan in north-central Yolo County, is the only unit within the Plan Area. Critical habitat has also been designated in Santa Barbara County (69 FR 68568) and within 20 counties in central California, including Yolo County (70 FR 49380).

Recovery Plan: Under development.

C.24.2 Species Description and Life History

The California tiger salamander (*Ambystoma californiense*) is an amphibian in the family Ambystomatidae. These terrestrial salamanders are large and thickset, with a wide, rounded snout (69 FR 47212). Adults range in size from 7.5 to 12.5 centimeters (cm) (2.95 to 4.92 inches) snout-to-vent length (SVL) (Jennings and Hayes 1994). Average SVL for both adult males and females is approximately 9 cm (3.58 inches), although the average total length for males and females is 20.3 and 17.3 cm (7.99 and 6.81 inches), respectively (69 FR 47212). Dorsal (back) coloration consists of a black background on the back and sides, interspersed with white or pale yellow spots or bars (69 FR 47212). Ventral (belly) coloration ranges from almost uniform white or pale yellow to a variegated pattern of white, pale yellow, and black (Jennings and Hayes 1994). The salamander's small eyes have black irises and protrude from their heads (Jennings and Hayes 1994). During the breeding season, the cloacal region of males becomes enlarged (Petranka 1998) and is a useful means of distinguishing sexes. The cloaca is a body cavity that receives the collective discharges from the intestinal, urinary, and reproductive canals. Males also have larger tails with more developed fins.

The California tiger salamander is restricted to grasslands, oak savannah, and coastal scrub communities of lowlands and foothill regions where aquatic sites are available for breeding. California tiger salamanders are typically found at elevations below 460 meters (1,509 feet) (68 FR 13498), although the known elevational range extends up to 1,053 meters (3,458 feet) (Jennings and Hayes 1994). Breeding sites generally consist of natural ephemeral pools (Barry and Shaffer 1994) or artificial ponds that mimic them (e.g., stock ponds that are allowed to dry). Bobzien and DiDonato (2007) report that in the East Bay Regional Park District (Contra Costa and Alameda

Counties) California tiger salamanders breed almost exclusively in seasonal and perennial stock ponds. Breeding sites may also include perennial features with open water refugia that do not support populations of bullfrog (*Rana catesbeiana*) or predatory fishes (Holomuzki 1986; Fitzpatrick and Shaffer 2004). Pools characterized by deep water may also support larvae through metamorphosis in relatively dry years (Trenham et al. 2000), whereas shallow pools may not (Semlitsch et al. 1996). Populations associated with shallow, natural vernal pools may be more dependent on suitable hydroperiod (Trenham et al. 2000). As illustrated by the 114-year-old reservoir at Lagunita (Stanford University, Santa Clara County), constructed ponds may also serve as habitat for California tiger salamander as long as they are drained annually, thus preventing exotic fish and amphibian predators (i.e., bullfrogs) from establishing (Barry and Shaffer 1994). Barry and Shaffer (1994) attribute the persistence of the salamander population at Lagunita to (1) large size of both aquatic and terrestrial habitats, and (2) the continuous filling and draining of the reservoir every year, which provides larvae a head start over fish predators each year.

Larvae require a minimum of approximately 10 weeks to complete metamorphic transformation (P. Anderson 1968; Feaver 1971), significantly longer than other amphibians such as the Pacific tree frog (*Pseudacris regilla*) and western spadefoot (*Spea hammondii*). Hydroperiod, or the timing and duration of waters in potential breeding sites, can be critical for reproductive success. Shaffer et al. (2008) indicate that California tiger salamanders can breed successfully in stock ponds, and in natural or constructed vernal pools remaining wet until mid-May. Larvae in coastal regions may not metamorphose until late July, and pools holding water into June, July, or later generally have higher success (Barry and Shaffer 1994). Larvae have been documented overwintering in perennial ponds in the higher elevations of the Ohlone Regional Wilderness in Alameda County (Bobzein and DiDonato 2007). Compared to the western toad (*Bufo boreas*) or western spadefoot, California tiger salamanders are poor burrowers and require subterranean refuges constructed by ground squirrels and other burrowing mammals (Jennings and Hayes 1994). Salamanders spend the dry season, which comprises most of a year, within these burrows (69 FR 47212). Although California tiger salamanders are often considered to be in a state of dormancy, called aestivation, during the period in which in they occupy these burrows, evidence suggests that salamanders may remain active while within their burrows (S. Sweet in litt. in 69 FR 47212).

Males usually migrate to the breeding ponds before females (Twitty 1941; Shaffer et al. 1993, Loredo and Van Vuren 1996; Trenham 1998b) and remain in the ponds for an average of six to eight weeks, while females stay for approximately one to two weeks (USFWS 2004b). Salamanders typically return to the same pond to breed in subsequent breeding seasons (Trenham 1998b). However, interpond dispersal does occur and is dependent on the distance between ponds and the quality of intervening upland habitat (Trenham 1998a). It appears that breeding takes place in pulses, with time between breeding events and the proportion of breeding adults per event associated with rainfall patterns and wetland inundation (J. Alvarez pers. comm.; S. Bobzein pers. comm.; D. Cook pers. comm.; M. Ryan pers. comm.). In Sonoma County there is a main breeding event in mid-December, which corresponds to the first large winter rain event that is sufficient to fill vernal pools, followed by one to two smaller breeding events after the next rainfalls (D. Cook pers. comm.). In drought years, insufficient water in the breeding pools may prevent breeding (Barry and Shaffer 1994). Trenham et al. (2000) found that within a population in Monterey County, female California tiger salamanders skipped breeding opportunities at a higher rate than males in years with later rainfall, a bias attributed to the date of pond filling, but not to total annual rainfall. Barry and Shaffer (1994) suggest that while local California tiger salamander populations may not breed during drought years when ephemeral pools do not fill, the longevity of adults is probably sufficient to ensure population persistence through all but the longest of droughts.

After mating, females lay their eggs in the water of the breeding habitat (Twitty 1941; Shaffer et al. 1993; Petranka 1998). Females usually attach their eggs to twigs, grass stems, vegetation, or debris (Storer 1925; Twitty 1941; Jennings and Hayes 1994). After breeding, adults leave the pool and return to the upland habitat, taking shelter during the day in small mammal burrows and emerging at night to feed during the breeding season (Shaffer et al. 1993; Loredo et al. 1996; Trenham 1998a). In two to four weeks, eggs hatch into aquatic larvae (Petranka 1998). Larvae feed on zooplankton, small crustaceans, and aquatic insects for about six weeks and then begin consuming larger prey such as small tadpoles (J. Anderson 1968). The larval stage usually lasts three to six months (Petranka 1998), but individuals may remain in their breeding sites over the summer if breeding pools remain inundated (Shaffer and Trenham 2005). The longer the inundation period, the larger the larvae and metamorphosed juveniles are able to grow, and the more likely they are to survive and reproduce (Semlitsch et al. 1988; Pechmann et al. 1989; Morey 1998; Trenham 1998b).

Lifetime reproductive success for California tiger salamanders is generally low, with many individuals breeding only once in their lifetime (Trenham 1998b; Trenham et al. 2000). Over the lifetime of a female, only a small number of metamorphic offspring are produced; and only a small percentage of a cohort survive to become breeding adults (Trenham 1998b; Trenham et al. 2000). Trenham et al. (2000) found that reproduction at Hastings Reserve in Monterey County was lower than replacement in all of six years studied. According to this study, the average female California tiger salamander breeds 1.4 times over a lifetime, producing 8.5 young surviving to metamorphosis per event and 12 lifetime metamorphic offspring per female (Trenham et al. 2000). To achieve 1:1 replacement by this reasoning would require 18.2 percent survival from metamorphosis to breeding; survival at Hastings during this time was only 5 percent, leading the authors to suggest that isolated breeding ponds may be insufficient for maintaining viable populations over the long term.

Juvenile California tiger salamanders have been observed to disperse up to 2.59 kilometers (km) (1.6 mile) from breeding pools to upland areas (Austin and Shaffer 1992). Adults have been observed up to 2 km (1.3 miles) from breeding ponds. Trenham et al. (2001) observed California tiger salamanders moving up to 670 meters (2,198 feet) between breeding ponds in Monterey County. Similarly, Shaffer and Trenham (2005) found that 95 percent of California tiger salamanders resided within 640 meters (2,100 feet) of their breeding pond at Jepson Prairie in Solano County.

Adults emerge from upland sites on rainy nights during fall and winter rains to feed and migrate to breeding ponds (Stebbins 1989, 2003; Shaffer et al. 1993). Adults use the same migratory routes between breeding pools and upland burrows year after year (Petranka 1998; Loredo et al. 1996). Metamorphosed juveniles leave the breeding sites in late spring or early summer and migrate to small mammal burrows (Zeiner et al. 1988; Shaffer et al. 1993; Loredo et al. 1996). Like adults, juveniles may emerge from burrows to feed during nights of high relative humidity (Storer 1925; Shaffer et al. 1993) before settling in their selected upland sites for the summer months. While most California tiger salamanders rely on rodent burrows for shelter, some individuals may utilize soil crevices as temporary shelter during upland migrations (Loredo et al. 1996).

The distance between occupied upland habitat and breeding sites depends on local topography and vegetation, and the distribution of California ground squirrel (*Spermophilus beecheyi*) or other rodent burrows (Stebbins 1989). California tiger salamanders seem to follow the pattern of a broadly defined metapopulation structure, in which a population is divided into a set of subpopulations, some of which become extinct and are later recolonized by migrants from other subpopulations (69 FR 47212). Semlitsch et al. (1996) points out that because many vernal pools and ponds used by salamanders are temporary over geological and ecological time, local extinction must be counterbalanced by colonization of new sites; thus, conservation plans must incorporate terrestrial habitats providing corridors for movement to new sites. In the case of California tiger salamanders, Trenham (1998b) indicates that the spatial arrangement of ponds and the migratory behavior of salamanders substantially affect pond utilization and sustainability of local populations. Interpond distances directly affect the probability of recolonization and subsequent opportunities for population rescue, which is important because physiology limits the distance that amphibians are able to disperse (Semlitsch 2000). While Marsh and Trenham (2001) reviewed the fit between theoretical metapopulations and pond-breeding amphibians and found that random extinctions of local populations were uncommon as long as terrestrial habitats were intact, Trenham and Shaffer (2005) found that local extinctions were likely where the probability of reproductive failure exceeded 0.5, and that reproductive failure was common in both permanent and highly ephemeral pools, underscoring the importance of interconnected breeding sites.

C.24.3 Habitat Requirements and Ecology

A diverse array of flora and fauna have adapted to the seasonal hydric cycle of vernal pools (69 FR 47212). Vernal pools and other seasonal rain pools are the primary breeding habitat of California tiger salamanders (68 FR 13498). Within the species range, there are numerous other sensitive vernal pool species, comprising 24 plants, four crustaceans, and one insect (Keeler-Wolf et al. 1998). Listed vernal pool crustaceans are able to complete their life cycle within a relatively short period of inundation (59 FR 48136). Therefore, many pools that support vernal pool crustaceans may not retain water for the 10 weeks or more required to complete metamorphosis of California tiger salamander larvae (P. Anderson 1968; Feaver 1971). Laabs et al. (2001) reported that, in eastern Merced County, California tiger salamander larvae were observed only in the largest vernal pools. California tiger salamanders, unlike vernal pool crustaceans, are known to successfully reproduce in perennial ponds (69 FR 47212).

Outside of the breeding season, post-metamorphic California tiger salamanders spend most time in burrows of small mammals, such as California ground squirrels and Botta’s pocket gopher (*Thomomys bottae*) (Storer 1925; Loredo and Van Vuren 1996; Petranka 1998; Trenham 1998a). Active rodent burrow systems are considered an important component of California tiger salamander upland habitat (Seymour and Westphal 1994; Loredo et al. 1996). Utilization of burrow habitat created by burrowing mammals such as ground squirrels suggests a commensal relationship (a relationship between two species in which one obtains food or other benefits without detriment or benefit to the other) between the two species (Loredo et al. 1996). Loredo et al. (1996) indicate that active ground-burrowing rodent populations are probably necessary to sustain California tiger salamander populations because inactive burrow systems begin to deteriorate and collapse over time. In a two-year radiotelemetry project in Monterey County (Hastings), Trenham (2001) found that salamanders preferentially used open grassland and isolated oaks; salamanders present in continuous woody vegetation were never more than 3 meters from open grassland, potentially because ground squirrels prefer to construct burrows in open habitats (Jameson and Peeters 1988 in Trenham 2001).

C.24.4 Species Distribution and Population Trends

C.24.4.1 Distribution

The California tiger salamander is endemic to California. Within the coastal range, the species occurs from southern San Mateo County south to San Luis Obispo County, with isolated populations in Sonoma and northwestern Santa Barbara Counties (CNDDB 2005). In the Central Valley and surrounding Sierra Nevada foothills, the species occurs from northern Yolo County southward to northwestern Kern County and northern Tulare and Kings Counties (CNDDB 2005). Throughout its range, occurrences of California tiger salamander are strongly associated with uplifted and dissected undeformed to moderately deformed Plio-Pleistocene sediments (Jennings and Hayes 1994, Wahrhaftig and Birman 1965).

Recorded occurrences of California tiger salamanders in Yolo County include an occurrence of several larvae in a stock pond on the west slope of the Capay Hills east of Rumsey Rancheria (Downs 2005), and five occurrences in the northern end of the Solano-Colusa vernal pool region, west and northwest of Dunnigan (CNDDB 2007) (Figure A-15). Four recorded occurrences were located within an area bounded by Interstate 5 to the east, Bird Creek to the south, and Buckeye Creek to the north and west. These four occurrences are from within an area that now comprises the Dunnigan Creek Unit (Central Valley Region Unit 1) of designated critical habitat Land ownership within this unit is entirely private (70 FR 49380) and therefore restricted (another historical, but extirpated occurrence, is recorded from a site adjacent to the designated critical habitat). A fifth recorded occurrence, from 1993, represents an individual found in the Willows apartment complex in Davis, adjacent to a stormwater detention basin managed by the City of Davis (CNDDB 2007). Queries of the online databases of the California Academy of Sciences (2008) and Museum of Vertebrate Zoology (2008) yielded no additional occurrence records.

C.24.5 Population Trends

California tiger salamanders still occur throughout much of their historical range (Trenham et al. 2000) and can be common at localities where it still occurs. Total adult population size is unknown, but certainly exceeds 10,000. Populations are thought to be declining due to habitat loss. Approximately 75 percent of the species' historical natural habitat has been lost. The species has been eliminated from 55 to 58 percent of historical breeding sites. Holland (1998) indicated that about 75 percent of the historical vernal pool breeding habitat has been lost, although some question the reliability of this estimate. Barry and Shaffer (1994) stated that this salamander soon will be in danger of extinction throughout its range and noted that it already is gravely threatened in the San Francisco Bay Area and in the San Joaquin Valley. In Santa Barbara County, half of the 14 documented breeding sites have been destroyed or have suffered severe degradation since mid-1999 (65 FR 57242).

Little is known of the population trends of California tiger salamanders in Yolo County. Four of the five recorded occurrences of the species in the county are from within an area that now comprises the Dunnigan Creek Unit (Central Valley Region Unit 1) of designated critical habitat. Land ownership within this unit is entirely private (70 FR 49380) and therefore restricted. The fifth recorded occurrence, in the City of Davis, consists of a solitary individual; lack of supporting habitat suggests this observation is the result of a translocated individual or a released pet (M. Ryan pers. comm.).

C.24.6 Threats to the Species

Conversion of land to residential, commercial, and agricultural activities is considered the most significant threat to California tiger salamanders. These activities result in destruction and fragmentation of upland and/or aquatic breeding habitat, and killing of individual California tiger salamanders (Twitty 1941; Hansen and Tremper 1993; Shaffer et al. 1993; Jennings and Hayes 1994; Fisher and Shaffer 1996; Launer and Fee 1996; Loredo et al. 1996; Davidson et al. 2002).

Fisher and Shaffer (1996) found an inverse relationship between introduced exotics and native amphibians. Exotic species, such as bullfrogs (*Ranacates beiana)*, mosquitofish (*Gambusia affinis*), sunfish species (e.g., largemouth bass [*Micropterus salmoides*] and bluegill [*Lepomis macrochirus*]), catfish (*Ictalurus* spp.), and fathead minnows (*Pimephales promelas*), that live in perennial ponds such as stock ponds are considered to have negatively affected California tiger salamander populations by preying on larval salamanders (Morey and Guinn 1992; Graf and Allen-Diaz 1993; Shaffer et al. 1993; Seymour and Westphal 1994; Fisher and Shaffer 1996; Lawler et al. 1999; Laabs et al. 2001; Leyse 2005). Shaffer et al. (2008) found that for other ambystomatids, introduction of larger fish can result in the loss of salamander life stages within one year while introduction of mosquitofish (*Gambusia affinis*) can eliminate salamanders in three to four years. Native fish, including salmonids, are known to prey on amphibian larvae that are palatable (Hencar and M'Closkey 1996). In a thorough review of available data, Fisher and Shaffer (1996) found that historical California tiger salamander localities are lower in elevation than current ones, implying extirpation in many areas occurring below 200 meters. In general, introduced exotics now occupy lower elevations, and suggest that habitat modification and low levels of topographic relief may facilitate invasion by increasing opportunities for dispersal through interconnected watersheds or suitable terrestrial habitats, or through deposition by floodwaters (Fisher and Shaffer 1996). Bobzein and DiDonato (2007) found pond co-occurrence to be negatively correlated for California tiger salamander and California newt, with sympatry only occurring in xeric regions of oak savannas and open woodland habitats. California newts are generally associated with mesic habitats such as redwood forests, deciduous hardwood forests, and oak bay woodlands, suggesting that California tiger salamanders and California newts segregate out along elevation lines (Bobzein and DiDonato 2007).

Pond size may bear on the ability of California tiger salamander to avoid invertebrate predators. In large fishless ponds, *A. Tigrinum nebulosum* larvae avoided predation by aquatic invertebrates by moving from the shallow, vegetated margins to deeper waters while predators were active (Holomuzki 1986), underscoring the importance of pond size and open water refuge for larval success.

Riley et al. (2003) examined hybridization between California tiger salamanders and an introduced congener, the tiger salamander (*Ambystoma tigrinum*). The tiger salamander has been deliberately introduced as fish bait in California and is contaminating the genome of California tiger salamanders through interbreeding (Riley et al. 2003). In the Salinas Valley, Riley et al. (2003) sampled salamanders from four artificial ponds and two natural vernal pools. Based on mitochondrial DNA and two nuclear loci, Riley et al. (2003) found that hybrids were present in all six ponds, and that these hybrids were viable and fertile. Hybridization with the barred tiger salamander (*Ambystoma* *tigrinum mavortium*) has been occurring since fishermen and bait shop owners began introducing the species 50 to 60 years ago, resulting 15–30 generations of genetic mixing (Fitzpatrick and Shaffer 2004). Fitzpatrick and Shaffer (2004) report more nonnative alleles in large perennial ponds despite the proximity of ephemeral ponds, perhaps attributable to the presence of open water refugia providing an extended breeding season or facilitating a paedomorphic life history strategy in which adult salamander retain larval characteristics. Fitzpatrick and Shaffer (2007) report evidence of hybrid vigor or increased fitness of hybrids based on early-larval survival. This finding raises questions regarding the relative values of genetic purity verses fitness and viability that are central to developing conservation strategies for California tiger salamander.

Pesticides, hydrocarbons, and other pollutants are all thought to negatively affect breeding habitat, while rodenticides and gases used in burrowing mammal control (e.g., chlorophacinone, diphacinone, strychnine, aluminum phosphide, carbon monoxide, and methyl bromide) are considered toxic to adult salamanders (Salmon and Schmidt 1984). California ground squirrel and pocket gopher control operations may have the indirect effect of reducing the availability of upland burrows for use by California tiger salamanders (Loredo-Prendeville et al. 1994).

Roads can fragment breeding and dispersal migratory routes in areas where they traverse occupied habitat. Features of road construction, such as solid road dividers, can further impede migration, as can other potential barriers such as berms, pipelines, and fences.

In the 70 FR 49380 critical habitat designation for the California tiger salamander, the concept of critical habitat was described as follows: “Critical habitat identifies specific areas, both occupied and unoccupied by a listed species, which are essential to the conservation of the species and that may require special management considerations or protection.” 70 FR 49380 further stated that “primary constituent elements for the California tiger salamander are aquatic and upland areas, including vernal pool complexes, where suitable breeding and nonbreeding habitats are interspersed throughout the landscape, and are interconnected by continuous dispersal habitat,” and that one or more of the primary constituent elements are present in all areas proposed for designation as critical habitat for the central population.

A recovery plan has not yet been prepared for the California tiger salamander, although the 69 FR 47212 has stated the intention to do so. In the interim, efforts toward conservation and recovery of the species should emphasize habitat preservation. Specifically, efforts should be directed toward protecting sites with vernal pool and other suitable rain pool habitat—in the largest blocks possible—from loss, fragmentation, degradation, and incompatible uses. Surrounding upland habitats will require similar protections that conserve burrowing mammals. Managed grazing programs may be a necessary component at many or all preserve sites in order to maintain the open, low-height grasslands required to sustain populations of California ground squirrels.

Physical disturbances to the underlying soils of seasonal rain pools should be avoided, as such disturbances could reduce their water-retaining capacity (Jennings and Hayes 1994). Such disturbances to vernal pool substrates also could destroy eggs of listed crustacean species.

In locations where roads traverse potential migratory routes, tunnels should be incorporated into the road design (Barry and Shaffer 1994). Barriers to migration, in the form of solid road dividers, should also be avoided on roads traversing potential migratory routes (Shaffer et al. 1989 in Jennings and Hayes 1994). Other potential barriers, such as berms and certain types of pipelines or fences, that can inhibit or prevent migration, should be avoided (Jennings and Hayes 1994).

Pesticides, hydrocarbons, and other pollutants should not be used or applied in a manner that runoff of these substances is transported into potential California tiger salamander breeding habitat. Rodenticides and gases used in burrowing mammal control may be toxic to resident adult and juvenile salamanders. Operations to control California ground squirrel and pocket gopher populations should be avoided in areas where California tiger salamanders may be present due to direct effects on the species and the potential indirect effects of reducing the availability of upland burrows.

Efforts should be undertaken to control the spread and introduction of exotic predatory species such as bullfrogs, mosquitofish, sunfish, catfish, and fathead minnows that live in perennial ponds—especially in areas where California tiger salamanders are known to occur. Although the sale of nonnative tiger salamanders for use as fish bait has been banned in California, efforts should continue to prevent the introduction and spread of this species, which has been shown to interbreed with native California tiger salamanders.

Based on a Monterey County study and a limited understanding of essential terrestrial habitats and buffer requirements of the species, Trenham et al. (2001) recommended that plans to maintain local populations of California tiger salamanders should include pond(s) surrounded by buffers of terrestrial habitat occupied by burrowing mammals, but noted that single isolated ponds might not support populations indefinitely even if surrounded by optimal uplands (Pechman and Wilbur 1994; Semlitsch and Bodie 1998 in Trenham et al. 2001). Based on individual dispersal of juveniles up to 1000 meters from their pool of origin, Searcey and Shaffer (2008) estimated that 95 percent of the reproductive value from a single large pond falls within approximately 2.4 km. Based on these findings, Shaffer et al. (2008) recommend a minimum buffer of 1 mile around breeding pools, relating to a preserve size of approximately 800 hectares (1,977 acres), greatly exceeding the 290-meter upper bound described by Semlitsch and Bodie (2003). This recommendation provides a useful and reasonable guideline for establishing salamander preserves of minimal functional size. Due to the potential for extirpation at single ponds due to random, stochastic events, sites with multiple complexes of vernal pools surrounded by much larger areas of suitable upland habitat should be considered for preserve sites, if feasible. Furthermore, sites with potential linkage corridors to other subpopulations should be considered. Sites chosen for preserves should also be occupied by burrowing mammals, especially California ground squirrels, in order to provide terrestrial habitat. Because contiguous blocks of land this size are not always available (e.g., Sonoma County), an experimental metapopulation approach may be required.

In their final report to USFWS titled "Guidelines for the relocation of California tiger salamanders (*Ambystoma californiense*)," Shaffer et al. (2008) make the following principal management recommendations: (1) eliminate fish and bullfrogs, (2) provide a means for draining all permanent ponds or eliminate them in favor of ephemeral ponds, (3) pools ponds should have sufficient watershed to provide an adequate hydroperiod for metamorphosis (three to six months), and (4) graze or burn to manage upland and wetland vegetation. Maret et al. (2006) found that disturbance or disruption of natural disturbance regimes can increase invisibility by exotic predators, but that disturbance-intolerant fish and bullfrogs can be eliminated by pond drying. Bullfrogs, which prefer permanent or semi-permanent water (Stebbins 1951), may be less likely to establish in ephemeral waters (Barry and Shaffer 1994). Increased drying regimes can limit predators, but can also reduce viability of salamander populations by limiting salamander breeding. However, Maret et al. (2006) found that the negative effects of drying on Sonoran tiger salamanders were generally minor relative to the negative effects of less frequent drying, and recommend ponds of varying depth to maintain a suitable hydroperiod for successful salamander reproduction while keeping exotic predators in check. At appropriate densities, cattle grazing can extend hydroperiod in ephemeral wetlands (Marty 2005) and may be an important factor in counteracting the hydrologic changes associated with climate change (Pyke and Marty 2005). Livestock grazing may also assist in maintaining open grassland and oak savanna communities that support rodents such as California ground squirrel and valley pocket gophers that provide retreats for California tiger salamanders (Bobzein and DiDonato 2007).

The most significant data gaps regarding California tiger salamanders are a lack of knowledge of its distribution and population trends within the Plan Area. California tiger salamanders may be more abundant in the Plan Area than available occurrence records indicate; however, surveys have not been conducted within the Dunnigan Unit of proposed critical habitat area and other areas where the species potentially occurs, and no information indicates recent or ongoing surveys at any Yolo County sites from which occurrences have been recorded.

C.24.7 Species Habitat Model and Location Data

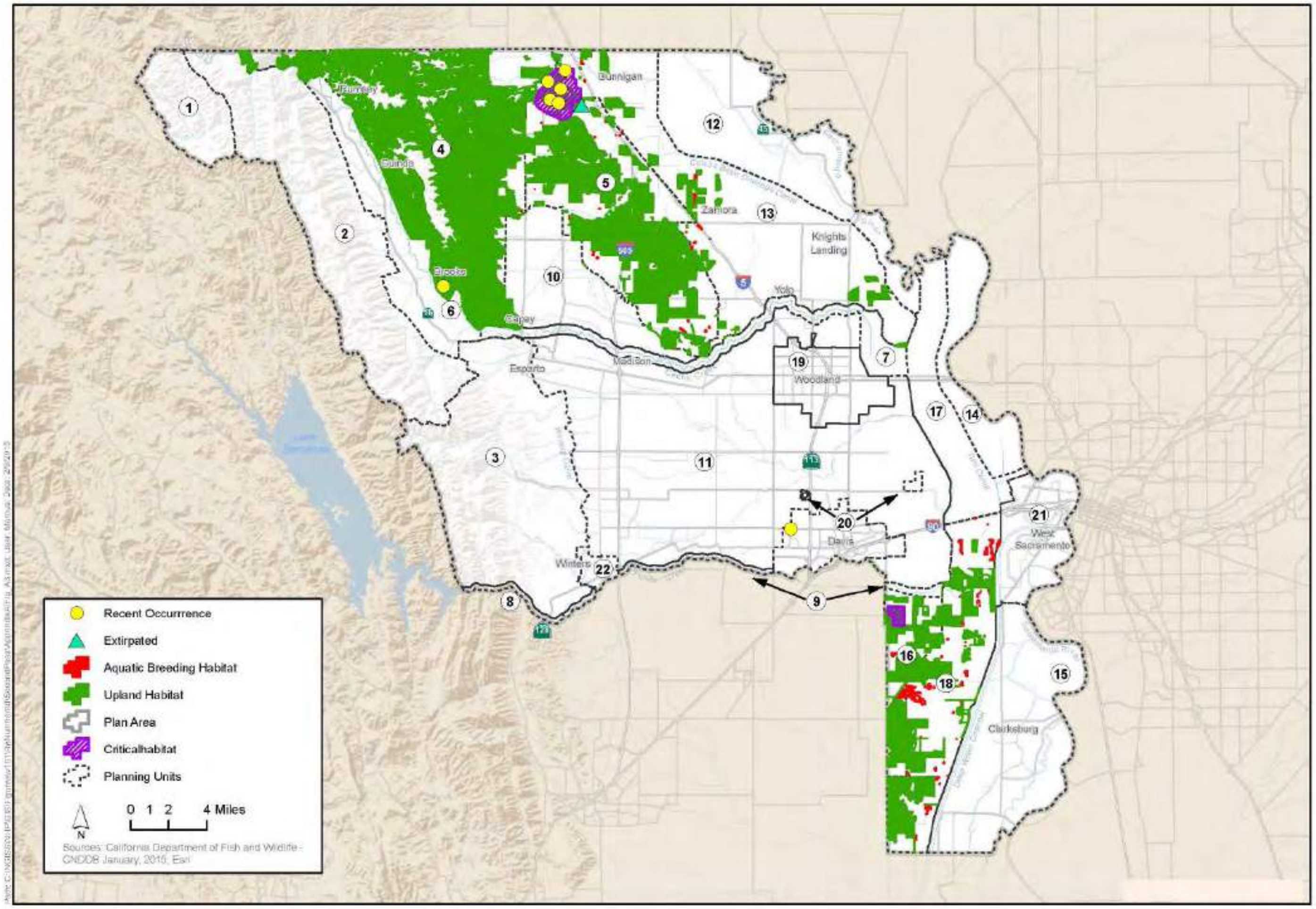
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.15.3, *Habitat Requirements and Ecology* (Figure A-15). The model parameters include the following.

- Aquatic Breeding Habitat: This habitat includes all potentially suitable aquatic breeding areas and was modeled by selecting all mapped vernal pools, alkali sinks, and ponds (except those that are known to be perennial) as listed below that occur below an elevation 1,509 feet. Habitat located within planning units 1 – 3, 6 – 12, 14, 15, 17, and 19 - 22 is excluded from the model because these Planning Units are not known to be currently occupied and are isolated from occupied habitat areas and are unlikely to be occupied in the future (e.g., presence of levees and highways that create barriers to movement).
- Upland Habitat: This habitat includes all potentially suitable upland nonbreeding habitat (including aestivation and dispersal areas). This habitat was modeled by selecting all mapped vegetation types as listed below that occur within 1.3 miles of modeled breeding habitat and below an elevation 1,509 feet. Studies indicate that 95 percent of California tiger salamanders reside within 2,100 feet of breeding habitat (Shaffer and Trenham 2005). Habitat located within planning units 1 – 3, 6 – 12, 14, 15, 17, and 19 - 22 is excluded from the model for the reasons described above. Upland habitat in the Yolo Bypass is suitable as dispersal habitat but is considered to generally be unsuitable as aestivation habitat because of frequent winter flooding of the Bypass.

C.24.7.1 Upland Habitat – Vegetation Types

- All Annual Grassland
- Blue Oak Woodland
- All Blue Oak – Foothill Pine
- Valley Oak Alliance
- Pastures

Figure C-19. California Tiger Salamander Modeled Habitat and Occurrences



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C.25 Foothill Yellow-Legged Frog (*Rana boylii*)

© William Flaxington

C.25.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.25.2 Species Description and Life History

Foothill yellow-legged frogs are moderately sized (37.2–82.0 millimeters [mm] in length, snout to urostyle; urostyle: frog homologue to pelvic bone) and vary in coloration (Jennings and Hayes 1994). Typical coloration includes dark to light gray, brown, green, or yellow and can be plain or mottled with brick or reddish pigments in appearance (Zweifel 1955). The snout is triangular in shape with a buff-colored patch that usually occurs from its tip to a line connecting to the eyelids (Stebbins 1985). The underside of the rear legs and lower abdomen are yellow or orangeish-yellow in larger individuals (Jennings and Hayes 1994). The rest of the underside is whitish with dark spots on throat and chest (Stebbins 1985). Irises are silvery gray with a horizontal, black counter-shading stripe (Jennings and Hayes 1994).

Breeding occurs from late March to early June, following streams at high water stage when less sediment is being transported (Storer 1925; Grinnell et al. 1930; Wright and Wright 1949; Jennings and Hayes 1994). Males probably defend areas around themselves during the breeding season (Martof 1953; Emlen 1968). Clusters of 300 to 1,200 eggs are deposited on the downstream side of submerged rocks over which a relatively thin, gentle flow of water exists (Storer 1925; Fitch 1936; Zweifel 1955). Stream velocity in suitable ovipositor sites should be less than 0.66 feet per second (0.2 meters/second) (Kupferberg 1996). Embryos have a critical thermal maximum temperature of 26 degrees Celsius (°C) (Zweifel 1955). A minimum of 15 weeks is required to attain metamorphosis, which typically occurs between July and September (Storer 1925; Jennings 1988). Adult size is attained in two years (Storer 1925), but no data are available onlongevity (Jennings and Hayes 1994).

Foothill yellow-legged frogs, unlike other ranid frog species in California, are rarely encountered far from permanent water sources (Morey 2000). Normal home ranges widths are probably less than 10 meters (Morey 2000). Occasional long distance movements up to 50 meters (165 feet) may occur during periods of high water conditions (Morey 2000). However, this species probably spends most of its time in or near streams during all seasons (Morey 2000).

C.25.3 Habitat Requirements and Ecology

Foothill yellow-legged frogs occupy a variety of habitats, including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadow, where clear, cool rocky streams are present (Morey 2000). Shallow, small to moderate-sized streams with flowing water and at least some cobbled-sized substrate are preferred (Hayes and Jennings 1988). The species has been found in streams lacking cobble or larger-sized substrate grain (Fitch 1936; Zweifel 1955), but it is unclear whether such habitats are regularly used (Hayes and Jennings 1988). Both adult and juvenile foothill yellow-legged frogs have also been found in lentic habitats such as seeps and ponds (California Natural Diversity Database [CNDDB] 2008), however, these observations likely represent temporary refugia during dispersal. Though non-breeding dispersal patterns are largely unknown, frogs have been found belowground and beneath surface objects as far as 50 meters from water (Nussbaum et al. 1983). It occurs at elevations from sea level to approximately 2,040 meters (6,700 feet) (Stebbins 1985). The species usually absent from habitats where introduced aquatic predators, such as various fishes and bullfrogs,are present (Hayes and Jennings 1986, 1988;Kupferberg 1994).

Garter snakes (*Thamnophis* spp.) prey heavily on foothill yellow-legged frogs and tadpoles (Fitch 1941). Red-sided, western terrestrial, and Oregon garter snakes have been reported as feeding on the post-hatching stages (Fitch 1941; Zweifel 1955; Lind 1990). Rough-skinned newts have been reported as feeding on the eggs of foothill yellow-legged frogs (Evenden 1948). Additionally, fish, mammal (e.g., raccoons), and bird species are likely to prey on one or more stages offoothill yellow-legged frogs (Zweifel 1955). Nonnative predators, such as bullfrogs (*Rana catesbeiana)* and Centrarchid fishes, are also known to prey on stages of foothill yellow-legged frogs (Moyle 1973; Werschkul and Christensen 1977).

Aquatic and terrestrial arthropods, particularly insects, comprise the prey taken by adult and postmetamorph foothill yellow-legged frogs. Insects found inthe stomachs of collected individuals include grasshoppers, hornets, carpenter ants, water striders, smallbeetles, and dipterans (mosquitoes and others) (Stebbins 1951; Storer 1925).Tadpoles probably graze on algae and diatoms along rocky streambottoms (Morey 2000).

Foothill yellow-legged frogs are diurnal and active year-round in warmer climates but may become inactive or hibernate in cooler areas (Morey 2000). They often dive into water to take refuge under rocks or sediment when disturbed (Stebbins 1954; Storer 1925). The seasonal ecology and behavior of adult foothill yellow-legged frogs is essentially unknown (Jennings and Hayes 1994).

Although foothill yellow-legged frogs may co-occur with California red-legged frogs (*Rana boylii*) and the Cascades frog (*Rana cascadae)*, differences in microhabitat preferences limit competition (Zeiner et al.1988). However, bullfrogs and Centrarchid fishes may contribute to the reduction of populations (Moyle 1973;Werschkul and Christensen 1977).

C.25.4 Species Distribution and Population Trends

C.25.4.1 Distribution

Historically, the foothill yellow-legged frog occurred from west of the crest of theCascade Mountains in Oregon south to the Transverse Ranges in Los Angeles County, and in the Sierra Nevada foothills south to Kern County (Zweifel 1955; Stebbins 1985). Populations are not known from desert slopes, but an isolated population was reported in Sierra San Pedro Martír, Baja Mexico (Loomis 1965). The current range excludes coastal areas south of northern San Luis Obispo County and foothill areas south of Fresno County where the species is apparently extirpated (Jennings and Hayes 1994).

Queries of the online databases of the California Academy of Sciences (2008) and Museum of Vertebrate Zoology (2008) yielded five recorded occurrences of foothill yellow-legged frog in Yolo County (Figure A-17). Three of these records (also represented as an historical locality by Jennings and Hayes 1994) represent 1997 observations in northwestern Yolo County on Davis Creek both upstream and downstream of Davis Creek Reservoir. The remaining two records represent 1925 observations within Putah Creek, 8 miles west of Winters in southern Yolo County, which Jennings and Hayes (1994) presume to be extinct. A query of the California Natural Diversity Database (CNDDB 2008) yielded two additional records observed in 1999 in two ponds in the central stretch of the Blue Ridge Mountains.

C.25.4.2 Population Trends

Jennings and Hayes (1994) reported this species as endangered in central and Southern California south of the Salinas River, Monterey County. The species has not been observed in or south of the Transverse Ranges since before 1978 (Jennings and Hayes 1994). High water conditions estimated to be of 500-year frequency, which occurred over much of Southern California during the spring of 1969, are believed to be largely responsible for the apparent extirpation of this taxon in that region (Sweet 1983).

In the west slope drainages of the Sierra Nevada and southern Cascade Mountains east of the Sacramento-San Joaquin River axis the species has been reported as threatened (Jennings and Hayes 1994). The species has not been observed for nearly 20 years in at least 19 historical localities on the west slope of the southern Sierra Nevada, and localities at which this species is extant on the western slope of the northern Sierra Nevada and the extreme southern Cascades appear widely scattered (Jennings and Hayes 1994).

Foothill yellow-legged frogs still occur in many localities in coastal drainages north of the Salinas River system in California, some of which harbor significant numbers of frogs (Jennings and Hayes 1994). However, a number of risk factors, including exotic predators, threaten the species in this area and Jennings and Hayes (1994) consider populations in the area of special concern.

Though prevalent within the foothills of Yolo County west of Capay Valley and within adjacent Lake County, the paucity of recorded occurrences at lower elevations suggests that the foothill yellow-legged frog may never have been a common species throughout much of Yolo County.

The principal factors contributing to the decline of the foothill yellow-legged frog are thought to include past habitat destruction related to activities such as logging, mining, and habitat conversions for water development,irrigated agriculture, commercial development, and nonnative predators and competitors such asintroduced trout and bullfrogs (U.S. Forest Service [USFS] 2008). Other environmental factors that may adversely affect mountain yellow-legged frogs include pesticides, certain pathogens, ultraviolet-B (beyond the visible spectrum) radiation, or a combination of these factors (67 *Federal Register* 44382).

C.25.5 Threats to the Species

Habitat loss and degradation, nonnative predators, and toxic chemicals threaten the long-term survival of the foothill yellow-legged frogs. Additionally, poorly timed water releases from upstream reservoirs can scour eggs from oviposition substrates (Jennings and Hayes 1994) and decreased waterflows can force adults into permanent pools where they may be more susceptible to predation (Hayes and Jennings 1988).

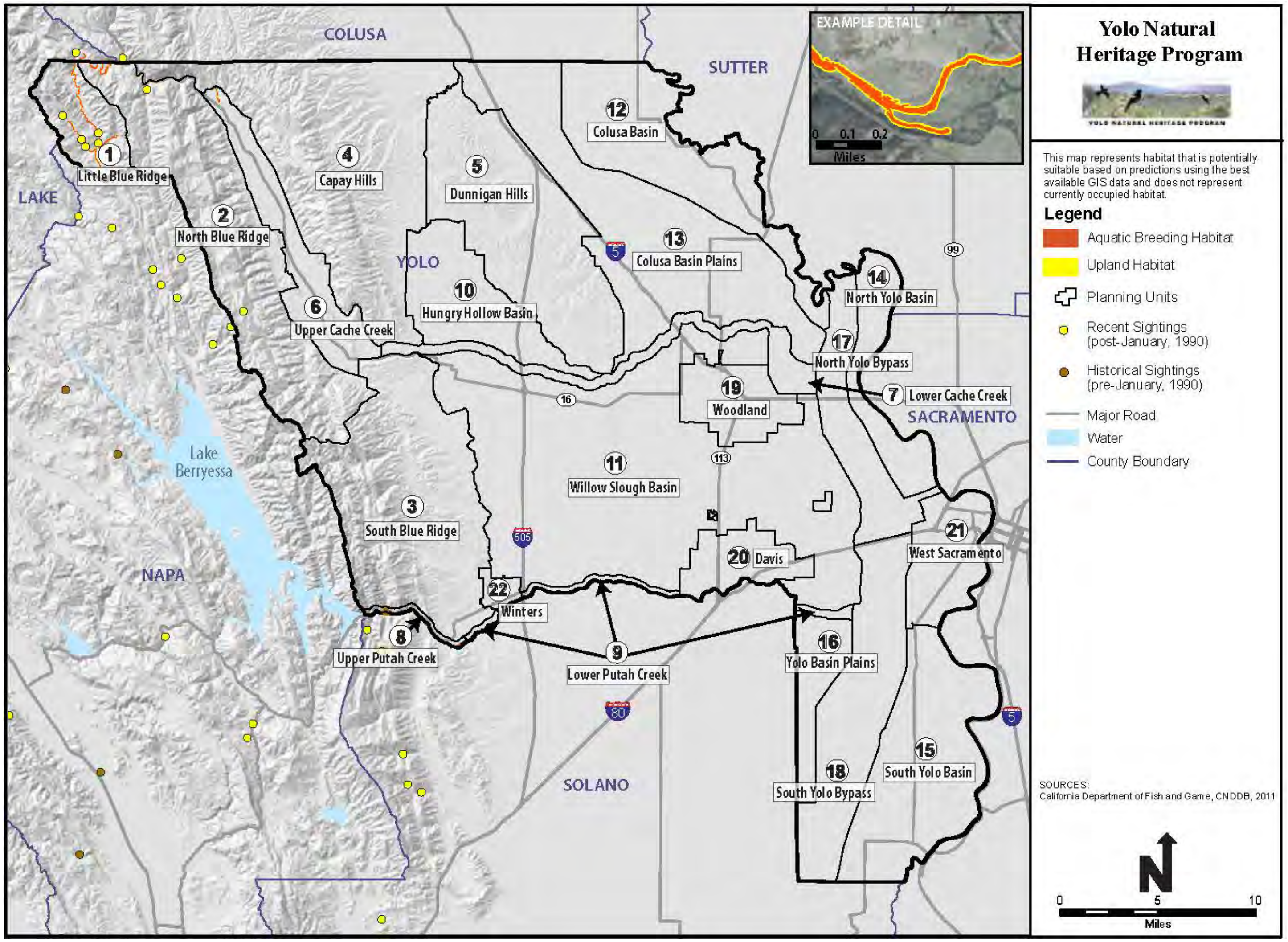
Suitable breeding habitat for the foothill yellow-legged frog should be identified in part by the presence of oviposition habitat having riffle areas with a substrate of cobble-sized or larger rocks. To provide this habitat, particular attention should be paid to maintaining a flow regime that facilitates differential sorting of loose substrate. Though specific tolerances remain unknown, management should avoid water releases that create excess flow and shear conditions while egg masses and the larval stages are present. Though egg masses of foothill yellow-legged frogs are known to accumulate suspended particulates (Storer 1925), increased silt loads generated by activities such as vegetation removal, logging and livestock grazing should be monitored until tolerance to silt deposition is better understood.

Nonnative predators pose a significant threat to foothill yellow-legged frog populations. Exotic predatory fish and bullfrogs prey on all life stages. Jennings (1996) found that the primary factor for decline in the Sierra Nevada is the introduction of nonnative predators. Centrarchid fishes have been found to readily eat eggs and may also contribute to the decline of the species (Werschkul and Christensen 1977).

C.25.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.17.3, *Habitat Requirements and Ecology* (Figure A-17). The model parameters include the following. wp

Figure C-20. Foothill Yellow-Legged Frog Mapped Habitat and Occurrences



- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB).
- Aquatic Breeding Habitat: This habitat includes all potentially suitable lotic breeding areas (streams) and was modeled by selecting all perennial streams from the National Hydrography Dataset Plus with a low gradient (less than or equal to 4 percent) in the Capay Hills, Blue Ridge, and Little Blue Ridge ecoregions. In addition to low gradient perennial streams other hydrologic features (e.g., Cache Creek, Putah Creek) were included based on assessment of Yolo NHP biologists. These were perennial stream features that were not captured correctly by the National Hydrography Dataset and thus were selected from surface water features extracted from the vegetation cover dataset.
- Upland Habitat: This habitat includes all potential nonbreeding habitat and was modeled by selecting all natural vegetation types and agricultural types within 10 meters (width of normal home range) (Morey 2000) of modeled aquatic breeding habitat.Urban and semi-agricultural land cover types were excluded.

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C.25.7.1 Federal Register Notices

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C.26 Western Spadefoot Toad (Spea [Scaphiopus] hammondii)


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C.26.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: Western spadefoot toad is included in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (U.S. Fish and Wildlife Service [USFWS] 2005).

C.26.2 Species Description and Life History

Western spadefoot (*Spea hammondii*) is an amphibian in the family Pelobatidae. Spadefoot toads are distinguished from true toads (genus *Bufo*) by their cat-like eyes (due to vertically elliptical pupils), black sharp-edged keratinized “spade” on each hind foot, teeth in their upper jaws, the reduction or absence of parotoid glands, and comparatively smooth skin.

Adults range in length from 3.8 to 6.4 centimeters (cm) (1.5 to 2.5 inches) (Stebbins 2003). The western spadefoot’s coloration ranges from a dusky green to gray, with four irregular light-colored stripes on the back, and a central pair of stripes distinguished by a dark hourglass shape. Skin tubercles (small, rounded protuberances) are sometimes tipped with orange or are reddish in color, particularly among young individuals. The irises of western spadefoots’ eyes are pale gold in color, and their abdomens are whitish without markings. Larvae are up to 7 cm (2.8 inches) in length (Stebbins 2003), with a rounded body, usually whitish-gray to very light gray-green in color, with eyes on the dorsal (upper) surface of the head (Holland and Goodman 1998). Some populations of spadefoots develop predacious and cannibalistic tadpoles with a beak on the upper jaw, a corresponding notch below, and enlarged jaw musculature (Orton 1954; Bragg 1964; Stebbins 1985).

Typical of toads, adult western spadefoots forage on a variety of insects, worms, and other invertebrates, including crickets, grasshoppers, true bugs, moths, ground beetles, predaceous diving beetles, ladybird beetles, click beetles, flies, ants, and earthworms. Although tadpoles consume planktonic organisms and algae, they are also carnivorous and will feed on dead amphibian larvae as well as their own species. Pfennig and Frankino (1997) found that for tadpoles of *S. multiplicata*, individuals were less likely to express cannibalistic phenotypes in pure sibship groups, but that chemical signals from nonkin were sufficient to trigger the carnivore phenotype. Farrar and Hey (1997) found that carnivorous spadefoots developed more pronounced beaks and jaw musculature and shorter intestines with fewer loops than omnivores. Carnivorous spadefoot tadpoles are also more likely to feed on fairy shrimp (Bragg 1962; Farrar and Hey 1997).

A terrestrial species, western spadefoots enter water only to breed (Dimmit and Ruibal 1980a). The breeding cycle of the western spadefoot is dependent on temperature and rainfall patterns (Jennings and Hayes 1994) but generally occurs between January and May (Stebbins 2003). Western spadefoots utilize vernal pools or other temporary pools for breeding (Jennings and Hayes 1994) but may also breed in slow-moving streams (Stebbins 2003). Western spadefoots require water temperatures between 9 degrees Celsius (°C) and 30°C (48 degrees Fahrenheit [°F] and 86°F) for breeding to occur (Brown 1967), and egg deposition does not occur until pools begin warming in late winter (Jennings and Hayes 1994). Western spadefoots are explosive breeders, with the number of individuals in a breeding aggregation potentially exceeding 1,000 (Jennings and Hayes 1994), although they are typically much smaller. Male western spadefoots clasp females during amplexus (breeding position) at the pelvic (hindlimb) region, unlike true toads, which clasp females at the pectoral (forelimb) region (Stebbins 2003). During amplexus the female deposits 10 to 42 eggs in small, irregularly cylindrical clusters, attaching them to plant stems or pieces of detritus (Storer 1925). Larvae hatch from eggs approximately 14.5 hours to six days after oviposition (egg-laying) (Brown 1967). Metamorphosis occurs three to 11 weeks after hatching, depending on temperature and food availability (Burgess 1950; Feaver 1971). Zeiner et al. (1988) reported that while in late metamorphic stages of development, the western spadefoot may spend a few hours to a few days near pond margins prior to dispersing. Holland and Goodman (1998) reported that individuals may remain in the vicinity of natal pools as long as several weeks following metamorphosis, hiding within drying mud cracks or beneath surface objects such as boards or decomposing cow dung (Weintraub 1980).

Movement patterns and colonization abilities of the adult western spadefoots are not fully understood (Jennings and Hayes 1994). Western spadefoots typically emerge at night during periods of warm rainfall to forage (Stebbins 1972). They move toward breeding sites in late winter to spring, in response to favorable temperatures and rainfall. The breeding season is brief (Stebbins 2003), sometimes lasting no more than one to two weeks. Following breeding, individuals return to upland habitats, where they spend most of the year aestivating (in a dormant state) in burrows. The western spadefoot may breed in the same ponds as California tiger salamanders (*Ambystoma californiense*), in areas where the two species are sympatric (California Natural Diversity Database [CNDDB] 2009).

C.26.3 Habitat Requirements and Ecology

Western spadefoot toads require two different types of habitat to complete their life cycle, both of which may need to be in close proximity (USFWS 2005): an aquatic habitat for breeding and a terrestrial upland habitat for feeding and aestivation.

Western spadefoot toads lay their eggs in a variety of permanent and temporary wetlands such as rivers, creeks, pools in intermittent streams, vernal pools, and temporary rain pools (CNDDB 2006), and stock ponds. Toads reproduce in water temperatures between 9°C and 30°C (48°F and 86°F). Water must be present for more than three weeks for the toad to undergo complete metamorphosis (Morey 1998; Jennings and Hayes 1994). Optimal habitat such as vernal pools and other temporary wetlands used for reproduction is free of native and nonnative predators such as fish, bullfrogs, and crayfish. The presence of these predators may impair recruitment by western spadefoot toad (Jennings and Hayes 1994).

Western spadefoot toads are mostly terrestrial and use upland habitats to feed and burrow in for their long dry-season dormancy. Upland western spadefoot toad habitat includes washes, floodplains, alluvial fans, and playas (Stebbins 2003), extending into foothills and mountains to an elevation of 1,360 meters (4,462 feet) (Jennings and Hayes 1994). The upper elevational limit in the general vicinity of Yolo County appears to be lower. The maximum elevation of records from Alameda County is 229 meters (750 feet), and Colusa County at 137 meters (450 feet) (CNDDB 2009). Western spadefoot may be active above ground on soil types ranging from loose sand to hardpan clay, although soil characteristics of burrow refugia are not known (Jennings and Hayes 1994). If soil characteristics are similar to those of *S. multiplicatus,* soils may harden significantly during the summer aestivation period (Ruibal et al. 1969), suggesting that spadefoots may be capable of utilizing compact soils by burrowing when conditions are moist (Jennings and Hayes 1994).

During dry periods, individuals typically excavate burrows into the ground at depths up to 3 feet, but they may also occupy burrows constructed by small mammals; whether these are used as short-term refugia during periods of surface activity is unknown (Jennings and Hayes 1994). Adult western spadefoots can consume roughly 11 percent of their body mass at a single feeding (Dimmitt and Ruibal 1980b) and can probably acquire the resources needed for aestivation in just a few weeks (Jennings and Hayes 1994). This aestivation period may continue for nine months at a time (Jennings and Hayes 1994). The skin of western spadefoots is very permeable, enabling them to absorb moisture from surrounding soil. Spadefoots may also be able to retain urea, increasing their internal osmotic pressure, thereby preventing water loss and facilitating water absorption from soils with relatively high moisture tensions (Ruibal et al. 1969; Shoemaker et al. 1969).

C.26.4 Species Distribution and Population Trends

C.26.4.1 Distribution

In North America, the range of the western spadefoot includes portions of California, extending south to Mesa de San Carlos in Baja California Norte, Mexico (Jennings and Hayes 1994; Museum of Vertebrate Zoology at UC Berkeley and California Academy of Sciences 2008). In California, the range of the western spadefoot includes portions of the Central Valley and bordering foothills, and the Coast Ranges south of Monterey Bay (Stebbins 2003). The species has experienced severe declines in the Northern California and lower elevation portions of its range (Stebbins 2003).

While western spadefoot toads once ranged throughout the Central Valley (Jennings and Hayes 1994), the paucity of current or historical recorded occurrences in Yolo suggests that the western spadefoot may never have been a common species in Yolo County. It is likely that the current land use patterns in the Central Valley portion of Yolo County (actively cultivated agriculture and increased road density) have significantly decreased any habitat suitability that may have been there.

Jennings and Hayes' (1994) distribution map indicates only one historical occurrence within the Plan Area, which is now considered extirpated, from near the southern border of Yolo County, west of Davis. Queries conducted in January 2008 of the collection databases of the Museum of Vertebrate Zoology at University of California, Berkeley and the California Academy of Sciences yielded no specimens of western spadefoots from Yolo County. The California Natural Diversity Database [CNDDB] (2009) lists three records of western spadefoots in Yolo County. Those records, from 1990 and 2000, were from Buckeye Creek, 4.8 and 5.6 kilometers (3.0 and 3.5 miles) northwest of Dunnigan. No other extant records are known from Yolo County.

C.26.4.2 Population Trends

Populations in Northern California have generally experienced severe declines (Stebbins 2003), and Yolo County populations may have experienced similar declines (USFWS 2005). The principal factors contributing to the decline of the western spadefoot are loss of habitat due to urban development, conversion of native habitats to agricultural lands, introduction of nonnative predators, and pesticide use (Fisher and Shaffer 1996; Hobbs and Mooney 1998; Davidson et al. 2002). Habitat loss and fragmentation result in small, isolated populations, which reduce individual movements and genetic exchange between populations. Reduction in gene flow may result in inbreeding depression and a subsequent reduction in population fitness. Furthermore, many remaining vernal pools and wetlands are suffering from habitat degradation by disking, intensive livestock grazing, off-road vehicle use, and contaminant runoff (Fisher and Shaffer 1996; Hobbs and Mooney 1998; Davidson et al. 2002).

The population status and trends of the western spadefoot outside of California (i.e., Baja California Norte, Mexico) are not well known. In general, populations of the western spadefoot have reportedly declined, and the species is now extirpated from much of lowland California (Stebbins 2003). Extensive losses have occurred in Northern California and in southern portions of the state from the Santa Clara River Valley to south of Los Angeles and Ventura Counties (Stebbins 2003).

C.26.5 Threats to the Species

The loss of vernal pool or other seasonal pool habitats due to land conversion is likely the greatest threat to the western spadefoot. More than 80 percent of occupied habitat in Southern California and more than 30 percent in Northern California have been lost to development or other land uses (Jennings and Hayes 1994). Habitat fragmentation and loss due to urban development, conversion of native habitats to agricultural lands, introduction of nonnative predators, and pesticide use are among the causes (Fisher and Shaffer 1996; Hobbs and Mooney 1998; Davidson et al. 2002). The relationship between habitat fragmentation and the metapopulation structure of the western spadefoot is not entirely understood (Jennings and Hayes 1994); however, ongoing land conversion is undoubtedly resulting in smaller, isolated populations.

Western spadefoots are suffering from habitat degradation by disking, intensive livestock grazing, off-road vehicle use, and contaminant runoff (Fisher and Shaffer 1996; Hobbs and Mooney 1998; Davidson et al. 2002). Direct mortality of toads may occur when toads burrow in actively tilled fields or are hit by vehicles when dispersing across roads. Where agricultural activities must coincide with the conservation of western spadefoot toad, appropriately grazed pastures will provide better habitat than intensively farmed lands subject to disking, planting, harvesting and other activities that could kill aestivating western spadefoot toad (USFWS 2005).

Natural predators of larval and post-metamorphic western spadefoots include raccoons (*Procyon lotor*), garter snakes (*Thamnophis* spp.), great blue herons (*Ardea alba*), and California tiger salamanders (Childs 1953). There are indications that the presence of introduced predators in breeding pools, such as mosquitofish (*Gambusia affinis*), crayfish (order Decapoda), and bullfrogs (*Rana catesbeiana*) may prevent recruitment (Jennings and Hayes 1994).

Although the degree to which predation affects the population dynamics of western spadefoots is poorly understood, their extended period of aestivation reduces exposure to predators. Spadefoots also produce toxic dermal secretions that deter predation (Duellman and Trueb 1986). Feaver (1971) noted that California tiger salamander larvae preyed on western spadefoot larvae whenever the two species co-occurred and California tiger salamander larvae metamorphosed first. However, Anderson (1968) found that if larvae of the two species are the same size, predation may not occur.

Nonnative invasive species are also a threat to the western spadefoot. The predation of spadefoot eggs and larvae by mosquitofish introduced into vernal pools through mosquito abatement programs may threaten some populations (Jennings and Hayes 1994; Stebbins 2003). Bullfrogs, which have been reported to emigrate to some western spadefoot breeding pools, may threaten those populations through predation of spadefoot eggs and larvae. Exotic predators such as mosquitofish may also compete with western spadefoot larvae for limited food resources.

Dimmitt and Ruibal (1980a) reported that low-frequency noises and vibrations can cause aestivating western spadefoots to become active and emerge from their burrows. Potential anthropogenic sources of such low-frequency noises and vibrations include seismic exploration for natural gas, land grading, or other motorized vehicles or machinery. Artificial irrigation can induce spadefoots to emerge and begin vocalizing in any month (Zeiner et al. 1988). Such artificially induced, aseasonal emergence could result in adverse effects such as mortality or decreased productivity.

The construction of roadways near conservation lands or other occupied habitat should be avoided to the extent possible. Breeding habitats located near roads are especially vulnerable to mortality caused by automobile strikes, which results in the loss of individuals and impedes access to potential movement corridors. Moreover, the low-frequency noises and vibrations that would occur during road construction, and the normal automobile and truck usage that would follow, could result in aseasonal emergences of aestivating spadefoots, generating additional adverse effects.

The western spadefoot was included for coverage in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005). The USFWS's stated goals for the western spadefoot and 12 other species of special concern covered under the Recovery Plan are to achieve and protect in perpetuity self-sustaining populations of each species and ensure the species' long-term conservation. The primary focus of the Recovery Plan is protection of vernal pool habitat, in the largest blocks possible, from loss, fragmentation, degradation, and incompatible uses (USFWS 2005). For the western spadefoot, the Recovery Plan calls for the following actions:

- Conducting research on juvenile and adult dispersal to and from breeding locations;
- Conducting research on the effects of habitat management practices on the western spadefoot and their habitat in order to determine the limiting factors with respect to determining minimum reserve sizes;
- Studying the impacts of low-frequency noises and vibrations; and
- Determining the influence of nonnative aquatic vertebrate predators (e.g., bullfrogs and mosquitofish) on population dynamics.

Jennings and Hayes (1994) state that the most significant data gap related to understanding western spadefoot populations is the relationship between habitat fragmentation and metapopulation structure. Movement patterns and colonization abilities of adult western spadefoots are also not fully understood. Comprehension of the life history and important habitat requirements of the western spadefoot is essential for conservation of the species (Jennings and Hayes 1994). Within

Yolo County, there are few records for the species that could be used to focus conservation or recovery efforts toward specific locations. Generally, however, habitat protection remains the primary strategy for conserving the western spadefoot.

Land acquisition is also an important conservation strategy. Land acquisition is a process in which a public agency or nonprofit land conservation organization purchases all the ownership rights to the land from a willing seller. The property that is to be acquired should contain all the parameters mentioned above. An important quality of the acquired property should be the allowance of genetic flow between populations via wildlife corridors. However, since movement patterns and colonization abilities of adult spadefoots are not fully understood, it is unknown how effective movement corridors between populations will affect the species.

The species has been documented to co-occur with several other rare species, some of which are federally protected (USFWS 2005). The following special status animals have been documented to co-occur: California tiger salamander, California red-legged frog (*Rana aurora draytonii*), vernal pool tadpole shrimp, vernal pool fairy shrimp, and California fairy shrimp (USFWS 2005). Federally listed plants that co-occur with the spadefoot toad include *Orcuttia inaequalis*, *Orcuttia pilosa*, *Castilleja campestris* ssp. *succulenta*, *Neostapfia colusana*, and *Chamaesyce hooveri* (USFWS 2005). Such co-occurrences provide an opportunity to conserve multiple species at one location.

C.26.6 Recovery Plan Goals

The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) contains the following goals for western spadefoot toad to be met within the Solano-Colusa Core Area: protect 85 percent of suitable species habitat. Since this core area extends beyond the Yolo NHP Plan Area, this goal overlaps with the Plan Area but is not specific to it.

C.26.7 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.16.3, *Habitat Requirements and Ecology* (Figure A-16). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB).
- Aquatic Breeding Habitat: This habitat includes all potentially suitable aquatic breeding areas and was modeled by selecting all areas above an elevation of 100 feet (land use intensification has essentially eliminated this species from the valley floor, E. Hansen, pers. comm.) with mapped vernal pools, ponds (except for known perennial ponds), and areas with fresh water emergent wetland, or washes (broad low gradient braided streams), and by including all first, second, and third order intermittent streams with a low gradient (less than or equal to 3 percent) below 229 meters (750 feet), that are within 1,207 feet (368 meters = mean maximum buffer distance for frogs, Semlitsch and Brodie 2003) of the upland habitat types listed below, and that occur in sandy loam, rocky loam, loam, gravelly loam, riverwash, or complex soil

texture types. Intermittent stream order information was interpreted by project biologist and utilized within the model as an input.[4]

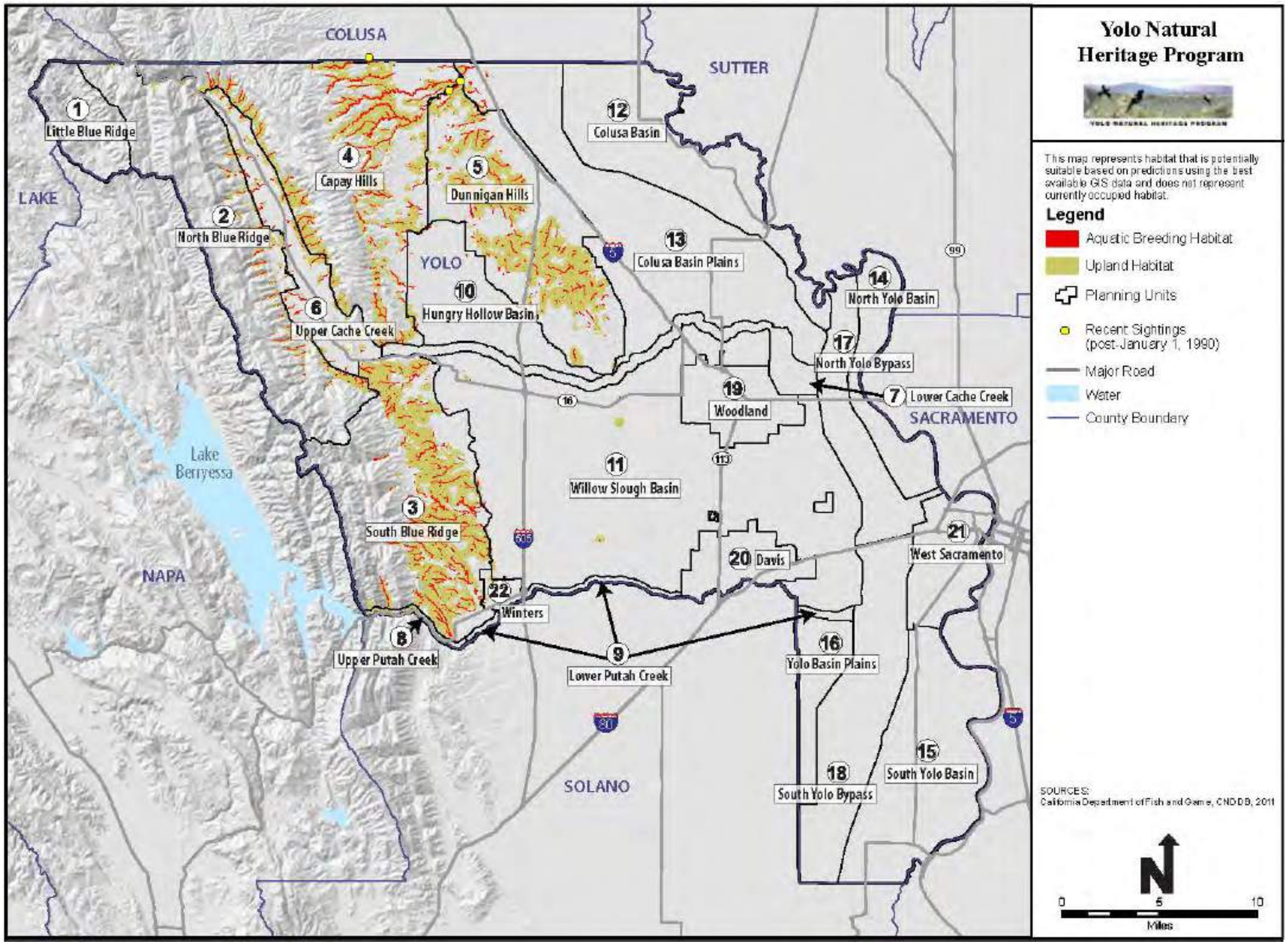
- Upland Habitat: This habitat includes all potentially suitable upland non-breeding habitat and was modeled by selecting all areas with mapped vegetation types, as listed below, that occur in sandy loam, rocky loam, loam, gravelly loam, riverwash, or complex soil texture types within 1,207 feet (Semlitsch and Brodie 2003) of modeled breeding habitat and below 229 meters (750 feet).

C.26.7.1 Upland Habitat – Vegetation Types

- All Annual Grassland
- All Serpentine
- All Barren
- All Mixed Chaparral
- All Chamise Alliance
- Blue Oak Woodland
- All Blue Oak – Foothill Pine
- Valley Oak Woodland
- Native and Mixed Pasture Types

[4] Stream order dataset was developed by Technology Associates in support of western spadefoot toad habitat modeling.

1 **Figure C-21. Western Spadefoot Toad Mapped Habitat and Occurrences**

2 

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C.27 Western Pond Turtle (*Actinemys marmorata*)

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C.27.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

Other Common Names: Northern Pacific Pond Turtle

Other Related Names: *Clemmys marmorata marmorata* (Baird and Girard 1852); *Emys (=Clemmys) marmorata marmorata* (Baird and Girard 1852); *Emys marmorata marmorata* (Baird and Girard 1852).

C.27.2 Species Description and Life History

The western pond turtle (*Actinemys marmorata marmorata*) (Holman and Fritz 2001; McCord and Joseph-Ouni 2006; Obst 2003) is a medium-sized aquatic turtle. Previously assigned to the genus *Clemmys*, Feldman and Parham (2002) have also proposed taxonomic realignments that would place *A. marmorata* within the genus *Emys*; current literature may refer to this taxon under either generic name. The carapace (upper portion of shell) color ranges from brown to black (Holland 1994). The carapace may be unmarked or covered with small, fine dark spots or lines (Holland 1994; Stebbins 2003). Adult size ranges from 8.9 to 21.6 centimeters (3.5 to 8.5 inches) straight-line carapace length (Stebbins 2003). The plastron (lower portion of shell) contains six pairs of yellowish shields, usually with dark blotches (Stebbins 2003). The head usually contains spots or a network of black coloring (Stebbins 2003). Adult females have a more domed, taller carapace, as compared to males, which have a more flattened, lower profile carapace (Holland 1994). Males also have larger, thicker tails than females (Holland 1994). Juveniles have a uniformly brown or olive carapace, with yellow markings along the edge of the marginals (the ring of shields encircling the carapace) and a tail nearly as long as the carapace (Stebbins 2003).

Field observations have reported copulation in May, June, and late August (Holland 1988). Oviposition (egg-laying) may occur as early as late April in central California (Rathbun et al. 1993) to late July, with most occurring in June and July (Holland 1994). A gravid (pregnant) female approaches the nesting site, empties the contents of her bladder onto the soil, excavates a nest chamber 90 to 125 millimeters (3.5 to 4.9 inches) deep and deposits one to 13 hard-shelled eggs (Holland 1994, Jennings and Hayes 1994). Incubation time ranges from 80 to more than 100 days in California (Holland 1994). In Northern California, hatchling western pond turtles (which are about the size of a quarter) overwinter inside the nest chamber and emerge the following spring (Holland 1994). The terrestrial movements of post-emergent hatchlings are poorly understood (Holland 1994), although it is known that at least some move quickly to aquatic habitats.

Adults sometimes engage in extended overland movements, which may be in response to drought or normal movements to aquatic habitats within a home range (Holland 1994). In one study, a turtle was observed making an overland movement of 5 kilometers (km) (3.1 miles), although in all other cases, overland movements were less than 3 km (1.9 miles) (Holland 1994). Such overland movements may be responses to an environmental stress such as drought or may be part of an individual's normal movements within a home range, which may consist of a series of ponds (Holland 1994). In lotic (stream) habitats, individuals move along the watercourse from pool to pool. During the course of one summer, Bury (1972) found average male, female, and juvenile linear movements were 354, 169, and 142 meters (1,161, 554, and 466 feet), respectively. In that study, adult males had the largest home ranges (0.98 hectare [2.42 acres]), followed by juveniles (0.36 hectare [0.89 acre]) and adult females (0.25 hectare [0.62 acre]).

C.27.3 Habitat Requirements and Ecology

The western pond turtle, although primarily found in natural aquatic habitats, also inhabits impoundments, irrigation ditches, and other artificial and natural water bodies (Ernst et al. 1994) and is found at elevations ranging from sea level to 2,041 meters (6,696 feet) (Stebbins 2003). The species is usually found in fresh water, but brackish habitats are also utilized (Ernst et al. 1994; D. Holland pers. comm.). The aquatic habitat may be comprised of either mud or rocky substrates and usually contains some vegetation (Ernst et al. 1994). Habitat quality often seems to be positively correlated with the number of available basking sites (Jennings and Hayes 1994). Turtles seem to avoid areas lacking in significant refugia (Holland 1994). Basking sites may be rocks, logs, vegetation, terrestrial islands within the aquatic habitat, and human-made debris (Holland 1994). Hatchlings use shallow, slow-moving waters with emergent vegetation, such as that found alongside channels of stream or pond margins, while juveniles one year old or older tend to utilize the same aquatic habitats as adults (D. Holland pers. comm.). Western pond turtles may overwinter in aquatic or upland habitats (Holland 1994). Like the giant garter snake (*Thamnophis gigas*), western pond turtles inhabit the irrigation ditches servicing rice agriculture in the Central Valley (E. Hansen, unpublished notes). While rice fields probably confer little advantage for adult western pond turtles, mature rice probably provides valuable cover and foraging habitat for hatchlings.

When overwintering in aquatic habitats, turtles enter a state of torpor and rest quietly on the pond or stream bottom, often in mud or under some type of refugium such as a log or undercut bank (Holland 1994). Overwintering western pond turtles may move between several sites during winter and have been observed swimming under ice in water temperatures as low as 1 degree Celsius (°C) (34 degrees Fahrenheit [F]) (Holland 1994). Individuals may occasionally emerge to bask on warm, sunny days during winter, even in northern Oregon (D. Holland pers. comm.).

Western pond turtles are generalist feeders, with most food being obtained by opportunistic foraging or scavenging (Ernst et al. 1994). Known food items include algae, various plants, crustaceans, various types of insects, spiders, fish, frogs, tadpoles, and birds (Pope 1939 in Ernst et al. 1994; Evenden 1948 in Ernst et al.1994; Carr 1952; Holland 1985; Bury 1986). Scavenging carrion of various vertebrate species may be a locally and/or seasonally important part of the diet (Holland 1994). Neustophagia, (a form of filter feeding) may be utilized to obtain abundant small invertebrate prey such as *Daphnia* (Ernst et al. 1994; Holland 1994).

Upland habitats are also important to western pond turtles for nesting, overwintering, and overland dispersal (Holland 1994). Nesting sites may be as far as 400 meters (1,312 feet) or more from the aquatic habitat, although usually the distance is much less and generally around 100 meters (328 feet) (Jennings and Hayes 1994; D. Holland pers. comm.; Slavens 1995). Nesting sites typically have a southern or western aspect, with slopes of 0 to 46 percent and compact, dry soils (Holland 1994;

Bury et al 2001). When turtles choose to overwinter in upland habitats, individuals typically leave the aquatic habitat in late fall, moving as much as 500 meters (1,640 feet) from the aquatic habitat (Holland 1994). Turtles typically burrow into duff (leaf litter) and/or soil, where they remain during the winter months (Holland 1994). For reasons not entirely clear, western pond turtles may move into upland habitats for variable intervals at other times of the year, during which times they may be found burrowed into duff or under shrubs (Rathbun et al. 1993).

Raccoons (*Procyon lotor*), bullfrogs (*Rana catesbeiana*), largemouth bass (*Micropterus salmoides*), gray fox (*Urocyon cineroargenteus*), coyote (*Canis latrans*), and feral and domestic dogs (*Canis familiaris*) are known to be major predators of western pond turtles (Holland 1994). Holland (1994) indicates that other known predators include Osprey (*Pandion haliaetus*), Bald Eagle (*Haliaetus leucocephalus*), black bear (*Euarctos americanus*), river otter (*Lutra canadensis*) (Manning 1990), and mink (*Mustela vison*).Numerous other fish, amphibian, bird, and mammal species are suspected to prey on the species (Holland 1994). Raccoons, in particular, are known to depredate nests, sometimes destroying all nests in an entire communal nesting area (D. Holland pers. comm.).

Western pond turtles spend considerable time basking in order to thermoregulate, preferring body temperatures between 24°C and 32°C (75°F and 90°F). Turtles seem to avoid body temperatures above 34°C (93°F) and usually cease basking at body temperatures well below their critical thermal maximum of 40°C (104°F). Individuals often bask above the water level on emergent logs, rocks, rocks, vegetation, or other objects. Turtles may sometimes bask at the surface, however, and sometimes within vegetation, where water temperatures may be 10°C to 15°C (18°F to 27°F) warmer than the water immediately below (Holland 1994). This type of basking may be utilized when air temperatures become too high for aerial basking (D. Holland pers. comm.). Western pond turtles also spend considerable time foraging (Holland 1994). Foraging may occur during the day or night (D. Holland pers. comm.; N. Sisk pers.obs.). Intraspecific (within-species) aggressive interactions, in the form of open-mouth gestures and shoving or bumping to secure positions on basking sites, are also common among western pond turtles (Holland 1994).

Nonnative invasive species are a threat to western pond turtles. Bullfrogs and exotic large predatory fish (e.g., largemouth bass) compete for invertebrate prey with western pond turtles and are known to eat hatchlings and small juveniles. Carp alter or eliminate emergent vegetation required as microhabitat by hatchlings (Holland 1994). Exotic turtles, including painted turtles, snapping turtles, and sliders, may compete with pond turtles for food and basking sites (D. Holland pers. comm.). These exotic turtles also may harbor and transmit diseases, such as upper respiratory diseases, to pond turtles (Holland 1994). Cattle trample and eat aquatic vegetation that serves as habitat for hatchlings and may crush nests. Domestic dogs sometimes kill or injure turtles (D. Holland pers. comm.).

C.27.4 Species Distribution and Population Trends

C.27.4.1 Distribution

The range of the western pond turtle in North America extends primarily from Pacific slopes of western Washington State (where it may now be extinct) south to the San Francisco Bay area, where it intergrades with the southwestern pond turtle (*C. m. pallida*) (Stebbins 2003). The range of the southwestern pond turtle (which does not occur in the Plan Area) extends from the zone of intergradation with the western pond turtle in central California, south to Baja California Norte, Mexico. Outside California, occurrences east of the Pacific crest include the Truckee, Carson, and East Walker Rivers in Nevada; Drews Creek in Lake County, Oregon; the Canyon Creek area in Lake County, Oregon; and introduced occurrences along the Deschutes River at Bend in Deschutes County, Oregon (Jennings and Hayes 1994; Stebbins 2003). In California, the western pond turtle ranges primarily from Pacific slopes along the Oregon-California state boundary south to the San Francisco Bay area (Stebbins 2003). Occurrences east of the crest of the Sierra Nevada Mountain Range include Susanville in Lassen County (Stebbins 2003). Molecular analyses place western pond turtles into four distinct groups, or clades, which include (1) a Northern clade extending from Washington south to San Luis Obispo County, California, west of the Coast Ranges; (2) a San Joaquin Valley clade from California's Great Central Valley; (3) a Santa Barbara clade from California's Santa Barbara and Ventura counties; and (4) a Southern clade occurring south of the Tehachapi Mountains and west of the Transverse Range south to Baja California, Mexico (Spinks and Shaffer 2005).

Queries conducted in January 2008 of the collection database of the California Academy of Sciences (2008) yielded seven Yolo County records of western pond turtles, all from 1997. Two of those records were from Davis Creek, near Davis Creek Reservoir in western Yolo County. The remaining five records were from the University of California (UC) Davis Arboretum (n = 1) and Arboretum Waterway (n = 4). Spinks et al. (2003) estimate a naturally occurring population of 53 individuals (95 percent CI = 48, 66) within the Arboretum Waterway. A similar query of records of the Museum of Vertebrate Zoology (2008) in Berkeley yielded no record of the western pond turtle in Yolo County. The California Natural Diversity Database (CNDDB) (2007) lists one record from 1990 of multiple western pond turtle individuals along Putah Creek and an unnamed tributary. This site is located less than 1.6 kilometers (1 mile) south-southeast of Winters, along the southern boundary of Yolo County. The CNDDB reports another occurrence from 2005 within Cache Creek, extending for 5.3 miles between Camp Haswell to an upper regional park, northwest of Capay Valley. A healthy population is also present at the Cache Creek Nature Preserve just west of Woodland (Spinks pers. comm.) Jennings and Hayes' (1994) distribution map shows one other extant occurrence from near the northeast corner of Yolo County and three extant occurrences from the Sacramento River Basin, along the southeastern boundary of Yolo County. At least three western pond turtles were observed within the Willow Slough Bypass between County Road 104 and County Road 105 during 2007 (E. Hansen unpublished notes). No other records from Yolo County, either extant or extirpated, were discovered.

More recent observations of western pond turtle have been made by Whisler (pers. comm., 2015). These include the following:

- Sacramento River at Gray's Bend (planning unit 12). Western pond turtle observe at Gray's Bend in1983, and were repeatedly observed through 2012.
- Putah Creek Riparian Reserve at UC Davis (between the University Airport and the Old Davis Road Bridge: planning unit 9). Western pond turtles observed throughout this area in 2014.
- Putah Creek Sinks (2010 and 2011) in the Yolo Bypass Wildlife Area: planning unit 18). Western pond turtles observed in the Putah Creek Sinks along with red-eared sliders and American bullfrogs.
- Lower Willow Slough area (planning unit 11): One adult western pond turtle observed sunning in the Conaway Ranch Water Delivery Canal at Yolo CRs 104 and 27 on March 27, 2010. The area is dominated by rice.

- Sacramento River Delta (planning unit15): Western pond turtles observed in Babel Slough and Winchester Lake during 2015. They probably occur in Elk Slough as well.
- West Sacramento (planning unit 21). Several western pond turtles in the borrow sloughs near the Water Treatment Plant south of Burrows Road in 2009.
- City Davis (planning unit 20). Several western pond turtles observed at the storm water detention basins and other ponds in Davis (West Davis Pond) and North Davis Ponds (Northstar Park Pond and Julie Partansky Pond). Red-eared sliders and American bullfrogs have also been observed at these ponds and are breeding successfully.

C.27.4.2 Population Trends

Populations in Washington State, where the species may be extinct (Stebbins 2003), have likely suffered the most. Stable populations remain in southern Oregon (D. Holland pers. comm.); however, northern Oregon populations have suffered severe declines (Hays et al. 1999), and most populations throughout the range have exhibited some declines (Holland and Bury 1998; D. Holland pers. comm.).

In California, Jennings and Hayes (1994) consider the western pond turtle as endangered from the Mokelumne River south and threatened elsewhere within the state. Loss of habitat is the most significant factor in western pond turtle declines. Over 90 percent of the historical wetlands in California have been drained, filled, or diked to support agricultural and urban development (Frayer et al. 1989). Many populations throughout California are heavily adult-biased (D. Holland pers. comm.), an indication that little recruitment is occurring within those populations. In the Central Valley, pond turtles were exploited for food from the 1890s to the 1920s, which is believed to have played an important role in the declines in the San Francisco area and Central Valley (Storer 1930; Hays et al. 1999).

It is likely that the western pond turtle once occurred in a relatively continuous distribution within suitable habitat in Yolo County, although there is no known site in the county where extirpation of a population has occurred. The population at the UC Davis Arboretum is characterized by a demographic profile characteristic of senescing populations, but has been supplemented by at least 33 captive-hatched individuals since 1996 (Spinks et al. 2003). Because the oldest record obtained from the County is from 1990, status changes that may have occurred prior to 1990 would not be evident from an examination of existing records. Moreover, although no extirpations have been recorded at any known occupied sites in Yolo County, recent survey data could not be located, and data on population trends at those sites are lacking. Therefore, with the exception of the UC Davis Arboretum, current status and population trends of the western pond turtle within the Plan Area are unknown.

C.27.5 Threats to the Species

The most significant threats to the western pond turtle are the continuing loss, degradation, and fragmentation of occupied habitats (D. Holland pers. comm.). Agricultural-related disturbances to wetlands and streams such as changes in the hydrological regime (e.g., water diversions) and removal of aquatic vegetation can render such wetlands unsuitable for pond turtles (D. Holland pers. comm.). The destruction of upland habitats comprising communal nesting areas for agricultural or urban development can result in significant adverse consequences on recruitment for many individuals or an entire population (D. Holland pers. comm.). Water releases from reservoirs, which alter the natural hydrologic regime, may adversely affect downstream habitat by eliminating or altering basking sites, refugia, foraging areas, and hatchling microhabitat (Holland 1991; Hays et al. 1999; U.S. Fish and Wildlife Service [USFWS] 1999). The potential transmission of parasites and diseases from exotic turtle species is a serious concern (Holland 1994; Jennings and Hayes 1994; Hays et al. 1999). Exotic turtles released into the wild typically originate from pet stores, where they are often kept in common containers under unsanitary conditions. When reared under such conditions, the potential for harboring and transmitting exotic pathogens and parasites is greatly increased when these diseased or parasite-ridden turtles are released into habitats occupied by pond turtles. Other threats include collection of individuals for the pet trade and shooting or other means of indiscriminate killing by humans (Holland 1994). Extended drought and associated fire can also result in significant mortality of western pond turtles (Holland 1991). Holland (1994) indicated that mortality caused by automobile strikes probably matches or exceeds mortality from most other anthropogenic sources.

Jennings and Hayes (1994) consider the variation in nesting location in response to variation in habitat, movement responses to habitat change, patterns of movement in the absence of change, and recolonization ability in structurally different habitats to be the most significant data gaps for the species. The lack of data on these parameters led Rathbun et al. (1992) to recommend protecting at least 500 meters (1,640 feet) from known occupied aquatic habitat to avoid impacts to nesting habitat. No recovery plan has been prepared for California populations of western pond turtles because the species is not listed, but the species is included among the recovery goals and objectives contained in the USFWS's (1999) *Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*)*, a species that shares the same wetland habitat types as the western pond turtle. The Plan does not propose any conservation measures designed to benefit the western pond turtle exclusively; however, recovery actions (e.g., habitat protection and restoration) undertaken in the Plan are expected to provide secondary benefits to the species.

Several conservation measures should be implemented in areas where the western pond turtle is known to occur. Populations of exotic predators or competitors, such as bullfrogs, large fish (e.g., largemouth bass), and turtles, should be controlled in habitats occupied by western pond turtles; and efforts to prevent their spread or introduction should be undertaken throughout the Plan Area. Controlling population size and spread of exotic wildlife within Yolo County could also reduce the transmission of infectious diseases to pond turtle populations. Protecting suitable nesting habitat, especially known historical nesting sites, is crucial. Jennings and Hayes (1994) recommended fencing off corridors between aquatic habitats and nesting habitat, and around nesting habitat, in a manner that allows turtle movement to and from nesting areas and prevents trampling of nests during incubation. To reduce the incidence of mortality caused by automobile strikes, the construction of new roads near occupied western pond turtle habitat should be avoided when possible. Maintaining a natural flow regime within lotic habitats occupied by western pond turtles is also of considerable importance in maintaining and improving existing habitat conditions. Considering the abundance of suitable aquatic habitat, western pond turtles may be more widely distributed within the Plan Area than indicated by existing occurrence records.

C.27.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.4.3, *Habitat Requirements and Ecology* (Figure A-4). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB, California Academy of Sciences Herpetology Department Collection Catalog).
- Other Unmapped Incidental Sightings Where Species is Known to Occur:

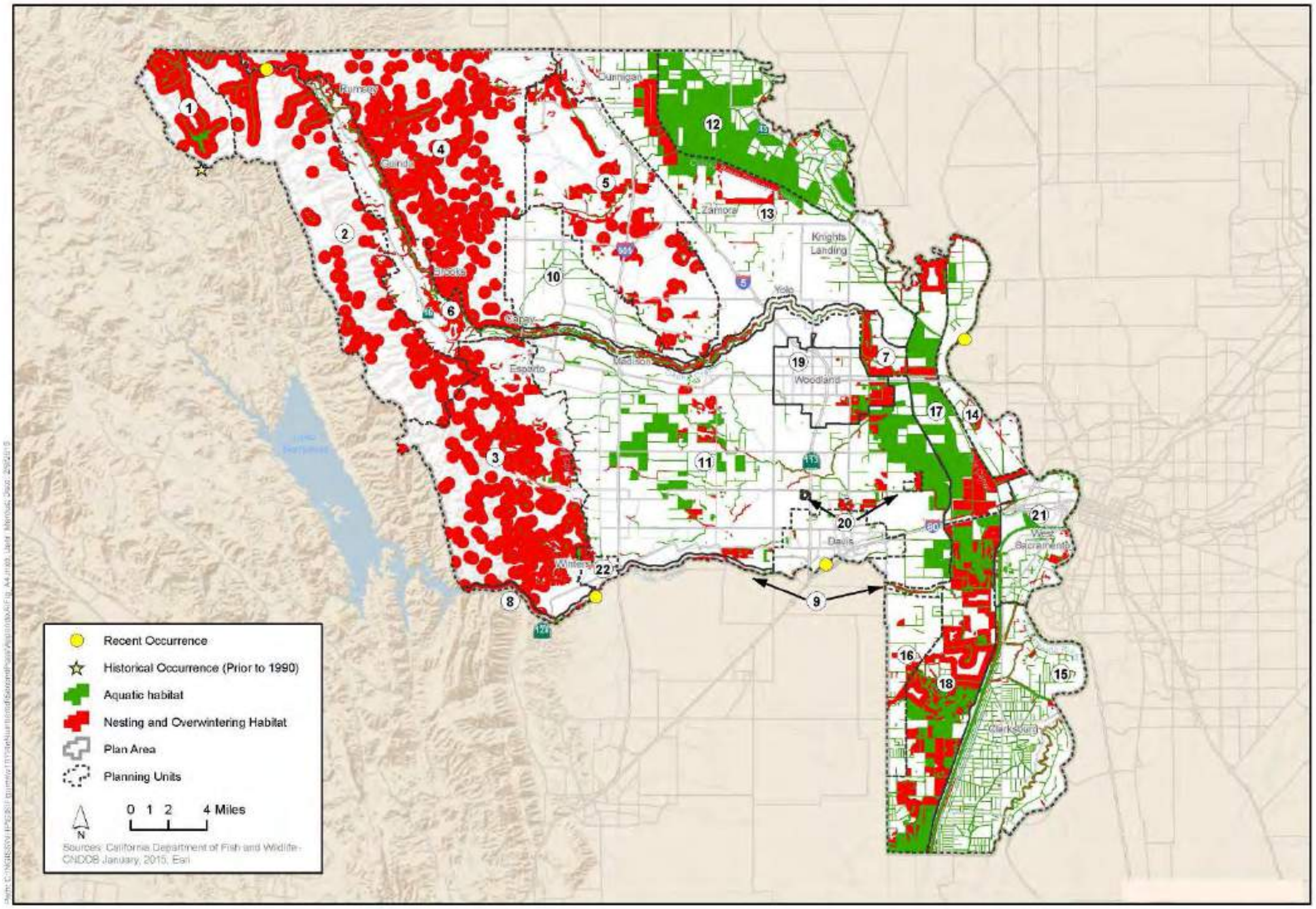
Unmapped Incidental Sighting	Source
Willow Slough Bypass between County Road 104 and County Road 105	Hansen pers. comm.
Cache Creek Nature Preserve just west of Woodland	Spinks pers. comm.

- Aquatic Habitat: This habitat includes all potentially suitable aquatic habitat and was modeled by selecting all mapped land cover types as listed below and by selecting and buffering 10 feet all perennial streams from the National Hydrography Dataset (Ernst et al. 1994) and perennial ponds in the Yolo NHP geographic information system (GIS) database set. Because the water land cover type includes water in small agricultural water conveyance channels that does not support habitat, the model overestimates the extent of this habitat type within the Valley Landscape Unit.

C.27.6.1 Aquatic Habitat – Vegetation Types

- Water
- Bulrush – Cattail Wetland Alliance
- Bulrush – Cattail Fresh Water Marsh Not Formally Defined (NFD) Super Alliance
- Alkali Bulrush – Bulrush Brackish Marsh NFD Super Alliance
- Rice
- Nesting and Overwintering Habitat: This habitat includes all potentially suitable nesting habitat. This habitat was modeled by selecting all natural vegetation types that occur within 1,312 feet of aquatic habitat (maximum distance nest can be from aquatic habitat) (Jennings and Hayes 1994; D. Holland pers. comm.; Slavens 1995; Bury et al. 2001). This habitat also includes all potentially suitable overwintering habitat outside of the nesting habitat. This habitat was modeled by selecting all natural vegetation types that occur between 1,312 feet and 1,640 feet from aquatic habitat (maximum distance of overwintering from aquatic habitat) (Holland 1994). Note that nesting habitat may also be used as overwintering habitat. Both modeled nesting and overwintering habitat exclude urban and agriculture vegetation types.

Figure C-22. Western Pond Turtle Modeled Habitat and Occurrences



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C.27.7.1 Printed References

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C.28 Giant Garter Snake (*Thamnophis gigas*)

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C.28.1 Listing Status

Federal: Threatened.

State: Threatened.

Recovery Plan: Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (1999).

C.28.2 Species Description and Life History

The giant garter snake (*Thamnophis gigas*) is an aquatic snake endemic to the Central Valley of California. Described as among California's most aquatic garter snakes (Fitch 1940), giant garter snakes are associated with low-gradient streams, and valley floor wetlands and marshes; they have adapted successfully to regions of rice agriculture. Giant garter snakes are one of the largest snakes in the genus *Thamnophis*. A sexually dimorphic species, females can reach sizes in excess of 1 meter (3.3 feet) and 850 grams (1.87 pounds), while proportionally smaller males seldom exceed 250 grams (0.55 pound). Giant garter snakes possess a dark brown or olive background color separated by light-colored longitudinal stripes. For this species, coloration is geographically and individually variable. Snakes from the San Joaquin Valley region may exhibit a black-checkered pattern along the back and sides, and often lack a distinct dorsal stripe; while snakes from the Sacramento Valley region are typically darker, with a complete dorsal stripe that varies from bright yellow to orange or dull brown. Originally considered a subspecies of *Thamnophis ordinoides* (Fitch 1940), the giant garter snake has undergone a lengthy series of taxonomic revisions, finally being accorded full species status based on morphological and distribution data in the late 1980s (Rossman and Stewart 1987), a classification later confirmed through genetic analyses (Paquin 2001; Paquin et al. 2006).

Upon emerging from overwintering sites, male giant garter snakes immediately disperse in search of mates and will continue breeding from March into early May. Female giant garter snakes brood young internally, giving birth to live young from late July through early September (Hansen and Hansen 1990). Young immediately disperse and seek shelter to absorb their yolk sacs, after which they molt and begin feeding on their own. Brood size ranges from 10 to 46 young, with a mean of 23.1 (n=19) (Hansen and Hansen 1990). Averaging 3 to 5 grams (0.11 to 0.18 ounce) with a snout-to-vent length of approximately 20.6 centimeters (8.1 inches), young giant garter snakes will double their size within their first year (Hansen and Hansen 1990; U.S. Fish and Wildlife Service [USFWS] 1999). Sexual maturity probably averages three years in males and five years in females (G. Hansen pers. comm.; USFWS 1999).

Giant garter snakes are strongly associated with aquatic habitats, typically overwintering in burrows and crevices near active season foraging habitat (Hansen 2004a; Hansen 2004b). Individuals have been noted using burrows as far as 50 meters (164 feet) from marsh edges during the active season, and retreating as far as 250 meters (820 feet) from the edge of wetland habitats while overwintering, presumably to reach hibernacula above the annual high water mark (Hansen 1986; Wylie et al. 1997; USFWS 1999).

Changing agricultural regimes, development, and other shifts in land use create an ever-changing mosaic of available habitat. Giant garter snakes disperse in response to these changes in order to find suitable sources of food, cover, and prey. Connectivity between regions is therefore extremely important for providing access to available habitat and for genetic interchange. In an agricultural setting, giant garter snakes rely largely upon the interconnected network of canals and ditches that provide irrigation and drainage to provide this connectivity. The canals and ditches within the Plan Area likely serve an important role in giant garter snake movement.

Data based on radiotelemetry studies show that home range varies by location, with median home range estimates varying between 9.2 hectares (23 acres) (range 4.2 to 82 hectares [10.3 to 203 acres], n=8) in a semi-native perennial marsh system and 53.2 hectares (131 acres) (range 1.3 to 1,330 hectares [3.2 to 2,792 acres], n=29) in a managed refuge (USFWS 1999).

C.28.3 Habitat Requirements and Ecology

Habitats occupied by giant garter snakes typically contain permanent or seasonal water, mud bottoms, and vegetated dirt banks (Fitch 1940; Hansen and Brode 1980). Abundances and densities of giant garter snakes vary with context of habitat; they are lowest in seasonal/managed marshes (dry in summer, flooded in winter for waterfowl habitat), greatest in natural marshes, and intermediate in rice fields (Wylie et al. 2012). Prior to reclamation, these wetlands consisted of freshwater marshes and low-gradient streams. In some rice-growing areas, giant garter snakes have adapted to vegetated, artificial waterways and associated rice fields (Hansen and Brode 1993) where velocities fall within tolerable limits (E. Hansen in litt. 2009).

This species appears to be mostly absent from permanent waters that support established populations of predatory game fishes; from streams and wetlands with sand, gravel, or rock substrates; and from riparian woodlands lacking suitable basking sites, prey populations, and cover vegetation (Hansen and Brode 1980; Rossman and Stewart 1987; Brode 1988; USFWS 1999). The species may also avoid natural or artificial waterways that undergo routine dredging, mechanical or chemical weed control, or compaction of bank soils (Hansen 1988; Hansen and Brode 1993). Giant garter snakes are associated with aquatic habitats characterized by the following features: (1) sufficient water during the snake's active season (typically early spring through mid-fall) to supply cover and food such as small fish and amphibians; (2) emergent, herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.), accompanied by vegetated banks to provide basking and foraging habitat and escape cover during the active season; (3) upland habitat (e.g., bankside burrows, holes, and crevices) to provide short-term refuge areas during the active season; and (4) high ground or upland habitat above the annual high water mark to provide cover and refuge from flood waters during the dormant winter period (Hansen and Brode 1980; Hansen 1998).

Survivorship and longevity of giant garter snakes are largely unknown, with few quantitative studies of survivorship available for the genus as a whole. One proxy comes from data on individual survival rates for a population of valley garter snakes (*Thamnophis sirtalis fitchi*) at a mountain lake in Northern California. Snakes from this population exhibited first-year survivorship among neonates ranging from 28.7 to 43.0 percent, with a second-year neonate survivorship of 16.4 percent. Survival of yearling snakes was greater than that of juveniles, at 50.8 percent, while survival of snakes two years and older decreased to 32.7 percent (Jayne and Bennett 1990). In a different study, Lind et al. (2005) found that survival estimates for female Pacific coast aquatic garter snakes (*Thamnophis* *atratus*) in northwestern California was higher than that of males, which is consistent with trends reported for giant garter snakes in the Natomas Basin (Jones & Stokes 2007).

Spending cool winter months in dormancy or periods of reduced activity, giant garter snakes typically emerge from late March to early April and remain active through October; the timing of annual activity is subject to varying seasonal weather conditions. Daily activity consists of emerging from burrows after sunrise, basking to warm bodies to active temperatures, and foraging or courting for the remainder of the day (Hansen and Brode 1993). Like others in their genera, giant garter snakes likely rely on chemical cues to determine reproductive status and to locate mates (Shine et al. 2003; O'Donnell et al. 2004; E. Hansen, pers. obs.). Activity generally peaks during spring emergence and courtship from April into June, whereupon observations of giant garter snakes diminish significantly until a second peak is observed after females give birth during late July into August (Hansen and Brode 1993; Wylie et al. 1997; USFWS 1999; Hansen 2004b). Giant garter snakes then remain actively foraging and occasionally courting until the onset of cooler fall temperatures.

Giant garter snakes feed on small fishes, tadpoles, and small frogs (Hansen 1980; USFWS 1999), specializing in ambushing prey underwater (Brode 1988). Historically, giant garter snakes preyed on native species such as the thick-tailed chub (*Gila crassicauda*) and California red-legged frog (*Rana aurora draytonii*), which have been extirpated from the giant garter snake's current range), as well as the pacific treefrog (*Pseudacris regilla*) and Sacramento blackfish (*Orthodox microlepidus*) (Cunningham 1959; Rossman et al*.* 1996; USFWS 1999). Giant garter snakes now utilize introduced species, such as small bullfrogs (*Rana catesbeiana*) and their larvae, carp (*Cyprinus carpio*)*,* and mosquitofish (*Gambusia affinis*). While juveniles probably consume insects and other small invertebrates, giant garter snakes are not known to consume larger terrestrial prey such as small mammals or birds.

Large vertebrates, including raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargentius*), river otters (*Lutra canadensis*), opossums (*Didelphis virginiana*), harriers (*Circus cyaneus*), hawks (*Buteo* spp.), herons (*Ardea herodius*, *Nycticorax nyctycorax*), egrets (*Ardea alba*, *Egretta thula*), and American bitterns (*Botaurus lentiginosus*) prey on giant garter snakes (USFWS 1999). In areas near urban development, giant garter snakes may also fall prey to domestic or feral house cats (G. E. Hansen pers. comm.). In permanent waterways, introduced predatory game fishes, such as bass (*Micropterus* spp.), sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus* spp.), prey on giant garter snakes and compete with them for smaller prey (Hansen 1998; USFWS 1993).

Giant garter snakes coexist with the valley garter snake (*Thamnophis sirtalis fitchi*). In limited instances, both may be found together with the mountain garter snake (*Thamnophis elegans elegans*), a subspecies of western terrestrial garter snake, in locations where this species' range extends to the floor of the Central Valley. The extent of competition among these species is unknown but, generally, differences in habitat use and foraging behavior allow their coexistence (C; USFWS 1999).

C.28.4 Species Distribution and Population Trends

C.28.4.1 Distribution

The current known distribution of giant garter snakes is variable, and extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County. Occurrences of giant garter snakes are not known from the northern portion of the San Joaquin Valley north to the eastern fringe of the Sacramento-San Joaquin River Delta, where the floodplain of the San Joaquin River is limited to a relatively narrow trough (Hansen and Brode 1980; USFWS 1993). The resulting gap of approximately 100 kilometers (km) (62.3 miles) separates the southern and northern populations, with no giant garter snakes known from the lowland regions of Stanislaus County (California Natural Diversity Database [CNDDB] 2004; Hansen and Brode 1980). Scattered records within the Sacramento-San Joaquin River Delta suggest that giant garter snakes may have occupied this region at one time, but longstanding reclamation of wetlands for intense agricultural applications has eliminated most suitable habitat (CNDDB 2004; Hansen 1986). Recent records within the Sacramento-San Joaquin Delta are haphazard, and repeated surveys have failed to identify any extant population clusters in the region (Hansen 1986; Patterson and Hansen 2002; Patterson 2003). Recent occurrence records indicate that, within this range, garter snakes are distributed in 13 unique population clusters coinciding with historical flood basins, marshes, wetlands, and tributary streams of the Central Valley (Hansen and Brode 1980; Brode and Hansen 1992; USFWS 1999). These populations are isolated, without protected dispersal corridors to other adjacent populations, and are threatened by land use practices and other human activities, including development of wetland and suitable agricultural habitats.

One of these 13 extant giant garter snake populations, the northern Yolo Basin population is distributed along the northeastern edge of the Yolo Basin near the Sacramento River. Yolo County is well within the Central Valley proper and includes the floodplains of the Sacramento River as well as those of Cache, Willow, and Putah Creeks. Upon receding, these creeks may have provided the wetland habitat and prey utilized by giant garter snakes during the spring and summer active season. The historical distribution of giant garter snakes in Yolo County is unclear, however, with the majority of sightings made only in recent decades (Hansen 1986; CNDDB 2007).

Giant garter snakes are documented in two distinct concentrations along the eastern edge of Yolo County (CNDDB 2007; Hansen 2006, 2007a, 2008; Wylie et al. 2004; Wylie and Martin 2005; Wylie and Amarello 2006). The first concentration lies in the northeastern portion of Yolo County, northwest of Knights Landing and in the southern end of the Colusa Basin near Sycamore Slough and the Colusa Basin Drainage Canal. Wylie and Amarello (2006) report a population density in the Colusa Basin Drainage Canal of 20±3 snakes/km during 2006, falling within 2003 and 2004 confidence intervals, noting, however, that local distribution appears to have shifted away from areas formerly in rice production that have either been fallowed or converted to other crop types. The second concentration lies in the east-central portion of Yolo County, with records in the Yolo Bypass east of Conaway Ranch near the Tule Canal, the Willow Slough/Willow Slough Bypass from Conaway Ranch south to the Yolo Wildlife Area, the Davis Wetlands complex south of Conaway Ranch between the Willow Slough Bypass and the Yolo Bypass, the Yolo Wildlife Area along the east edge of the Yolo Bypass west levee, and the adjacent ricelands east of the Yolo Wildlife Area. Surveys conducted in 2005, 2006, and 2007 resulted in captures of 34, nine, and one unique individual(s), respectively, in the Yolo Wildlife Area; eight, 18, and eight unique individuals, respectively, in the adjacent ricelands; and 36 unique individuals (2007 only) in the Davis Wetlands complex (Hansen in. litt. 2006, 2007, 2008). Hansen (2006, 2007a, 2008) reports an even distribution within size classes, estimating local populations ranging from 8 ± 2.6877 (95 percent confidence interval (C.I.) = 7 to 20) to 57 ± 9.53 (95 percent C.I. = 45 to 84) in the Yolo Wildlife Area; 5 ± 0.4932 (95 percent C.I. = 5 to 5) to 17 ± 5.9655 (95 percent C.I. = 12 to 39) in the adjacent ricelands; and from 26 ± 21.2829 (95 percent C.I. = 11 to 120) to 67 ± 59.7094 (95 percent C.I. = 22 to 322) within the Davis Wetlands Complex (Hansen 2006, 2007a, 2008). Queries of the online databases of the California Academy of Sciences (2008) and Museum of Vertebrate Zoology (2008) yielded one additional occurrence record (CAS 178594) situated within downtown Davis; however, the stated location for this record (a frontage road one mile east of the Yolo Causeway) conflicts with the stated coordinates, leaving the true location unclear.

Evidence that giant garter snakes may once have been distributed throughout the easterly reaches of Yolo County is illustrated by reported sightings in portions of Solano County adjacent to Yolo County, in South Fork Putah Creek near Davis, and in the Liberty Farms region of the Yolo Basin. Repeated attempts to assess local distribution suggest that both the Liberty Farms and Putah Creek populations are probably extirpated (Hansen 1986; Wylie and Martin 2005; D. Kelly pers. comm.).

Genetic analyses of tissue samples collected from giant garter snakes in the Yolo Wildlife Area and adjacent ricelands are ongoing. Engstrom (2007) reports that the Yolo Basin population is genetically very similar to those of the Natomas and Middle American Basins, but that genetic diversity within the Yolo Basin is lacking, which is typical of recently colonized populations. Engstrom reports, however, that there appears to be very little gene flow between the Yolo Basin and neighboring populations, and that ongoing migration into the Yolo Basin is not significant.

C.28.4.2 Population Trends and Abundance Estimates

Prior to listing in 1971, giant garter snakes were known from 16 localities, representing nine distinct populations based on available literature and museum records (Hansen and Brode 1980; USFWS 1993). Range-wide status surveys of the giant garter snake conducted during the mid-1970s and 1980s indicate that they have been extirpated from the San Joaquin Valley south of Mendota in Fresno County, an area comprising as much as one-third of the snake’s former range (Fitch 1940; Hansen and Brode 1980; Rossman and Stewart 1987; Stebbins 2003). Once plentiful in areas such as Mendota, Los Baños, and Volta, giant garter snakes are now known from only a small number of localities in the southern aspect of their range (USFWS 1999; Dickert 2003; Hansen 2007b). Giant garter snakes have not been documented from Burrell in Fresno County northward to Stockton since prior to 1980 and now appear to be most abundant in regions of the northern Sacramento Valley that are dominated by rice agriculture (USFWS 1993, 1999; CNDDB 2007).

Abundances and densities of giant garter snakes vary with context of habitat; they are lowest in managed seasonal marshes (dry in summer, flooded in winter for waterfowl habitat), greatest in natural marshes, and intermediate in rice fields (Wylie et al. 2011). In general, giant garter snakes select areas with a dense network of canals, often in close proximity to rice agriculture, with a low density of streams and close to open water and wetlands, compared to available environments in the Sacramento Valley (Halstead et al. 2010).

Most density estimates for giant garter snakes have been derived from linear trapping transects along canals, linear wetlands, or ecotones between deep water and upland habitat. Standard survey methodology for giant garter snake entails transects consisting of 50 floating aquatic funnel traps (Casazza et al. 2000) located along the open water/terrestrial or open water/emergent vegetation interface in areas of standing or slow-moving water and, where possible, emergent aquatic vegetation. Traps are spaced approximately 10 meters (33 feet) apart, resulting in traplines of approximately 500 meters (1,640 feet).

Lineal densities of individuals captured per transect (and extrapolated to lineal miles of habitat) can be converted into two-dimensional densities (snakes/acre) in two ways: First, the “area of influence” around a transect may provide a small-scale reference based on the spatial behavior of snakes (Wylie et. al 2010). Thus, a trapline is typically estimated to adequately sample the number of snakes present in an area of 100 meters on either side of the transect, or a total area of 200 meters by 500 meters = 100,000 square meters (approximately 25 acres). Thus, using the “area of influence” approach, snake densities reported per lineal mile are based on a total area of 80 acres.

Secondly, on a landscape scale, the density of the number of snakes captured along lineal structures (e.g., canals, shorelines) is derived from the overall density of conveyances per acre of surrounding habitat. Thus, the number of snakes per lineal mile is multiplied with the number of lineal miles of canal per acre of snake habitat. This measure is perhaps a more meaningful estimator for landscape and population-level measurements of giant garter snake densities in agricultural areas, where rice paddies and conveyance channels are both considered habitat. But such densities are more challenging to derive for more complex natural and restored wetlands, due to the contorted shoreline and the difficulty to delineate habitat in emergent marshes and wetlands.

Hansen and Brode (1993) estimated a local population size of 1,000 snakes per square mile (1.56 snakes per acre) of rice lands based on year-to-year mark recapture rates (U.S. Fish and Wildlife Service 1999). Giant Garter snake population densities (snakes per lineal mile of rice irrigation canal) in Yolo county ranged from 13 (95 percent C.I. = 11 to 32) to 92 (95 percent C.I. = 72 to 135) in the Yolo Wildlife Area; 8 (95 percent C.I. = 8 to 8) to 27 (95 percent C.I. = 19 to 63) in the adjacent ricelands; and from 42 (95 percent C.I. = 18 to 193) to 108 (95 percent C.I. = 35 to 518) within the Davis Wetlands Complex (Hansen in. litt. 2006, 2007, 2008). For the Colusa Drain and adjacent rice habitat, a mean density of 22.6 snakes per lineal mile of survey was determined for three consecutive years (Wylie and Amarello 2008). The U.S. Geological Survey (USGS) (Wylie et al. 2000a, 2000b, 2001, 2002, 2004) reported linear densities in selected trapping areas ranging from 13 (95 percent C.I. = 10–19) to 88 (95 percent C.I. not reported) giant garter snakes per linear mile from 1999 to 2003 in the Natomas Basin. Mean landscape-level densities of giant garter snakes reported from the Natomas Basin (all habitats combined) range from 5.1 to 22.7 giant garter snakes per linear mile (Table 1) and have fluctuated considerably among the years.

Table C-1. Giant Garter Snake Densities (Individuals Captured per Mile Surveyed) Reported in Rice and Other Wetland Habitats from Various Sites in the Sacramento Valley, 1999–2010

Location	Habitat	Individuals Captured	Miles	Individuals per Mile	Reference
Badger Creek (southern Sacramento County)	Natural wetlands	103	0.5	221.0	Wylie et al 2010
Colusa NWR	Managed wetlands	22	1.1	20.2	Wylie et al 2010
Colusa NWR	Restored wetlands				
Gilsizer Slough (Sutter County)	Rice	67	1.8	37.8	Wylie et al 2010
Colusa Drain (2003)	Rice	40	2.4	16.8	Wylie and Amarello 2008
Colusa Drain (2004)	Rice	24	2.4	10.0	Wylie and Amarello 2008
Colusa Drain (2006)	Rice	30	2.4	12.4	Wylie and Amarello 2008
Natomas Basin	Rice	141	4.1	34.1	Wylie et al 2010
Butte and Glenn Counties	Rice	28	3.5	7.5	Wylie et al. 2011
Natomas Basin Average (1999-2004)	All	NA	NA	22.7	Jones and Stokes 2005
Natomas Basin 2009	All	155	19. 3	8.0	Jones and Stokes 2010
Natomas Basin 2010	All	112	22.1	5.1	ICF 2011

NWR = National Wildlife Refuge.

In general, higher densities of snakes were recorded in linear drainage and irrigation features associated with rice, compared with managed or seasonal marsh habitats (ICF 2011). The availability of managed marsh habitat has been deemed important for giant garter snakes when they emerge from winter dormancy and begin feeding, dispersing, and mating – at which times rice fields and other aquatic habitats are not available (ICF 2011). Core home range size of radio-tagged female garter snakes (Valcarel et al. 2011) were smaller in rice habitats and overlapped considerably more, compared to those in restored wetlands in Gilsizer Slough (Sutter County).

C.28.4.3 Giant Garter Snake Habitat Types and Populations in the Yolo NHP Area

The NHP geospatial database was developed from the California Department of Fish and Wildlife (DFW) Wildlife Habitat Relationships (WHR) database, which identifies vegetation communities according to their function as habitat for the giant garter snake. Aquatic habitat availability is the primary determinant of giant garter snake abundance; therefore, this analysis only considers aquatic habitats as an obligate habitat prerequisite for the species. For the purpose of this analysis, and to facilitate the crosswalk of modeled habitat types with those reported in the literature (e.g., Wylie et al. 2010) aquatic habitat was categorized as follows:

Rice: Rice agriculture has become a major habitat for giant garter snakes in the Central Valley (Hansen and Brode 1993). Within the giant garter snake focal areas of the NHP Plan Area (i.e., Planning Units 11, 12, 13, and 19), rice land habitat is an important element of the species' life history. The primary giant garter snake habitat within rice lands are the conveyance channels and irrigation canals, which provide foraging and movement habitat and which ensure spatial connectivity of habitat and populations within the rice agricultural landscape. Studies indicate that despite the presence of ditches or drains, giant garter snakes will generally abandon aquatic habitat that is not accompanied by adjacent shallow-water wetlands or rice fields (Jones and Stokes 2008; Wylie et al. 2006). Giant garter snakes tend to expand their foraging activities from the canals and ditches into rice fields soon after the rice plants emerge above the water's surface, and they continue to use the fields until the water is drained during late summer or fall (Hansen and Brode 1993). During the winter period, banks along the ditches provide crucial hibernacula that are protected from flooding. Thus, within rice lands, a greater density of canals and irrigation structures is expected to support higher densities of giant garter snakes, due to a greater and more stable prey base and the presence of habitat refugia in times when some canals are dry or during maintenance events. In addition, complex habitat structure providing cover from predation and perhaps locally lower predation rates may also contribute to higher giant garter snake densities. Isolated patches of habitat containing small, discrete snake populations would likely result where this aquatic connectivity is lost.

Wylie et al (2011) provide the currently best available landscape-level estimates of giant garter snake density in rice-dominated agricultural areas, based on captures and recaptures at 44 transects along linear canals within rice fields and in managed wetlands in Butte and Glenn County from 2008 through 2010. To make the results of Wylie et al (2011) more applicable to the rice area in the Plan Area, the total density of snakes per lineal mile of canal habitat from all transects, including those that did not result in snake captures, was calculated. Density estimates ($\bar{x}$ =7.48, sd = 8.10, range = 0 to 19.65) were calculated from data provided by Wylie et al. (2011). These estimates are among the lowest estimates compared to other recent studies in adjacent areas (Table 1), but probably are realistic estimates for a large landscape area, since Wylie's et al. (2011) study included transects that did not yield captures. Wylie et al. (2011) established a lower confidence interval boundary of 0.2 snakes per ha (= 0.49 per acre) at the study site with the lowest overall density of snakes (excluding sites that had no snake captures), which translates into a low estimate of 6.34 snakes/mile for occupied sites. This estimate is also well within the range of data for giant garter snakes in Sacramento Valley (Table 1). An upper estimate of snake density was derived as the mean plus one standard deviation from Wylie et al. (2011). Thus, a high estimate of the area-wide density of snakes was calculated as ($\bar{x}$ + sd) = 15.58 snakes/mile. The distribution of giant garter snakes in the Plan Area is probably clumped and likely disjunct (Glenn Wylie, pers. comm.), with large areas of unoccupied habitat interspersed by patches of higher population densities. Such distributions have been related to historical (Paquin et al. 2006) and spatial dynamics of habitat manipulations and conveyance management (Hansen and Brode 1983). In addition, the presence and abundance of prey and non-native and native predators (e.g., bull frogs, predatory fish, egrets, and herons) may also affect the metapopulation structure of giant garter snakes in the Plan Area.

Based on 117 miles of drainage canals within rice lands in the Colusa Basin Subpopulation (Planning Units 12 and 13) and 32 miles in the Willow Slough/Yolo Bypass Subpopulation (Planning Units 11 and 19), and the conservative mean estimate of 7.48 snakes per lineal mile of canals, which takes into account currently unoccupied habitat, a total estimate of giant garter snakes for the 29,470 acres of riceland of the relevant Planning Units is 1,122 giant garter snakes, or 0.039 snakes per acre of rice. This density estimate compares well with the landscape level estimate of 0.41 snakes per acre derived from Wylie et al. (2010). Although the habitat model for giant garter snake also included irrigated croplands and seasonal managed wetlands, for the purpose of estimating snake population size, these habitat types were assumed not to provide year-round stable habitat and thus were not included for the calculation of a population estimate.

Seasonal/Managed Wetlands: Most emergent wetland types and vegetation associations in the in the Colusa Basin Subpopulation (Planning Units 12 and 13) and the Willow Slough/Yolo Bypass Subpopulation (Planning Units 11 and 19) are considered marginal habitat, as they are flooded primarily during winter only. Hence, they may not provide the warm water summer habitat for giant garter snake but rather lower-quality winter cold water foraging habitat and put snakes at risk in their winter hibernacula. There are 4,490 acres of managed wetlands within the NHP giant garter snake conservation focal areas in Planning Units 11, 12, 13, and 19 NHP habitat mapping units classified as Freshwater Emergent Vegetation. Based on visual estimates from summer aerial imagery (September 2011), approximately 3,600 acres of these mapped seasonal wetlands are winter flooded (80 percent of fresh emergent wetland cover type), but considerable inaccuracies and resolution incongruence exist. No densities of giant garter snakes were assigned to these acreages because they are not expected to provide summer aquatic habitat for the species.

Summer Flooded/Perennial Wetlands: Wetlands that are flooded during summer or are perennial provide the highest quality habitat for giant garter snake. Since existing summer-flooded, perennial or natural wetlands could not be distinguished from the fresh emergent wetland data layer in the NHP geographic information system (GIS) database, it was necessary to estimate the proportion of summer flooded wetlands that potentially provide garter snake habitat functions. The percentage of habitat that is summer flooded managed/seasonal wetlands was identified by overlaying the NHP habitat GIS layer for managed wetlands and estimating the proportion in each parcel that could be considered summer flooded or perennial wetland from 2011 aerial imagery. Approximately 900 acres were considered summer flooded permanent or seasonal wetlands that may be expected to provide habitat functions for giant garter snake.

Only one local density estimate (i.e., 20.2 snakes/mile of transect) exists for giant garter snakes in managed wetlands from a study on the Colusa NWR, which was translated into a density of 0.25 individuals/acre (based on a 100 m buffer on each side of the transect as described by Wylie et. al 2011). Based on a density of 0.25 snakes per acre, the population estimate for the estimated summer flooded or perennial wetlands in the conservation focal areas is 900x.25 = 225 snakes.

Restored Wetlands: Wetlands restored specifically for giant garter snake habitat provide an opportunity to produce high densities of snakes. Ideally, these habitats function as natural perennial wetlands and provide year-round habitat function for the species. Studies of restored wetlands specifically as habitat for giant garter snake are only just beginning. Local density estimates for giant garter snakes in restored wetlands in the Colusa Wildlife Refuge range from 48 to 194 snakes per mile depending on the trapping location on the Refuge, similar to values in a previous year (87-169/mile) (Wylie et al. 2002). Framed by a minimum density estimate of 0.063 snakes/acre (or 5.8 snakes/mile) (ICF 2010, 2011) and a conservative maximum density value of 0.46 snakes/acre (37.6 snakes/mile) (Wylie et al. 2010), an average landscape-level density estimates from all studies (except natural wetlands) (Wylie 2010) results in a mean of 0.21 snakes/acre of restored wetland (sd=0.137), with a low to high estimate ($\bar{x} \pm sd$) of 0.073 to 0.348 snakes/acre.

C.28.4.4 Plan Area Population Estimate Summary

No systematic density evaluation or survey of giant garter snakes in the NHP Plan Area has been conducted to date. Thus, an estimate of a total population size of giant garter snakes cannot be derived based on systematic demographic studies. Instead, landscape-level densities observed in multiple studies were used to estimate population sizes, based on the acreage or spatial extent of the respective habitat type. Population estimation was separated by habitat type, based on the different observed densities of giant garter snakes in rice and seasonal/managed wetlands. The distribution of giant garter snake aquatic habitat types by Planning Unit and subpopulation is presented in Table 2, and resulting population estimates are presented in Table 3.

Table C-2. Acreage of Giant Garter Snake Aquatic Habitat

	Colusa Basin Subpopulation			Willow Slough/Yolo Bypass Subpopulation[1]			
Aquatic Habitat Type	**PU 12**	**PU13**	**Subtotal**	**PU11**	**PU19**	**Subtotal**	**Total**
Rice – miles of canals	*113*	*4*	*117*	*28*	*4*	*32*	149
Rice - acreage	*20,045*	*1,592*	*21,637*	*6,535*	*1,298*	*7,833*	29,470
Managed/seasonal wetland	*840*	*3,063*	*3,903*	*587*	*0*	*587*	4,490
Managed summer flooded and perennial wetlands	*168*	*612.6*	*780.6*	*117.4*	*0*	*117.4*	*898*
Total acreage	***20,885***	***4,655***	***25,540***	***7,122***	***1,298***	***8,420***	***33,960***

[1] Excluding the Yolo Bypass (Planning Units 17 and 18) within which no conservation actions are proposed by the Implementing Entity.

Table C-3. Giant Garter Snake Population Estimate by Subpopulation and Habitat Type

	Colusa Basin Subpopulation			Willow Slough/Yolo Bypass Subpopulation[1]			
Aquatic Habitat Type	**PU 12**	**PU13**	**Subtotal**	**PU11**	**PU19**	**Subtotal**	**Total**
Rice	*845*	*30*	*875*	*209*	*30*	*239*	*1115*
Managed/seasonal wetland – winter flooded	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Managed summer flooded and perennial wetlands	*42*	*153*	*195*	*29*	*0*	*29*	*225*
Total number of snakes	887	183	1,070	239	30	269	1,339

[1] Excluding the Yolo Bypass (Planning Units 17 and 18) within which no conservation actions are proposed by the Implementing Entity.

C.28.5 Threats to the Species

Continued loss of wetland or other suitable habitat resulting from agricultural and urban development constitutes the greatest threat to this species' survival. Conversion of Central Valley wetlands for agriculture and urban uses has resulted in the loss of as much as 95 percent of historical habitat for the giant garter snake (Wylie et al. 1997). In areas where the giant garter snake has adapted to agriculture, maintenance activities such as vegetation and rodent control, bankside grading or dredging, and discharge of contaminates, threaten their survival (Hansen and Brode 1980; Brode and Hansen 1992; Hansen and Brode 1993; USFWS 1999; Wylie et al. 2004). Within agricultural areas, giant garter snakes are also threatened by fluctuations in the amount and locations of rice production, and by the conversion of rice lands to other crop types. Giant garter snakes are subject to mortality through loss or degradation of habitat; predation of juvenile giant garter snakes by introduced predators; elimination of giant garter snakes or prey species by pesticides and other toxins; road mortality; maintenance and modification of agricultural ditches, drains, and flood control systems; and flooding (Hansen 1986; USFWS 1999). Snakes remaining in rice fields are subject to threats from mechanical harvesting, including disrupted foraging, thermoregulating, or direct mortality; the extent of these threats is unknown (USFWS 2006). For many snake species, chemoreceptivity plays an integral role in habitat (Clark 2004) and mate selection (Shine et al. 2003; O'Donnell et al. 2004) in snakes' ability to navigate through their habitat, find overwintering sites, and locate mates. In developed areas, threats of vehicular mortality also are increased. Paved roads likely have a higher rate of mortality than dirt or gravel roads due to increased traffic and traveling speeds, and as many as 31 giant garter snake traffic mortalities have been reported during a four-year period in the Natomas Basin (Hansen and Brode 1993).

The loss of wetland habitat is compounded by elimination or compaction of adjacent upland and associated bankside vegetative cover, as well as water fouling; these conditions are often associated with cattle grazing (Thelander 1994). While cattle grazing and irrigated pastures may provide the summer water that giant garter snakes require, high stocking rates may degrade habitat by removing protective plant cover and underground and aquatic retreats such as rodent and crayfish burrows (Hansen 1986; USFWS 1999). Studies of wandering garter snakes (*Thamnophis elegans vagrans*) in Northern California have shown population numbers to be much higher in areas where grazing was excluded (Szaro et al. 1985). Radiotelemetry studies in perennial wetlands where grazing was differentially excluded show that giant garter snakes avoid areas where grazing is frequent (Hansen 2002). Cattle grazing may, however, provide an important function in controlling invasive vegetation that can compromise the overall value of wetland habitat (Hansen 2002).

Giant garter snakes are also threatened by the introduction of exotic species. Examinations of gut contents confirm that introduced bullfrogs (*Rana catesbeiana*) prey on juvenile giant garter snakes throughout their range (Treanor 1983; Dickert 2003; Wylie et al. 2003). While the extent of this predation and its effect on population recruitment is poorly understood, estimates based on preliminary data from a study conducted at Colusa National Wildlife Refuge suggests that 22 percent of neonate (newborn) giant garter snakes succumb to bullfrog predation (Wylie et al. 2003). Other studies of bullfrog predation on snakes have documented bullfrogs ingesting other species of garter snakes up to 80 centimeters (31.5 inches) long, resulting in a depletion of this size-class within the population (Bury and Wheelan 1984). Introduced predatory game fishes, such as black bass (*Micropterus* spp.), sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus* spp.), prey on giant garter snakes and compete with them for smaller prey (Hansen 1988; USFWS 1993).

Selenium contamination and impaired water quality have been identified as a threat to giant garter snakes, particularly in the southern portion of their range (USFWS 1999). While little data are available regarding the effects of specific contaminants, the bioaccumulative properties of selenium in the food web have been well documented in the Kesterson National Wildlife Refuge area (Saiki and Lowe 1987; Ohlendorf et al. 1988; Saiki and May 1988; Saiki et al. 1991; USFWS 1999).

Recent findings demonstrate that giant garter snakes are extant within Yolo County (CNDDB 2007; Hansen 2006, 2007a, 2008; Wylie et al. 2003, 2004, 2006). However, little is known of their regional distribution or their population status throughout the remainder of Yolo County. While some estimates are available (e.g., Hansen and Brode 1993; Wylie et al. 2004), giant garter snake population sizes and densities are not well known throughout their range. Differential dispersal and home range patterns between males and larger females who spend the majority of the active season gestating young are not reported. Lifetime dispersal patterns of both neonates and adults of this species are unknown.

Until uncertainties regarding population structure, population dynamics, and the strength, frequency, and direction of environmental fluctuations and edge effects are resolved, it is impossible to establish population numbers as a delisting criterion for this species (USFWS 1999). Current criteria for assessing the species' status include the quality and distribution of available habitat and the presence of both young and adults, indicating a stable population structure within known populations (USFWS 1993, 1999).

Throughout the Central Valley, GIS modeling has been used to analyze microhabitat characteristics and suitability of aquatic and upland habitats for the giant garter snake (Hansen 2003). Modeling includes the use of 23 distinct habitat variables correlated with giant garter snake life history and ecological requirements. Data are maintained within a comprehensive database, which is updated in response to changes in land use or habitat management. Coverage currently includes all navigable waterways within California Department of Boating and Waterways Aquatic Weed Control Division's Water Hyacinth and *Egeria densa* Control Program service areas, spanning the Central Valley from the Port of Sacramento in Sacramento County south to the Mendota Pool area in Fresno and Madera Counties, and in select areas within Sacramento, Sutter, and Yuba Counties.

In the Central Valley, rice fields have become important habitat for giant garter snakes. Irrigation water typically enters the rice lands during April along canals and ditches. Giant garter snakes use these canals and their banks as permanent habitat for both spring and summer active behavior and winter aestivation. Where these canals are not regularly maintained, lush aquatic, emergent, and streamside vegetation develops prior to the spring emergence of giant garter snakes. This vegetation, in combination with cracks and holes in the soil, provides much-needed shelter and cover during spring emergence and throughout the remainder of the summer active period.

Rice is planted during spring, after the winter fallow fields have been cultivated and flooded with several inches of standing water. In some cases, giant garter snakes move from the canals and ditches into these rice fields soon after the rice plants emerge above the water's surface, and they continue to use the fields until the water is drained during late summer or fall (Hansen and Brode 1993). It appears that the majority of giant garter snakes move back into the canals and ditches as the rice fields are drained, although a few may overwinter in the fallow fields, where they hibernate within burrows in the small berms separating the rice checks (Hansen 1998).

While within the rice fields, the snakes forage in the shallow warm water for small fish and the tadpoles of bullfrogs and treefrogs. For shelter and basking sites, giant garter snakes utilize the rice plants, vegetated berms dividing the rice checks, and vegetated field margins. Gravid (pregnant) females may be observed within the rice fields during summer, and at least some giant garter snakes are born there (Hansen and Brode 1993; Hansen 1998). Suitability of rice fields for giant garter snakes may vary by crop type. Wild rice species (e.g., *Zizania* spp.) may reach 5 to 6 feet in height, obscuring sunshine and limiting opportunities for snakes to thermoregulate. White or brown rice species are shorter in stature, providing superior basking opportunities.

Water is drained from the fields during late summer or fall by a network of drainage ditches. These ditches are sometimes routed alongside irrigation canals and are often separated from the irrigation canals by narrow vegetated berms that may provide additional shelter. Drainage typically occurs one month prior to harvest for white or brown rice and two to three weeks prior to harvest for wild rice crops (D. Sills pers. comm.). Remnants of old sloughs also may remain within rice-growing regions, where they serve as drains or irrigation canals. Giant garter snakes may use vegetated portions along any of these waterways as permanent habitat. Studies indicate that despite the presence of ditches or drains, giant garter snakes will generally abandon aquatic habitat that is not accompanied by adjacent shallow-water wetlands (Hansen 2008, Jones and Stokes 2008, Wylie et al. 2006), underscoring the important role that this crop plays in this species' life history.

Central Valley wetland conservation occurs through a combination of both public and privately managed refuges, mitigation banks, and duck clubs, creating a large network of wetland preserves throughout the historical range of the giant garter snake. A large percentage of these wetland conservation efforts, however, are geared toward waterfowl management, often placing greater emphasis on winter water rather than the summer water upon which giant garter snakes depend (G. Hansen pers. comm.; USFWS 1999). With proper consideration given to design, location, and management, these efforts might also significantly benefit the giant garter snake and other wetland-dependent species (USFWS 1999).

Under the 1999 *Draft Recovery Plan for the Giant Garter Snake* (*Thamnophis gigas*), initiation of the delisting process is anticipated by 2028, given that defined recovery criteria are adequately met. To accomplish the recovery of this species, the U.S. Fish and Wildlife Service emphasizes habitat protection; public participation, outreach, and education; habitat management and restoration; surveying and monitoring; and continued research (USFWS 1993).

C.28.6 Species Habitat Model and Location Data

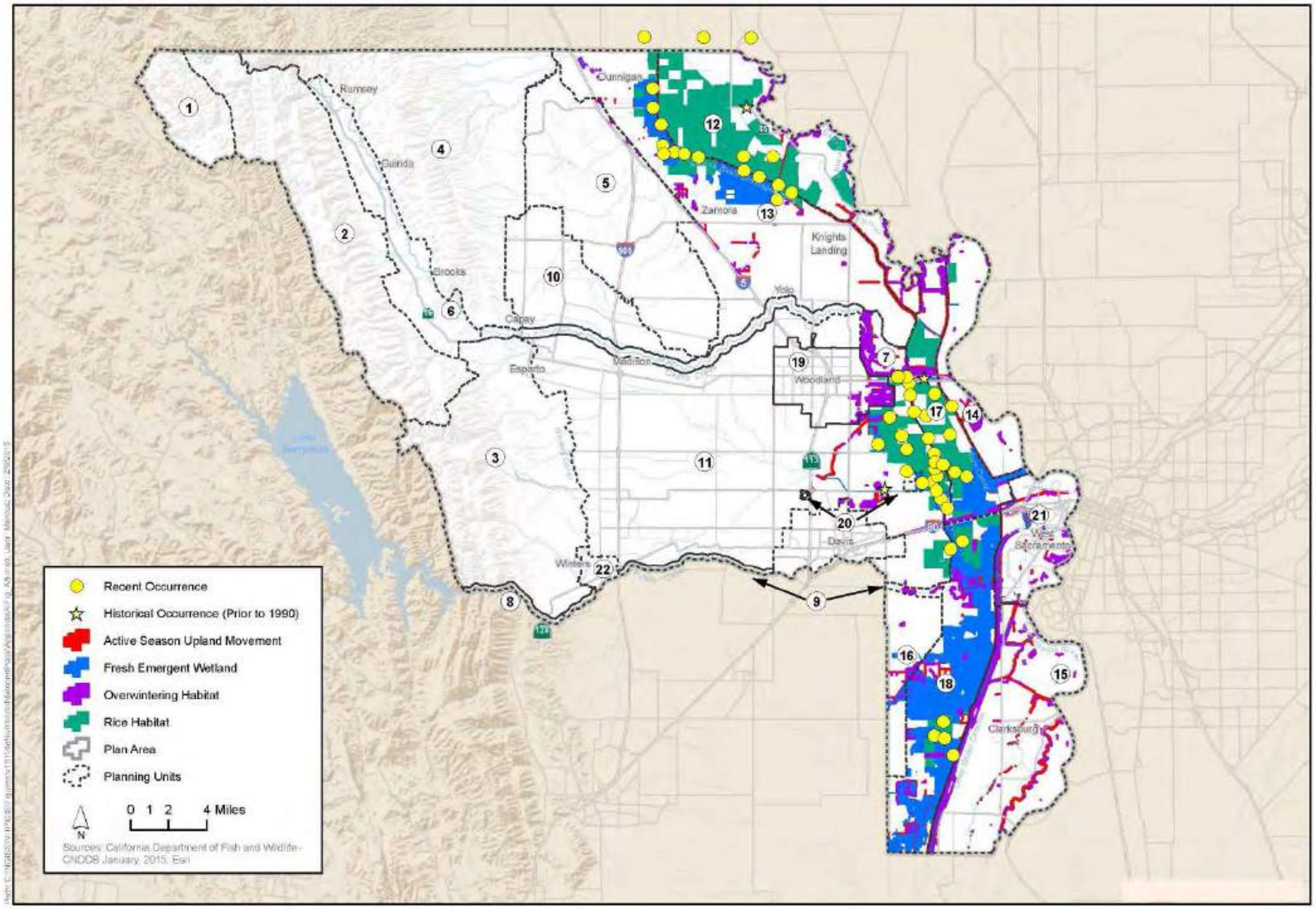
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.5.3, *Habitat Requirements and Ecology* (Figure A-5). The model parameters were limited to regions east of Highway 113 and Interstate 5 and include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., California Natural Diversity Database [CNDDB]; U.S. Geological Survey; Eric Hansen).
- Rice Habitat: Based on the known distribution of giant garter snake within the Plan Area (Figure A-19). This habitat includes all mapped rice land that occur east of Highway 113 and east of Interstate 5 from its junction with Highway 113. Mapped rice land includes associated water conveyance channels.
- Fresh Water Emergent Habitat: Based on the known distribution of giant garter snake within the Plan Area (Figure A-19) this habitat includes all mapped fresh emergent wetland that occurs east of Highway 113 and east of Interstate 5 from its junction with Highway 113. Freshwater emergent habitat is generally seasonal or managed wetlands that may support inclusions of perennial wetland.
- Active Season Upland Movement: This habitat includes all potentially suitable active season upland movement habitat adjacent to modeled rice, open water, and fresh emergent wetland land cover types with the potential to provide basking and short-term refuge. This habitat was modeled by selecting all natural vegetation types that occur within 200 feet of modeled rice and fresh emergent wetland land cover types (Hansen 1986; Wylie et al. 1997; USFWS 1999). Note

that if habitat in this category remains outside the winter flood zone it may also be used for overwintering.

- Overwintering Habitat: This habitat includes all potentially suitable overwintering habitat outside of the active season upland movement habitat that may provide long-term refuge during the winter. This habitat was modeled by selecting all natural vegetation types that occur between 200 feet and 820 feet from modeled rice and fresh emergent wetland land cover types (Hansen 1986, Wylie et al. 1997, USFWS 1999).
- Aquatic Habitat: This habitat type includes all aquatic features that might be used by the giant garter snake. This habitat was modeled by selecting all open water features that occur east of Highway 113 and east of Interstate 5 from its junction with Highway 113. Larger water features including Cache and Putah Creeks, the Sacramento River, and the Deep Water Channel were excluded along with water features surrounded by development without surrounding upland habitat. (Hansen 1986, Wylie et al. 1997, USFWS 1999).

Figure C-23. Giant Garter Snake Modeled Habitat and Occurrences



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C.29 Tricolored Blackbird (*Agelaius tricolor*)

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C.29.1 Listing Status

Federal: None.

State: Endangered.

Recovery Plan: None; however, a conservation strategy for this species was prepared (Tricolored Blackbird Working Group 2007).

C.29.2 Species Description and Life History

Tricolored blackbirds (*Agelaius tricolor*) form the largest colonies of any North American passerine bird, and these may consist of tens of thousands of breeding pairs (Beedy and Hamilton 1999). Tricolored blackbirds are largely endemic to California and the state is home to more than 95 percent of the global population.

This species closely resembles red-winged blackbird (*Agelaius phoeniceus*), with subtle differences in coloration, bill shape, and overall morphology (Beedy and Hamilton 1999). The adult male is black, with shades of glossy blue, and has a bright red patch on the wing (an epaulet), similar to that of a red-winged blackbird. However, the epaulet of tricolored blackbirds is deeper red with a white lower border, as opposed to an orange-red patch with a yellowish border or no border at all. The adult females are brownish and black, streaked with gray, with small reddish epaulets (rarely visible in the field) and pale gray or whitish chin and throat. Tricolored blackbirds have longer, slightly narrower wingtips and thinner bills than the red-winged blackbirds (Beedy and Hamilton 1999).

C.29.3 Seasonal Patterns

Many tricolored blackbirds reside throughout the year in the Central Valley of California (Beedy 2008). However, local populations can move considerable distances, and some are migratory and move from inland breeding locations to wintering habitats in the Sacramento-San Joaquin River Delta and coastal areas. During the breeding season, most birds nest in the San Joaquin Valley and in Sacramento County in their first breeding efforts. They may later move northward into the Sacramento Valley, northeast California, and southern Oregon to nest again (Hamilton 1998; Beedy 2008). Thus, individual tricolored blackbirds may occupy and breed at several sites, or re-nest at the same site, during a given breeding season, depending on environmental conditions and their previous nesting success (Hamilton 1998; Beedy and Hamilton 1999; Meese 2006). In fall, after the nesting season, large roosts form at managed wildlife refuges and other marshes near abundant food supplies such as rice (*Oryza sativa*) and water grass (*Echinochloa crus galli*) (Beedy and Hamilton 1997). During winter, many tricolored blackbirds move out of the Sacramento Valley to the Sacramento-San Joaquin River Delta. Large flocks also winter in the central and southern San Joaquin Valley, and at the dairy farms in coastal areas such as Point Reyes and Monterey County (Beedy and Hamilton 1997). In early March to early April, these flocks move from wintering areas to their breeding colonies in Sacramento County and the San Joaquin Valley (Beedy and Hamilton 1997).

C.29.3.1 Reproduction

Tricolored blackbirds nest colonially, enabling them to synchronize their timing of nest building and egg laying (Beedy and Hamilton 1999). A few breeding colonies documented during fall months (September to November) had more protracted nest-building periods that led to asynchronous egg laying and fledging of young (Orians 1960). Females typically lay three to four eggs and incubate them for 11 to14 days, then both parents feed young until they fledge nine to 14 days after hatching (Beedy and Hamilton 1999).

C.29.3.2 Home Range/Territory Size

As many as 20,000 to 30,000 nests have been recorded in cattail (*Typha* spp.) marshes of 4 hectares or less, with individual nests less than 0.5 meter from each other (Neff 1937; DeHaven et al. 1975). Nest heights range from a few centimeters to about 1.5 meters above water or ground at colony sites in freshwater marshes (Neff 1937) and up to 3 meters in the canopies of willows (*Salix* spp.) and other riparian trees; rarely, they are built on the ground. The species typically selects breeding sites adjacent to open accessible water and places its nests in a protected nesting substrate, often including either flooded or thorny or spiny vegetation. Breeding colonies must have suitable foraging space providing adequate insect prey within a few kilometers (Beedy and Hamilton 1999).

C.29.3.3 Foraging Behavior and Diet

Diets of adult tricolored blackbirds are dependent on geographic location and the availability of local insect foods. Among the most important prey for adults provisioning nestlings include Coleopterans (beetles), Orthopterans (grasshoppers, locusts), Hemipterans (true bugs), other larval insects, and Arachnids (spiders and allies) (Crase and DeHaven 1977; Beedy and Hamilton 1999). The primary diet of a colony depends on the local food availability, and large hatches of dragonflies (Odonata) are especially favorable to this species (Meese pers. comm.); they are also attracted to large outbreaks of grasshoppers (Orians 1961). Adult females require insects to form eggs, and nestlings require insects since they are unable to digest plant materials until they are at least nine days old and ready to leave their nests (Beedy and Hamilton 1999). During the nonbreeding season, tricolored blackbirds often congregate at dairy feedlots to consume grains and other livestock feed, while others forage on insects, grains, and other plant material in grasslands and agricultural fields (Beedy and Hamilton 1999; Skorupa et al. 1980).

C.29.4 Habitat Requirements and Ecology

C.29.4.1 Nesting

Tricolored blackbird colonies require access to water, suitable nesting substrates (including marsh vegetation or thorny or spinous vegetation to protect them from mammalian predators), and foraging habitat with significant populations of insect prey within a few miles (Beedy and Hamilton 1999; Hamilton 2004). Breeding habitat includes diverse wetland and upland and agricultural areas, including those with dense cattails (*Typha* spp.), bulrushes (*Scirpus* spp.), willows (*Salix* spp.), blackberry (*Rubus* spp.), thistles (*Cirsium* and *Centaurea* spp.), and nettles (*Urtica* sp.) (Neff 1937; Hamilton 1998; Beedy and Hamilton 1999). Some of the largest colonies are in silage and grain fields in the San Joaquin Valley, and many are in the vicinity of dairies and feedlots (Hamilton 1998, Beedy and Hamilton 1999).

C.29.4.2 Foraging

Tricolored blackbirds forage in areas that provide abundant insects, including pastures, dry seasonal pools, agricultural fields such as alfalfa and rice, feedlots, and dairies. Tomatoes may occasionally be used as foraging habitat. With the loss of the natural flooding cycle and most native wetland and upland habitats in the Central Valley, breeding tricolored blackbirds now forage primarily in anthropogenic habitats. Tricolored blackbirds have been able to exploit foraging conditions created when shallow flood-irrigation, mowing, or grazing keeps the vegetation at an optimal height (less than 15 centimeters [cm]). Preferred foraging habitats include crops such as rice, alfalfa, safflower, irrigated pastures, and ripening or cut grain fields (e.g., oats wheat, silage) as well as annual grasslands and shrublands (Beedy and Hamilton 1999; Beedy 2008).

In recent years, an increasing percentage and now large majority of adults have foraged on grains provided to livestock as in cattle feedlots and dairies. Tricolored blackbirds also forage in remnant native habitats, including wet and dry vernal pools and other seasonal wetlands, riparian scrub habitats, and open marsh borders. Vineyards, orchards, and row crops (sugar beets, corn, peas, beets, onions, etc.) do not provide suitable nesting substrates or foraging habitats for tricolored blackbirds (Beedy and Hamilton 1999). Both adults feed the nestlings; adults feeding young typically forage within 5 kilometers (km) (3.11 miles) of the colony, but can range up to 13 km (8 miles) from the colony (Beedy and Hamilton 1999).

Some small breeding colonies may occur at private and public lakes, reservoirs, and parks provided that they are near suitable foraging habitats. Many of these colonies are surrounded by shopping centers, subdivisions, and other urban development; adults from such colonies forage in undeveloped uplands nearby.

C.29.5 Species Distribution and Population Trends

C.29.5.1 Distribution

Tricolored blackbirds are endemic to the western edge of North America; however, about 95 percent of the global population resides in California where breeding has occurred in 46 counties (Beedy and Hamilton 1999). Except for a few peripheral sites, the geographic distribution has not declined; breeding colonies in northeastern California, southern Oregon, Washington, western Nevada, and central and western Baja California have been documented (Beedy and Hamilton 1999). While the overall geographic breeding distribution of the species may not have changed since historical times, there are now large gaps in their former range encompassing entire counties (e.g., Kings, San Joaquin, Riverside, San Bernardino counties).

C.29.5.2 Population Trends

The first systematic surveys of the tricolored blackbird's population status and distribution were conducted by Neff (1937). During a five-year interval, he found 252 breeding colonies in 26 California counties; the largest colonies were in rice-growing areas of the Sacramento Valley. Neff observed as many as 736,500 adults per year (1937) in eight Central Valley counties. The largest colony he observed, in Glenn County, covered almost 24 hectares (59 acres), and contained more than 200,000 nests (about 300,000 adults). Several other colonies in Sacramento and Butte counties contained more than 100,000 nests (about 150,000 adults).

DeHaven et al. (1975) estimated that the overall population size in the Sacramento and northern San Joaquin Valleys had declined by more than 50 percent since the mid-1930s. DeHaven et al. (1975) performed surveys in the areas surveyed by Neff (1937) and observed significant population declines and reductions of suitable habitat since Neff's surveys. Orians (1961) observed colonies of up to 100,000 nests in Colusa, Yolo, and Yuba counties but did not attempt to survey the entire range of the species. Recent statewide censuses have shown dramatic declines in tricolored blackbird numbers in the Central Valley (Beedy and Hamilton 1997; Hamilton et al. 1999; Hamilton 2000; Green and Edson 2004; Cook and Toft 2005). Statewide totals of adults in four late-April surveys covering all recently known colony sites were 369,359 in 1994, 237,928 in 1997, 104,786 in 1999, and 162,508 in 2000 (Hamilton 2000). In April 2004, statewide surveys focused on only those colonies that had supported greater than 2000 adults in at least one previous year. Of 184 sites surveyed, only 33 supported active colonies at the time of the survey. Of the 33 colonies, 13 held greater than 2000 adults each, collectively representing greater than 96 percent of the census total (Green and Edson 2004). A statewide survey performed on April 25 to 27, 2008 found a total of 394,858 adults at 155 sites in 32 counties (Kelsey 2008). The most recent statewide survey for tricolored blackbirds was conducted in 2014, at which time the number of tricolors dropped to 145,135 birds (Meese 2014).

C.29.5.3 Distribution and Population Trends in the Plan Area

In Yolo County, tricolored blackbirds historically bred primarily in marshes with emergent vegetation. The species forages in grasslands, wetlands, and agricultural fields from March through July, but are irregular visitors during the remainder of the year (Yolo Audubon Society Checklist Committee 2004). Recent surveys revealed very few nesting colonies in Yolo County (Meese pers. comm.). Fourteen colonies were documented in the county from 1994 to 2004, with populations estimated from 15 to 1,500 adults. Surveys in 2007 revealed a highly successful colony of more than 30,000 breeding adults in milk thistle on the Conaway Ranch in the Yolo Bypass. This was one of only three documented colonies statewide that were large and successful, and this colony was estimated to have produced about 30,000 young (Meese 2007). Other recent colony sites in the county included: "Bill's Grasslands," a newly-discovered colony located within a patch of Himalayan blackberry approximately one km south of the intersection of County Roads 92B and 15B, that was active in 2006 and again in 2007. This colony was active again in 2012 in a slightly different location off Road 92B. Another colony in milk thistle on County Road 88B, about two km north of State Route 16 that was active in 2005 and 2007, but not in 2006. Four small colonies were also found in the Yolo Bypass in 2005 that have not been occupied since. A historical colony at the Sunsweet Drying facility, just south of County Road 27 and about 1 km west of I-505, has not been active in the past three years (Meese pers. comm.). A total of 1,900 adults were observed at two colonies in the Yolo Bypass during the 2008 statewide survey (Kelsey 2008).

C.29.6 Threats to the Species

C.29.6.1 Habitat Loss and Degradation

The greatest threats to this species are the direct loss and degradation of habitat from human activities (Beedy and Hamilton 1999). Most native habitats that once supported nesting and foraging tricolored blackbirds in the Central Valley have been replaced by urbanization and agricultural croplands unsuited to their needs. In Sacramento County, an historical breeding center of this species, the conversion of grassland and pastures to vineyards expanded from 3,050 hectares in 1996 to 5,330 hectares in 1998 (DeHaven 2000) to 6,762 hectares in 2003 (California Agriculture Statistics Services).[5] Conversions of pastures and grasslands to vineyards in Sacramento County and elsewhere in the species' range in the Central Valley have resulted in the recent loss of several large colonies and the elimination of extensive areas of suitable foraging habitat for this species (Cook 1996; DeHaven 2000; Hamilton 2004).

C.29.6.2 Direct Mortality During Crop Harvest

Entire colonies (up to tens of thousands of nests) in cereal crops and silage are often destroyed by harvesting and plowing of agricultural lands (Beedy and Hamilton 1999; Hamilton 2004; Cook and Toft 2005). While adult birds can fly away, eggs and fledglings cannot. The concentration of a high proportion of the known population in a few breeding colonies increases the risk of major reproductive failures, especially in vulnerable habitats such as active agricultural fields.

C.29.7 Predation

Historical accounts documented the destruction of nesting colonies by a diversity of avian, mammalian, and reptilian predators (Beedy and Hamilton 1999). Recently, especially in permanent freshwater marshes of the Central Valley, entire colonies have been lost to black-crowned night-herons (*Nycticorax nycticorax*) and common ravens (*Corvus corax*). Recently, cattle egrets (*Bubulcus ibis*) have been observed preying on tricolored blackbird nests, and at one colony in Tulare County more than 125 egrets were present throughout the breeding season (Meese 2007). Some large colonies (up to 100,000 adults) may lose more than 50 percent of nests to coyotes (*Canis latrans*), especially in silage fields, but also in freshwater marshes when water is withdrawn (Hamilton et al. 1995). Thus, water management by humans often has the effect of increasing predator access to active colonies.

C.29.7.1 Poisoning and Contamination

Various poisons and contaminants have caused mass mortality of tricolored blackbirds. McCabe (1932) described the strychnine poisoning of 30,000 breeding adults as part of an agricultural experiment. Neff (1942) considered poisoning to regulate numbers of blackbirds preying upon crops (especially rice) to be a major source of mortality. This practice continued until the 1960s, and thousands of tricolored blackbirds and other blackbirds were exterminated to control damage to

[5] http://www.nass.usda.gov/ca/.

rice crops in the Central Valley. Beedy and Hayworth (1992) observed a complete nesting failure of a large colony (about 47,000 breeding adults) at Kesterson Reservoir, Merced County, and selenium toxicosis was diagnosed as the primary cause of death. At a colony in Kern County, all eggs sprayed by mosquito abatement oil failed to hatch (Beedy and Hamilton 1999). Hosea (1986) attributed the loss of at least two colonies to aerial herbicide applications.

C.29.7.2 Other Conservation Issues

Important information gaps in the ecology of the species include the effects of land use changes on the reproductive success of colonies and on the distribution of wintering birds, the relationship of invertebrate prey abundance and brood size, winter distribution, diet, and survival rates, and measures of suitable foraging habitat (Beedy and Hamilton 1999; Meese 2007).

Tricolored blackbirds have been the focus of recent management concern due to population decline, very limited global range, and vulnerability of large breeding colonies to habitat losses, predation, and human-induced impacts. Recommendations for the species conservation (Beedy and Hamilton 1999; Hamilton 2004) include frequent monitoring of breeding and wintering population sizes, colony locations, and reproductive success; protection of colony locations and foraging habitats; protection of colonies on farmland by avoiding harvesting/tilling until young have fledged; providing adequate protection in Habitat Conservation Plans; focusing on dairy-dependence for breeding and wintering populations; developing or restoring breeding habitat near reservoirs, rice fields, alfalfa fields and other optimal foraging habitats; and managing major predators in or near breeding colonies, including common ravens, black-crowned night-herons, cattle egrets, and coyotes when feasible.

C.29.8 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.31.3, *Habitat Requirements and Ecology* (Figure A-31). The model parameters include the following.

- Known Recent Colonies in Yolo NCCP/HCP Species Locality Database: Location where colonies have relatively recently (post-January 1, 2000) been documented according to one or more species locality records databases (i.e., California Natural Diversity Database [CNDDB], John Kemper, University of California, Davis (UC Davis) Museum of Wildlife and Fish Biology, BIOS, Bob Meese, Avian Knowledge Network).
- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Other location where the species has relatively recently (post-January 1, 1990) been documented, but not identified as a colony site, according to one or more species locality records databases (i.e., CNDDB, John Kemper, UC Davis Museum of Wildlife and Fish Biology, BIOS, Bob Meese, Avian Knowledge Network).
- Nesting Habitat: This habitat includes all potentially suitable breeding habitat in natural habitat communities. This habitat was modeled by selecting all mapped vegetation types as listed below that occur in the Yolo Bypass, Central Valley, Capay Valley, and Dunnigan Hills ecoregions.
- Foraging Habitat: This habitat includes all potentially suitable foraging habitat. This habitat was modeled by selecting all mapped vegetation types listed below that occur within 13 km (8 miles) of nesting habitat.

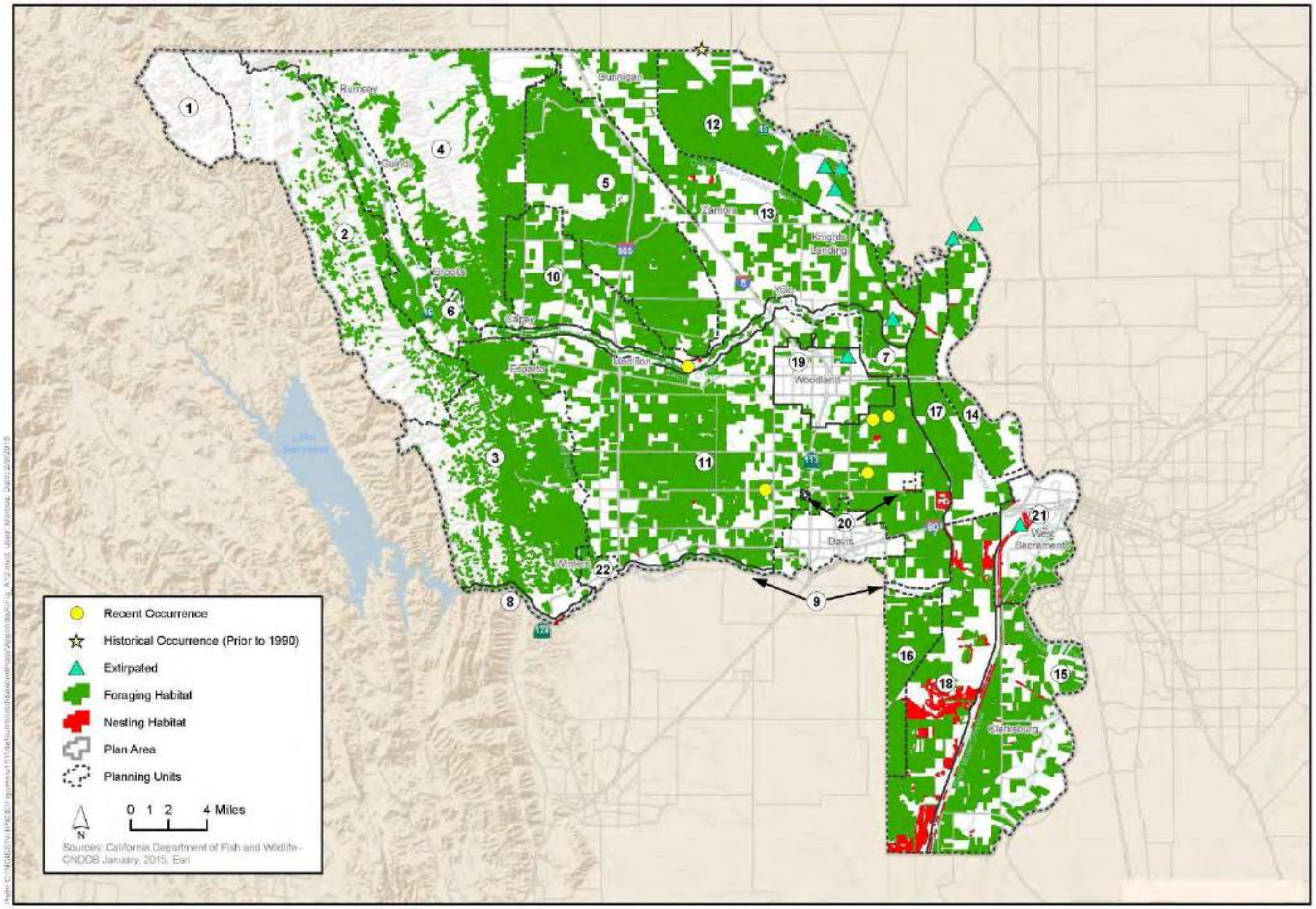
C.29.8.1 Nesting Habitat – Vegetation Types

- Alkali Bulrush – Bulrush Brackish Marsh Not Formally Defined (NFD) Super Alliance
- Bullrush – Cattail Wetland Alliance
- Bulrush – Cattail Fresh Water Marsh NFD Super Alliance
- Blackberry NFD Super Alliance
- Undifferentiated Riparian Bramble and Other

C.29.8.2 Foraging Habitat – Vegetation Types

- All Annual Grassland
- All Pasture
- Safflower and Sorghum
- Grain and Hay Crops
- Rice
- Undetermined Alliance – Managed
- Livestock Feedlots
- Poultry Farms

Figure C-24. Tricolored Blackbird Modeled Habitat and Occurrences



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C.30 Grasshopper Sparrow (*Ammodramus savannarum*)


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C.30.1 Listing Status

Federal: None

State: Species of Special Concern

Recovery Plan: None

C.30.2 Species Description and Life History

Grasshopper sparrows (*Ammodramus savannarum*) are short to medium-distance migrants that nest primarily in the eastern half of the United States, and winter in southern United States, Mexico, and northern Central America (Vickery 1996). Small breeding populations are also found in scattered locations in the western states, including California (Vickery 1996). Grasshopper sparrows are small, large-headed, flat-crowned and short-tailed, and are the only small grassland sparrows with unstreaked breasts.

C.30.2.1 Seasonal Patterns

In California, grasshopper sparrows arrive on their breeding territories from March to mid-May, depending on location (Vickery 1996). In Yolo County, most breeding season records have been from late March until late May, scattered nonbreeding records from January, September, October, November, and December (Yolo Audubon Society Checklist Committee 2004).

C.30.2.2 Reproduction

Females lay three to six eggs and incubate them for 11–13 days. Both parents and, occasionally, related adult and juvenile helpers feed the nestlings, which remain in the nest for eight to nine days. Grasshopper sparrows frequently renest in response to nest predation; rates may exceed 50 percent. Rates of brown-headed cowbird (*Molothrus ater*) brood parasitism are reportedly lower for grasshopper sparrow than for other grassland bird species, presumably because grasshopper sparrow nests are more difficult to find (Vickery 1996).

C.30.2.3 Home Range/Territory Size

Grasshopper sparrows often nest semi-colonially in clusters of territories (Grinnell and Miller 1994; Vickery 1996). Reported mean territory sizes vary considerably throughout the species' distribution and range from 0.19 to 1.40 hectares (ha) (0.47 to 3.46 acres) (Vickery 1996). Populations in Maine require habitat patches greater than 100 ha (247 acres) (Vickery 1996). Grasshopper sparrows are area sensitive, preferring large grassland areas over small areas. In Illinois, the minimum area on which grasshopper sparrows were found was 10–30 ha, and the minimum area needed to support a breeding population may be ≥30 ha (Herkert 1994). In Nebraska, the minimum area in which grasshopper sparrows were found was 8–12 ha (Helzer and Jelinski 1999). Occurrence of grasshopper sparrows was positively correlated with patch area and inversely correlated with perimeter-area ratio (Helzer and Jelinski 1999). Territory sizes and habitat patch requirements have not been studied in California.

C.30.2.4 Foraging Behavior and Diet

Grasshopper sparrows forage primarily for grasshoppers, but other insects, including bees and wasps, beetles, and caterpillars, are also eaten. Studies have shown that insects account for 61 percent and 29 percent of the summer and fall diets, respectively. The remainder of the diet is comprised of seeds. Stomach analysis in California (N=8) found seeds from knotweed (*Polygonum* spp.), campion (*Lychnis* spp.), oats (*Avena* spp.), and pigweed (*Amaranthus* spp.) (Vickery 1996).

C.30.3 Habitat Requirements and Ecology

C.30.3.1 Nesting

In California, grasshopper sparrows require dry, well-drained grasslands with patches of bare ground (Grinnell and Miller 1944). These grasslands often include scattered, taller shrubs or annuals that are used for song perches (Grinnell and Miller 1944; Vickery 1996). They breed in a variety of grassland habitats including native bunchgrass, wild rye, wet meadows with a variety of forbs, annual grasslands with scattered shrubs, and rarely in pasturelands and annual grasslands dominated by star thistle (J. Sterling pers. obs.). Although they often occupy hillsides, they may also occur in flat terrain (J. Sterling pers. obs.). In California and perhaps elsewhere, grasshopper sparrows are most often found in clusters of breeding territories resulting in clumped distribution leaving much seemingly available habitat unoccupied (J. Sterling pers. obs.). Winter habitat may differ from breeding habitat, but there are too few records of wintering birds in the Central Valley to adequately describe their winter habitats.

C.30.3.2 Foraging

Grasshopper sparrows primarily forage on the ground within or near their breeding territories (Vickery 1996).

C.30.4 Species Distribution and Population Trends

C.30.4.1 Distribution

Grasshopper sparrows breed throughout the United States east of the Rocky Mountains, and in scattered locations in the western states, in southern Mexico and the Greater Antilles (except for Cuba), as well as in Columbia and Ecuador. They winter primarily in grasslands in the southeastern United States, Mexico, Cuba, and northern Central America (Vickery 1996).

Grinnell and Miller (1944) described the grasshopper sparrow's occurrence in California as "sparse and irregularly distributed" from Mendocino, Trinity, Shasta, and Lassen Counties south to San Diego County and west of the Sierra Nevada and desert regions. Grasshopper sparrows are now known from Del Norte and Siskiyou Counties and many additional areas that were unknown to

Grinnell and Miller (Sterling pers. comm.). However, their statewide distribution is still best described as sparse and irregular.

C.30.4.2 Population Trends

Breeding Bird Survey data are inadequate to assess population trends throughout the species' range (Sauer et al. 2001). Regional population trends are related to land use. For example, an 85 percent decline occurred in Illinois during the past 35 years due to conversion of pasture to row crops. A severe decline was also noted in Florida due to conversion of native prairie to agriculture, and an increase was observed in South Carolina, perhaps due to an increase in pasture (Vickery 1996).

Grasshopper sparrow populations around metropolitan areas in Southern California have significantly declined in recent decades (Unitt 2008). These declines are a result of loss of habitat through conversion of grasslands to agriculture and suburban/urban development, and habitat degradation from overgrazing and invasion plants (Vickery 1996; Unitt 2008). Because the Central Valley region's current and historical breeding distribution is not clearly known, and current and historical population sizes have not been estimated, population trends are unknown.

C.30.4.3 Distribution and Population Trends in the Plan Area

In Yolo County, they are considered rare and irregular (not annual) breeders in the Yolo Bypass and the grasslands in the lower foothills. Breeding season localities where they have been observed historically include along County Road 105 and near Pleasant's Valley Bridge, and breeding season records since 1999 include "Longspur Corner" near the Dunnigan Hills, along County Road 88, near the intersection of County Roads 27 and 96, and at the Grasslands Regional Park (Yolo Audubon Society Checklist Committee 2004).

C.30.5 Threats to the Species

The primary population threats to this species come from development of grasslands for housing and commercial buildings. Grasshopper sparrows avoid highly fragmented grasslands in California and elsewhere (J. Sterling pers. obs.; Vickery 1996). Fragmentation reduces the ability of an area to sustain a population, leading to local extirpations and the loss of source populations.

Available breeding habitats for the grasshopper sparrow may also be degraded by poorly managed livestock grazing and by invasive nonnative plants. Early season mowing of breeding sites may also destroy nests (Vickery 1996). Hay and grass mowing during the nesting season (conducted earlier in spring now than was done historically) has resulted in nest failure and mortality of young and/or eggs (Vickery 1996).

Predation on adults by loggerhead shrikes (*Lanius ludovicianus*) and on nestlings by corvids, snakes, and a variety of mammals may significantly affect small populations. Nest predation rates are higher near woodlands and brush fields due increased to exposure to avian and mammalian predators (Vickery 1996).

Significant data gaps relating to many aspects of the life history of the grasshopper sparrow exist. Data gaps include specific effects of habitat fragmentation or degradation, minimum patch size, sources of mortality, mating system dynamics, winter ecology and distribution, and population structure.

Many large grassland areas in Dunnigan Hills, Capay Valley and Central Valley appear to be unoccupied, but apparently represent suitable habitat for grasshopper sparrow (J. Sterling pers. obs.), although most of these areas are privately owned and have not been thoroughly surveyed. In addition, factors determining local population fluctuations need to be fully understood in order to guide effective management actions to increase and stabilize populations at local carrying capacity.

C.30.6 Species Habitat Model and Location Data

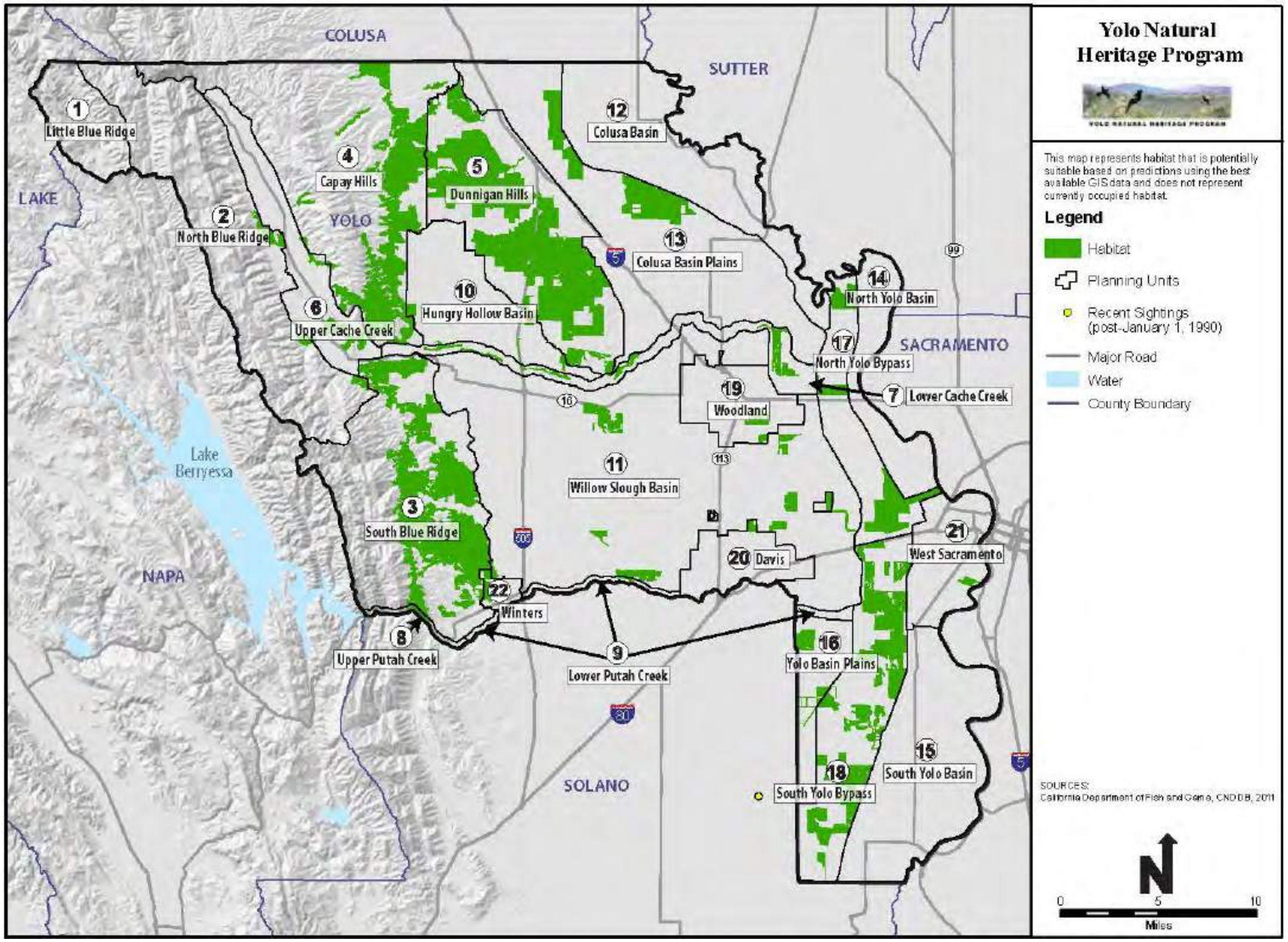
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.30.3, *Habitat Requirements and Ecology* (Figure A-30). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., Ted Beedy, Jim Estep).
- Habitat: This habitat includes all larger potentially suitable vegetation communities on the lower foothills and valley floor. This habitat was modeled by selecting all mapped vegetation types as listed below that occur below an elevation of 1,000 feet with a patch size of 100 acres or greater.

C.30.6.1 Habitat – Vegetation Types

- All Annual Grassland
- *Carex* spp. – *Juncus* spp. – Wet Meadow Grasses NFD Super Alliance
- *Crypsis* spp. – Wetland Grasses – Wetland Forbs NFD Super Alliance

Figure C-25. Grasshopper Sparrow Mapped Habitat and Occurrences



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C.30.7.1 Personal Communications

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C.31 Western Burrowing Owl (Athene cunicularia hypugaea)


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C.31.1 Listing Status

Federal: Species of Conservation Concern (U.S. Fish and Wildlife Service [USFWS] Regions 1, 2, and 6) (USFWS 2002).

State: Species of Special Concern.

Recovery Plan: None.

C.31.2 Species Description and Life History

Western burrowing owls (*Athene cunicularia hypugaea*) inhabit much of the western United States and southern interior of western Canada (Haug et al. 1993). They are unique among the North American owls in that they nest and roost in burrows. This small owl stands about 22.86 centimeters (9 inches) tall. The sexes are similar (although females are often slightly darker than males) with distinct oval facial ruff, white eyebrows, yellow eyes, and long stilt-like legs. Wings are relatively long (51–61 centimeters [20–24 inches]) and somewhat rounded. The owl is sandy colored with pale white spots on the head, back, and upperparts of the wings and white-to-cream with barring on the breast and belly (Haug et al. 1993).

C.31.2.1 Seasonal Patterns

Burrowing owls are resident in northern California. The breeding season (defined as from pair bonding to fledging) generally occurs from February to August with peak activity occurring from April through July (Haug et al. 1993). Pairs may be resident at breeding sites throughout the year or migrate out of the breeding area during the nonnesting season. Some individual birds only winter in the region. Thus, the demographics of this species in the region are relatively dynamic. Burrowing owls have a strong affinity for previously occupied nesting and wintering habitats. They often return to burrows used in previous years, especially if they had been reproductively successful (Lutz and Plumpton 1999). Additionally, burrowing owls often return as breeding adults to the general area in which they were born. For these reasons, efforts that enhance productivity help to ensure continued use of burrows and territories.

Migration patterns vary among burrowing owls. As noted above, in Northern California burrowing owls are generally year-round residents although some may migrate from or migrate to other regions during winter. Those burrowing owls that do migrate often return to the same nesting territories in successive years.

C.31.2.2 Reproduction

Adults begin pair bonding and courtship in February through March. Following pair formation, a nest is established in the natal burrow and females lay a clutch of six to 11 eggs. Average clutch size is seven to nine. Eggs are incubated entirely by the female for a period of between 28 and 30 days. During this time, the female is provisioned with food by the male. Following hatching, the young remain in the natal burrow for two to four weeks, after which they begin to emerge from the burrow and can be observed roosting at the burrow entrance. The female begins hunting as young become less dependent. Adults also often relocate chicks to satellite burrows presumably to reduce the risk of predation (Desmond and Savidge 1998) and possibly to avoid nest parasites (Dechant et al. 2003). After approximately 44 days, young leave the natal burrow and by 49–56 days begin to hunt live insects. On average, three to five young fledge, but fledging rates can range from a single chick to as many as eight or nine (Lutz and Plumpton 1999). During this time, the juveniles expand their range and may find cover in the satellite burrow. The juveniles continue to be provisioned by the adults until mid-September when they molt into adult plumage and begin to disperse (Landry 1979). King and Belthoff (2001) report that dispersing young use satellite burrows in the vicinity of their natal burrows for about two months after hatching before departing the natal area.

C.31.2.3 Home Range/Territory Size

Few valid measures of territory or home range size of burrowing owls have been published; home range has not often been measured directly (e.g., via telemetry studies), and is highly subject to observer bias or equipment effect. Accordingly, caution is warranted when interpreting home range estimates. Gervais et al. (unpublished 2000 report) estimated that the mean minimum convex polygon (MCP) home range estimates for 22 burrowing owls in Fresno and Kings Counties, California was 1.89 square kilometers (km^2) (467 acres). Haug and Oliphant (1990) estimated that the mean MCP for six owls in Saskatchewan was 2.41 km^2 (595 acres).

In Colorado, Plumpton and Lutz (D. Plumpton pers. comm.) recorded densities of nesting burrowing owls that ranged from 21 to 34 pairs on roughly 9.06 km^2 (2,240 acres) of available habitat (i.e., 0.43 $km^2$and 0.26 km^2 [106 and 65 acres]/pair, respectively). Thomsen (1971) estimated territory size based on nearest-neighbor distances between nest burrows, producing a result of six pairs of owls averaging 0.008 km^2, with a range of between 0.0004 to 0.016 km^2 (1.98 acres; range: 0.1 to 4.0 acres). The preceding values demonstrate the disparity among studies, the different values attained when using different methods of estimating abundance, and the risk in relying on the results of a single study.

C.31.2.4 Foraging Behavior and Diet

Burrowing owls are active day and night and will hunt throughout the 24-hour day, but are mainly crepuscular, hunting mostly at dusk and dawn, and are less active in the peak of the day. They tend to hunt insects in daylight and small mammals at night. They usually hunt by walking, running, hopping along the ground, flying from a perch, hovering, and fly-catching in mid-air.

Burrowing owls tend to be opportunistic feeders. Large arthropods, mainly beetles and grasshoppers, comprise a large portion of their diet. In addition, small mammals, especially mice and voles (*Microtus, Peromyscus*, and *Mus* spp.) are also important food items. Other prey animals include reptiles and amphibians, young cottontail rabbits, bats, and birds, such as sparrows and horned larks. Consumption of insects increases during the breeding season (Zarn 1974; Tyler 1983; Thompson and Anderson 1988; John and Romanow 1993; Green et al. 1993; Plumpton and Lutz 1993a). Productivity may increase in proportion to the amount of mice and voles in the diet (D. Plumpton unpublished data).

As with most raptors, burrowing owls select foraging areas based on prey availability as well as prey abundance. Prey availability (the ability of a raptor to detect prey) decreases with increasing vegetative cover, thus foraging habitat suitability decreases with increasing grass height or vegetative density.

C.31.3 Habitat Requirements and Ecology

Burrowing owls are found in open, dry grasslands, agricultural and range lands, and desert habitats often associated with burrowing animals (Klute et al. 2003). They also occupy golf courses, airports, road and levee embankments, and other disturbed sites where there is sufficient friable soil for burrows (Haug et al. 1993). Because they typically use the burrows created by other species, particularly the California ground squirrel (*Spermophilus beecheyi*), presence of these species is usually a key indicator of potential occurrence of burrowing owl (Gervais et al*.* 2008). Burrowing owls in cismontane California were likely historically associated with herbaceous vegetation suppressed by tule elk herds.

C.31.3.1 Nesting

In northern California, most nest sites occur in abandoned ground squirrel burrows; however, other mammal burrows and various artificial sites, such as culverts, pipes, rock piles, and artificially constructed burrows are also used (Gervais et al. 2008). Burrowing owls generally select sites in relatively sandy habitats that allow for modification of burrows and maximize drainage. In addition to providing nesting, roosting, and escape burrows, ground squirrels improve habitats for burrowing owls in other ways. Burrowing owls favor areas with short, sparse vegetation (Coulombe 1971; Haug and Oliphant 1990; Plumpton and Lutz 1993b) to facilitate viewing and hunting, which is typical around active sciurid colonies. Additionally, burrowing owls may select areas with a high density of burrows (Plumpton and Lutz 1993b). Typical habitats are treeless, with minimal shrub cover and woody plant encroachment, and have low vertical density of vegetation and low foliage height diversity (Plumpton and Lutz 1993b). While occupied burrows are sometimes found in flat landscapes, often in elevated mounds created by burrowing activity, they are also commonly found on hillsides, levee slopes, or other vertical cuts, probably to facilitate drainage and maximize visibility. Nest sites are also often associated with nearby perches, including stand pipes, fences, or other low structures.

Optimal nesting locations are within an open landscape with level to gently sloping topography, sparse or low grassland or pasture cover, and a high density of burrows.

Burrowing owls are tolerant of human-altered open spaces, such as areas surrounding airports, golf courses, and military lands, where burrows are readily adopted (Thomsen 1971; Gervais et al. 2008). Burrowing owls may select areas adjacent to unimproved and improved roads (Brenckle 1936; Ratcliff 1986); a modest volume of vehicle traffic does not appear to significantly affect behaviors or reproductive success (Plumpton and Lutz 1993c). In the South San Francisco Bay region, in the Sacramento area, and in several locations in and around the City of Davis, burrowing owls nest and winter in highly human-affected environments and can adjust to most types of human activity if habitats remain in a suitable condition.

The dimensions of the nest burrow vary with location, age of burrow, and the species that originally excavated it. Typical burrows constructed by ground squirrels are from 3 to 6 inches in diameter and extend underground at a gradual downward slope from 3 to 10 feet with an enlarged cavity at the end of the burrow. Burrow entrances are often adorned with various objects as well as feathers and pellets. The burrow is often lined with grass or other material (Haug et al. 1993).

Burrowing owls are solitary nesters or may nest in loose colonies – usually from 4 to 10 pairs (Zarn 1974); however, larger colonies have been documented. Most pairs occupy a natal burrow and at least one additional satellite burrow.

As semi-colonial owls, colony size is indicative of habitat quality. Colony size is also positively correlated with annual site reuse by breeding burrowing owls; larger colonies (those with more than five nesting pairs) are more likely to persist over time than colonies containing fewer pairs or single nesting pairs (DeSante et al. 1997). Nest burrow reuse by burrowing owls has been well documented (Martin 1973; Gleason 1978; Rich 1984; Plumpton and Lutz 1993b; Lutz and Plumpton 1999). Former nest sites may be more important to continued reproductive success than are mates from previous nest attempts (Plumpton and Lutz 1994). Past reproductive success may influence future site re-occupancy by burrowing owls. Female burrowing owls with large broods tend to return to previously occupied nest sites, while females that failed to breed or produced small broods may change nest territories in subsequent years (Lutz and Plumpton 1999).

In general, burrowing owls show a high degree of nest site fidelity and reuse the same nesting burrows and satellite burrows for many years if left undisturbed (Haug et al. 1993).

C.31.3.2 Foraging

Burrowing owls forage in open grasslands, pasturelands, agricultural fields and field edges, fallow fields, and along the edges of roads and levees. Vegetation is low to maximize visibility and access. Short perches such as fence posts are often used to enhance visibility. While they will defend the immediate vicinity of the nest, burrowing owls will often forage in common areas (Haug et al. 1993).

C.31.4 Species Distribution and Population Trends

C.31.4.1 Distribution

There are two subspecies of burrowing owls in North America (Dechant et al. 2003). The breeding range of *A. cunicularia floridana* is restricted to Florida and adjacent islands. The breeding range of *Athene cunicularia hypugaea* extends south from southern Canada throughout most of the western half of the United States and south to central Mexico. The winter range is similar to the breeding range except that most owls from the northern areas of the Great Plains and Great Basin migrate south and southern populations are resident year-round (Haug et al. 1993).

Burrowing owls were once widespread and generally common over western North America, in treeless, well-drained grasslands, steppes, deserts, prairies, and agricultural lands (Haug et al. 1993). The owl's range has contracted in recent decades, and populations have been generally diminished in some areas.

In California, burrowing owls are widely distributed in suitable habitat throughout the lowland portions of the state; however, occupied sites have ranged from 200 feet below sea level at Death Valley to above 12,000 feet at Dana Plateau in Yosemite National Park (California Department of Fish and Game [DFG] 2000; Gervais et al. 2008). In southern California, the species is fairly common along the Colorado River Valley (Rosenberg et al. 1991) and in the agricultural region of the Imperial Valley. Only small, scattered populations are thought to occur in the Great Basin and the desert regions of southern California (DeSante et al. 1997). Burrowing owl breeding populations have greatly declined along the California coast, including the southern coast to Los Angeles, where these owls have been eliminated from virtually all private land, and occur only in small populations on some federal lands (Trulio 1997; Garrett and Dunn 1981). Breeding populations in Central California include the southern San Francisco Bay south of Alameda and Redwood City, the interior valleys and hills in the Livermore area, and the Central Valley (DeSante et al. 1997; Gervais et al. 2008).

The current distribution of burrowing owls in Yolo County is localized primarily in remaining low elevation uncultivated areas, such as the grasslands along the western edge of the Central Valley, the pasturelands in the southern panhandle, and the Yolo Bypass Wildlife Area. Other sites include some urban and semi-urban areas, particularly in and around the City of Davis, and other scattered locations associated with edges of cultivated lands.

While comprehensive surveys of the plan area have not been conducted, coordinated surveys have been undertaken in portions of the county. The majority of recent information is a result of these efforts, including monitoring surveys in and around the City of Davis (McNerney pers. comm.); surveys conducted by the California Department of Fish and Game at the Yolo Bypass Wildlife Area; and surveys coordinated by the Burrowing Owl Preservation Society in coordination with the Institute of Bird Populations on 12 selected 5-square-mile survey blocks in Yolo County in 2007 and 2014 (Wilkerson pers. comm., Catherine Portman pers. comm.). Additional data is gathered and reported incidentally by knowledgeable individuals from other areas of the County.

The results of these surveys and incidental reports indicate that the majority of known burrowing owl breeding locations are in the southern portion of Yolo County, centered in and around the City of Davis, the Yolo Bypass Wildlife Area, and the southern panhandle. A total of 50 breeding pairs were reported in Yolo County in 2007 (Table A9-1), and surveys of these same sites in 2014 indicated that only 15 breeding pairs were present in these locations. These data represent only reported sightings from several locations in Yolo County where surveys were conducted and data were recorded and made available. This summary does not represent the total number of burrowing owl breeding pairs in the county. However, it does represent the most significant known breeding areas for burrowing owl in Yolo County.

During 2010 and 2011, there were 6 documented burrowing owl nests northeast of Davis along the north side of CR 28H between CR 102 and 104 (Whistler pers. comm.). During 2015, Whisler observed only one pair of burrowing owl north of CR 28H, just west of CR 104. This pair was in the former ConAgra (Hunt-Wesson) property nesting on a dirt mound.

C.31.4.2 Population Trends

Overall population trend throughout the subspecies' North American range is reportedly declining. James (1993) reports that 54 percent of the areas sampled reported declining burrowing owl populations. Breeding Bird Surveys (BBS) conducted between 1980 and 1989 also report significant declines in many areas (Haug et al. 1993).

Burrowing owl was formerly common or abundant throughout much of California, but a decline noticeable by the 1940s (Grinnell and Miller 1944) has continued to the present time. The decline has been almost universal throughout California. Conversion of grasslands and pasturelands to incompatible crop types and the destruction of ground squirrel colonies have been the main factors causing the decline of the burrowing owl population (Zarn 1974; Gervais et al. 2008). Assimilation of poisons applied to ground squirrel colonies also affects burrowing population levels (Gervais et al. 2008).

A census of burrowing owls from 1991 to 1993 (DeSante et al. 1997) estimated there were approximately 10,000 pairs of burrowing owls in California. Over 70 percent of the owls in California are in the Imperial Valley, an area that represents less than 2 percent of the state's landmass (D. Plumpton pers. comm.). Numbers have been declining for decades in several areas of the state. Owls are extinct or have been reduced to very low numbers in several parts of the state, including coastal southern California and parts of the San Francisco Bay area. The statewide census indicated there has been a 50 percent decline in numbers of owls and the number of breeding groups in some parts of the state from the 1980s to 1990s.

Although California has a significant burrowing owl population, development pressures and recent population trends suggest that the species may continue to be extirpated from large portions of its range in California during the next decade. In the San Francisco Bay area, burrowing owls are commensal with the California ground squirrel and reside in undeveloped grassland remnants amid a rapidly expanding human population. An estimated 167 nesting pairs (1.8 percent of California's population) remain (all figures as of 1991, based on DeSante et al. [1997]), representing a decline of approximately 50 percent since the mid-1980s. In the southern California coastal population, burrowing owls have been almost entirely extirpated from private lands and are now found only on a few undeveloped federal lands, where an estimated 260 nesting pairs (3 percent of California's population) persist. An estimated 2,224 nesting pairs exist in the Central Valley (24 percent of California's population). Burrowing owls are mostly commensal with the round-tailed ground squirrel (*Spermophilus tereticaudus*) in the Imperial Valley, where burrowing owls are almost completely relegated to irrigation canal banks and where an estimated 6,570 nesting pairs (71 percent of California's population) remain (all data from DeSante et al. 1997, presented also in Barclay et al. 1998).

Table C-4. Breeding Season Burrowing Owl Occurrences Reported from Yolo County in 2007

Location	No. of Breeding Pairs	No. of Unpaired Singles	Total No. of Adults	No. of Young
Davis city limits	21	6	48	61
Yolo Bypass Refuge	19		38	60
Davis vicinity	4	4	12	
Woodland vicinity	3		6	
South panhandle	3		6	11
Total	50	10	110	132

There is evidence that the overall population in the county has declined based on severe declines or extirpations of known colonies. For example, the owl colony on the University of California, Davis campus had declined from 22 pairs in 1981 to one pair in 1991, then rebounded to several pairs in the late 1990s (Johnson pers. comm.). Another colony of 10 pairs documented in 1976 near the Yolo County Airport had been eliminated when the location was flooded in 1983 to create a pond (California Natural Diversity Database [CNDDB] 2007). More recently, a small colony on the north side of Winters was displaced by grading activities in preparation of a new development project.

However, burrowing owls have increased or continue to be relatively stable during the last several years in other areas, such as the Mace Ranch Preserve and the Wildhouse agricultural buffer and golf course (McNerney pers. comm.) in the Davis area. Habitat restoration efforts by the California Department of Fish and Wildlife (DFW) at the Yolo Bypass Wildlife Area may also be responsible for the increase in reported occurrences of owls at that location. Thus, in some areas owls appear to respond favorably to protection and restoration efforts.

C.31.5 Threats to the Species

Urbanization, including residential and commercial development and infrastructure development (roads and oil, water, gas, and electrical conveyance facilities) is one of the principal causes of habitat loss for burrowing owls and is a continuing threat to remaining northern California populations. Urbanization permanently removes habitat and has led to permanent abandonment of many burrowing owl colonies in the developing portions of the Central Valley, Bay Area, and throughout the state (Gervais et al. 2008).

Burrowing owls have shown a high level of tolerance for human encroachment, degradation of native habitats, and fragmentation of habitats (Gervais et al. 2008). Owls will often continue to occupy traditional sites as long as essential habitat elements remain present and until the extent of available habitat is reduced below the species' habitat requirement thresholds. Some burrowing owls nest on the edges of agricultural areas and forage in suitable agricultural landscapes, such as recently harvested fields, alfalfa and other hay fields, irrigated pastures, and fallow fields. The conversion of these fields to incompatible crop types, such as orchards, vineyards, and other crops that are not conducive to burrowing owl foraging, reduce available foraging habitat and lead to abandonment of traditional nesting areas. Many burrowing owl nests are known to occur along the outside slope or at the toe of levees. Levee stability practices for flood control, including vegetation removal, grading, and reinforcing with rock can destroy burrowing owl nesting habitat.

Although burrowing owls are relatively tolerant of low levels of human activity, human-related impacts such as shooting and burrow destruction adversely affect this species (Zarn 1974; Haug et al. 1993). Rodent control, particularly along levees and roadsides, can decimate ground squirrel populations and ultimately reduce available nesting and cover habitat for burrowing owls. Artificially enhanced populations of native predators (e.g., gray foxes, coyotes) and introduced predators (e.g., red foxes, cats, dogs) near burrowing owl colonies can also be a significant local problem. Burrowing owls also get tangled in loose fences, abandoned wire, fishing line, rat traps, and other materials.

The overall effect of population-level threats (e.g., habitat conversion or ground squirrel eradication) is of much greater concern than sources of individual mortality (e.g., shooting or vehicle collisions), as these former forces operate at a population, regional, and/or range-wide level. As obligate burrow nesters that do not excavate their own burrows, burrowing owls are largely dependent on burrowing mammals that have no legal status or protection, and are commonly and purposefully eradicated by humans. Whereas individual mortality cumulatively represents a significant number of individuals, a population that is secure and productive can offset these losses. Conversely, populations that are failing because of population-level effects cannot be sustained even in absence of direct sources of individual mortality. In California, significant economic development pressures exist, and habitat conversion for human purposes continues to degrade the abundance and quality of owl nesting habitat (Barclay et al. 1998). Few provisions exist to protect habitats over time. As a result, burrowing owls appear to be declining throughout most of California.

Important conservation milestones, such as the investigation and rejection of the case for changing the status of the burrowing owl to either threatened or endangered at the state or federal levels, have been reached in recent years. Significant data gaps exist in regard to migration, dispersal from nesting sites, and other aspects of annual movements. Small body size and habit of dwelling in burrows make the burrowing owl a poor choice for study using radio telemetry. Accordingly, much of what is known is the result of leg-banding studies that rely on visual detection or physical recapture of previously banded owls. These results are very specific to location, based on small sample sizes, and subject to observer effects. Accordingly, these data are not reliable for inference across the range of these owls, and should not be extrapolated to a specific location. Anecdotal accounts offer the most locality-specific data on dispersal, but few reliable data exist.

Burrowing owls are known to reoccupy habitats over their lifespan, if these habitats remain suitable (Rich 1984; Lutz and Plumpton 1999). Accordingly, preservation of large areas of consistently suitable habitat is the most important management and conservation option available. These habitats will include native grasslands that also support the native suite of species—including ground squirrels—that dig burrows, and prey such as voles, mice, ground beetles, and grasshoppers.

C.31.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.9.3, *Habitat Requirements and Ecology* (Figure A-9). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (e.g., CNDDB, Burrowing Owl Preservation Society, City of Davis, Yolo Basin Wildlife Area).
- Primary Habitat: This habitat includes all potentially suitable habitat in preferred natural habitats, pastures, and other open or barren areas on the lower slopes and valley floors. This habitat was modeled by selecting all mapped land cover types as listed below, where they occur in the Central Valley, Dunnigan Hills, and Yolo Bypass ecoregions.
- Other Habitat: This habitat includes selected pasture types, where uncultivated field borders may be suitable for potential nesting burrows and fields may be suitable for foraging. This habitat was modeled by selecting all pasture types except for turf farms, within the Central Valley, Dunnigan Hills, and Yolo Bypass ecoregions.
- Added Land Cover that was had the vegetation type ‘Semi-Agriculture/Incidental to Agriculture’ that was within 50’ of habitat that was modeled with the aforementioned criteria.

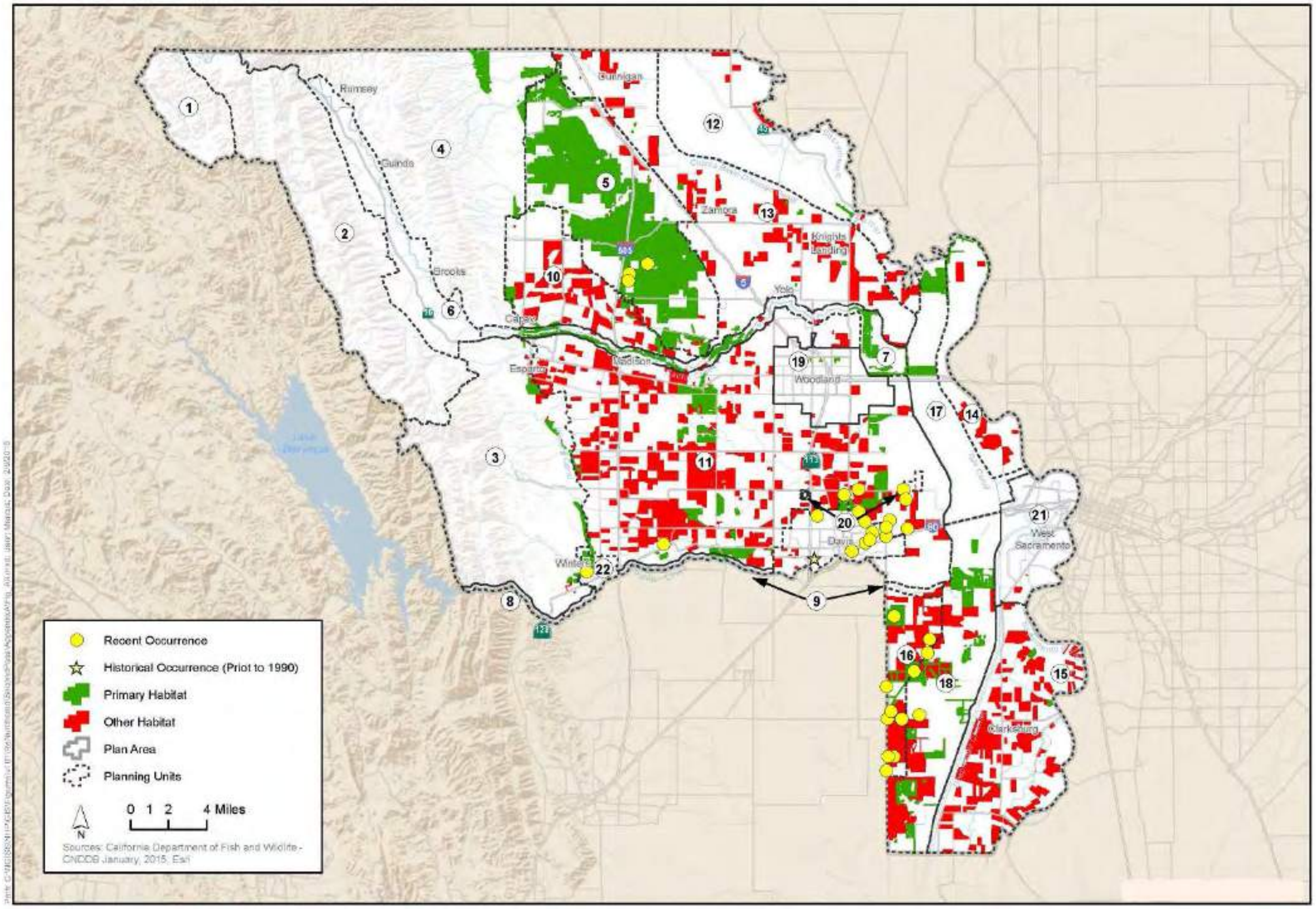
C.31.6.1 Primary Habitat – Vegetation Types

- California Annual Grasslands Alliance
- Upland Annual Grasslands and Forbs Formation
- Barren – Anthropogenic
- Native Pasture

C.31.6.2 Other Habitat – Vegetation Types

- Mixed Pasture
- Miscellaneous Grasses (grown for seed)
- Alfalfa

Figure C-26. Western Burrowing Modeled Habitat and Occurrences



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C.32 Swainson's Hawk (*Buteo swainsoni*)

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C.32.1 Listing Status

Federal: Bird of Conservation Concern (U.S. Fish and Wildlife Service [USFWS] 2008).

State: Threatened.

Recovery Plan: None.

C.32.2 Species Description and Life History

Swainson's hawk (*Buteo swainsoni*) is a long-winged, medium-sized soaring raptor, (48 to 56 centimeters [19 to 22 inches] and 693 to 1367 grams [24.46 to 48.26 ounces]) that nests and roosts in large trees in flat, open grassland or agricultural landscapes. Females average larger than males, but there are no distinguishing plumage characteristics for separating the sexes.

Swainson's hawk is characterized by its long, narrow, and tapered wings held in flight in a slight dihedral shape. The body size is somewhat smaller, thinner, and less robust than other *Buteos*, although the wings are at least as long as other *Buteos*. This body and wing shape allows for efficient soaring flight and aerial maneuverability, important for foraging, which Swainson's hawks do primarily from the wing, and during courtship and inter-specific territorial interactions.

There are three definitive plumage morphs: light, rufous, and dark. However, there are numerous intermediate variations between these plumage morphs. The two most distinguishing plumage characteristics are a dark breast band and the contrasting darker flight feathers and lighter wing lings on the underwings, giving most individuals a distinctive bicolored underwing pattern. These characteristics are most pronounced in lighter morph birds and become less so as the plumage darkens, and are indistinguishable in the definitive dark morph, which is completely melanistic. All three definitive plumage morphs are present in the Central Valley with a relatively large proportion of the population categorized as intermediate morph, with varying amounts of streaking or coloration in the belly and wing linings.

C.32.2.1 Seasonal Patterns

Swainson's hawks arrive on their breeding grounds in the Central Valley from early March to early April. The breeding season extends through mid-to-late August, when most young have fledged and breeding territories are no longer defended. By late August pre-migratory groups begin to form. The fall migration begins early- to mid-September. By early October, most Swainson's hawks have migrated out of the Central Valley. Central Valley Swainson's hawks winter from Central Mexico, to northern and central South America (Bradbury et al. in preparation). This differs from what is known about the migratory pattern and wintering grounds of Swainson's hawk populations outside of the Central Valley, most of which take a different migratory route and winter entirely in southern

South America, with the largest wintering populations known to occur in northern Argentina (England et al. 1997).

C.32.2.2 Reproduction

Swainson's hawks exhibit a high degree of nest site fidelity, using the same nests, nest trees, or nesting stands for many years (England et al. 1997). Pairs are monogamous and may maintain bonds for many years (England et al. 1997). Immediately upon arrival onto breeding territories, breeding pairs begin constructing new nests or repairing old ones. One to four eggs are laid in mid- to late April followed by a 30- to 34-day incubation period. Nestlings begin to hatch by mid-May followed by an approximately 20-day brooding period. The young remain in the nest until they fledge in 38 to 42 days after hatching (England et al. 1997). Studies conducted in the Sacramento Valley indicate that one or two, and occasionally three, young typically fledge from successful nests (Estep in preparation). The rate of young fledged per nest in the Central Valley is among the lowest recorded in the entire species range. This geographic difference in reproductive success may be related to the reliance on small voles that may not meet the high energetic demands of breeding adults and developing young compared to the diets that include a higher proportion of gophers, rabbits, ground squirrels and other larger mammals consumed in other locations (S. England pers. comm.). In Yolo County, fledging rates ranged from 1.15 to 1.96 young per successful nest from 1988 to 2000 (Table 1) (Estep in preparation).

After fledging, young remain near the nest and are dependent on the adults for about four weeks, after which they permanently leave the breeding territory (Anderson et al. in preparation).

C.32.2.3 Home Range/Territory Size

Home ranges are highly variable depending on cover type, and fluctuate seasonally and annually with changes in vegetation structure (e.g., growth, harvest) (Estep 1989; Woodbridge 1991; Babcock 1995). Smaller home ranges consist of high percentages of alfalfa, fallow fields, and dry pastures (Estep 1989; Woodbridge 1991; Babcock 1995). Larger home ranges were associated with higher proportions of cover types with reduced prey accessibility, such as orchards and vineyards, or reduced prey abundance, such as flooded rice fields. Swainson's hawks regularly forage across a very large landscape compared with most raptor species. Data from Estep (1989) and England et al. (1995) indicate that it remains energetically feasible for Swainson's hawks to successfully reproduce when food resources are limited around the nest and large foraging ranges are required. Radio-telemetry studies indicate that breeding adults in the Central Valley routinely forage as far as 30 kilometers (km) (18.7 miles) from the nest (Estep 1989; Babcock 1995).

Home ranges (calculated as minimum convex polygons) for 12 Swainson's hawks in the Central Valley, including six in Yolo County, averaged 27.6 square kilometers (km^2)(10.7 square miles [mi^2]) (range: 3.36 to 87.18 km^2 [1.3 to 33.7 mi^2) (Estep 1989). Using similar methods, four Swainson's hawks in West Sacramento averaged 40.5 km^2 (15.6 mi^2) (range: 7.2 to 76.6 km^2 [2.8 to 29.6 mi^2]), and included fields planted in grain, alfalfa, tomatoes, and safflower, as well as fallow fields (Babcock 1995).

Swainson's hawks in the central region of the Central Valley (including Yolo County) had the shortest distances between nests of those reported in England et al. (1997); on average, nests were 1.14 km (0.7 miles) apart (Estep 1989). Nesting density in the Central Valley was calculated at 30.2 pairs/100 km^2 (11.7 pairs/100 mi^2) (range: 21.4 to 39.1 km^2; [8.3 to 15.1 mi^2]) (England et al.

1995). This high nest density was attributed to widely available, uniformly distributed optimal foraging habitat and relatively abundant nesting sites along narrow riparian corridors, farm shelterbelts, roadside trees, remnant groves, and isolated trees. Results from a 2007 baseline survey of nesting Swainson's hawks in Yolo County indicate a nesting density within the survey area (excluding the higher elevation portions of the county of 98 pairs/100 km^2 (37.8/100 mi^2), the highest nesting density reported for this species (Estep 2008).

C.32.2.4 Foraging Behavior and Diet

Swainson's hawks hunt primarily from the wing, searching for prey from a low-altitude soaring flight, 30 to 90 meters (98.4 to 295.2 feet) above the ground and attack prey by stooping toward the ground (Estep 1989). This species is also highly responsive to farming activities that expose and concentrate prey, such as cultivating, harvesting, and disking. During these activities, particularly late in the season, Swainson's hawks will hunt behind tractors searching for exposed prey. Other activities, such as flood irrigation and burning, also expose prey and attract foraging Swainson's hawks.

In the Central Valley, Swainson's hawks feed primarily on small rodents, usually in large fields that support low vegetative cover (to provide access to the ground) and high densities of prey (Bechard 1982; Estep 1989). These habitats include hay fields, grain crops, certain row crops, and lightly grazed pasturelands. Fields lacking adequate prey populations (e.g., flooded rice fields) or those that are inaccessible to foraging birds (e.g., vineyards and orchards) are rarely used Estep 1989; Babcock 1995; Swolgaard 2004).

Meadow vole (*Microtus californicus*) is the principal prey item taken by Swainson's hawks in the Central Valley (Estep 1989). Pocket gopher (*Thomomys bottae*) is also an important prey item. Other small rodents, including deer mouse (*Peromyscus californicus*) and house mouse (*Mus musculus*) are also taken along with a variety of small birds, reptiles, and insects.

During late summer, the diet of post-breeding adults and juveniles includes an increasing amount of insects, including grasshoppers and dragonflies. Dragonflies may constitute a major proportion of the diet of post-breeding and migrant birds. In the Central Valley during summer, dragonfly species that swarm in large numbers and that are a potentially important, abundant food source are common green darner (*Anax junius*), spot-winged glider (*Pantalahy hymenaea*), and wandering glider (*Pantala flavescens*). In alfalfa and corn crops in Idaho, post-breeding flocks also forage primarily on grasshoppers (Johnson et al. 1987). Dragonflies are also the primary prey for wintering birds in Argentina (Jaramillo 1993).

Following their arrival back on the breeding grounds, Swainson's hawks again shift their diet to include larger prey such as small rodents, rabbits, birds, and reptiles (England et al. 1997). This shift to a higher quality diet is prompted by the nestlings' nutritional demands during rapid growth and the adults' high energetic costs of breeding.

C.32.3 Habitat Requirements and Ecology

C.32.3.1 Nesting

Throughout much of its range, both in North and South America, the Swainson's hawk inhabits grasslands, prairies, shrub-steppes, and agricultural landscapes, including dry and irrigated row crops, alfalfa and hay fields, pastures, and rangelands. They nest in trees most often in riparian woodlands and farm shelterbelts (England et al. 1997), as well as in urban/suburban areas with large trees adjacent to suitable foraging habitat (England et al. 1995; James 1992). Suitable nest trees are usually deciduous and tall (up to 30.48 meters [100 feet]); but in suburban/urban areas, most nest trees are conifers (England et al. 1997; England et al. 1995). Nests are built of sticks sometimes several feet in diameter. They are generally placed in the uppermost and outermost branches that will support the nest, often in mistletoe clumps (England et al. 1997).

In the Central Valley, Swainson's hawks usually nest in large native trees such as valley oak (*Quercus lobata*), cottonwood (*Populus fremontii*), walnut (*Juglans hindsii*), and willow (*Salix* spp.), and occasionally in nonnative trees such as eucalyptus (*Eucalyptus* spp.). Nests occur in riparian woodlands, roadside trees, trees along field borders, isolated trees, small groves, and on the edges of remnant oak woodlands. Stringers of remnant riparian forest along drainages contain the majority of known nests in the Central Valley (Estep 1984; Schlorff and Bloom 1984; England et al. 1997). This appears to be a function of nest tree availability, however, rather than dependence on riparian forest. Nests are usually constructed as high as possible in the tree, providing protection to the nest as well as visibility from it.

Tables 1 and 2 indicate the nesting habitat results from the 2007 baseline survey (Estep 2008). Riparian habitat was the most frequently used nesting habitat type, followed by roadside tree rows, isolated trees, and rural residential trees. Valley oak (*Quercus lobata*) was the most frequently used nest tree species, followed by Fremont cottonwood (*Populus fremontii*), walnut (*Juglans hindsii*), willow (*Salix* spp.), and eucalyptus trees (*Eucalyptus* spp.).

Table C-5. Nesting Habitat Associations of Swainson's Hawk Territories in the Yolo County Study Area, 2007

Nesting Habitat Type	Number of Territories	Percent of Total
Riparian (natural)	106	36.6
Roadside Tree Row	39	13.4
Riparian (channelized)	36	12.4
Isolated Tree	32	11.0
Rural Residential	26	9.0
Tree Row	19	6.6
Isolated Roadside Tree	15	5.2
Eucalyptus Grove	6	2.1
Oak Grove	4	1.4
Urban	3	1.0
Cottonwood Grove	1	0.3
Savanna	1	0.3
Farmyard	1	0.3
Mixed Grove	1	0.3
Total	**290**	**100**

Table C-6. Nest Tree Species used by Nesting Swainson's Hawks in the Yolo County Study Area, 2007

Tree Species	Number of Active Nest Sites	Percent of Total
Valley Oak	101	35.7
Cottonwood	76	26.9
Walnut	33	11.7
Willow	32	11.3
Eucalyptus	26	9.2
Pine	7	2.5
Locust	4	1.4
Redwood	2	0.7
Sycamore	2	0.7
Total	**283**	**100**

C.32.3.2 Foraging

Swainson's hawks are essentially plains or open-country hunters, requiring large areas of open landscape for foraging. Historically, the species used the grasslands of the Central Valley and other inland valleys, and valley oak savanna with and understory of *Elymus triticoides*. With substantial conversion of these grasslands to farming operations, Swainson's hawks have shifted their nesting and foraging into those agricultural lands that provide low, open vegetation for hunting and high rodent prey populations.

Foraging habitat value is a function of patch size (i.e., Swainson's hawks are sensitive to fragmented landscapes; use will decline as suitable patch size decreases), prey accessibility (i.e., the ability of hawks to access prey depending on the vegetative structure), and prey availability (i.e., the abundance of prey populations in a field). In the Central Valley, agricultural land use or specific crop type determines the foraging value of a field at any given time. Cover types were evaluated by Estep (1989) and ranked based on these factors. However, suitability ranking is based on a variety of site-specific issues and at a landscape level should be characterized only on a general basis. On a site-specific level – important for land management purposes to maximize foraging value – individual cover types can be assessed based on site-specific and management conditions.

Important land cover or agricultural crops for foraging are alfalfa and other hay, grain and row crops, fallow fields, dryland pasture, and annual grasslands. The matrix of these cover types across a large area creates a dynamic foraging landscape as temporal changes in vegetation results in changing foraging patterns and foraging ranges.

Hay crops, particularly alfalfa, provide the highest value because of the low vegetation structure (high prey accessibility), relatively large prey populations (high prey availability), and because farming operations (e.g., weekly irrigation and monthly mowing during the growing season) enhance prey accessibility. Most row and grain crops are planted in winter or spring and have foraging value while the vegetation remains low, but become less suitable as vegetative cover and density increases. During harvest, vegetation cover is eliminated while prey populations are highest, significantly enhancing their suitability during this period. Some crop types, such as rice, orchards, and vineyards, provide little to no value because of reduced accessibility and relatively low prey populations.

C.32.4 Species Distribution and Population Trends

C.32.4.1 Distribution

In North America, Swainson's hawks nest in the grassland plains and agricultural regions from southern Canada (and possibly in the northern provinces and territories, and Alaska) to northern Mexico. Other than a few documented small wintering populations in the United States (Herzog 1996; England et al. 1997), the species winters primarily in the Pampas region of Argentina. The Central Valley population winters between Mexico and central South America (Bradbury et al. in preparation).

Early accounts described Swainson's hawk as one of the most common raptors in California, occurring throughout much of lowland the portions of the state (Sharp 1902). Since the mid-1800s, native habitats that supported the species have undergone a gradual conversion to agricultural or urban uses. Today, native grassland habitats are virtually nonexistent in the state, and only remnants of the once vast riparian forests and oak woodlands still exist (Katibah 1983). While the species has successfully adapted to certain agricultural landscapes, this habitat loss has caused a substantial reduction in the breeding range and in the size of the breeding population in California (Bloom 1980; England et al. 1997). Current breeding populations occur primarily in the Central Valley, but also in the Klamath Basin, the northeastern plateau, Owens Valley, and rarely in the Antelope Valley (Grinnell and Miller 1944; Bloom 1980; Garrett and Dunn 1981). The bulk of the Central Valley population resides in Yolo, Sacramento, Solano, and San Joaquin Counties.

In Yolo County, the species is distributed throughout the low elevation agricultural region east of the Interior Coast Range. Closely associated with agricultural cover type, the distribution of the species generally follows the pattern of hay, grain, and row crops. The majority of nesting pairs occur from several miles north of Woodland south to Putah Creek and east to the Sacramento River. Fewer pairs occur in the predominantly rice growing region in the northeastern portion of the county, in the orchard region in the northwest and southwest portions of the county, and the wetland-dominated areas of the southern panhandle. They generally avoid scrub, chaparral, savannah, or oak-dominated habitats in the western portion of the county. The highest nesting concentrations are north of Woodland to County Road 12; along oak and cottonwood-dominated riparian corridors such as Willow Slough, Putah Creek, and the Sacramento River; and between Davis and Woodland, and west to approximately Interstate 505 and east to the Sacramento River (Estep 2008).

C.32.4.2 Population Trends

Swainson's hawk populations have declined in California, Utah, Nevada, and Oregon (England et al. 1997). Populations in other western states are considered stable. Bloom (1980) reported a statewide estimate of 375 breeding pairs. This was followed by estimates of 550 (California Department of Fish and Game [DFG] 1988) in the late 1980s and 800 to 1,000 breeding pairs in the late 1990s (Swainson's Hawk Technical Advisory Committee 1999). However, none of these estimates was generated using a statistically based statewide survey effort and would be considered less credible than the results of a more statistically valid approach. The most recent statewide population estimate for California is 2,081 breeding pairs (Anderson et al. 2006) and is based on a statistically valid statewide survey effort conducted in 2005 and 2006. While this estimate is higher than the original statewide estimate that led to the state listing of the species (Bloom 1980) and subsequent estimates through the 1980s and 1990s, it represents a substantial decline (50–90 percent) of the historical statewide breeding population in California (Bloom 1980).

Baseline surveys conducted in 2007 located a total of 290 active breeding territories in Yolo County (Estep 2008). This was the first comprehensive baseline of this species in the County, and thus cannot be used to assess a trend in the number of breeding pairs in the County. However, based on the results of a long-term population study conducted in Yolo County since the mid-1980s (Estep in preparation), there appears to have been an upward trend in the number of breeding pairs (Table 3). While this may be at least partially attributed to increasing observer detection skill in the early years of the study, this local population appears to be at least stable with respect to the number of breeding pairs. Whether or not this population is stable based on productivity and recruitment is undetermined.

Table C-7. Swainson's Hawk Activity Data: Yolo County Study Area 1988–2000[1]

Year	Active Territories	Nesting Pairs	Successful Nests	Number of Young	Fledging Rate per Successful Nest
1988	55	48	46	62	1.34
1989	71	61	60	90	1.50
1990	85	72	70	118	1.69
1991	108	95	83	122	1.45
1992	122	110	94	136	1.45
1993	101	80	68	105	1.54
1994	137	128	110	188	1.70
1995	140	110	83	110	1.33
1996	139	101	75	107	1.43
1997	125	78	66	92	1.39
1998	158	103	27	31	1.15
1999	131	127	71	139	1.96
2000	136	126	69	102	1.48

[1] From Estep, J. A. In preparation. Ecology of the Swainson's Hawk in the Central Valley of California.

C.32.5 Threats to the Species

Swainson's hawks face different threats in different portions of their range. In California, causes of population decline are thought to be loss of nesting habitat (Schlorff and Bloom 1984) and loss of foraging habitat to urban development and to conversion to unsuitable agriculture such as orchards and vineyards (England et al. 1997; England et al*.* 1995). Nestlings are vulnerable to starvation and fratricide (i.e., the larger nestling killing the smaller nestling in times of food stress); predation from other raptors, crows, and ravens cause significant nestling losses. Natural population cycles of voles in central California may be a major factor in reproductive success where vole population crashes suppress reproduction or lead to increased starvation rates of nestlings (J. Estep pers. comm.). In addition, insecticides and rodenticides may contribute to these rates by reducing prey abundance. There is little evidence that adult Swainson's hawks are killed by natural predators, but collisions with moving vehicles and illegal shooting and trapping have been identified as sources of mortality (England et al. 1997).

Well-documented mass poisoning of hundreds or thousands of Swainson's hawks wintering in Argentina (Woodbridge et al. 1995; Goldstein et al. 1996) have led to that country's ban of an insecticide (organophosphate monocrotophos) used on alfalfa and sunflower fields to control grasshopper populations. Levels of dichlorodiphenyldichloroethylene (DDE), a breakdown product of DDT, in Swainson's hawks from the Central Valley may have been high enough to negatively affect reproductive success during the decades when it was used extensively in the United States. However, levels of DDE measured in eggs collected in 1982–1983 were not considered high enough to indicate a health threat (Risebrough et al. 1989).

Where populations are limited by inadequate nesting and foraging habitat, the most effective approach for Swainson's hawk conservation may be in management of agricultural landscapes (Smallwood 1995). Nesting density is greatest in cultivated areas where tree density (Schmutz 1984) and prey availability (Bechard 1982) are highest. Alfalfa fields are among the more valuable foraging habitats in California, even when compared with nonagricultural areas. However, valuable prey species such as pocket gophers (*Thomomys* spp.) and other small mammals may be exterminated in such fields (Smallwood 1995). While agricultural areas may benefit these hawks, fully realizing the conservation potential of cultivated areas to Swainson's hawks will be impaired when prey populations are controlled by means of poisons. Maintenance of critical prey populations is necessary to attain the full benefits of alfalfa fields and other agricultural crops to Swainson's hawks (Smallwood 1995).

In contrast to some agricultural landscapes, Swainson's hawks are absent from or are in very low densities in large expanses of annual grasslands in the Central Valley (Detrich 1996 cited in Woodbridge 1998). These grasslands have high densities of nocturnal, burrowing rodents that are rarely available as prey to Swainson's hawks and have low densities of voles (*Microtus* spp.) and pocket gophers that the hawks prefer (Woodbridge 1998). Because voles are active during the day and live among vegetation, they are especially accessible and important prey for hawks. Restoring perennial grasslands and promoting agriculture that supports high densities of voles and pocket gophers would create or enhance foraging habitat and could potentially expand Swainson's hawk distribution in Yolo County.

Many populations of prey species, especially voles, mice and insects, fluctuate due to annual, seasonal, and local geographic variations in rainfall, predation pressures, natural population cycles, and agricultural practices, including changing crop types, harvesting, applying rodenticides and insecticides, flood irrigating, and disking. The timing of harvesting and disking also strongly affects prey abundance (Woodbridge 1998). The importance of crop types for foraging habitat rest on two variables: abundance of voles and other important prey, and amount of vegetative cover that affects access to prey (Estep 2009). Alfalfa is an important habitat because although it supports lower populations of voles, the amount of vegetative cover is not sufficient to provide much protection to voles from foraging hawks. Tomato and beets fields, in contrast, support high populations of voles, but their higher vegetative cover provides better protection for voles, thereby decreasing those habitats' value. Furthermore, as crops mature, their protective cover for rodents increases, making prey less available to hawks (Bechard 1982; Woodbridge 1998; Estep 2009). In agricultural landscapes, prey abundance and accessibility to hawks continuously change through the breeding season. All of these factors play major roles in reproductive success (J. Estep pers. comm.). To reduce negative effects on regional populations, large areas of optimal foraging habitats should be preserved or managed for populations of Swainson's hawks and their prey (DFG 1994). Better understanding of the dynamics and processes of how agricultural practices affect these populations on a landscape level would help to guide conservation planning.

In areas with suitable foraging habitat that lack Swainson's hawks, surveys of potential nest trees should be conducted to assess whether the hawk population is limited by lack of suitable nest trees. Also, the relationship between Swainson's hawks and locally breeding red-shouldered hawks, red-tailed hawks, and great horned owls should be studied to determine whether competition for nest trees and prey are negatively affecting the Swainson's hawk population or distribution in Yolo County.

C.32.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.6.3, *Habitat Requirements and Ecology* (Figure A-6). The model parameters include the following.

Nesting Habitat: This modeled habitat type includes all potentially suitable nesting habitat and was modeled by selecting all mapped vegetation types as listed below that occur below an elevation of 350 feet outside of Planning Units 3 and 4 (Hofmann pers. comm.). In addition, all remnant woody vegetation outside of blue oak woodland and blue oak foothill pine occurring in isolated patches or isolated trees in agricultural fields or field borders (Tuil 2008) outside of Planning Units 3 and 4 below an elevation of 350 feet were included as potential nesting habitat to the extent that they were mapped. The majority of isolated trees and roadside and field border trees, which are commonly used as Swainson's hawk nest trees, were not mapped and thus the extent and distribution of potential nesting habitat is underestimated. The elevation limit was based on the elevational extent of potential nesting habitat in the Plan Area.

- Eucalyptus
- Valley Oak Woodland
- Fremont Cottonwood – Valley Oak – Willow (Ash – Sycamore) Riparian Forest Not Formally Defined (NFD) Association
- Great Valley Valley Oak Riparian Association
- Mixed Fremont Cottonwood – Willow spp. NFD Alliance
- Mixed Willow Super Alliance
- Valley Oak – Fremont Cottonwood – (Coast Live Oak) Riparian Forest NFD Association
- Valley Oak Alliance –Riparian
- White Alder (Mixed Willow) Riparian Forest NFD Association
- Undifferentiated Riparian Woodland/Forest

- Agricultural Foraging Habitat: This modeled habitat type includes all of the annually cultivated irrigated cropland and semi-perennial hay crops (e.g., alfalfa) listed below that occur at an elevation of 500 feet or lower. While there is a high degree of variability in the suitability of these agricultural crop types, because they rotate annually or periodically, field-level value changes across the landscape each year.
  - All Field Crops
  - All Grain/Hay Crops
  - Pasture (alfalfa)
  - Native Pasture
  - Miscellaneous Grasses
  - Mixed Pasture
  - All Truck and Berry Crops
- Natural Foraging Habitat: This modeled habitat type includes the uncultivated grassland and seasonal wetland land cover types listed below that occur at an elevation of 500 feet or lower. These land cover types generally produce less available microtine prey due to dryer conditions or periodic inundation. While suitable foraging habitat, these types are expected to be used less frequently than cultivated habitats.
  - California Annual Grassland Alliance
  - Upland Annual Grassland and Forbs Formation
  - Alkali Sink
  - Vernal Pool Complex
  - *Carex* spp. *Juncus* spp. Wet Meadow Grasses NFD Super Alliance
  - *Crypsis* spp. Wetland Grasses – Wetland Forbs NFD Super Alliance
  - Undetermined Alliance – Managed
- Modeling limited to Planning Units: 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 14, 16, 17, 18, 19, 20, 21, 22

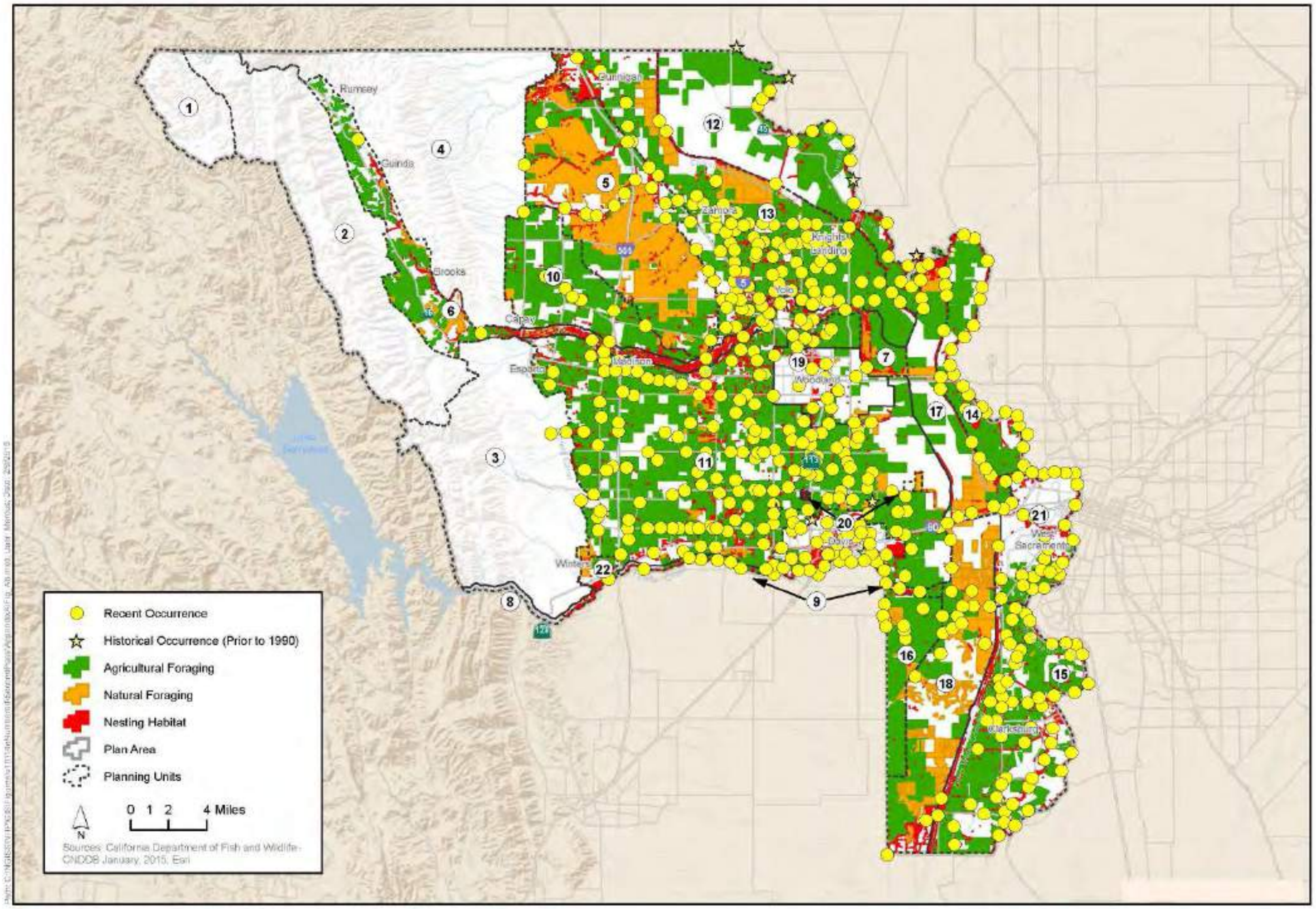
C.32.6.1 Cumulative Nest Locations and Sightings

Figure A-20 displays the cumulative distribution of recent and historical nest locations and sightings (nesting records with lower mapping precision) from a variety of data sources.

- Nest Locations (2007 surveys): Nest locations mapped from 2007 surveys (Estep 2008).
- Other Recent Nest Locations: Location where the nests have relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., California Natural Diversity Database [CNDDB], California Department of Fish and Wildlife [DFW], and Chris DiDio of the University of California, Davis (UC Davis).
- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB, California Department of Fish and Game,

Chris DiDio of UC Davis, UC Davis Museum of Wildlife and Fish Biology, California eBird, Avian Knowledge Network).

Figure C-27. Swainson's Hawk Modeled Habitat and Occurrences



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C.33 Swainson's Hawk (*Buteo swainsoni*)


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C.33.1 Listing Status

Federal: Bird of Conservation Concern (U.S. Fish and Wildlife Service [USFWS] 2008).

State: Threatened.

Recovery Plan: None.

C.33.2 Species Description and Life History

Swainson's hawk (*Buteo swainsoni*) is a long-winged, medium-sized soaring raptor, (48 to 56 centimeters [19 to 22 inches] and 693 to 1367 grams [24.46 to 48.26 ounces]) that nests and roosts in large trees in flat, open grassland or agricultural landscapes. Females average larger than males, but there are no distinguishing plumage characteristics for separating the sexes.

Swainson's hawk is characterized by its long, narrow, and tapered wings held in flight in a slight dihedral shape. The body size is somewhat smaller, thinner, and less robust than other *Buteos*, although the wings are at least as long as other *Buteos*. This body and wing shape allows for efficient soaring flight and aerial maneuverability, important for foraging, which Swainson's hawks do primarily from the wing, and during courtship and inter-specific territorial interactions.

There are three definitive plumage morphs: light, rufous, and dark. However, there are numerous intermediate variations between these plumage morphs. The two most distinguishing plumage characteristics are a dark breast band and the contrasting darker flight feathers and lighter wing lings on the underwings, giving most individuals a distinctive bicolored underwing pattern. These characteristics are most pronounced in lighter morph birds and become less so as the plumage darkens, and are indistinguishable in the definitive dark morph, which is completely melanistic. All three definitive plumage morphs are present in the Central Valley with a relatively large proportion of the population categorized as intermediate morph, with varying amounts of streaking or coloration in the belly and wing linings.

C.33.2.1 Seasonal Patterns

Swainson's hawks arrive on their breeding grounds in the Central Valley from early March to early April. The breeding season extends through mid-to-late August, when most young have fledged and breeding territories are no longer defended. By late August pre-migratory groups begin to form. The fall migration begins early- to mid-September. By early October, most Swainson's hawks have migrated out of the Central Valley. Central Valley Swainson's hawks winter from Central Mexico, to northern and central South America (Bradbury et al. in preparation). This differs from what is known about the migratory pattern and wintering grounds of Swainson's hawk populations outside of the Central Valley, most of which take a different migratory route and winter entirely in southern

South America, with the largest wintering populations known to occur in northern Argentina (England et al. 1997).

C.33.2.2 Reproduction

Swainson's hawks exhibit a high degree of nest site fidelity, using the same nests, nest trees, or nesting stands for many years (England et al. 1997). Pairs are monogamous and may maintain bonds for many years (England et al. 1997). Immediately upon arrival onto breeding territories, breeding pairs begin constructing new nests or repairing old ones. One to four eggs are laid in mid- to late April followed by a 30- to 34-day incubation period. Nestlings begin to hatch by mid-May followed by an approximately 20-day brooding period. The young remain in the nest until they fledge in 38 to 42 days after hatching (England et al. 1997). Studies conducted in the Sacramento Valley indicate that one or two, and occasionally three, young typically fledge from successful nests (Estep in preparation). The rate of young fledged per nest in the Central Valley is among the lowest recorded in the entire species range. This geographic difference in reproductive success may be related to the reliance on small voles that may not meet the high energetic demands of breeding adults and developing young compared to the diets that include a higher proportion of gophers, rabbits, ground squirrels and other larger mammals consumed in other locations (S. England pers. comm.). In Yolo County, fledging rates ranged from 1.15 to 1.96 young per successful nest from 1988 to 2000 (Table 1) (Estep in preparation).

After fledging, young remain near the nest and are dependent on the adults for about four weeks, after which they permanently leave the breeding territory (Anderson et al. in preparation).

C.33.2.3 Home Range/Territory Size

Home ranges are highly variable depending on cover type, and fluctuate seasonally and annually with changes in vegetation structure (e.g., growth, harvest) (Estep 1989; Woodbridge 1991; Babcock 1995). Smaller home ranges consist of high percentages of alfalfa, fallow fields, and dry pastures (Estep 1989; Woodbridge 1991; Babcock 1995). Larger home ranges were associated with higher proportions of cover types with reduced prey accessibility, such as orchards and vineyards, or reduced prey abundance, such as flooded rice fields. Swainson's hawks regularly forage across a very large landscape compared with most raptor species. Data from Estep (1989) and England et al. (1995) indicate that it remains energetically feasible for Swainson's hawks to successfully reproduce when food resources are limited around the nest and large foraging ranges are required. Radio-telemetry studies indicate that breeding adults in the Central Valley routinely forage as far as 30 kilometers (km) (18.7 miles) from the nest (Estep 1989; Babcock 1995).

Home ranges (calculated as minimum convex polygons) for 12 Swainson's hawks in the Central Valley, including six in Yolo County, averaged 27.6 square kilometers (km^2)(10.7 square miles [mi^2]) (range: 3.36 to 87.18 km^2 [1.3 to 33.7 mi^2) (Estep 1989). Using similar methods, four Swainson's hawks in West Sacramento averaged 40.5 km^2 (15.6 mi^2) (range: 7.2 to 76.6 km^2 [2.8 to 29.6 mi^2]), and included fields planted in grain, alfalfa, tomatoes, and safflower, as well as fallow fields (Babcock 1995).

Swainson's hawks in the central region of the Central Valley (including Yolo County) had the shortest distances between nests of those reported in England et al. (1997); on average, nests were 1.14 km (0.7 miles) apart (Estep 1989). Nesting density in the Central Valley was calculated at 30.2 pairs/100 km^2 (11.7 pairs/100 mi^2) (range: 21.4 to 39.1 km^2; [8.3 to 15.1 mi^2]) (England et al.

1995). This high nest density was attributed to widely available, uniformly distributed optimal foraging habitat and relatively abundant nesting sites along narrow riparian corridors, farm shelterbelts, roadside trees, remnant groves, and isolated trees. Results from a 2007 baseline survey of nesting Swainson's hawks in Yolo County indicate a nesting density within the survey area (excluding the higher elevation portions of the county of 98 pairs/100 km^2 (37.8/100 mi^2), the highest nesting density reported for this species (Estep 2008).

C.33.2.4 Foraging Behavior and Diet

Swainson's hawks hunt primarily from the wing, searching for prey from a low-altitude soaring flight, 30 to 90 meters (98.4 to 295.2 feet) above the ground and attack prey by stooping toward the ground (Estep 1989). This species is also highly responsive to farming activities that expose and concentrate prey, such as cultivating, harvesting, and disking. During these activities, particularly late in the season, Swainson's hawks will hunt behind tractors searching for exposed prey. Other activities, such as flood irrigation and burning, also expose prey and attract foraging Swainson's hawks.

In the Central Valley, Swainson's hawks feed primarily on small rodents, usually in large fields that support low vegetative cover (to provide access to the ground) and high densities of prey (Bechard 1982; Estep 1989). These habitats include hay fields, grain crops, certain row crops, and lightly grazed pasturelands. Fields lacking adequate prey populations (e.g., flooded rice fields) or those that are inaccessible to foraging birds (e.g., vineyards and orchards) are rarely used Estep 1989; Babcock 1995; Swolgaard 2004).

Meadow vole (*Microtus californicus*) is the principal prey item taken by Swainson's hawks in the Central Valley (Estep 1989). Pocket gopher (*Thomomys bottae*) is also an important prey item. Other small rodents, including deer mouse (*Peromyscus californicus*) and house mouse (*Mus musculus*) are also taken along with a variety of small birds, reptiles, and insects.

During late summer, the diet of post-breeding adults and juveniles includes an increasing amount of insects, including grasshoppers and dragonflies. Dragonflies may constitute a major proportion of the diet of post-breeding and migrant birds. In the Central Valley during summer, dragonfly species that swarm in large numbers and that are a potentially important, abundant food source are common green darner (*Anax junius*), spot-winged glider (*Pantalahy hymenaea*), and wandering glider (*Pantala flavescens*). In alfalfa and corn crops in Idaho, post-breeding flocks also forage primarily on grasshoppers (Johnson et al. 1987). Dragonflies are also the primary prey for wintering birds in Argentina (Jaramillo 1993).

Following their arrival back on the breeding grounds, Swainson's hawks again shift their diet to include larger prey such as small rodents, rabbits, birds, and reptiles (England et al. 1997). This shift to a higher quality diet is prompted by the nestlings' nutritional demands during rapid growth and the adults' high energetic costs of breeding.

C.33.3 Habitat Requirements and Ecology

C.33.3.1 Nesting

Throughout much of its range, both in North and South America, the Swainson's hawk inhabits grasslands, prairies, shrub-steppes, and agricultural landscapes, including dry and irrigated row crops, alfalfa and hay fields, pastures, and rangelands. They nest in trees most often in riparian woodlands and farm shelterbelts (England et al. 1997), as well as in urban/suburban areas with large trees adjacent to suitable foraging habitat (England et al. 1995; James 1992). Suitable nest trees are usually deciduous and tall (up to 30.48 meters [100 feet]); but in suburban/urban areas, most nest trees are conifers (England et al. 1997; England et al. 1995). Nests are built of sticks sometimes several feet in diameter. They are generally placed in the uppermost and outermost branches that will support the nest, often in mistletoe clumps (England et al. 1997).

In the Central Valley, Swainson's hawks usually nest in large native trees such as valley oak (*Quercus lobata*), cottonwood (*Populus fremontii*), walnut (*Juglans hindsii*), and willow (*Salix* spp.), and occasionally in nonnative trees such as eucalyptus (*Eucalyptus* spp.). Nests occur in riparian woodlands, roadside trees, trees along field borders, isolated trees, small groves, and on the edges of remnant oak woodlands. Stringers of remnant riparian forest along drainages contain the majority of known nests in the Central Valley (Estep 1984; Schlorff and Bloom 1984; England et al. 1997). This appears to be a function of nest tree availability, however, rather than dependence on riparian forest. Nests are usually constructed as high as possible in the tree, providing protection to the nest as well as visibility from it.

Tables 1 and 2 indicate the nesting habitat results from the 2007 baseline survey (Estep 2008). Riparian habitat was the most frequently used nesting habitat type, followed by roadside tree rows, isolated trees, and rural residential trees. Valley oak (*Quercus lobata*) was the most frequently used nest tree species, followed by Fremont cottonwood (*Populus fremontii*), walnut (*Juglans hindsii*), willow (*Salix* spp.), and eucalyptus trees (*Eucalyptus* spp.).

Table C-8. Nesting Habitat Associations of Swainson's Hawk Territories in the Yolo County Study Area, 2007

Nesting Habitat Type	Number of Territories	Percent of Total
Riparian (natural)	106	36.6
Roadside Tree Row	39	13.4
Riparian (channelized)	36	12.4
Isolated Tree	32	11.0
Rural Residential	26	9.0
Tree Row	19	6.6
Isolated Roadside Tree	15	5.2
Eucalyptus Grove	6	2.1
Oak Grove	4	1.4
Urban	3	1.0
Cottonwood Grove	1	0.3
Savanna	1	0.3
Farmyard	1	0.3
Mixed Grove	1	0.3
Total	**290**	**100**

Table C-9. Nest Tree Species used by Nesting Swainson's Hawks in the Yolo County Study Area, 2007

Tree Species	Number of Active Nest Sites	Percent of Total
Valley Oak	101	35.7
Cottonwood	76	26.9
Walnut	33	11.7
Willow	32	11.3
Eucalyptus	26	9.2
Pine	7	2.5
Locust	4	1.4
Redwood	2	0.7
Sycamore	2	0.7
Total	**283**	**100**

C.33.3.2 Foraging

Swainson's hawks are essentially plains or open-country hunters, requiring large areas of open landscape for foraging. Historically, the species used the grasslands of the Central Valley and other inland valleys, and valley oak savanna with and understory of *Elymus triticoides*. With substantial conversion of these grasslands to farming operations, Swainson's hawks have shifted their nesting and foraging into those agricultural lands that provide low, open vegetation for hunting and high rodent prey populations.

Foraging habitat value is a function of patch size (i.e., Swainson's hawks are sensitive to fragmented landscapes; use will decline as suitable patch size decreases), prey accessibility (i.e., the ability of hawks to access prey depending on the vegetative structure), and prey availability (i.e., the abundance of prey populations in a field). In the Central Valley, agricultural land use or specific crop type determines the foraging value of a field at any given time. Cover types were evaluated by Estep (1989) and ranked based on these factors. However, suitability ranking is based on a variety of site-specific issues and at a landscape level should be characterized only on a general basis. On a site-specific level – important for land management purposes to maximize foraging value – individual cover types can be assessed based on site-specific and management conditions.

Important land cover or agricultural crops for foraging are alfalfa and other hay, grain and row crops, fallow fields, dryland pasture, and annual grasslands. The matrix of these cover types across a large area creates a dynamic foraging landscape as temporal changes in vegetation results in changing foraging patterns and foraging ranges.

Hay crops, particularly alfalfa, provide the highest value because of the low vegetation structure (high prey accessibility), relatively large prey populations (high prey availability), and because farming operations (e.g., weekly irrigation and monthly mowing during the growing season) enhance prey accessibility. Most row and grain crops are planted in winter or spring and have foraging value while the vegetation remains low, but become less suitable as vegetative cover and density increases. During harvest, vegetation cover is eliminated while prey populations are highest, significantly enhancing their suitability during this period. Some crop types, such as rice, orchards, and vineyards, provide little to no value because of reduced accessibility and relatively low prey populations.

C.33.4 Species Distribution and Population Trends

C.33.4.1 Distribution

In North America, Swainson's hawks nest in the grassland plains and agricultural regions from southern Canada (and possibly in the northern provinces and territories, and Alaska) to northern Mexico. Other than a few documented small wintering populations in the United States (Herzog 1996; England et al. 1997), the species winters primarily in the Pampas region of Argentina. The Central Valley population winters between Mexico and central South America (Bradbury et al. in preparation).

Early accounts described Swainson's hawk as one of the most common raptors in California, occurring throughout much of lowland the portions of the state (Sharp 1902). Since the mid-1800s, native habitats that supported the species have undergone a gradual conversion to agricultural or urban uses. Today, native grassland habitats are virtually nonexistent in the state, and only remnants of the once vast riparian forests and oak woodlands still exist (Katibah 1983). While the species has successfully adapted to certain agricultural landscapes, this habitat loss has caused a substantial reduction in the breeding range and in the size of the breeding population in California (Bloom 1980; England et al. 1997). Current breeding populations occur primarily in the Central Valley, but also in the Klamath Basin, the northeastern plateau, Owens Valley, and rarely in the Antelope Valley (Grinnell and Miller 1944; Bloom 1980; Garrett and Dunn 1981). The bulk of the Central Valley population resides in Yolo, Sacramento, Solano, and San Joaquin Counties.

In Yolo County, the species is distributed throughout the low elevation agricultural region east of the Interior Coast Range. Closely associated with agricultural cover type, the distribution of the species generally follows the pattern of hay, grain, and row crops. The majority of nesting pairs occur from several miles north of Woodland south to Putah Creek and east to the Sacramento River. Fewer pairs occur in the predominantly rice growing region in the northeastern portion of the county, in the orchard region in the northwest and southwest portions of the county, and the wetland-dominated areas of the southern panhandle. They generally avoid scrub, chaparral, savannah, or oak-dominated habitats in the western portion of the county. The highest nesting concentrations are north of Woodland to County Road 12; along oak and cottonwood-dominated riparian corridors such as Willow Slough, Putah Creek, and the Sacramento River; and between Davis and Woodland, and west to approximately Interstate 505 and east to the Sacramento River (Estep 2008).

C.33.4.2 Population Trends

Swainson's hawk populations have declined in California, Utah, Nevada, and Oregon (England et al. 1997). Populations in other western states are considered stable. Bloom (1980) reported a statewide estimate of 375 breeding pairs. This was followed by estimates of 550 (California Department of Fish and Game [DFG] 1988) in the late 1980s and 800 to 1,000 breeding pairs in the late 1990s (Swainson's Hawk Technical Advisory Committee 1999). However, none of these estimates was generated using a statistically based statewide survey effort and would be considered less credible than the results of a more statistically valid approach. The most recent statewide population estimate for California is 2,081 breeding pairs (Anderson et al. 2006) and is based on a statistically valid statewide survey effort conducted in 2005 and 2006. While this estimate is higher than the original statewide estimate that led to the state listing of the species (Bloom 1980) and subsequent estimates through the 1980s and 1990s, it represents a substantial decline (50–90 percent) of the historical statewide breeding population in California (Bloom 1980).

Baseline surveys conducted in 2007 located a total of 290 active breeding territories in Yolo County (Estep 2008). This was the first comprehensive baseline of this species in the County, and thus cannot be used to assess a trend in the number of breeding pairs in the County. However, based on the results of a long-term population study conducted in Yolo County since the mid-1980s (Estep in preparation), there appears to have been an upward trend in the number of breeding pairs (Table 3). While this may be at least partially attributed to increasing observer detection skill in the early years of the study, this local population appears to be at least stable with respect to the number of breeding pairs. Whether or not this population is stable based on productivity and recruitment is undetermined.

Table C-10. Swainson's Hawk Activity Data: Yolo County Study Area 1988–2000[1]

Year	Active Territories	Nesting Pairs	Successful Nests	Number of Young	Fledging Rate per Successful Nest
1988	55	48	46	62	1.34
1989	71	61	60	90	1.50
1990	85	72	70	118	1.69
1991	108	95	83	122	1.45
1992	122	110	94	136	1.45
1993	101	80	68	105	1.54
1994	137	128	110	188	1.70
1995	140	110	83	110	1.33
1996	139	101	75	107	1.43
1997	125	78	66	92	1.39
1998	158	103	27	31	1.15
1999	131	127	71	139	1.96
2000	136	126	69	102	1.48

[1] From Estep, J. A. In preparation. Ecology of the Swainson's Hawk in the Central Valley of California.

C.33.5 Threats to the Species

Swainson's hawks face different threats in different portions of their range. In California, causes of population decline are thought to be loss of nesting habitat (Schlorff and Bloom 1984) and loss of foraging habitat to urban development and to conversion to unsuitable agriculture such as orchards and vineyards (England et al. 1997; England et al*.* 1995). Nestlings are vulnerable to starvation and fratricide (i.e., the larger nestling killing the smaller nestling in times of food stress); predation from other raptors, crows, and ravens cause significant nestling losses. Natural population cycles of voles in central California may be a major factor in reproductive success where vole population crashes suppress reproduction or lead to increased starvation rates of nestlings (J. Estep pers. comm.). In addition, insecticides and rodenticides may contribute to these rates by reducing prey abundance. There is little evidence that adult Swainson's hawks are killed by natural predators, but collisions with moving vehicles and illegal shooting and trapping have been identified as sources of mortality (England et al. 1997).

Well-documented mass poisoning of hundreds or thousands of Swainson's hawks wintering in Argentina (Woodbridge et al. 1995; Goldstein et al. 1996) have led to that country's ban of an insecticide (organophosphate monocrotophos) used on alfalfa and sunflower fields to control grasshopper populations. Levels of dichlorodiphenyldichloroethylene (DDE), a breakdown product of DDT, in Swainson's hawks from the Central Valley may have been high enough to negatively affect reproductive success during the decades when it was used extensively in the United States. However, levels of DDE measured in eggs collected in 1982–1983 were not considered high enough to indicate a health threat (Risebrough et al. 1989).

Where populations are limited by inadequate nesting and foraging habitat, the most effective approach for Swainson's hawk conservation may be in management of agricultural landscapes (Smallwood 1995). Nesting density is greatest in cultivated areas where tree density (Schmutz 1984) and prey availability (Bechard 1982) are highest. Alfalfa fields are among the more valuable foraging habitats in California, even when compared with nonagricultural areas. However, valuable prey species such as pocket gophers (*Thomomys* spp.) and other small mammals may be exterminated in such fields (Smallwood 1995). While agricultural areas may benefit these hawks, fully realizing the conservation potential of cultivated areas to Swainson's hawks will be impaired when prey populations are controlled by means of poisons. Maintenance of critical prey populations is necessary to attain the full benefits of alfalfa fields and other agricultural crops to Swainson's hawks (Smallwood 1995).

In contrast to some agricultural landscapes, Swainson's hawks are absent from or are in very low densities in large expanses of annual grasslands in the Central Valley (Detrich 1996 cited in Woodbridge 1998). These grasslands have high densities of nocturnal, burrowing rodents that are rarely available as prey to Swainson's hawks and have low densities of voles (*Microtus* spp.) and pocket gophers that the hawks prefer (Woodbridge 1998). Because voles are active during the day and live among vegetation, they are especially accessible and important prey for hawks. Restoring perennial grasslands and promoting agriculture that supports high densities of voles and pocket gophers would create or enhance foraging habitat and could potentially expand Swainson's hawk distribution in Yolo County.

Many populations of prey species, especially voles, mice and insects, fluctuate due to annual, seasonal, and local geographic variations in rainfall, predation pressures, natural population cycles, and agricultural practices, including changing crop types, harvesting, applying rodenticides and insecticides, flood irrigating, and disking. The timing of harvesting and disking also strongly affects prey abundance (Woodbridge 1998). The importance of crop types for foraging habitat rest on two variables: abundance of voles and other important prey, and amount of vegetative cover that affects access to prey (Estep 2009). Alfalfa is an important habitat because although it supports lower populations of voles, the amount of vegetative cover is not sufficient to provide much protection to voles from foraging hawks. Tomato and beets fields, in contrast, support high populations of voles, but their higher vegetative cover provides better protection for voles, thereby decreasing those habitats' value. Furthermore, as crops mature, their protective cover for rodents increases, making prey less available to hawks (Bechard 1982; Woodbridge 1998; Estep 2009). In agricultural landscapes, prey abundance and accessibility to hawks continuously change through the breeding season. All of these factors play major roles in reproductive success (J. Estep pers. comm.). To reduce negative effects on regional populations, large areas of optimal foraging habitats should be preserved or managed for populations of Swainson's hawks and their prey (DFG 1994). Better understanding of the dynamics and processes of how agricultural practices affect these populations on a landscape level would help to guide conservation planning.

In areas with suitable foraging habitat that lack Swainson's hawks, surveys of potential nest trees should be conducted to assess whether the hawk population is limited by lack of suitable nest trees. Also, the relationship between Swainson's hawks and locally breeding red-shouldered hawks, red-tailed hawks, and great horned owls should be studied to determine whether competition for nest trees and prey are negatively affecting the Swainson's hawk population or distribution in Yolo County.

C.33.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.6.3, *Habitat Requirements and Ecology* (Figure A-6). The model parameters include the following.

Nesting Habitat: This modeled habitat type includes all potentially suitable nesting habitat and was modeled by selecting all mapped vegetation types as listed below that occur below an elevation of 350 feet outside of Planning Units 3 and 4 (Hofmann pers. comm.). In addition, all remnant woody vegetation outside of blue oak woodland and blue oak foothill pine occurring in isolated patches or isolated trees in agricultural fields or field borders (Tuil 2008) outside of Planning Units 3 and 4 below an elevation of 350 feet were included as potential nesting habitat to the extent that they were mapped. The majority of isolated trees and roadside and field border trees, which are commonly used as Swainson's hawk nest trees, were not mapped and thus the extent and distribution of potential nesting habitat is underestimated. The elevation limit was based on the elevational extent of potential nesting habitat in the Plan Area.

- Eucalyptus
- Valley Oak Woodland
- Fremont Cottonwood – Valley Oak – Willow (Ash – Sycamore) Riparian Forest Not Formally Defined (NFD) Association
- Great Valley Valley Oak Riparian Association
- Mixed Fremont Cottonwood – Willow spp. NFD Alliance
- Mixed Willow Super Alliance
- Valley Oak – Fremont Cottonwood – (Coast Live Oak) Riparian Forest NFD Association
- Valley Oak Alliance –Riparian
- White Alder (Mixed Willow) Riparian Forest NFD Association
- Undifferentiated Riparian Woodland/Forest

- Agricultural Foraging Habitat: This modeled habitat type includes all of the annually cultivated irrigated cropland and semi-perennial hay crops (e.g., alfalfa) listed below that occur at an elevation of 500 feet or lower. While there is a high degree of variability in the suitability of these agricultural crop types, because they rotate annually or periodically, field-level value changes across the landscape each year.
  - All Field Crops
  - All Grain/Hay Crops
  - Pasture (alfalfa)
  - Native Pasture
  - Miscellaneous Grasses
  - Mixed Pasture
  - All Truck and Berry Crops
- Natural Foraging Habitat: This modeled habitat type includes the uncultivated grassland and seasonal wetland land cover types listed below that occur at an elevation of 500 feet or lower. These land cover types generally produce less available microtine prey due to dryer conditions or periodic inundation. While suitable foraging habitat, these types are expected to be used less frequently than cultivated habitats.
  - California Annual Grassland Alliance
  - Upland Annual Grassland and Forbs Formation
  - Alkali Sink
  - Vernal Pool Complex
  - *Carex* spp. *Juncus* spp. Wet Meadow Grasses NFD Super Alliance
  - *Crypsis* spp. Wetland Grasses – Wetland Forbs NFD Super Alliance
  - Undetermined Alliance – Managed
- Modeling limited to Planning Units: 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 14, 16, 17, 18, 19, 20, 21, 22

C.33.6.1 Cumulative Nest Locations and Sightings

Figure A-20 displays the cumulative distribution of recent and historical nest locations and sightings (nesting records with lower mapping precision) from a variety of data sources.

- Nest Locations (2007 surveys): Nest locations mapped from 2007 surveys (Estep 2008).
- Other Recent Nest Locations: Location where the nests have relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., California Natural Diversity Database [CNDDB], California Department of Fish and Wildlife [DFW], and Chris DiDio of the University of California, Davis (UC Davis).
- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB, California Department of Fish and Game,

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C.34 Greater Sandhill Crane (*Grus canadensis tabida*)

C.34.1 Listing Status

Federal: No listing

State: Threatened

C.34.2 Species Description and Life History

The greater sandhill crane is one of six subspecies of sandhill crane in North America; three of which are nonmigratory and occupy ranges in the southeastern United States and Cuba (Littlefield and Ivey 2000). The remaining three are migratory and include the lesser and greater subspecies, both of which are further divided into distinct populations. The greater sandhill crane is divided into five migratory populations, all of which return to the same breeding territory and wintering sites each year. These include the Eastern Population, the Prairie Population, the Rocky Mountain Population, the Lower Colorado River Population, and the Central Valley Population. The Central Valley Population breeds in northeastern California (Figure 2A.19-1), central and eastern Oregon, southwestern Washington, and southern British Columbia; and winters in the Central Valley of California (Littlefield and Ivey 2000).

The greater sandhill crane is the largest of the six sandhill crane subspecies. It stands up to 4.9 feet tall and has a wing span from 5.9 to 6.9 feet. Adult males and females are similar in appearance with gray plumage, whitish face, chin, and upper throat, and a bare red forehead and crown. Greater sandhill cranes sometimes preen iron-rich mud into their feathers leaving a rusty-brown hue that can last throughout the summer months and sometimes remains detectable during the early winter. Juveniles are easily detectable through their first winter by their smaller size and cinnamon-brown plumage, which changes to gray during their first year (Tacha et al. 1992).

Nesting generally begins in April and May and extends from July through August. By September, the Central Valley population begins their migration and arrives onto the wintering grounds by late September, where the cranes remain until approximately late February to early March, when they begin their northward migration back to the breeding grounds (Tacha et al. 1992). Local winter movements continue throughout the winter season in response to changes in flooded habitat and available food resources. For example, Pogson and Lindstedt (1988) and Littlefield (2002) report extensive use of the Butte Basin during the early part of the winter season in October and November and movement of a large segment of the population into the Delta during December and January.

Nesting areas are selected on the basis of meadow size, flooding regime, condition of meadow and presence of cattle, vegetation composition, available food resources, and proximity to human disturbances (Armbruster 1987). Nests are usually constructed as mounds in shallow water (generally less than 12 inches deep), typically in wetland vegetation. The nest is constructed by plucking and stacking the dominant vegetation in the nesting area to form a mound. These are often very large, 2 to 3 feet high and up to 6 feet in diameter. They often use all of the vegetation from several feet around the nest creating a distinctive circular unvegetated ring around the nest mound (Smith 1999). Nests are also constructed on dry ground.

Females usually lay two eggs. Both the male and female incubate the eggs; incubation lasts from 29 to 32 days. One or two young fledge from successful nests. Young fledge at 67 to 75 days. Juveniles remain with the adults during the first year in family groups and do not disperse until they return to the breeding areas the following year (Tacha et al. 1992).

Sandhill cranes are omnivorous and primarily search for subsurface food items by probing soil with their bill. Sandhill crane diet consists of tubers, seeds, grains (particularly corn and rice), small vertebrates (e.g., mice and snakes) and a variety of invertebrates.

C.34.3 Habitat Requirements and Ecology

Greater sandhill cranes are primarily birds of open freshwater wetlands. In California, nesting typically occurs in open grazed meadows. Most of these are bulrush or sedge meadows adjacent to grasslands or short vegetation uplands (Littlefield and Ryder 1968; U.S. Geological Survey 2013; Littlefield 1982). While breeding sites occur on state and federal refuges or U.S. Forest Service lands, more than 60% occur on private lands (Ivey and Herziger 2001).

Wintering habitat is found almost entirely in cultivated lands, and to a lesser extent in managed wetlands and grasslands. Greater sandhill cranes, like many birds, exhibit a high degree of fidelity to their wintering grounds and to specific roosting and foraging habitat areas (Littlefield and Ivey 2000). Wintering habitat consists of three primary elements: foraging habitat, loafing habitat, and roosting habitat. There are two principal foraging habitat types used during winter. In the Strategy Area, harvested corn fields are the most commonly used foraging habitat along with winter wheat, alfalfa, pasture, and fallow fields (Pogson and Lindstedt 1988). Ivey (pers. comm. in Sacramento County 2008) rated foraging habitat cover types in the Delta region in the following order of importance to greater sandhill cranes: harvested corn, winter wheat, irrigated pasture, and alfalfa fields.

Loafing generally occurs midday when birds loosely congregate along agricultural field borders, levees, rice-checks, ditches, managed wetlands, or in alfalfa fields or pastures. Cranes will often loaf in rocky uplands or along gravel roads where they collect grit, which is important in the digestion of grain seeds. During the late afternoon and evening, cranes begin to congregate into large, dense communal groups where they remain until the following morning. Providing protection from predators during the night, roost sites are typically within 2 to 4 miles of foraging and loafing areas (Ivey pers. comm. 2010) and thus available roosting sites are an essential component of winter habitat. Roosting habitat typically consists of shallowly flooded open fields of variable size (1 to 300 acres) or wetlands interspersed with uplands. Water depth is important and averages 4.5 inches. Littlefield U.S. Geological Survey (19932013) reported cranes abandoning roosting sites when water depth reached 8 to 11 inches. He recommended roost sites be a minimum of 20 acres in size with water maintained from early September to mid-March. If properly managed, roost sites are often used for many years.

Greater sandhill cranes are considered intolerant of excessive human disturbances and the level of disturbance may play a role in habitat selection (Lovvorn and Kirkpatrick 1981). Excessive disturbances have caused cranes to abandon foraging and roosting sites; and repeated disturbance may affect their ability to feed and store the energy needed for survival. Ivey and Herziger (2003) documented disturbances of greater sandhill cranes on Staten Island, a high-use area, and found that aircraft, vehicles, hunting, and recreational activities (e.g., birding, walking, horseback riding, bicycling, boating) can cause cranes to run or fly away.

C.34.4 Species Distribution and Population Trends

C.34.4.1 Distribution

There are an estimated 500,000 sandhill cranes in North America, of which an estimated 62,600 are greater sandhill cranes. An estimated 8,500 of these belong to the Central Valley Population (Littlefield and Ivey 2000). The most recent breeding surveys have recorded 1,151 breeding pairs in Oregon, 465 breeding pairs in California, 20 pairs in Washington, and 11 pairs in Nevada (Engler and Brady 2000 as cited in Ivey and Herziger 2001; Ivey and Herziger 2000). The exact number of breeding pairs in British Columbia remains unknown; however, Littlefield and Ivey (2000) estimate approximately 2,500 individuals.

In California, the breeding distribution is restricted to a six-county area in the northeastern corner of the state, including Siskiyou, Modoc, Shasta, Lassen, Plumas, and Sierra Counties (Littlefield 1982, 1989; Ivey and Herziger 2001). Ivey and Herziger (2001) conducted the most recent surveys and found that the greatest number of breeding pairs are in Modoc County (54%) followed by Lassen County (26%). A total of 91% of the breeding pairs were found in Modoc, Lassen, and Siskiyou Counties (Ivey and Herziger 2001).

Pogson and Lindstedt (1991) identified eight distinct wintering locations in the Central Valley from Chico/Butte Sink in the north to Pixley National Wildlife Refuge near Delano in the south, with over 95% in the Sacramento Valley between Butte Sink and the Sacramento–San Joaquin River Delta. Use varies seasonally within this area probably as a function of the winter flooding regime and food resources. The Butte Sink has been reported to support a large segment of the population (more than 50%) during October and November. Use then shifts to the Delta and the Cosumnes River floodplain during December and January, where an estimated two-thirds of the population resides the remainder of the winter (Pogson and Lindstedt 1988; Littlefield and Ivey 2000).

Wintering greater sandhill cranes have been observed in the Yolo Bypass[6], although all known roosting colonies are east and south of Yolo County. As shown in Figure C-32, modeled foraging habitat occurs in the panhandle area around Clarksburg.

C.34.4.2 Population Trends

Prior to the early 1970s, surveys were insufficient to accurately estimate the breeding population of greater sandhill crane; however, major population declines have been noted and attributed to the widespread destruction of essential wetland habitats between 1870 and 1915 (Walkinshaw 1949). The first comprehensive surveys were conducted in 1971 (112 pairs), followed by surveys in 1981 (129 pairs) and 1988 (170 pairs), indicating a positive trend in the breeding population during that period (Littlefield 1982, 1989). The next subsequent, and most recent, survey was conducted in 2000 (Ivey and Herziger 2001) when 465 pairs were reported, an increase of 68% since the 1988

[6] https://www.inaturalist.org/check_lists/6853-Yolo-Bypass-Wildlife-Area-Check-List

survey. Much of this increase may be attributable to protection of traditional nesting areas on state and national wildlife refuges, lack of hunting, and a variety of management practices.

The first exhaustive winter survey was conducted in the mid-1980s (Pogson and Lindstedt 1988), which estimated a wintering population of 6,000 birds. This was adjusted in the early 1990s to 8,500 birds as a result of additional follow-up survey work in the Sacramento Valley (Littlefield and Ivey 2000; U.S. Geological Survey 2013). Although portions of the wintering population have been monitored periodically prior to and since the mid-1980s, no other comprehensive survey has been conducted and information has been insufficient to reliably detect trends.

C.34.5 Threats to the Species

On the breeding grounds, threats include changes in water regime that lowers the water table and eliminates nesting areas; cattle grazing that can degrade habitat, destroy nests, and disturb nesting birds; and mowing and haying operations that can kill young cranes.

Threats on the wintering grounds include changes in water availability; flooding fields for waterfowl, which reduces foraging habitat for cranes; conversion of cereal cropland to vineyards or other incompatible crop types; human disturbances; collision with power lines and other structures; disease; and urban encroachment (Littlefield and Ivey 2000).

The most significant threat to wintering greater sandhill cranes is the loss of traditional winter habitat from urbanization and agricultural conversion. While relatively limited urbanization has occurred to date within key crane areas, surrounding development and increased levels of human disturbances may threaten the long-term sustainability of important wintering lands. In the Delta region, the conversion of suitable agricultural foraging and roosting habitats to unsuitable cover types, particularly orchards and vineyards, has removed key habitats and altered the distribution and behavior of wintering greater sandhill cranes.

Greater sandhill cranes are also sensitive to human presence and do not tolerate regular disturbances, including low-level recreational disturbances. Types of disturbances include hunting, birding, photography, operating equipment for habitat management, boating, and aircraft. Disturbances cause birds to abandon otherwise suitable habitats, and may cause birds to deplete important energy stores needed for survival during wintering and migration. Only a single predawn disruption can cause cranes to abandon a site (Littlefield and Ivey 2000). Disturbance from hunting also poses a threat to cranes. Hunters accessing hunt areas during predawn hours flush cranes from their roosts and hunter presence can keep cranes from roosting or foraging in an area (Ivey and Herziger 2003). Flooding of agricultural fields for waterfowl hunting also reduces available foraging habitat for wintering cranes.

C.34.6 Recovery Plan Goals

In 1997, the California Endangered Species Act was amended, explicitly requiring CDFW to develop a recovery strategy pilot program for the greater sandhill crane (California Department of Fish and Game 2001). A recovery strategy team was assembled with representatives from state and federal agencies, local landowners, environmental groups, and species experts; and it produced a draft recovery strategy. The strategy included long-term recovery goals, and a range of alternative management goals and activities. The overall goal was to improve the status of the species through a variety of specific habitat protections and other actions so the protections of the California Endangered Species Act are no longer necessary, and delisting could be proposed (California Department of Fish and Game 2005). The draft recovery strategy has not been finalized or implemented.

C.34.7 Species Model and Location Data

C.34.7.1 Geographic Information System (GIS) Map Data Sources.

DWR developed the greater sandhill crane model for the Bay Delta Conservation Plan. The model uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture 2005, 2010), and land use survey of the Delta and Suisun Marsh area-version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable winter roosting and foraging greater sandhill crane habitat in the Plan Area. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

C.34.7.2 Habitat Model Description

The greater sandhill crane wintering habitat model includes four types of habitat: roosting and foraging-permanent; roosting and foraging-temporary; foraging; and the winter use area. For modeling purposes, roosting and foraging habitat are combined because many foraging habitats, particularly agricultural lands, can also function as roosting habitat under appropriate inundation conditions. The roosting and foraging type and the foraging type are described below. The winter use area is used as a model boundary to confine the three habitat model components. The winter use area layer (Ivey pers. comm. 2013) is based on the greater sandhill crane range in the Plan Area.

The permanent and temporary roosting and foraging model types (Ivey pers. comm. 2013) are based on years of greater sandhill crane surveys in the Plan Area. Permanent roosting and foraging sites are those used regularly, year after year, while temporary roosting and foraging sites are those used in some years. Roosting and foraging habitat is primarily composed of managed seasonal wetlands and flooded cultivated lands such as corn and rice. Additional land cover types in the roosting and foraging layer include pasturelands, hay crops, grasslands, natural seasonal wetlands, and other annually rotated agricultural crops that occur within the defined winter range.

The model for foraging habitat includes appropriate crop and vegetation types within a 4-mile radius of both the permanent and temporary roosting and foraging types (i.e., lands in the winter use area as described above). Below is a list of crop and natural community vegetation types known to provide suitable greater sandhill crane foraging habitat.

- Cultivated lands
    - Grain and hay crops
        - Barley
        - Wheat
        - Oats

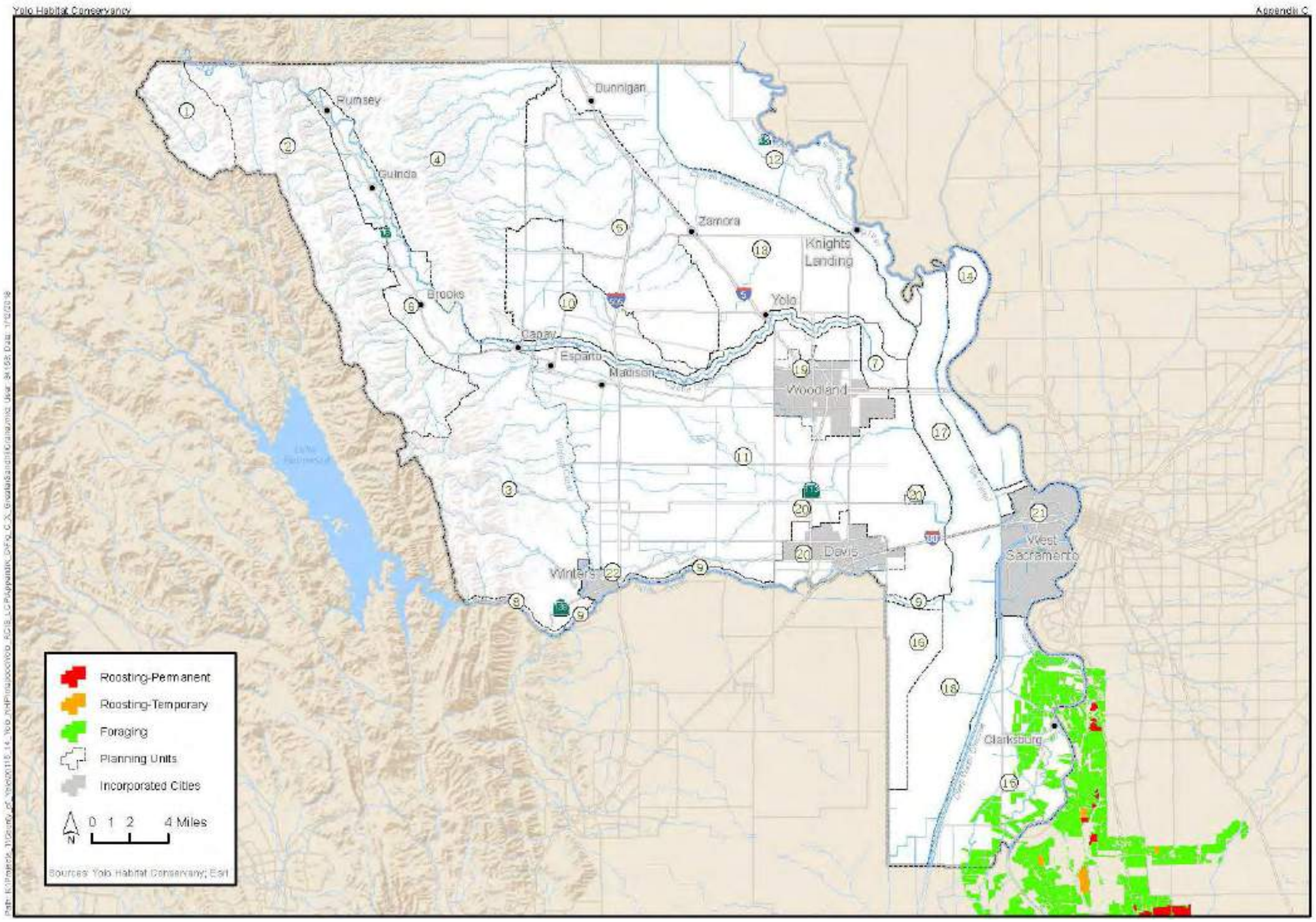
        - Rice
        - Miscellaneous grain and hay
        - Mixed grain and hay
    - Field crops
        - Safflower
        - Sugar beets
        - Corn
        - Grain sorghum
        - Sudan
        - Beans
        - Miscellaneous field
        - Sunflowers
    - Pasture
        - Alfalfa and alfalfa mixtures
        - Clover
        - Mixed pasture
        - Native pasture
        - Induced high-water-table native pasture
        - Miscellaneous grasses
        - Non-irrigated mixed pasture
        - Non-irrigated native pasture
        - Other pasture
    - Truck, nursery and berry crops
        - Asparagus
        - Beans
        - Onions and garlic
        - Tomatoes
        - Peppers
        - Potatoes
        - Green beans
    - Rice
        - Rice
        - Wild rice

- Idle
  - Land not cropped the current or previous crop season, but cropped within the past 3 years
  - New lands being prepared for crop production
- Citrus and subtropical
- Deciduous fruits and nuts
- Flowers, nursery, Christmas trees
- Vineyards
- Native Vegetation (A land use type similar to non-irrigated pasture)

- Grasslands
  - Ruderal herbaceous grasses and forbs
  - California annual grasslands–herbaceous
  - Bromus diandrus–Bromus hordeaceus
  - Italian ryegrass (Lolium multiflorum)
  - Lolium m*ultiflorum–Convolvulus arvensis*
- Managed Wetlands
  - 'Temporarily Flooded Grasslands
  - Rabbitsfoot grass (Polypogon monspeliensis)
  - Intermittently flooded perennial forbs
  - Managed annual wetland vegetation (nonspecific grasses and forbs)
  - Shallow flooding with minimal vegetation
  - Seasonally flooded undifferentiated annual grasses and forbs
  - Managed alkali wetland (Crypsis)
  - Intermittently or temporarily flooded undifferentiated annual grasses and forbs
  - Scirpus spp. in managed wetlands
  - Smartweed Polygonum spp. - Mixed Forbs
  - Distichlis spicata - Annual Grasses
  - Seasonally Flooded Grasslands
- Alkali seasonal wetland complex and other natural seasonal wetlands
  - *Distich*lis spicata–annual grasses
  - Seasonally flooded grasslands
- Vernal pools
  - Temporarily flooded perennial forbs

- Juncus balticus - meadow vegetation
- Annual grasses generic
- Annual grasses/weeds
- Baccharis/Annual Grasses
- Bromus spp./Hordeum
- Crypsis schoenoides
- *Crypsis* spp.–wetland grasses–wetland forbs NFD super alliance
- Cultivated annual graminoid
- Cynodon dactylon
- *Distichlis*/annual grasses

1 **Figure C-28. Greater Sandhill Crane Mapped Habitat and Occurrences**

2 

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C.35 Northern Harrier (*Circus cyaneus*)


© Tom Greer

C.35.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.35.2 Species Description and Life History

Northern harriers (*Circus cyaneus*) are the only representative of the cosmopolitan genus *Circus* in North America; they breed throughout North America, Europe, and Asia. It is a long-distance migrant and the most northerly breeding and most broadly distributed of all harriers (slender, narrow-winged hawks) (MacWhirter and Bildstein 1996). Northern harriers' degree of sexual dimorphism in plumage and their propensity for polygyny are exceptional among birds of prey (MacWhirter and Bildstein 1996). Northern harriers are a medium-sized hawk (45.7 to 60.9 centimeters (cm) [18 to 24 inches]), long-winged (101.6 to 116.8 cm [40 to 46 inches]) and long-tailed with a distinctive white rump, and an owl-like facial disc; they are usually seen gliding unsteadily over marshes with their wings held in a shallow "V." Males generally have a pale gray back, head, and breast, while the larger females and young are brown above and streaked below.

C.35.2.1 Seasonal Patterns

Northern harriers are year-round residents in California, with an influx of migrating birds from northern populations during winter. Breeding territories are occupied (including pair bonding and courtship periods) from approximately March through September with peak period in June/July. Fall migration occurs from August through December and the spring migration period is from February through May (MacWhirter and Bildstein 1996; Davis and Niemela 2008).

Breeding pairs and juveniles may roost communally in late autumn and winter (Smith and Murphy 1973).

C.35.2.2 Reproduction

Northern harriers are predominantly monogamous, but polygyny also regularly occurs and is positively associated with prey abundance (Simmons et al. 1986). Nests are constructed on the ground and are usually a relatively flimsy structure built of sticks, straws, or grasses on wet areas and a smaller cup of grasses on dry sites (Call 1978).

Northern harriers generally lay four to six eggs that are incubated for 29 to 39 days, then feed and brood nestlings until they fledge 29 to 34 days after hatching (MacWhirter and Bildstein 1996). Peak hatching period is in May and ranges from April through June.Harriers will lay replacement clutches when clutches are disturbed during egg-laying or shortly thereafter (Simmons 1984).

C.35.2.3 Home Range/Territory Size

Territory size varies according to habitat type and prey availability (Martin 1987; Temeles 1987). In Yolo County, California, Temeles (1987) documented that harriers adjusted territory size to maintain a constant prey base.

There is no information on breeding season home range or territory sizes from the Central Valley; however, studies from other regions provide information that may apply to the Yolo County breeding population. During the breeding season, home ranges vary according to habitat and prey availability, with a range of 170 to 15,000 hectares (ha) (420 to 37,066 acres) (240 ha [593acres] median, n = 8) reported from eight studies outside of California (Idaho, eastern Washington, Utah, Missouri and New Hampshire) (MacWhirter and Bildstein 1996).

Home ranges of females are smaller than males, probably due to females hunting closer to the nest (Call 1978) and more intensive territory defense by females, which can exclude males from higher quality habitat (Martin 1987). Breeding home ranges averaged 113 ha (279 acres) for females and 1,570 ha (3,879 acres) for males (Martin 1987). The home ranges of both sexes can expand by over 250 percent as the breeding season progresses and the young develop (MacWhirter and Bildstein 1996). Because home ranges depend on the density of prey, home range sizes in Yolo County vary according to factors that affect rodent and bird prey abundance, such as annual variation in climate, habitat type, habitat patch size, adjacent land cover types, and density of predators.

The winter ecology of northern harriers in Yolo County has been the subject of several important research studies by Temeles (1986, 1987, and 1989). These studies have shown that winter home range sizes are also closely tied to the abundance of mice and that, in some years, a harrier's home range is reduced by the number of other harriers intruding onto its territory. There is also a difference between the sexes in winter foraging ecology. The larger and more aggressive females tend to forage in fields with taller vegetation, hunt at slower speeds, and aggressively chase males away from high-quality foraging areas. This effectively results in smaller winter home ranges for females. Temeles (1987) found that wintering females occupied mean territory size of 33.6 ha (83.0 acres), ranging from 3.9 ha (9.6 acres) to 124.9 ha (308.6 acres).

C.35.2.4 Foraging Behavior and Diet

Harriers hunt on the wing, using low patrol, quartering flights 1 to 9 meters (3.3 to 29.5 feet) above open ground. Prey capture occurs following a dive from flight or hovering above prey (Bildstein 1988). Their owl-like facial ruffs and face structure aid in prey detection (MacWhirter and Bildstein 1996).

Harriers predominantly feed on small rodents, mainly microtus species. However, harriers are also generalists and include reptiles, amphibians, birds, and invertebrates in their diet (Terres 1980).

Harrier ecology is strongly correlated with prey availability. Microtus species tend to remain the dominant prey throughout the breeding season and microtus population cycles have been found to influence a variety of ecological factors. During mid and high ranges of microtus cycles, harriers exhibited greater nesting densities, clutch size, nest success, and presence of polygyny (Hamerstrom et al. 1985; Simmons et al. 1986).

Bernard et al. (1987) found that nesting or fledgling passerines became the second most important prey group for nesting harriers during the breeding season. Harrier nestling stages coincide with passerine nestling stages, providing abundant, easy prey (Bernard et al. 1987).

C.35.3 Habitat Requirements and Ecology

C.35.3.1 Nesting

Northern harriers roost and nest on the ground where tall grasses and forbs provide cover (Bent 1937). Harriers use habitats such as open wetlands, wet and lightly grazed pastures, dry uplands, upland prairies, wet grasslands, drained marshlands, croplands, shrub-steppe, meadows, open rangelands, desert sinks, and fresh and saltwater emergent wetlands (Bent 1937; MacWhirter and Bildstein 1996). There is an apparent preference, and higher reproductive potential, for sites that are near water (Simmons and Smith 1985) such as marshlands, seasonal wetlands, and other wet grasslands and prairies. Simmons and Smith (1985) reported that harriers nesting in wet sites (wetland fringe or wet meadows) were more successful than dry sites and wet sites were preferred in relation to their availability. Vegetation differences appeared to be less significant determinants of success than moisture.

While wet sites are preferred, upland sites are also selected, such as cultivated fields and grasslands, where wetlands are limited (Temeles 1987). In Yolo County, harrier nests were located in three different upland types: an uncultivated field of grasses and weeds, a cultivated rice field, and a cultivated field of clover (Temeles 1987). Harriers are also known to nest in wheat fields and similar agricultural landscapes; however, nests in hay and grain fields may be at risk during early summer harvesting activities before young fledge.

Harrier nests in upland fields are predominately surrounded by grasses and forbs, while harrier nests in wet areas are surrounded by marsh grasses and cattails (Hamerstrom and Kopeny 1981; Simmons and Smith 1985; Loughman and McLandress unpublished data). Average height of vegetation around nests ranged from 32 to 61.2 centimeters (cm) (12.6 to 24.1 inches) in the Suisun Marsh in neighboring Solano County (Loughman and McLandress unpublished data). Most harrier nest canopies are open. Simmons and Smith (1985) found concealed nests to be less successful. Loughman and McLandress (unpublished data) found 71 percent of nests at Suisun Marsh and 93 percent of nests in northeastern California had no canopy cover.

Northern harriers have highest reproductive success at nest sites in wetlands that are close to foraging habitat with abundant prey (Simmons and Smith 1985). Nest site selection may be a compromise between the availability of a wetland nest site, proximity to optimum foraging habitat, and access to a mate with a high food provisioning rate (Simmons and Smith 1985). Prey abundance also influences nesting density, which typically ranges from 3.3 to 9 nests/square kilometer (1.3 to 3.5 nests/square mile) in suitable contiguous habitat, but has been reported up to 24.8 nests/square kilometer (9.6 nests/square mile) in areas of exceptionally high vole abundance (Loughman and McLandress unpublished data).

C.35.3.2 Foraging

Northern harriers forage in marshes, seasonal wetlands, irrigated pastures, annual grasslands, and agricultural fields, and may occasionally use vineyards. Similar foraging habitats are used throughout the year; however, use is dependent on prey abundance and prey availability. Martin (1987) showed that diet shifts were highly correlated with vegetation growth, which can be particularly evident in active agricultural fields. Harriers hunting alfalfa fields preyed on microtus until the vegetation reached 46 cm, after which time harriers stopped hunting alfalfa fields and shifted diets to reptiles and passerines. Following cutting, alfalfa fields were again used as diets shifted back to microtus.

As noted, female harriers defend territories, thereby excluding nonterritorial males from preferred habitat. Thus, male harriers tend to have larger home ranges, and forage more in riparian and open habitats (Temeles 1987; MacWhirter and Bildstein 1996).

C.35.4 Species Distribution and Population Trends

C.35.4.1 Distribution

The northern harrier occurs as a breeding bird across the northern United States and Canada, occurring throughout most of California and the central portion of the United States south to Texas. It is absent from desert regions and the southeastern parts of the United States (Bildstein 1988; MacWhirter and Bildstein 1996). During winter, the northern harrier occurs throughout southern Canada and all of the United States, and as far south as Panama (Bildstein 1988; MacWhirter and Bildstein 1996).

In California, northern harriers inhabit annual grassland up to alpine meadow habitats, as high as 3,000 meters (9,843 feet) (Garrett and Dunn 1981; Davis and Niemela 2008). They breed from sea level in the Central Valley to 1,700 meters (5,577 feet) in the Sierra Nevada, and up to 800 meters (2,625 feet) in northeastern California. They are also widespread winter visitors in suitable habitat. Some individuals migrate to winter in California; others migrate south to Central America or northern South America (Davis and Niemela 2008).

In Yolo County, northern harriers occur throughout all of the lowland areas and in the foothill grasslands. In general, their distribution is associated with irrigated cropland and irrigated pastureland common to the interior of the County, the seasonal wetlands and pasturelands of the Yolo Basin and southern panhandle, and the grassland foothills on the western edge of the valley floor. Other than on a very local basis, the nesting distribution of northern harriers has not been monitored in Yolo County. While the species is known to be widespread throughout the lowland areas of the County, California Natural Diversity Database (CNDDB) reports no nesting records of this species. However, nests have been documented in seasonal wetlands, permanent marshes, active and fallow rice fields, along the edges of large irrigation and bypass channels (such as Willow Slough Bypass), and in grain and other agricultural fields. The largest populations likely occur in the managed wetlands and pasturelands of the Yolo Basin south of Interstate 5, including the Conaway Ranch, Yolo Bypass Wildlife Area, and other private lands south to the southern end of the panhandle. Nest sites have also been documented along the wetland and grassy edges of large water conveyance channels (e.g., Willow Slough Bypass) and in hay and grain fields throughout the lowland portions of the County.

C.35.4.2 Population Trends

The number of breeding northern harriers in North America has declined in the twentieth century due to loss of habitat through extensive draining of wetlands, monotypic farming, and reforestation of farmlands (U.S. Fish and Wildlife Service [USFWS] 1987; Serrentino 1992). In the contiguous United States, Christmas Bird Count data from 1952 to 1971 indicate a 40 percent decline in wintering birds for that period, with local increases in California during the 1960s (Brown 1973). Breeding Bird Survey and Christmas Bird Count data suggest that the North American population has remained stable or declined slowly since the early 1960s (Collins and Wendt 1989; Kirk et al. 1995), with significant regional declines in the southwestern and central United States (USFWS 1987). In Canada, Breeding Bird Survey data suggest long-term significant harrier population increases in western mountain provinces, with declines in the prairies, particularly during 1982–1991; elsewhere, the numbers are stable (Kirk et al. 1995).

In California, the population has decreased historically (Grinnell and Miller 1944; Remsen 1978) and according to Breeding Bird Survey and Christmas Bird Count data, continues to decrease slowly (Sauer et al. 2004). However, the species can be locally abundant where suitable habitat remains free of disturbance from intensive agriculture and development. In both wetland and upland areas, the largest populations are typically associated with continuous tracts of undisturbed habitats that are dominated by thick vegetation growth (MacWhirter and Bildstein 1996). Locally, the number of breeding pairs and reproductive success is affected by prey availability, predation, nestsite quality, and weather (MacWhirter and Bildstein 1996).

In Yolo County, northern harriers also appear to be in slow decline (Sauer et al. 2004 [Zamora Survey Route]). However, nest density and nest success is variable depending on weather conditions and the response of prey populations, particularly microtine rodents. Where relatively undisturbed open grasslands, pasturelands, marshes, and seasonal wetlands occur, such as the southern panhandle, Yolo Bypass Wildlife Refuge, and foothill grasslands, populations are likely more stable and nesting success is likely higher than in the more intensive agricultural areas of the interior County. However, active harrier nests are regularly detected in active grain fields, fallow rice fields, and along the weedy and marshy edges of open irrigation or bypass channels.

C.35.5 Threats to the Species

Threats to breeding populations of northern harriers include destruction of wetland habitat, native grassland, and moist meadows, combined with the burning and plowing of nesting areas during early stages of the breeding cycle (Remsen 1978). MacWhirter and Bildstein (1996) have concluded that continued widespread destruction of freshwater and estuarine wetlands is the primary threat to breeding and wintering populations in the United States. In addition, conversion of native grassland prairies for monotypic farming has contributed to declines of local populations. In upland areas, mechanized agriculture and early mowing have increased the threat of nest destruction. Overgrazing of pastures and the advent of larger crop fields, fewer fencerows, and widespread use of insecticides and rodenticides have reduced prey availability and thus the amount of appropriate habitat for the species.

Within the Plan Area, threats to northern harriers are the result of continued urbanization of agricultural lands and conversion to unsuitable crop types. Threats to the species include the following:

- Urbanization of grassland habitats along the western edge of the valley north of Winters;
- Urbanization of agricultural lands in the West Sacramento Southport area between the Sacramento River and the Deep Water Ship Channel;
- Urbanization of agricultural lands around the cities Woodland and Davis;
- Conversion of grasslands to vineyards in the Dunnigan Hills; and
- Conversion of hay, grain, and row crops to orchards in the northwestern corner of the valley floor.

The threats to the species may be partially offset, however, with an increase in managed wetland habitats in the County over the last several years, including the following:

- Davis Wetlands,
- Yolo Bypass Wildlife Refuge,
- Roosevelt Ranch Preserve north of the County Road 12, and
- Conaway Ranch managed wetlands in the Yolo Bypass.

Supplemented by other existing refuges for northern harriers and other raptors, including the Grasslands Regional Park, the Hawk and Owl Reserve adjacent to the Yolo County landfill, and the marshlands and pasturelands of the southern panhandle, wetland habitats may have increased in Yolo County over the last several years.

Population trends and reproductive success are difficult to assess for the northern harrier. This is primarily due to the species' ground-nesting behavior and tendency to not flush from the nest until the observer is within 2 meters (6.56 feet) of the nest, which makes it difficult to census (Lehman et al. 1998).

The population size may increase with some agricultural practices (e.g., grain crops), provided that cover and nesting habitat are preserved or enhanced. Because northern harriers can move nomadically from one area to another, they may expand their populations in response to local increases in prey population (MacWhirter and Bildstein 1996).

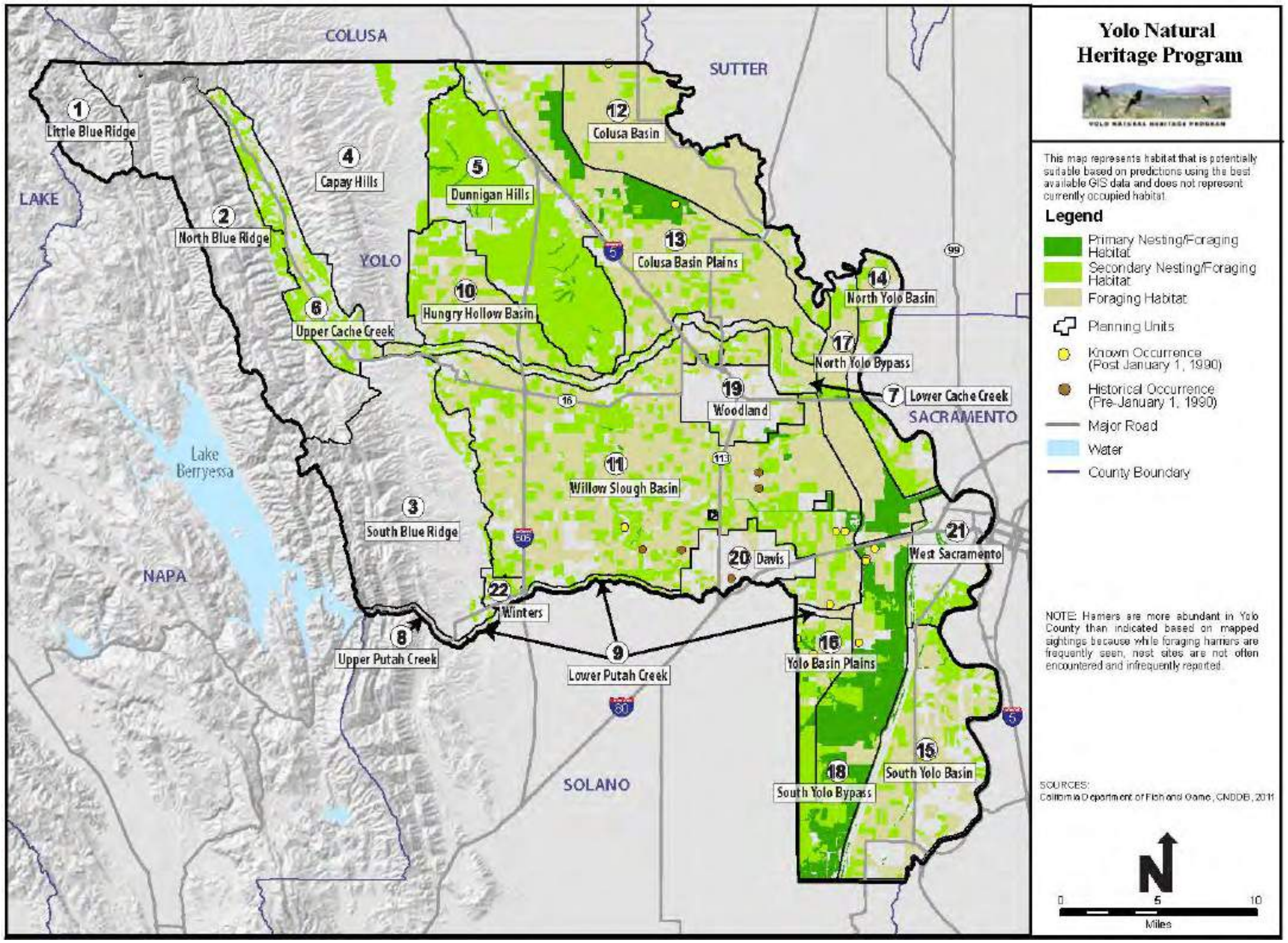
Furthermore, wetland preservation for waterfowl and habitat management practices for upland game birds are beneficial to the overall conservation of the species. Habitat management recommendations for the northern harrier include the acquisition and protection of undisturbed habitat in which early successional plants can grow and where dead vegetation is not removed. Prescribed burning and grazing are also recommended active management techniques in old fields and shrubby habitat to prevent revegetation. Finally, elimination of winter livestock grazing from wetland and grassland ecosystems is recommended to improve winter habitat (MacWhirter and Bildstein 1996).

C.35.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.21.3, *Habitat Requirements and Ecology* (Figure A-21). The model parameters include the following.

- **Known Recent Sightings in Yolo NCCP/HCP Species Locality Database**: Location where the species has relatively recently (post–January 1, 1990) been documented according to one or more species locality records databases (i.e., University of California, Davis Museum of Wildlife and Fish Biology, California eBird, Avian Knowledge Network).

Figure C-29. Northern Harrier Mapped Habitat and Occurrences



- **Primary Nesting/Foraging Habitat**: This habitat includes all potentially suitable breeding habitat in natural wetland vegetation types and was modeled by selecting all mapped vegetation types as listed below. The Blue Ridge, Little Blue Ridge, and Capay Hill ecoregions were excluded to confine the results to the lower elevations in the valley floor (Estep pers. comm.). These types may also be used for foraging:
    - All Fresh Emergent Wetland types
    - Undetermined Alliance – Managed Alkali Sink
    - Vernal Pool Complex
- **Secondary Nesting/Foraging Habitat**: This habitat includes all potentially suitable breeding habitat in grasslands and suitable agricultural types and was modeled by selecting all mapped land cover types as listed below. The Blue Ridge, Little Blue Ridge, and Capay Hill ecoregions were excluded to confine the results to the lower elevations in the valley floor (Estep pers. comm.) (i.e., ecoregions that were predominantly valley were selected and ecoregions that were generally higher in elevation were excluded). These types may also be used for foraging:
    - Upland Annual Grasslands and Forbs Formation
    - California Annual Grasslands Alliance
    - Native Pasture
    - Mixed Pasture
    - Grain/Hay Crops
- **Foraging Habitat**: This habitat includes potentially suitable foraging habitat that is not considered breeding habitat (foraging also occurs in breeding habitats above) and was modeled by selecting all mapped agriculture types as listed below. The Blue Ridge, Little Blue, and Capay Hill ecoregions were excluded to confine the results to the lower elevations in the valley floor (Estep pers. comm.).
    - Field Crops
    - Rice
    - Pasture (alfalfa)
    - Truck and Berry Crops

C.35.7 References

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C.35.7.1 Personal Communications

James (Jim) Estep, Wildlife Biologist, Sacramento, California.

C.36 Black Tern (Chlidonias niger)

© Peter LaTourrette

C.36.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.36.2 Species Description and Life History

Black terns (*Chlidonias niger*) are short- to medium-distance migrants that nest primarily in the western Great Plains of the United States and winter in California, Arizona, New Mexico and northern Mexico (Dunn and Agro 1995). During the breeding season, black terns are primarily black and gray with white undertail coverts.

C.36.2.1 Seasonal Patterns

In California, black terns arrive from their South American wintering grounds in late April through mid-May. Fall migration may begin as early as late July with a peak from mid-August until mid-September, with a few birds lingering as late as October (Dunn and Agro 1995).

C.36.2.2 Reproduction

Both males and females build cup nests consisting of marsh vegetation on floating mats of dead vegetation, muskrat lodges, islands, and even on artificial platforms or floating cow dung (Shuford 2008; Shealer et al. 2006). Females initiate egg laying in mid-May and a clutch typically comprises three eggs. Both parents incubate the eggs until they hatch in 19 to 22 days, and both feed nestlings for about 18 days (Dunn and Agro 1995). Eggs are adapted to damp conditions by having more pores than eggs of similar mass, and these pores allow more water vapor conductance, thereby ensuring proper regulation of temperature of damp or wet eggs (Davis and Ackerman 1985).

C.36.2.3 Home Range/Territory Size

Black terns are semicolonial nesters, especially in productive foraging areas, and nest clusters range from about 10 to 50 nests. Most nests are 5 to 20 meters apart, but they can be placed within 1 meter of each other (Dunn and Agro 1995).

C.36.2.4 Foraging Behavior and Diet

The diet of black terns in California has not been studied (Shuford 2008). However, they are documented to be primarily insectivorous during the breeding season in other regions, but also consume small fish when available (Dunn and Agro 1995). The primary insect prey are damselflies and dragonflies (Odonata), but terns also consume mayflies (Ephemeroptera), caddisflies (Trichoptera), beetles (Coleoptera), moths (Lepidoptera), dipterans, grasshoppers, crickets, and locusts (Orthoptera), water scorpions (Hemiptera), spiders (Araneida), grubs and larvae, amphipods, crayfish, and small mollusks (Dunn and Agro 1995; Gilbert and Servello 2005a).

C.36.3 Habitat Requirements and Ecology

C.36.3.1 Nesting

In California, black terns are restricted to flooded rice fields and freshwater marshes, including lakes and ponds with marsh edges when breeding (Shuford et al. 2001). They nest mostly on floating mats of vegetation in marsh areas surrounded by emergent vegetation, presumably as a buffer to wind and wave action (Bergman et al. 1970; Dunn and Agro 1995). In the Central Valley, most black terns nest in rice fields, especially with small islands (dirt mounds), although they formerly nested in ephemeral seasonal marshes created from flood events (Shuford et al. 2001). They tend to select nest sites in freshwater marshes with tall sparse vegetation or short dense vegetation (Naugle et al. 2000). They also build nests closer to the water surface (2–4 centimeters above water) than Forster's terns (*Sterna forsteri*) (average of 21 centimeters), and were not considered to compete with Forster's terns for nest sites (Bergman et al. 1970).

Black terns are generally considered to be an area-dependent species that require marshes greater than 5 hectares (12.4 acres) within marsh complexes or isolated marshes greater than 11 hectares (27.2 acres) (Brown and Dinsmore 1986). In the Great Plains, they require large landscapes of wetland complexes and upland habitats, and tend to nest in larger wetlands of regenerating or degenerating vegetation within high density areas of wetlands and near untilled upland grasslands (Naugle et al. 2000). Although this study is not directly comparable to the Sacramento Valley because of the difference in habitat – freshwater marsh versus flooded rice fields – the importance of landscape-level factors is probably similar.

C.36.3.2 Foraging

Black terns forage near their nesting sites using low, circling flight with shallow wingbeats and bills pointing downward. They sometimes forage from perches over water. They may catch large insects in midair, especially dragonflies (Dunn and Agro 1995).

C.36.4 Species Distribution and Population Trends

C.36.4.1 Distribution

Black terns breed throughout much of the United States east of the Rocky Mountains, and in scattered locations in the western states, including California, and in southern Mexico and the Greater Antilles (except for Cuba), and possibly in Columbia and Ecuador. They winter primarily in the nearshore of the Pacific Ocean and the Caribbean Sea off the coasts of Mexico, Central America, and South America (Dunn and Agro 1995).

In California, black terns breed in isolated sites in the Central Valley, Klamath Basin and the Modoc Plateau (Shuford et al. 2001; Shuford 2008). Due to lack of suitable freshwater habitat in most national wildlife refuges and state wildlife areas during the summer, black tern breeding sites in the

SacramentoValley are primarily flooded rice fields. These rice fields supported 90 percent of the Central Valley breeding population during surveys in 1997 and 1998 (Shuford et al. 2001).

While black terns probably nested historically throughout the vast wetlands in the eastern part of Yolo County, there have been no recent nesting records in the Plan Area (Yolo Audubon Society Checklist Committee 2004). However, presumed migrants can often be observed foraging over flooded rice fields in the Yolo Bypass, especially from the eastern end of County Road 25, where it meets the levee, usually from late April until mid-May (Beedy pers. obs.).

C.36.4.2 Population Trends

Declines in numbers of the black tern in California are a result of habitat loss, especially the widespread loss of freshwater marshes. Breeding Bird Survey data reveal a steady, significant decline over the species' range from 1966–1992 (National Biological Service data in Dunn and Agro 1995), however, these data are inadequate to provide a trend assessment for California (Sauer et al. 2005; Shuford 2008).

C.36.5 Threats to the Species

There are currently few major threats to this species. However, because black terns have such a limited distribution and are dependent upon flooded rice fields for breeding in the Sacramento Valley, conversion of rice fields to other crops such as cotton or to dry land rice would pose a significant threat to the Yolo County migrant population. Water management of these rice fields must also be sensitive to the needs of breeding terns. Rapid lowering of water levels in rice fields may expose nests to mammalian predators, and subsequent rising of water levels may drown re-nesting attempts (Lee 1984 cited in Shuford et al. 2001;Gilbert and Servello 2005b). Effects from exposure to pesticides in rice fields should be investigated, but previous studies outside California have found no ill effects on eggs or development of young (Dunn and Agro 1995; Weseloh et al. 1997 cited in Shuford et al*.* 2001). Pesticides likely reduce populations of insect prey. Adult black terns are also susceptible to botulism outbreaks (Manuwal 1967).

Significant data gaps relating to many aspects of the ecology of the black tern exist. Data gaps include sources of mortality, effects of pesticides as well as diet and foraging ecology. Many large rice land areas in the Central Valley appear to be unoccupied, but apparently represent suitable habitat for black terns.

C.36.6 Species Habitat Model and Location Data

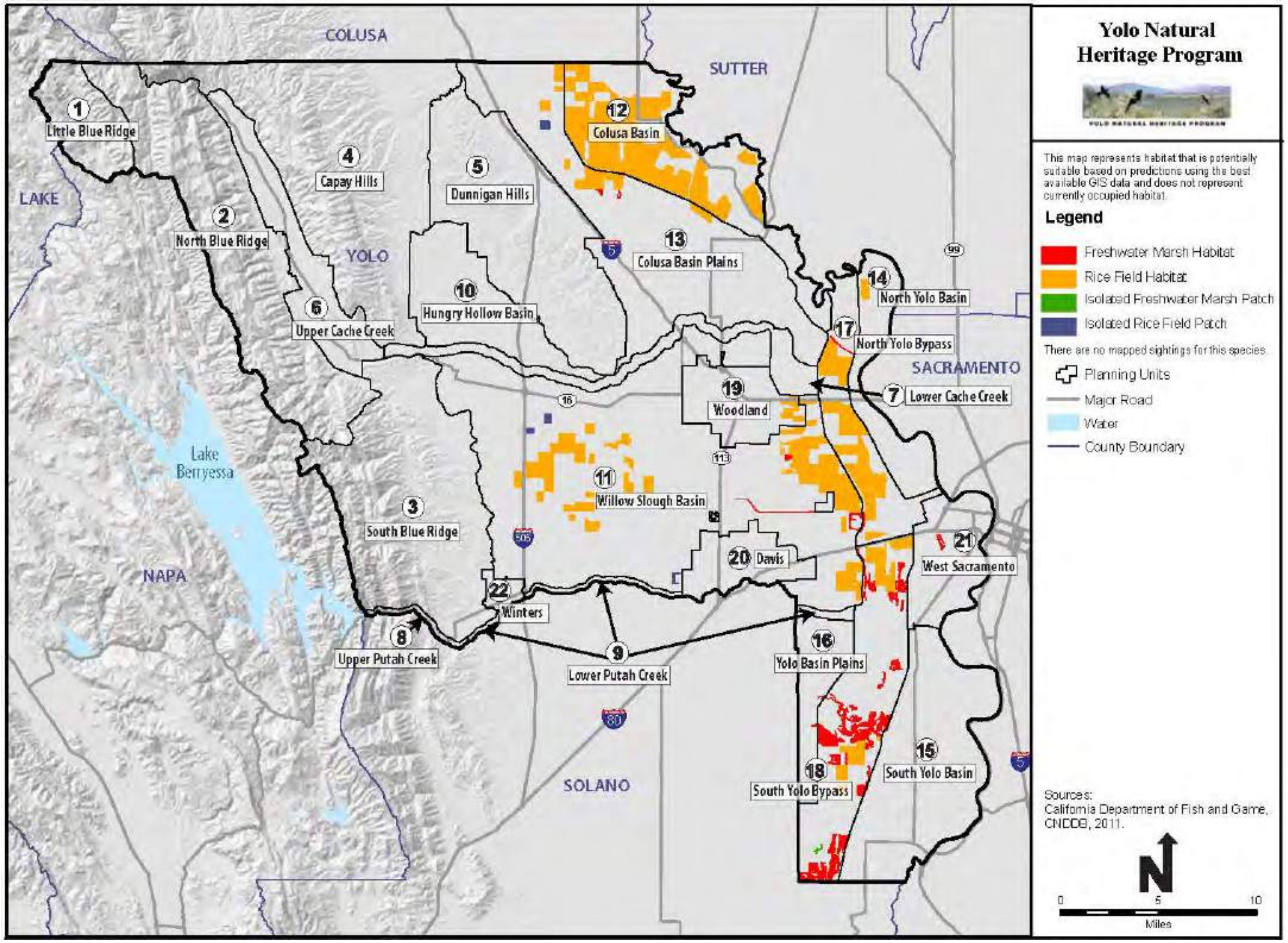
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.23.3, *Habitat Requirements and Ecology* (Figure A-23). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: None post-January 1, 1990.
- Other Unmapped Incidental Sightings Where Species is Known to Occur:

Unmapped Incidental Sighting	Source
Rice fields in the Yolo Bypass from mid-April through mid-May	T. Beedy pers. comm., Yolo Audubon Society 2004

- Freshwater Marsh Habitat: This habitat includes all potentially suitable freshwater marsh distributed in a complex of nearby patches that meet the black tern's area requirements. This habitat was modeled by selecting all mapped vegetation types as listed below that occur in patch sizes of at least 12.5 acres (two or more habitat areas separated by less than 100 feet from each other are considered one patch) in the Central Valley and Yolo Bypass ecoregions. Patches greater than 12.5 acres and within 1,500 feet of each other were considered to be part of a complex.
- Rice Field Habitat: This habitat includes all potentially suitable rice fields in a complex of nearby patches that meet the black tern's area-dependent habitat requirements. This habitat was modeled by selecting all rice fields listed below that occur in patch sizes of at least 12.5 acres (two or more habitat areas separated by less than 100 feet from each other are considered one patch) in the Central Valley and Yolo Bypass ecoregions. Patches greater than 12.5 acres and within 1,500 feet of each other were considered to be part of a complex.
- Isolated Freshwater Marsh Patch: This habitat includes all potentially suitable freshwater marsh that is isolated from other suitable habitat but that meets the black tern's area-dependent habitat requirements. This habitat was modeled by selecting all mapped vegetation types as listed below that occur in patch sizes of at least 25 acres and are greater than 1,500 feet from another freshwater marsh complex or another 25-acre patch in the Central Valley and Yolo Bypass ecoregions.
- Isolated Rice Field Patch: This habitat includes all potentially suitable isolated rice fields that are isolated from other suitable habitat but that meet the black tern's area-dependent habitat requirements. This habitat was modeled by selecting all rice fields listed below that occur in patch sizes of at least 25 acres and are greater than 1,500 feet from another rice field complex or another 25-acre patch in the Central Valley and Yolo Bypass ecoregions.

Figure C-30. Black Tern Mapped Habitat and Occurrences



C.36.6.1 Freshwater Marsh Habitat/Isolated Freshwater Marsh Patch – Vegetation Types

- Cattail Wetland Alliance
- Bulrush – Cattail Fresh Water Marsh Not Formally Defined (NFD) Super Alliance
- Alkali Bulrush – Bulrush Brackish Marsh NFD Super Alliance

C.36.6.2 Rice Habitat/Isolated Rice Patch – Vegetation Types

- Rice

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C.36.7.1 Personal Communications

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C.37 Western Yellow-Billed Cuckoo (*Coccyzus americanus*)

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C.37.1 Listing Status

Federal: Threatened.

State: Threatened.

Recovery Plan: None.

C.37.2 Species Description and Life History

C.37.2.1 Description

The western yellow-billed cuckoo (*Coccyzus americanus*) is a medium-sized bird about 30 centimeters (11.8 inches) in length with a wingspan of 38–43 centimeters (15–17 inches). The species has a slender, long-tailed profile, with a fairly stout and slightly down-curved bill, which is blue-black with yellow on the base of the lower mandible. Plumage is grayish-brown above and white below, with red primary flight feathers. The tail feathers are boldly patterned with characteristic rows of large white spots on the underside. The legs are short and bluish-gray. Adults have a narrow, yellow eye ring. Juveniles resemble adults, except the tail patterning is less distinct, and the lower bill may have little or no yellow (Hughes 1999).

C.37.2.2 Seasonal Patterns

In California on the Sacramento River, birds arrive onto breeding territories; pair formation occurs from late June to mid-July following the northward migration from South America and is followed by nest building and raising of young (Halterman 1991). The species is restricted to the mid-summer period for breeding presumably due to a seasonal peak in large insect abundance (Rosenberg et al. 1982). To accommodate this, development of young is very rapid with a breeding cycle of 17 days from egg-laying to fledging. Following a relatively short period of post-fledging juvenile dependency, cuckoos migrate out of California from approximately mid-August to early September. The species migrates to South America during the nonbreeding season and is thus not present in the Central Valley between October and May.

C.37.2.3 Reproduction

The pair constructs a flimsy twig nest which is typically 5 to 40 feet above the ground in dense canopy cover. Nests in the riparian forest along the South Fork of the Kern River consisted of twigs and were lined with roots and dried leaves and were rimmed with pine needles. Clutch size is usually three to four eggs, rarely five (Bent 1940). Both the female and the male incubate the eggs, which lasts for 10 to 11 days (Hamilton and Hamilton 1965). Both parents also share incubating and brooding duties and provision young with food. Young develop very rapidly and fledge from six to eight days post-hatching. Parental care continues for an additional three to four weeks before the southern migration begins (Halterman 1991).

In the well-studied Kern River population, it was found that 70 percent of western yellow-billed cuckoo pairs were monogamous, while the remaining 30 percent included a helper at the nest (Laymon 1998). When prey is abundant, cuckoos increase clutch size and may lay eggs in nests of other western yellow-billed cuckoo pairs and other nests of other species (Fleischer et al. 1985; Laymon 1998; Hughes 1999). Further, the Kern River studies determined that cuckoos tend to lay more eggs when they are able to feed nestlings a high percentage diet of katydids, and they tend to fledge more young when prey are easily and quickly captured (Laymon 1998).

C.37.2.4 Home Range/Territory Size

Limited information is available on home range and territory size. Territory size at the South Fork Kern River ranged from 8 to 40 hectares (ha) (20 to 100 acres) (Laymon and Halterman 1985), and on the Colorado River as small as 4 ha (10 acres) (Laymon and Halterman 1989). Patch size, type and quality of habitat, and prey abundance largely determine the size of territories (Halterman 1991).

Western yellow-billed cuckoos are loosely territorial and do not defend territories, but given uniform habitat they are regularly spaced through the landscape (Laymon 1998). Laymon (1980) found nests placed as close as 60 meters (197 feet) apart along the Sacramento River in an area where foraging habitat was abundant but nesting habitat was extremely limited. Breeding densities at the South Fork Kern River from 1985 to 1996 averaged 0.85 pairs/40 ha and ranged from a low of 0.15 pairs/40 ha in 1990 to a high of 1.4 pairs/40 ha in 1993 (Laymon unpublished data in Laymon 1998).

C.37.2.5 Foraging Behavior and Diet

Western yellow-billed cuckoos are primarily foliage gleaners (Laymon 1998). The typical strategy is to slowly hop from limb to limb in the canopy searching for movement of prey. They also sally from perches to catch flying insects or drop to the ground to catch grasshoppers or tree frogs (Laymon 1998).

Food resources vary greatly from year to year and significantly affect reproductive success (Laymon et al. 1997). Cuckoos forage within the riparian canopy primarily on slow-moving insects. The principal food item is green caterpillar (primarily sphinx moth larvae) (44.9 percent), with lesser amounts of katydids (21.8 percent), tree frogs (23.8 percent), and grasshoppers (8.7 percent). The diet also includes cicadas, dragonflies, butterflies, moths, beetles, and spiders (Laymon et al. 1997). Primary food items, particularly sphinx moth larvae, are associated with cottonwood trees and likely explain high reported use of cottonwood trees as foraging habitat for cuckoos (Laymon and Halterman 1985).

C.37.3 Habitat Requirements and Ecology

The western yellow-billed cuckoo is a riparian obligate species. Its primary habitat association is willow-cottonwood riparian forest, but other species such as alder (*Alnus glutinosa*) and box elder (*Acer negundo*) may be an important habitat element in some areas, including occupied sites along the Sacramento River (Laymon 1998). Nests are primarily in willow trees; however, other species are occasionally used, including cottonwood and alder. Along the Sacramento River, English walnut trees and more rarely prune, plum, and almond trees in adjacent orchards have also been reportedly used for nesting (Laymon 1980). Several nests on the Sacramento River were draped with wild grape (Gaines and Laymon 1984; Laymon 1998). Nest site height in willow trees average 4.3 meters (14.1 feet), but those in cottonwood trees have been reported at 30 meters (98.4 feet). Canopy cover is typically dense (averaging 96.8 percent at the nest) and large patch sizes (generally greater than 20 ha [49.4 acres] are typically required (Laymon 1998).

While western yellow-billed cuckoos nest primarily in willow (*Salix* spp.) trees, cottonwood (*Populus fremontii*) trees are important as foraging habitat, particularly as a source of insect prey. All studies indicate a highly significant association with relatively expansive stands of mature cottonwood-willow forests, especially dynamic riverine habitats where the river is allowed to meander and willows and cottonwoods can regenerate on point bars and stream banks (Grecco 2008). However, western yellow-billed cuckoos will occasionally occupy a variety of marginal habitats, particularly at the edges of their range (Laymon 1998). Continuing habitat succession has also been identified as important in sustaining breeding populations (Laymon 1998). Meandering streams that allow for constant erosion and deposition create habitat for new rapidly-growing young stands of willow, which create preferred nesting habitat conditions. Channelized streams or levied systems that do not allow for these natural processes become over-mature and presumably less optimal (Grecco 2008).

Along the Sacramento and Feather Rivers, primary factors influencing nest site selection include the presence of cottonwood/willow riparian forest, patch size, and density of understory vegetation. Laymon and Halterman (1989) found a significant trend toward increased occupancy with increased patch size. In California, except for the population along the Colorado River, cuckoos occupied 9.5 percent of 21 sites 20 to 40 ha in extent, 58.8 percent of 17 sites 41 to 80 ha in extent, and 100 percent of 7 sites greater than 80 ha in extent (Laymon and Halterman 1989). On the Sacramento River, Halterman (1991) found that the extent of patch size was the most important variable in determining occupancy.

C.37.4 Species Distribution and Population Trends

C.37.4.1 Distribution

There are two currently recognized subspecies, *C.a. occidentalis*, found west of the Rocky Mountains and *C.a. americanus*, found in deciduous forests east of the Rocky Mountains. There is a continuing debate over the taxonomic separation of the two subspecies, which is based primarily on morphological and plumage differences (Banks 1988; Franzreb and Laymon 1993), and more recently on genetics studies initiated by the U.S. Fish and Wildlife Service during the status review for federal listing.

The range of western yellow-billed cuckoo historically extended from southern British Columbia to the Rio Grande in northern Mexico, and east to the Rocky Mountains (Bent 1940). Currently the only known populations of breeding western yellow-billed cuckoo are several disjunct locations in California, Arizona, and western New Mexico (Halterman 1991). Western yellow-billed cuckoos winter in South America from Venezuela to Argentina after a southern migration that extends from

August to October (Laymon and Halterman 1985). They migrate north in late June and early July (DeSchauensee 1970).

In California, where much of its historical range has been greatly reduced, western yellow-billed cuckoos still occur in isolated sites in the Sacramento Valley from Tehama to Sutter Counties, along the South Fork of the Kern River, and in the Owens Valley, Prado Basin, and Lower Colorado River Valley (Gaines and Laymon 1984; Laymon 1998).

C.37.4.2 Population Trends

Studies conducted since the 1970s indicate that there may be fewer than 50 breeding pairs in California (Gaines 1977; Laymon and Halterman 1987; Halterman 1991; Laymon et al. 1997). While a few occurrences have been detected elsewhere recently, including the Eel River, the only locations in California that currently sustain breeding populations include the Colorado River system in Southern California, the South Fork Kern River east of Bakersfield, and isolated sites along the Sacramento River in Northern California (Laymon and Halterman 1989; Laymon 1998).

Declines in numbers of the western yellow-billed cuckoo in California are a result of "removal widely of essential habitat conditions," as described by Grinnell and Miller (1944). These declines have continued primarily in the San Joaquin Valley, north coast, and central coast (where the populations had been extirpated by 1977) (Gaines and Laymon 1984), and the species was nearly extirpated in the Lower Colorado River Valley by 1999. In the Sacramento Valley, only 1 percent of the species' historical habitat remains to support a small population estimated at only 50 pairs in 1987 and 19 pairs in 1989 (Laymon and Halterman 1989). Population estimates based on surveys conducted in 1999 are similar to those from the 1980s (66 FR 38611). Because no surveys have been conducted since 1999, the current status of the Sacramento Valley population is not known.

C.37.4.3 Distribution and Population Trends in the Plan Area

The historical distribution of western yellow-billed cuckoo extended throughout the Central Valley, where the species was considered common (Belding 1890). In the mid-1940s, Grinnell and Miller (1944) still considered the Central Valley distribution to extend from Bakersfield to Redding. While there are few historical records from Yolo County, presumably the species nested within the county along the west side of the Sacramento River and possibly along smaller tributary drainages, including Putah Creek, Willow Slough, and Cache Creek.

Since 1965, there have been nine records of western yellow-billed cuckoo in Yolo County, including the following:

- Willow Slough in 1965
- Sacramento River in 1977
- Elkhorn Regional Park in 1982
- Gray's Bend in 1997
- City of Davis in 2001
- Putah Creek Sinks in June 2005
- Cache Creek Settling Basin in July 2005

- Fremont Weir in June 2006
- Fremont Weir in July 2006

These records were reported in Gaines (1974), Yolo Audubon Society Checklist Committee (2004), Yolo Audubon Society (2005), and by Steve Hampton.[7] All of these records are presumed to be migrants or nonbreeding individuals. While there are no confirmed breeding records for Yolo County, they are fairly common nesters just across the Sacramento River in Sutter County, especially in riparian forests along the western toe drain of the Sutter Bypass. Up to 15 birds responded to taped vocalizations while canoeing this area in a single day in mid-June 1995 (Beedy pers. obs.).

Very little potential breeding habitat remains in Yolo County, and the mostly channelized and riprapped banks of the Sacramento River provide few opportunities for river meandering and/or riparian restoration that would provide suitable western yellow-billed cuckoo breeding habitat (Grecco 2008). While migrants could potentially use riparian habitats along the Sacramento River and other watercourses, there are few areas that support sufficient contiguous patches of suitable habitat to support breeding cuckoos.

C.37.5 Threats to the Species

Historical declines have been due primarily to the removal of riparian forests in California for agricultural expansion and urban expansion (66 FR 38611). Habitat loss and degradation continues to be the most significant threat to remaining populations. Habitat loss continues as a result of bank stabilization and flood control projects, urbanization along edges of watercourses, agricultural activities, and river management that alter flow and sediment regimes. Fragmentation reduces the ability of an area to sustain a population, leading to local extirpations and the loss of dispersal corridors (66 FR 38611). Nesting cuckoos are sensitive to habitat fragmentation that reduces patch size to less than 100 by 300 meters (Hughes 1999). Fragmentation of occupied habitats could make nest sites more accessible and more vulnerable to predation. Adults have been preyed upon by falcons (Hector 1985), and nestlings have been taken by hawks, jays, grackles (*Quiscalus quiscala*) (Nolan and Thompson 1975; Launer et al. 1990) and by various snake and mammal species (Nolan 1963). Predation is a significant source of nest failures, which have been recorded at 80 percent in some areas (Hughes 1999). In addition, pesticide use associated with agricultural practices may also pose a long-term threat to cuckoos. Pesticides may affect behavior and cause death or potentially affect prey populations (Hughes 1999; 66 FR 38611).

Overuse by livestock has been a major factor in the degradation and modification of riparian habitats in the western United States. The effects include changes in plant community structure and species composition, and relative abundance of species and plant density. (Wiggins 2005). Harris et al. (1986) believed that termination of grazing along portions of the South Fork of the Kern River in California was responsible for increases in riparian vegetation.

Another likely factor in the loss and modification of the western yellow-billed cuckoo is the invasion by the exotic tamarisk (*Tamarisk* sp.). The spread and persistence of tamarisk has resulted in significant changes in riparian plant communities. In monotypic tamarisk stands, the most striking

[7] http://www.geocities.com/rainforest/canopy/6181/yolo.html.

change is the loss of community structure. The multi-layered community of herbaceous understory, small shrubs, middle-layer willows, and overstory deciduous trees is often replaced by one monotonous layer. Plant species diversity has declined in many areas and relative species abundance has shifted in others. Other effects include changes in percent cover, total biomass, fire cycles, thermal regimes, and perhaps insect fauna (Rosenberg et al. 1991; Busch and Smith 1993). Conversion to tamarisk typically coincides with reduction or complete loss of bird species strongly associated with cottonwood-willow habitat, including the western yellow-billed cuckoo (Hunter et al. 1987; Hunter et al. 1988; Rosenberg et al. 1991).

West Nile virus is spreading throughout portions of the western United States and poses a threat to bird species. The National Wildlife Health Center of the U.S. Geological Survey (USGS) has identified the western yellow-billed cuckoo as a species that may be affected by West Nile virus (USGS 2003).

Significant data gaps relating to many aspects of the life history of the western yellow-billed cuckoo exist. Data gaps include spacing parameters, the capacity for producing offspring, sources of mortality, mating system dynamics, and population structure. Brood parasitism by the western yellow-billed Cuckoo requires further study to identify the physiological and behavioral controls associated with the production of extra eggs. The current extent and causes of eggshell thinning and the effects of pesticides on cuckoos and the availability of prey need to be understood (Laymon 1998). Furthermore, detailed censuses of declining western populations must continue to determine locations of remnant populations and viable sizes necessary for future conservation programs (Laymon 1980).

A habitat model developed by Gaines (1974) for the western yellow-billed cuckoo in the Sacramento Valley includes the following: patch size of at least 25 acres, at least 100.5 meters (330 feet) wide and 302 meters (990 feet) long, within 100.5 meters (330 feet) of surface water, and dominated by cottonwood/willow gallery forest with high-humidity microclimate. Halterman and Laymon (1989) further refined the model by classifying habitat patch sizes for suitability. A willow-cottonwood forest patch greater than 604 meters (1,980 feet) wide and greater than 81 ha (200 acres) is classified as optimum habitat; a patch 201 to 603.5 meters (660 to 1,980 feet) wide and 41.5 to 81 ha (102.5 to 200 acres) is suitable; a patch 100.5 to 201 meters (330 to 660 feet) wide and 20 to 40 ha (50 to 100 acres) is marginal, and smaller patches are unsuitable. Management objectives for the Sacramento Valley include six subpopulations of 25 pairs each to maintain viable populations sizes (Laymon 1998). To achieve this goal, it would be necessary to establish or preserve at least 6,070 ha (15,000 acres) of optimum/suitable habitat. As of 1998, only 2,367 ha (5,850 acres) of habitat were considered suitable (Laymon 1998).

Many large riparian areas along the Sacramento River in Tehama County and along the Feather River in Yuba and Sutter Counties appear to be unoccupied but apparently represent suitable habitat for western yellow-billed cuckoo (Gaines and Laymon 1984). In addition, factors determining local population fluctuations need to be fully understood in order to guide effective management actions to increase and stabilize populations at local carrying capacity.

C.37.6 Species Habitat Model and Location Data

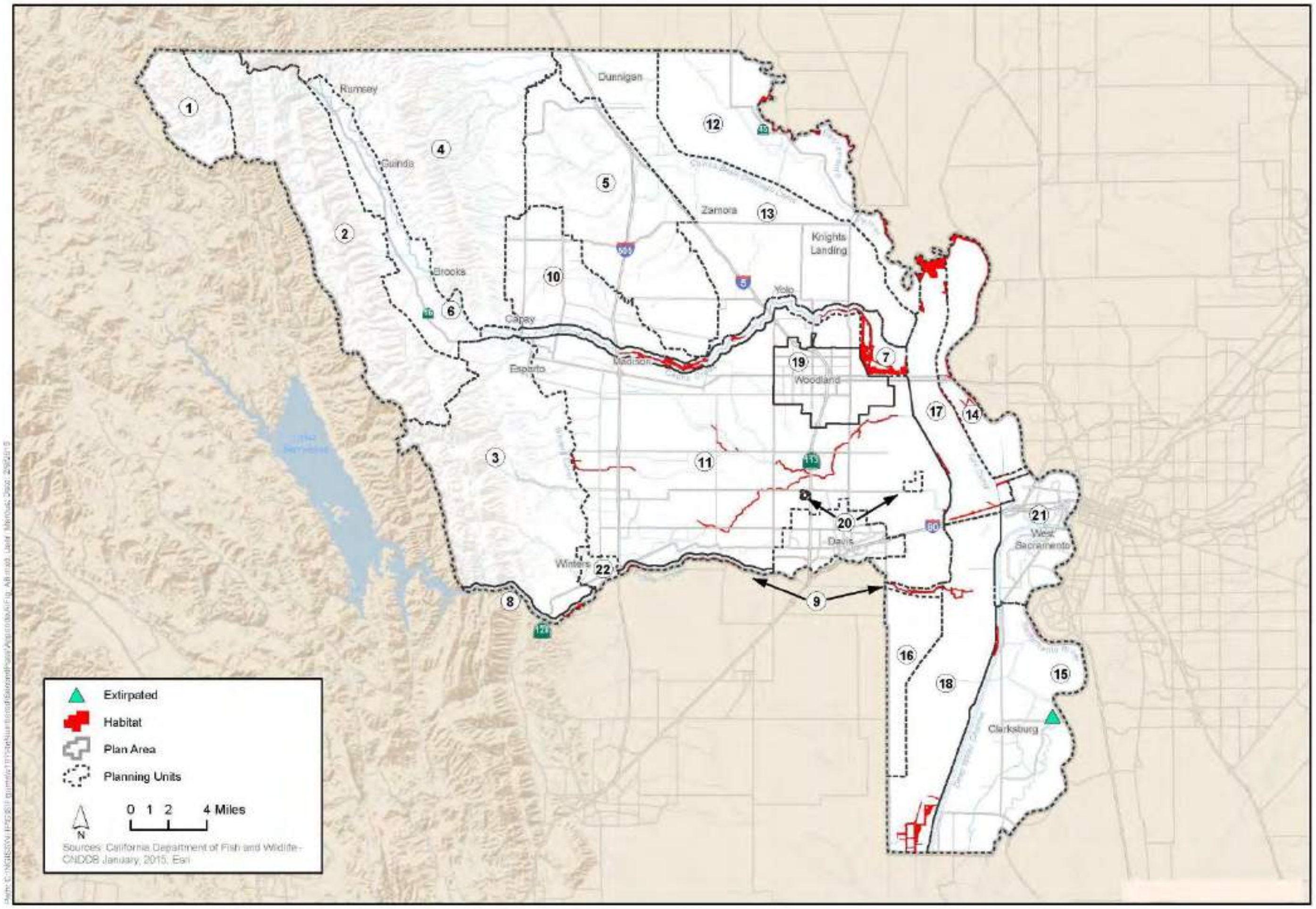
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.8.3, *Habitat Requirements and Ecology* (Figure A-8). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., Yolo Audubon Society records).
- Nesting/Foraging Habitat: This habitat includes all potentially suitable habitat. This habitat was modeled by selecting all mapped vegetation types as listed below that occur in patch sizes of 25 acres or greater and have a width of at least 330 feet.
- Limited modeling to Planning Units: 7, 8, 9, 11, 12, 14, 15, 17, 18.

C.37.6.1 Nesting/Foraging Habitat – Vegetation Types

- Fremont Cottonwood – Valley Oak – Willow (Ash – Sycamore) Riparian Forest Not Formally Defined (NFD) Association
- Mixed Fremont Cottonwood – Willow spp. NFD Alliance
- Mixed Willow Super Alliance
- White Alder (Mixed Willow) Riparian Forest NFD Association
- Undifferentiated Riparian Woodland/Forest

Figure C-31. Western Yellow-Billed Cuckoo Modeled Habitat and Occurrences



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C.37.7.2 Personal Communications

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C.38 White-Tailed Kite (*Elanus leucurus*)

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C.38.1 Listing Status

Federal: None.

State: Fully Protected.

Recovery Plan: None.

C.38.2 Species Description and Life History

The white-tailed kite (*Elanus leucurus*) is a medium-sized (32- to 38-centimeter) raptor of open grasslands, savannahs, and agricultural areas. It is identified by its unique plumage and habit of hovering while hunting. It has long, narrow, and pointed wings and a long, bright-white tail, face, and underside that contrast with distinctive black patches on the inner wings. Adults also have gray backs and red eyes. The sexes are similar, but the female has a slightly darker back (Dunk 1995).

C.38.2.1 Seasonal Patterns

Although apparently a resident bird throughout most of its breeding range, dispersal occurs during the nonbreeding season, resulting in some range expansion during the winter. Stendell (1972) believed it to be resident, becoming nomadic during periods of low prey abundance. While population changes and local and regional movements appear to be somewhat predictable based on vole and other rodent cycles, it remains unknown whether in Northern California this constitutes a migration movement or nomadic response to changes in the prey populations (Dunk and Cooper 1994).

C.38.2.2 Reproduction

The breeding season from pair bonding to juvenile independence occurs from approximately January to October with peak activity occurring from May through August (Dunk 1995). Nests are constructed of loosely piled sticks and twigs that are lined with grass, straw, or rootlets. The nest is placed near the top of a dense oak, willow, or other tree; usually 6 to 20 meters above ground in trees that vary from 3 to 50 meters in height (Dixon et al. 1957). Females typically lay a clutch of four eggs, with a range of three to six. The female incubates exclusively and performs most brooding while the male provisions the female and nestlings. Eggs are incubated for about 28 days. Young fledge in 35–40 days following hatching, with the peak fledging period occurring in May–June (Erichsen 1995).

C.38.2.3 Home Range/Territory Size

Territory size is variable and regulated primarily by prey abundance and vegetation structure (i.e., accessibility of prey); however, this species also responds to the abundance of interspecific and intraspecific competitors (Dunk 1995; Erichsen 1995). Reported average territory sizes include 1.6–21.5 hectares (ha) (Dunk and Cooper 1994), 19–52 ha with a mean of 29 ha (Waian 1973), and 17–120 ha (Henry 1983). As with other raptors species, particularly those occurring in agricultural habitats, home ranges may overlap and foraging may be limited to a small portion of the total area. This may be a result of competition or fluctuating prey accessibility due to changes in vegetation structure (Henry 1983). Communal roosts are used during the nonbreeding season (Waian and Stendell 1970). Home ranges for nonbreeders is more difficult to determine since communal roosts may be tens of kilometers away (Dunk 1995).

C.38.2.4 Foraging Behavior and Diet

White-tailed kites generally hunt from a central perch over areas as large as 3 square kilometers (km^2) (Warner and Rudd 1975), but foraging usually occurs within 0.8 km from the nest during the breeding season (Hawbecker 1942). Kites are not particularly territorial. The nest site and the immediate surrounding area are defended against other raptors and crows (Pickwell 1930, Dixon et al. 1957). Small wintering territories of about 0.10 km^2 have been documented to be defended as well (Bammann 1975).

The white-tailed kite preys mostly on voles, but also takes other small, diurnal mammals, and occasionally birds, insects, reptiles, and amphibians. Small mammal prey comprises 95 percent of the kite diet (Dunk 1995). It forages in undisturbed, open grasslands, meadows, farmlands and emergent wetlands, ungrazed grasslands, fence rows and irrigation ditches adjacent to grazed lands (Dunk 1995). It soars, glides, and hovers less than 30 meters above the ground in search of prey. It hunts almost exclusively by hovering from 5 to 25 meters in height, with hovering bouts lasting up to 60 seconds. During this time, kites scan the ground searching for prey and watching for potential competitors or predators. The hovering bout ends in a dive to the ground for prey; flight to another location; soaring or interacting with another bird; or flight to the perch (Warner and Rudd 1975).

C.38.2.5 Predation

The primary cause of egg mortality is inclement weather and predation (Stendell 1972). Circumstantial evidence suggests red-tailed hawks may take adults (Pinkston and Caraviotis 1980). Skeletons of immature white-tailed kites with feathers on wings have been found beneath perches used by larger raptors, also suggesting predation (Dunk 1995).

C.38.3 Habitat Requirements and Ecology

C.38.3.1 Nesting

The white-tailed kite inhabits low elevation, open grasslands, savannah-like habitats, agricultural areas, wetlands, and oak woodlands (Dunk 1995). Habitat elements that influence nest site selection and nesting distribution include habitat structure (usually trees with a dense canopy) and prey abundance and availability (primarily the association with meadow vole), while the association with specific vegetation types (e.g., riparian, oak woodland, etc.) appears less important (Erichsen 1995; Dunk 1995). White-tailed kite nests have been documented in a variety of tree species, including valley oak (*Quercus lobata*), Fremont cottonwood (*Populus fremontii*), willow (*Salix* spp.), live oak (*Quercus wislizenii*), box elder (*Acer negundo*), ornamental trees including olive and pine trees, and occasionally in tall shrubs (Dixon et al. 1957; Dunk 1995).

Nest trees appear to be selected on the basis of structure and security, and thus typically have a dense canopy or are within a dense group of trees, such as riparian forest or oak woodland. Kites will occasionally use isolated trees, but this is relatively rare. Most nests in the Sacramento Valley are found in oak/cottonwood riparian forests, valley oak woodlands, or other groups of trees and are usually associated with compatible agricultural foraging habitat, such as pasture and hay crops, compatible row and grain crops, or natural vegetation such as seasonal wetlands and annual grasslands (Erichsen 1995).

Kites often nest in close association with other nesting kites and with several other raptors. These include the Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*Buteo jamaicensis*), and red-shouldered hawk (*Buteo lineatus*) (particularly in riparian habitats of the Sacramento Valley).

C.38.3.2 Foraging

The white-tailed kite uses a variety of foraging habitat types, but those that support larger and more accessible prey populations are more suitable. The presence and abundance of white-tailed kites are strongly correlated with the presence of meadow voles (Stendell 1972). As a result, population cycles of meadow voles can also influence nesting and wintering abundance of white-tailed kites. Cover types that appear to be preferred include alfalfa and other hay crops, irrigated pastures, and some cultivated habitats, particularly sugar beets and tomatoes, both of which can support relatively large populations of voles (Estep 1989) and which have been highly correlated with kite nest site densities (Erichsen et al. 1994). Kites also forage in dry pastures, annual grasslands, rice stubble fields, and occasionally in orchards (Erichsen 1995).

Winter foraging habitat is similar to breeding season foraging habitat (particularly the association with agricultural habitats and vole populations); however, there is less association with riparian forests and woodlands.

C.38.4 Species Distribution and Population Trends

C.38.4.1 Distribution

The white-tailed kite was threatened with extinction in North America during the early twentieth century (Eisenmann 1971). Until the 1960s, the species was considered declining throughout its North American range, but since then has recovered in some areas. Currently, the distribution of the species includes the East Coast and southeast United States, the southwest United States from Texas to California, and north to Washington State, and from Mexico to South America (Dunk 1995). Relatively stable resident populations occur in California, portions of coastal Oregon and Washington, southern Florida, southern Texas, and portions of northern Mexico. The species is considered rare in remaining portions of its North American range. Range expansion has also been noted in some Central American locales (Eisenmann 1971).

White-tailed kite has been reported from most of the open, lowland habitats in Yolo County. The species is underreported in the California Natural Diversity Database (CNDDB 2009) with only six nest sites reported, all in the vicinity of Davis. A total of 13 nest sites was reported during a survey of the lowland portion of Yolo County conducted in 2007 (Estep 2008). Most were found in riparian areas, including three along Putah Creek, three along Willow Slough, two along Dry Slough, one along the Sacramento River, one along the Willow Slough Bypass, and one along the Knights Landing

Ridge Cut. Two nonriparian sites included one in West Sacramento and one near Dunnigan. Whisler (pers. comm., 2015) reported several suburban nests in east and north Davis and the Willowbank area (planning unit 20), El Macero Golf Course, and UC Davis during 2001 and 2002. No trend information for Yolo County is available.

C.38.4.2 Population Trends

California populations were also thought to be seriously declining prior to the 1960s, likely due to habitat loss, shooting, and possible egg collecting (Pickwell 1930; Waian and Stendell 1970). From the 1940s to the 1970s, populations and distribution increased (Fry 1966, Waian and Stendell 1970, Eisenmann 1971) due to protection from shooting and possibly due to increasing agricultural development, which may have increased rodent habitat and expanded the foraging range of white-tailed kite (Eisenmann 1971; Small 1994). In the Sacramento Valley, the kite has increased predominantly in irrigated agricultural areas where meadow vole (*Microtus californicus*) populations are found (Warner and Rudd 1975).

California is currently considered the breeding range stronghold for white-tailed kite in North America, with nearly all areas up to the western Sierra Nevada foothills and southeast deserts occupied (Small 1994; Dunk 1995). It is common to uncommon and a year-round resident in the Central Valley, other lowland valleys, and along the entire length of the coast (Dunk 1995).

Although white-tailed kite is probably resident through most of its breeding range, dispersal occurs during the non-breeding season, leading to a winter range expansion that includes most of California (Small 1994; Dunk 1995).

While white-tailed kite populations may have recovered to some extent since the 1960s as a result of agricultural crop conversions in Yolo County, the species is also subject to interspecific competition with nesting great-horned owls, Swainson's hawks, red-tailed hawks, and red-shouldered hawks, which can result in territory abandonment or nest failure. Erichsen (1995) reported six of 13 kite nest failures in riparian areas due to displacement by nesting Swainson's hawks.

C.38.5 Threats to the Species

C.38.5.1 Urbanization/Fragmentation

Urbanization, including residential and commercial development and infrastructure development (roads and oil, water, gas, and electrical conveyance facilities) is one of the principal causes of continuing habitat loss for white-tailed kite and is a continuing threat to remaining populations, particularly in rapidly urbanizing areas in the Sacramento Valley. Urbanization permanently removes habitat and results in permanent abandonment of nesting territories. Proximity to urban areas also influences kite occurrence. While there are examples of kites nesting and roosting in urban areas, in general, the species is intolerant of noise and human activities and will abandon nesting areas that are subject to increasing levels of human disturbances. Kites are also sensitive to habitat fragmentation. Low density urbanization or isolation of habitats, even if relatively large patches remain undisturbed, also leads to territory abandonment.

C.38.5.2 Agricultural Crop Conversion

As noted above, white-tailed kite populations are closely associated with rodent abundance and accessibility, which can be influenced by crop patterns. Kite populations have recovered to some extent in California due in part to the expansion of compatible agricultural types. The conversion to crop patterns that do not support sufficient rodent prey or that restrict accessibility to prey can result in the abandonment of traditionally active territories.

C.38.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.7.3, *Habitat Requirements and Ecology* (Figure A-7). The model parameters include the following.

- CNDDB Location: These are locations where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (CNDDB).
- Nesting Habitat: This habitat type includes all potentially suitable nesting habitat, which was modeled by selecting all mapped vegetation types as listed below that occur below an elevation of 500 feet. In addition, all remnant woody vegetation occurring in isolated patches or isolated trees in agricultural fields or field borders (Yolo County Remnant Woody Vegetation mapping project)[8] were included as potential nesting habitat.
- Primary Foraging Habitat: This habitat includes all potentially suitable foraging habitat on the valley floor that is of higher value because these vegetation types are nearer to nesting habitat and have the physical structure and planting/harvesting patterns to make higher density prey available to white-tailed kites. This habitat was modeled by selecting all mapped pasture types (including alfalfa) and annual grasslands, that occur at an elevation of 500 feet or lower and are within 1 mile of modeled nesting habitat and reported nesting location in all ecoregions.
- Secondary Foraging Habitat: This habitat includes all potentially suitable foraging habitat that is also nearer to nesting habitat but has crop and vegetation communities that are used less frequently than those in the Primary Foraging category. This habitat was modeled by selecting all mapped vegetation types as listed below that occur at an elevation of 500 feet or lower and are within 1 mile of modeled nesting habitat and reported nesting location in all ecoregions.

C.38.6.1 Nesting Habitat – Vegetation Types

- Blue Oak Woodland
- Blue Oak – Foothill Pine
- Eucalyptus
- Valley Oak Woodland
- Fremont Cottonwood – Valley Oak – Willow (Ash – Sycamore) Riparian Forest NFD Association
- Great Valley – Valley Oak Riparian Association
- Mixed Fremont Cottonwood – Willow spp. NFD Alliance
- Mixed Willow Super Alliance
- Valley Oak – Fremont Cottonwood – (Coast Live Oak) Riparian Forest NFD Association
- Valley Oak Alliance – Riparian
- White Alder (Mixed Willow) Riparian Forest NFD Association
- Undifferentiated Riparian Woodland/Forest

[8] GIS layer prepared by J. Tuil in 2008 for Yolo County NHP.

C.38.6.2 Primary Foraging Habitat – Vegetation Types

- All pasture types (including alfalfa)
- Annual grassland

C.38.6.3 Secondary Foraging Habitat – Vegetation Types

- *Crypsis*
- Carex
- Undetermined Alliance – Managed
- Alkali Sink
- Vernal Pool Complex
- Grain/Hay Crops
- Field Crops
- Truck/Berry Crops

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C.39 California Black Rail (Laterallus jamaicensis coturniculus)

C.39.1 Listing Status

Federal: No listing

State: Threatened

C.39.2 Species Description and Life History

The California black rail is one of two subspecies of black rail that inhabit North America. The range of the California black rail extends throughout portions of California and Arizona. The eastern black rail (*Laterallus jamaicensis jamaicensis*) is found along the eastern seaboard, the Gulf Coast, and rarely at inland sites in the Midwest (Eddleman et al. 1994). The California black rail is a small (12 to 15 centimeters [4.7 to 5.9 inches] long), secretive, marsh-associated bird (Eddleman et al. 1994). They are black to gray in color with a small black bill, white speckled sides and back, and a deep chestnut brown nape (California Department of Fish and Game 198799). Difficult to observe, rails are usually identified by their call.

Very little information is available on seasonal patterns, timing of reproduction, dispersal, or other activities. The breeding season begins as early as February with pair formation and extends through approximately early to mid-June. Egg laying peaks around May 1 (Eddleman et al. 1994). The species is generally known as a medium-distance migrant that winters in Mexico and Central America, although San Francisco Bay black rails are considered year-round residents, as are those from inland populations in central California. At these locations, seasonal movements, including juvenile dispersal and adult relocation to other wetland breeding sites, occur each year sometime during the nonbreeding season between approximately August and February (Tecklin 1999).

Black rails are monogamous birds. They build cup nests with a woven canopy in dead or new emergent vegetation over shallow water less than 3 centimeters (1.2 inches) in depth (Eddleman et al. 1994). They initiate egg laying within a few days after nest construction is complete. Rails in California usually lay one single brood with an average clutch size of six eggs (range equals three to eight eggs) (Eddleman et al. 1994). Occasionally there are multiple nesting attempts but there is no evidence of multiple broods being produced (Spautz and Clipperton pers. comm.). The incubation period ranges from 17 to 20 days and both adults apparently incubate the eggs (Flores and Eddleman 1993); however, there is very limited data on this period. After hatching, the semiprecocial young leave the nest within a day, but at least one parent continues to brood the young for several additional days (Eddleman et al. 1994). Limited information is available on length of brooding period, timing of fledging, parental care, or reproductive success.

The species is assumed to be an opportunistic daytime feeder that forages exclusively in wetland habitat, presumably on or near the ground at the edges of emergent vegetation. Its diet consists of insects, small mollusks, amphipods, and other invertebrates, and seeds from bulrushes (*Schoenoplectus* spp.) and cattails (*Typha* spp.) (Eddleman et al. 1994).

C.39.3 Habitat Requirements and Ecology

California black rails inhabit saltwater, brackish, and freshwater marshes (Grinnell and Miller 1944; Manolis 1978; Spautz et al. 2005). A highly secretive and rarely observed bird, it appears to have a preference in coastal areas for tidal salt marshes dominated by dense pickleweed (Salicornia pacifica) with an open structure below (Tsao et al. 2009a). This provides a dense canopy for protective cover while providing nesting habitat and accessibility below the canopy (Evens and Page 1983). Rails are susceptible to predation by herons, egrets, northern harriers, short-eared owls, and several mammalian predators. A dense canopy that provides optimal cover is essential for survival.

Black rails tend to be associated with areas where *Schoenoplectus* (formerly *Scirpus)* spp. and *Salicornia* border each other. Evens et al. (1991) found rails in areas with a mosaic of *Juncus* (40%), *Schoenoplectus* (30%), *Triglochin* (10%), *Grindelia* (<10%), *Distichlis* (less than 10%), and *Typha* (less than 10%). In Suisun Marsh, presence of black rails occurs in conjunction with a pickleweed-alkali heath-American bulrush plant association in the high marsh zone. Data from Spautz et al. (2005) indicate that black rails prefer marshes that are close to water (bay or river), large, away from urban areas, and saline to brackish with a high proportion of *Salicornia*, *Grindelia*, *Bolboschoenus maritimus* ssp. *paludosus* (formerly *Scirpus maritimus*), *Juncus*, and *Typha*. Escape cover is critical to these birds. Rail nests consist of loosely made, deep cups either at ground level or slightly elevated. Nests are concealed in dense marsh vegetation near the upper limits of tidal flooding (California Department of Water Resources 2001).

At Suisun Marsh, low marsh habitats dominated by *Schoenoplectus acutus* and *S. californicus* do not provide breeding habitat, but they are used by black rails for foraging. In addition, upland transition zones provide both foraging habitat and refuge during extreme high tide events. Finally, managed wetlands that are intensively managed (e.g., by mowing and discing) for waterfowl generally provide only marginal habitat for this species, while less intensively managed shallow-water areas may provide more suitable habitat. Collectively, managed wetlands are considered secondary habitat compared to tidal middle and high marsh wetlands.

CDFW and DWR surveyors recorded black rails at instream islands in the central Delta and at one managed marsh on the eastern edge of the Delta during the 2009 and 2010 breeding seasons (California Department of Water Resources et al. 2012). The instream islands consisted of mixed tule (Schoenoplectus spp.) wetland and willow-dogwood scrub. The managed marsh consisted of two tule-dominated wetlands in the White Slough Wildlife Area northwest of Stockton.

Away from coastal estuaries and salt marshes, black rails are restricted to breeding in freshwater marshes with stands of tule, cattail, bulrush, and sedge (*Carex* spp.) (Eddleman et al. 1994). These sites are very shallow (usually less than 3 centimeters), but require a perennial water source. A relatively narrow range of conditions is required for occupancy and successful breeding. Water depth is an important parameter for successful nest sites, because rising water levels can prevent nesting or flood nests and reduce access to foraging habitat (Eddleman et al. 1994). Too little water will lead to abandonment of the site until the water source is reestablished. Primary factors determining their presence are annual fluctuations in water levels and shallow water depth (less than 3 centimeters) (Rosenberg et al. 1991; Eddleman et al. 1994; Conway et al. 2002). No information is available on minimum patch size for the California black rail in the Central Valley and Delta Region; however, in the foothills of the central Sierra Nevada, rails are in marshes ranging from 0.5 to 25 acres (0.2 to 10.1 hectares) in size, with 32% of occupied sites in wetlands less than

0.75 acre (0.3 hectare) (Tecklin 1999). The discovery of these Sierra Nevada populations suggests that the species is able to colonize isolated habitat patches (Aigner et al. 1995; Trulio and Evens 2000).

Black rails occur in marshland only, a habitat mostly destroyed or modified in the western United States since the mid-1800s (Atwater et al. 1979; Zedler 1982; Josselyn 1983; Nichols et al. 1986 in California Department of Water Resources 2001). Populations and numbers have and will continue to decline as loss and alteration of habitat continues. Currently, the species is confined to mostly pristine remnants of historical tidal marshlands, mainly along the large tributaries and shoreline of northern San Pablo Bay, along the Carquinez Strait, and throughout parts of Suisun Bay (Evens et al. 1991; Spautz et al. 2005). The marshes of San Pablo and Suisun Bays are important in that they are currently the last large refuge areas for a viable population. However, recent observations of California black rails using restored wetlands in the Bay area (Herzog et al. 2004; Liu et al. 2006) provide hope that for future population expansion, and success for restoration opportunities in Suisun Marsh and the Delta.

C.39.4 Species Distribution and Population Trends

C.39.4.1 Distribution

The historical range of the California black rail extended from the San Francisco Bay, throughout the Sacramento–San Joaquin River Delta (Delta), along the coast to northern Baja California, and at other southern California locales such as the Salton Sea and the lower Colorado River. Early 20th century breeding records indicate that black rail populations existed on coastal marshes in San Diego, Los Angeles, and Santa Barbara Counties. Loss of tidal marsh habitat has resulted in the extirpation of populations from much of its coastal range, particularly in Southern California and much of the San Francisco Bay since the 1950s (Manolis 1978; Garrett and Dunn 1981 in California Department of Water Resources 2001).

The species persists in remaining tidal marshes in the northern San Francisco Bay estuary, Tomales Bay, Bolinas Lagoon, the Delta, Morro Bay, the Salton Sea, and the lower Colorado River (Manolis 1978; Evens et al. 1991; Eddleman et al. 1994). Several small, isolated populations also still exist in southeastern California and western Arizona (Evens et al. 1991). The species has also been found more recently at several inland freshwater sites in the Sierra Nevada foothills in Butte, Yuba, and Nevada Counties (Aigner et al. 1995; Tecklin 1999), and most recently in Clover Valley (City of Rocklin) in southern Placer County (California Black Rail Project 2006). Additional detections have been made recently at the Cosumnes River Preserve in South Sacramento County and Bidwell Park in Chico, Butte County (Trochet 1999; Kemper and Manolis 1999). Additional recent unconfirmed sightings from rice fields in the Butte Sink and Sutter County suggest that there may be downslope movement from the foothill breeding population.

Until 1994, the black rail was unknown from the Sacramento Valley except for a single winter record at the California Department of Fish and Wildlife (CDFW) Gray Lodge Wildlife Area in Butte County. In 1994, a population of the rail was found occupying a freshwater marsh at the University of California's Sierra Field Station in Yuba County (Aigner et al. 1995). Further examination revealed that the species could be breeding at four separate freshwater marsh ponds within approximately 3.7 miles (6 kilometers) of each other. As a result, CDFW provided funding for a more regional survey effort that resulted in additional occurrences in Butte, Yuba, and Nevada Counties (Tecklin

1999). Since then, the University of California has continued with the California Black Rail Project, which strives to locate additional subpopulations in their Sierra Nevada foothill study area and examines how each of these isolated subpopulations is functioning as a metapopulation.

California black rails are rare in Yolo County. As shown on Figure A-37, there is one California black rail occurrence from the Deepwater Ship Channel near West Sacramento. There are small patches of modeled black rail habitat in and adjacent to the Yolo Bypass (Figure A-37).

C.39.4.2 Population Trends

Black rail populations are declining in California as a result of habitat loss and degradation along with an increase in exotic predators such as black rats and red foxes (Evens et al. 1991). However, because there are no estimates of historical population levels, the extent of population declines is not fully understood. Evens et al. (1991) examined relative abundance of rails at various locations within the species' range and determined that more than 80% of the remaining population is confined to the northern reaches of the San Francisco Bay estuary. They also determined that the species was subject to continuing and ongoing population decline resulting from habitat loss and/or degradation.

C.39.5 Threats to the Species

Throughout its range, the primary threat to California black rail is the loss and fragmentation of habitat from urbanization, flood control projects, agricultural practices, hydrologic changes that affect water regimes, and sea level rise. The most significant historical threat was the draining of tidal marshes, which may be responsible for over 90% of the population declines of this species, and which is still occurring in some areas, albeit at a slower rate.

At inland sites, agricultural practices, livestock grazing, and urbanization may threaten individual subpopulations. Use of pesticides, including those used for mosquito control programs may also have unintended consequences for black rails. These isolated subpopulations are also susceptible to metapopulation dynamics and stochastic variables (Evens et al. 1991), meaning they are more susceptible to localized extirpation from processes such as storm events or disease. Other potential threats include increased predation by domestic cats and by native predators as a result of hydrologic and vegetation changes that increase black rail susceptibility to predation, pollution and its effect on freshwater marshes, and collisions with automobiles and utility lines.

Data gaps relating to many aspects of the ecology of the black rail are significant, including minimum patch size for successful breeding colonies, parameters of population sinks, sources of mortality, site fidelity and movement in winter, winter diet, and foraging ecology.

C.39.6 Recovery Plan Goals

A USFWS recovery plan has not been prepared for this species and no recovery goals have been established; however, the CALFED Bay-Delta Ecosystem Restoration Program Plan's *Multi-Species Conservation Strategy* designates the California black rail as "Contribute to Recovery" (CALFED Bay-Delta Program 2000). This means that the Ecosystem Restoration Program will undertake actions under its control and within its scope that are necessary to contribute to the recovery of the species.

Recovery is equivalent to the requirements of delisting a species under federal and state endangered species acts.

C.39.7 Species Model and Location Data

C.39.7.1 Geographic Information System (GIS) Map Data Sources [TBD: to use BDCP models if authorized]

The California black rail model developed by DWR uses vegetation types and associations from the following data sets: BDCP composite vegetation layer (Hickson and Keeler-Wolf 2007 [Delta], Boul and Keeler-Wolf 2008 [Suisun Marsh], TAIC 2008 [Yolo Basin]), aerial photography (U.S. Department of Agriculture 2005 & 2010), and land use survey of the Delta and Suisun Marsh area-version 3 (California Department of Water Resources 2007). Using these data sets, the model maps the distribution of suitable California black rail habitat in the Plan Area. Vegetation types were assigned based on the species requirements as described above and the assumptions described below.

C.39.7.2 Habitat Model Description

In the central Delta portion of the Plan Area, California black rail may be found in patches of tidal freshwater emergent wetland found along the perimeter of sloughs and on in-channel islands of larger watercourses (Figure 2A.17-2) (National Audubon Society 2008). The habitat mapping region used in the California black rail model is Suisun Marsh, the Delta west of Sherman Island, and the central and northern Delta.

The model identifies suitable habitat as tidal and nontidal, brackish, and freshwater marsh with appropriate vegetation alliances, especially those dominated by pickleweed (*Salicornia* spp.), bulrush (*Scirpus americanus*), and cattail (*Typha* spp.). Because California black rail vegetation associations vary by location in the Plan Area, the primary and secondary habitat models have three geographically distinct types: Suisun Marsh, Delta, and midchannel islands in the Delta.

In Suisun Marsh, primary habitat includes all *Scirpus americanus*-, *Typha* spp.-, and *Salicornia* spp.-dominated patches in the tidal brackish emergent wetland natural community. When *Scirpus americanus*-, *Typha* spp.-, and *Salicornia* spp.-dominated vegetation types occur in the managed wetland natural community, they are secondary California black rail habitat. Vegetation communities dominated by *Scirpus acutus* and *Scirpus californicus* are secondary habitat only when adjacent to primary or secondary habitat types in Suisun Marsh. All secondary vegetation types in Suisun Marsh are restricted to within 750 meters of primary modeled habitat.

In the Delta, there are two California black rail habitat model types: Delta and midchannel islands. The vegetation types included as primary or secondary habitat in each model type varies; however, for both the Delta and midchannel island model types, primary and secondary vegetation patches must combine to meet a 4-acre minimum mapping unit requirement. The 4-acre patch can be composed of both primary and secondary vegetation types.

California black rail primary habitat in the Delta model type includes *Scirpus americanus*- and *Typha* spp.-dominated patches in the tidal and nontidal freshwater emergent wetland natural communities. Modeled secondary habitat in the Delta primarily includes vegetation communities dominated by other *Scirpus* species (see list below) in tidal and nontidal freshwater emergent wetland natural communities. In the Delta model type, *Scirpus actus* pure and *Scirpus acutus*-*Typha latifolia* are not included in the primary or secondary habitat model.

To capture unique habitat types on midchannel islands in the Delta, CDFW created a separate midchannel island GIS layer. Primary and secondary modeled habitat on the midchannel include riparian and tidal and nontidal freshwater emergent wetland vegetation communities. When the riparian vegetation community types are adjacent to the selected emergent wetland types, the habitat is considered primary. Secondary habitat consists of those emergent wetland types when not directly adjacent to riparian vegetation patches.

The black rail model in Suisun Marsh includes the below-listed types from the BDCP composite vegetation layer. The primary model includes these vegetation patches when mapped within the tidal brackish emergent wetland community, and the secondary habitat model includes these patches when mapped within the managed wetland natural community. No minimum patch size is applied to these areas. All secondary habitat in Suisun Marsh is constrained to occur within 750 meters of primary habitat.

- *Distichlis*/*Salicornia*
- *Salicornia* (generic)
- *Salicornia virginica*
- *Salicornia*/*Cotula*
- *Salicornia*/*Atriplex*
- *Salicornia*/annual grass
- *Salicornia*/*Crypsis*
- *Salicornia*/*Polygonum–Xanthium–Echinochloa*
- *Salicornia*/*Sesuvium*
- Mixed Scirpus mapping unit
- *Typha angustifolia–Distichlis spicata*
- *Scirpus*(*californicus* or *acutus*)/*Rosa*
- *Schoenoplectus* (*californicus* or *acutus*)/wetland herb
- *Schoenoplectus* (*californicus* or *acutus*)–*Typha* spp.
- *Scirpus americanus* (generic)
- *Scirpus americanus*/*Lepidium*
- *Scirpus americanus*/*Potentilla*
- *Schoenoplectus californicus*/*S. acutus*
- Mixed *Scirpus*/floating aquatics (*Hydrocotyle–Eichhornia*)
- Mixed *Scirpus*/submerged aquatics (*Egeria–Cabomba–Myriophyllum* spp.)
- *Phragmites australis*

- *Scirpus acutus*–pure
- *Scirpus maritimus*
- *Scirpus maritimus/Salicornia*
- *Typha angustifolia/S. americanus*
- *Typha* species (generic)
- Bulrush–cattail freshwater marsh NFD super alliance
- *Scirpus americanus/S. californicus/S. acutus*
- *Scirpus maritimus/Sesuvium*
- *Typha angustifolia/Phragmites*
- *Typha angustifolia/Polygonum–Xanthium–Echinochloa*
- *Distichlis–Juncus–Triglochin–Glaux*
- *Distichlis–S. americanus*
- *Distichlis–Juncus*
- *Calystegia–Euthamia*
- *Distichlis/Salicornia*
- *Distichlis/S. americanus*
- *Distichlis/Juncus/Calystegia/Euthamia*
- *Lepidium* (generic)
- Narrow-leaf cattail (*Typha angustifolia*)
- American bulrush (*Scirpus americanus*)

The following vegetation types are selected as secondary black rail habitat in Suisun Marsh when adjacent to primary or secondary habitat. All secondary habitat in Suisun Marsh is constrained to occur within 750 meters of primary habitat.

- *Scirpus acutus–Typha angustifolia* (secondary)
- *Scirpus acutus–Typha latifolia* (secondary)
- *Scirpus acutus–Typha latifolia–Phragmites australis* (secondary)
- *Scirpus californicus–Eichhornia crassipes* (secondary)
- *Scirpus californicus–Scirpus acutus* (secondary)
- *Scirpus californicus/S. acutus* (secondary)

The following vegetation types are included in the Delta model type as primary habitat when mapped as tidal or nontidal freshwater emergent wetland. Primary and secondary model patches must combine to meet the 4-acre minimum mapping unit requirement. *Scirpus actus* pure and *Scirpus acutus-Typha latifolia* are not included in the primary or secondary habitat model.

- *Distichlis/Salicornia*

- *Salicornia* (generic)
- *Salicornia virginica*
- *Salicornia*/*Cotula*
- *Salicornia*/*Atriplex*
- *Salicornia*/annual grass
- *Salicornia*/*Crypsis*
- *Salicornia*/*Polygonum–Xanthium–Echinochloa*
- *Salicornia*/*Sesuvium*
- Mixed *Scirpus* mapping unit
- *Scirpus americanus* (generic)
- *Typha angustifolia* (dead stalks)
- *Typha angustifolia–Distichlis spicata*
- American bulrush (*Scirpus americanus*)
- Broad-leaf cattail (*Typha latifolia*)
- Narrow-leaf cattail (*Typha angustifolia*)
- *Distichlis–Juncus–Triglochin–Glaux*
- *Distichlis/S. americanus*
- *Distichlis spicata–Juncus balticus*
- *Distichlis/Juncus*
- *Calystegia/Euthamia*
- *Lepidium latifolium–Salicornia virginica–Distichlis spicata*
- Pickleweed (*Salicornia pacifica*)
- Perennial pepperweed (*Lepidium latifolium*)
- *Phragmites australis*

The following vegetation types are included in the Delta model type as secondary habitat when mapped as tidal or nontidal freshwater emergent wetland. Primary and secondary model patches must combine to meet the 4-acre minimum mapping unit requirement. *Scirpus actus* pure and *Scirpus acutus–Typha latifolia* mapped within the tidal freshwater emergent wetland natural community are not included in the primary or secondary habitat model.

- Mixed *Scirpus*/floating aquatics (*Hydrocotyle–Eichhornia*) (secondary)
- Mixed *Scirpus*/submerged aquatics (*Egeria–Cabomba–Myriophyllum* spp.) (secondary)
- *Scirpus acutus–Typha angustifolia*
- *Scirpus acutus*–(*Typha latifolia*)–*Phragmites australis*
- *Scirpus californicus–Eichhornia crassipes*

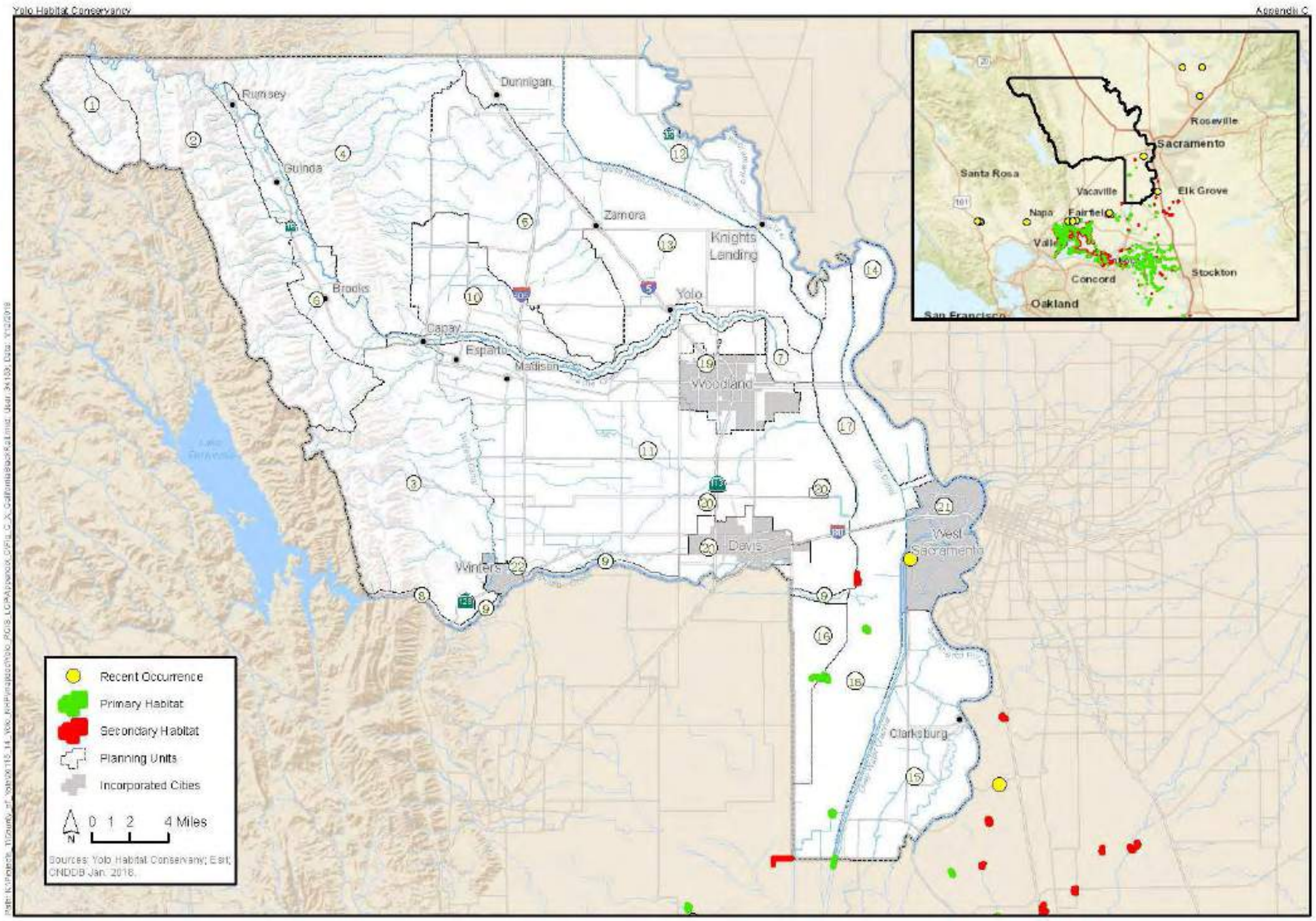
- *Scirpus californicus–Scirpus acutus*
- *Scirpus californicus/S. acutus*
- California bulrush (*Scirpus californicus*)
- Hard-stem bulrush (*Scirpus acutus*)

The below-listed riparian vegetation types are included in the primary portion of the midchannel island model type. Primary and secondary model patches must combine to meet the 4-acre minimum mapping unit requirement to be included in the model.

- Arroyo willow (*Salix lasiolepis*)
- *Baccharis pilularis*/annual grasses & herbs
- Blackberry (*Rubus discolor*)
- Buttonbush (*Cephalanthus occidentalis*)
- California dogwood (*Cornus sericea*)
- California wild rose (*Rosa californica*)
- *Cornus sericea–Salix exigua*
- *Cornus sericea–Salix lasiolepis/Phragmites australis*
- Coyotebush (*Baccharis pilularis*)
- Intermittently or temporarily flooded deciduous shrublands
- Narrow-leaf willow (*Salix exigua*)
- *Blackberry* (*Rubus discolor*)
- *Salix exigua* (*Salix lasiolepis–Rubus discolor–Rosa californica*)
- *Salix gooddingii–Quercus lobata/*wetland herbs
- *Salix gooddingii/Rubus discolor*
- *Salix gooddingii/*wetland herbs
- *Salix lasiolepis* (*Cornus sericea*)/*Schoenoplectus* spp. –(*Phragmites australis–Typha* spp.) complex
- *Salix lasiolepis*-mixed brambles (*Rosa californica–Vitis californica–Rubus discolor*)
- *Distichlis/Salicornia*
- *Salicornia* (generic)
- *Salicornia virginica*
- *Salicornia/Cotula*
- *Salicornia/Atriplex*
- *Salicornia*/annual grass
- *Salicornia/Crypsis*
- *Salicornia/Polygonum–Xanthium–Echinochloa*

- *Salicornia*/*Sesuvium*
- Mixed *Scirpus* mapping unit
- Mixed *Scirpus*/floating aquatics (*Hydrocotyle*–*Eichhornia*) complex (secondary)
- Mixed *Scirpus*/submerged aquatics (*Egeria*–*Cabomba*–*Myriophyllum* spp.) (secondary)
- *Scirpus acutus* pure
- *Scirpus acutus*–*Typha angustifolia*
- *Scirpus acutus*–(*Typha latifolia*)–*Phragmites australis*
- *Scirpus californicus*–*Eichhornia crassipes*
- *Scirpus californicus*–*Scirpus acutus*
- *Scirpus californicus/S. acutus*
- *Scirpus americanus* (generic)
- *Typha angustifolia* (dead stalks)
- *Typha angustifolia*–*Distichlis spicata*
- American bulrush (*Scirpus americanus*)
- Broad-leaf cattail (*Typha latifolia*)
- Narrow-leaf cattail (*Typha angustifolia*)
- *Distichlis*–*Juncus*–*Triglochin*–*Glaux*
- *Distichlis/S. americanus*
- *Distichlis spicata*–*Juncus balticus*
- *Distichlis/Juncus*
- *Calystegia/Euthamia*
- *Lepidium latifolium*–*Salicornia pacifica*–*Distichlis spicata*
- Pickleweed (*Salicornia pacifica*)
- Perennial pepperweed (*Lepidium latifolium*)
- *Distichlis spicata*–*Salicornia virginica*
- *Salicornia virginica*–*Cotula coronopifolia*
- *Salicornia virginica*–*Distichlis spicata*

Figure C-32. California Black Rail Mapped Habitat and Occurrences



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C.40 Loggerhead Shrike (*Lanius ludovicianus*)

C.40.1 Listing Status

Federal: Bird of Conservation Concern (U.S. Fish and Wildlife Service [USFWS] Regions 1[a], 2, 3, 5, and 6) (USFWS 2008).

State: Species of Special Concern.

Recovery Plan: None.

C.40.2 Species Description and Life History

The loggerhead shrike (*Lanius ludovicianus*) is a medium-sized songbird (20–23 centimeters [8–9 inches]) found throughout North America. Their distinctive gray and white plumage with black wings, tail, and mask are features that make them easily distinguished from other species, except for the similar northern shrike, a rare winter visitor to California. They are most often seen perched on telephone wires, barbed-wire fences, and isolated shrubs along pastures, grasslands, and agricultural fields. Shrikes are unique among songbirds in that they prey upon small birds and mammals (Yosef 1996; Humple 2008).

C.40.2.1 Seasonal Patterns

Seasonal patterns vary among loggerhead shrikes in different regions (Humple 2008). Throughout most of the southern portion of its range including California, the shrike is resident year round. Northern populations are migratory and may winter in California (Yosef 1996). The breeding season generally extends from February through July.

C.40.2.2 Reproduction

Loggerhead shrikes initiate their breeding season in February and may continue with raising a second brood as late as July. They often re-nest if their first nest fails or to raise a second brood. Females lay four to seven eggs and then incubate them for an average of 16 days. Nestlings remain in the nest for an average of 20 days and are fed by both parents. Brown-headed cowbird (*Molothrus ater*) brood parasitism rates are not well-known or widely reported; however, because loggerhead shrikes are known to aggressively chase cowbirds from nesting areas, parasitism rates may be lower than for other grassland/shrubland species (Yosef 1996).

C.40.2.3 Home Range/Territory Size

Shrikes are highly territorial and aggressive during the breeding season. In geographic locations where shrikes are resident, including the Central Valley, they usually live in pairs on permanent territories (Yosef 1996). Migratory populations establish and defend winter territories during the nonbreeding season (Miller 1931; Smith 1973). Miller and Stebbins (1964) observed large territories of 12.1–16.2 hectares (30–40 acres) while Yosef (1996) cites a mean territory size of 8.5 ha (21 acres). Territories in California range from 4.4 ha (10.9 acres) to 16 ha (39.5 acres) (Miller 1931 cited in Yosef 1996) and are jointly defended by pairs during the breeding season, but during the fall these pairs disband and defend separate, although often adjacent, winter territories (Yosef 1996).

C.40.2.4 Foraging Behavior and Diet

In general, loggerhead shrikes prey upon large insects, small birds, amphibians, reptiles, and small rodents (*Microtus, Peromyscus,* and *Mus* spp.) (Yosef 1996; Humple 2008). In central California, however, they are primarily insectivorous (Craig 1978). Important groups of insects in the diet of shrikes in Florida included dragonflies and damselflies, beetles, true bugs, butterflies and moths, and grasshoppers and crickets (Yosef and Grubb 1993). Shrikes hunt from perches on electrical lines, fences, shrubs, and trees, and often return to these perches to impale their prey on barbed wire and thorns.

Unlike other birds of prey, shrikes have weak, nonraptorial feet and so must kill vertebrate prey by piercing the cerebral vertebrae with their specialized, hooked bills.

C.40.3 Habitat Requirements and Ecology

Nesting

Loggerhead shrikes occur in open landscapes characterized by widely spaced shrubs and low trees within a variety of plant associations, including arid shrublands, grasslands, savannahs, pasturelands, and farmlands. Trees and shrubs used for nesting generally share common characteristics of having dense foliage, and being bushy or thorny (Poole 1992; Brooks and Temple 1990). Shrikes usually avoid nesting in continuous hedgerows and riparian corridors, possibly in response to higher nest predation rates in those locations from scrub-jays, crows, magpies, and other species (Yosef 1996). Native shrubs are regularly used where available; Woods and Cade (1996) found the most nests (65 percent) in Idaho were constructed in sagebrush (*Atemisia tridentata*), as well as frequent use of bitterbrush and greasewood shrubs. The California Natural Diversity Database (CNDDB) (2007) reports shrike nest sites from central and Southern California occurring in willow (*Salix* spp.), coyotebrush (*Baccharis pilularis*), mule fat (*Baccharis salicifolia*), western juniper (*Juniperus occidentalis*), and unidentified ornamental shrubs. Suitable nesting sites in Yolo County include small isolated native and ornamental trees along irrigation canals, roadsides, rural driveways, farmyards, feedlots, and rural residences. Nest tree selection appears primarily related to the amount of cover and protection the plant provides rather than the tree species. Shrikes will readily use ornamental shrubs and small trees if they provide sufficient protection (Porter et al. 1975; Gawlik and Bildstein 1990). Presence of foraging perches may also be important in nest site selection (Woods and Cade 1996).

C.40.3.1 Foraging

Shrikes use open habitats for foraging during both breeding and nonbreeding seasons. The species is known to forage in open grasslands, pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf courses, open woodlands, riparian areas, agricultural fields and desert and chaparral habitats (Unitt 1984; Yosef 1996). The number and heights of perch sites for hunting is important for the habitat suitability of shrikes, and preferred perch heights vary seasonally (shorter in winter or with shorter vegetation height) (Craig 1978; Yosef and Grubb 1994). Vegetation height in natural grasslands did not affect shrikes (Chavez-Ramirez et al. 1994; Yosef and Grubb 1994). The density of hunting perches in agricultural landscapes plays a strong role in determining the amount and suitability of foraging habitat, as shrikes forage within 10 meters (33 feet) of perches (Yosef 1996).

A study of shrike predatory behavior in Yolo County found that shrike hunting activity varied during the day and varied seasonally with temperature and insect-prey activity levels (Craig 1978). The average rate of successful captures of prey (mostly insects) was a very high 65 percent of all attacks; however, efficiency was dependent on a minimum density of prey (Craig 1978). Because insects are “cold-blooded” and shrikes relied heavily on finding moving prey, the colder temperatures in mornings and during winter were not conducive to insect and shrike hunting activity (Craig 1978). Insect availability is at its lowest in December, when shrikes have a high metabolic rate and are often physically stressed due to low caloric intake (Craig 1978). Changes in vegetation height may alter the availability of insect prey; however, one study found no significant differences between tall grass and mowed fields in shrike foraging success and territory size, and that shrikes altered foraging behavior to increase success in tall vegetation (Yosef and Grubb 1993).

C.40.4 Species Distribution and Population Trends

C.40.4.1 Distribution

Loggerhead shrikes are still common in much of the western United States but are extirpated from much of the eastern United States and are severely declining in the Midwest and Canada (Yosef 1996; Pruitt 2000; D. Easterla pers. comm.).

Loggerhead shrikes were once widespread and generally common over North America, in grasslands, steppes, deserts, prairies, and agricultural landscapes (Yosef 1996). The range of this species has contracted in eastern North America in recent decades, and populations are generally diminished in many areas (Pruitt 2000). The current breeding range includes Alberta, Saskatchewan, and Manitoba; most of the United States except the Pacific Northwest; and Mexico. Northern populations are migratory; the winter distribution includes areas from northern California, northern Nevada, northern Utah, central Colorado, Kansas, western Missouri, northern Kentucky, and northern Virginia south through the southern United States and Mexico (Yosef 1996; Pruitt 2000).

In the foothills and lowlands of California, loggerhead shrikes are year-round residents or short-distance migrants of open, dry grasslands, farmlands, deserts, and shrub-steppe habitats. Only small, scattered populations currently occur in the metropolitan areas of Southern California and the San Francisco Bay region. They do not occur along the coast north of Sonoma County, in the North Coast Range and other high mountain areas such as the Sierra Nevada and Transverse Ranges (Humple 2008); however, nesting has been documented to 7,500 feet elevation (Humple 2008), and where suitable open foraging habitat occurs at higher elevations in Yolo County, it is assumed that the species could occur.

In Yolo County, loggerhead shrikes occupy grasslands, pasturelands, and farmlands. While considered fairly common in the lowland and foothill areas of the County, there is no reliable information on nesting distribution or nesting density in the County. Shrikes are also considered fairly common during the nonbreeding season with up to 274 birds counted in one day during the 2004-2005 Sacramento and Putah Creek Christmas Bird Counts (about one-half of these count areas are in Yolo County).

C.40.4.2 Population Trends

The loggerhead shrike is common throughout much of California, but a decline noticeable by the 1980s in some regions has continued to the present time. Recently, Christmas bird count data and Breeding Bird Survey data have revealed an overall downward trend across the continent that appears to be related to alterations in habitat structure and loss of habitat as well as loss of pasturelands and increase in intensive row-crop agriculture (Cade and Woods 1997; Prescott and Collister 1993; Telfer 1992; Gawlik and Bildstein 1993; Smith and Kruse 1992). Since the 1980s, breeding populations have greatly declined along the California coast (Humple 2008), where shrikes have been eliminated from many areas in Los Angeles and Orange Counties (D. Cooper pers. comm.). Conversion from native grasslands to agriculture may have contributed to early declines (Walk et al. 2006), and more recently, conversion of grasslands, pasturelands, and agriculture to suburban/urban development may be the main factor causing the declines in some regions, but direct causes of the range-wide declines across North America are not well understood. Although California still has a large loggerhead shrike population, development pressures and recent population trends in North America suggest that the species may be subject to population declines in California during the next few decades (Humple 2008).

Loggerhead shrikes are commonly observed in Yolo County; however, because they are relatively common and because their nests sites are difficult to detect, the species is underreported during the breeding season in Yolo County and throughout California. CNDDB reports only 19 breeding occurrences in the state, none of which are from Yolo County (CNDDB 2007). The University of California, Davis (UC Davis) Museum reports several sightings within Yolo County, both recent and historical (UC Davis Museum 2007). In the Natomas Basin, immediately east of Yolo County, biological effectiveness monitoring for the Natomas Basin Habitat Conservation Plan reports numerous breeding and nonbreeding season occurrences of shrikes, including two to five nest sites each year since 2004 (Jones & Stokes 2007), all associated with agricultural habitats.

C.40.5 Threats to the Species

Displacement of habitat through urban development is a primary concern in portions of the Sacramento Valley. In addition, while the loggerhead shrike is thought to be generally tolerant of human harassment, human disturbances resulting from ongoing encroachment can result in abandoned nesting attempts (Yosef 1996). Sources of mortality include vehicle collisions; poisoning by agricultural pesticides; and predation of nestlings and adults by jays, magpies, crows, and other nest-robbing birds, sharp-shinned and Cooper's hawks, snakes, and carnivorous mammals (Humple 2008; Walk et al. 2006).

Agricultural practices can also affect the availability of habitat and cause direct and indirect mortality (Yosef and Deyrup 1998). Conversion from suitable grassland, pastureland, and hay/row/grain crop agriculture to vineyards and orchards reduces available foraging habitat (Humple 2008). The removal of trees and shrubs along field borders and roadsides reduces available nesting habitat and possibly access to some agricultural foraging habitats. The spraying of pesticides reduces insect prey, and the spraying of herbicides can affect the survivability of isolated trees and shrubs in agricultural habitats. A study of the effect of spraying the common fertilizer, sodium ammonium nitrate, on cattle pastures concluded that the foraging territories of shrikes increased on average to 138 percent of a control group and the survivorship of eggs, nestlings and fledglings as well as adults was reduced (Yosef and Deyrup 1998).

The overall effect of population-level threats (e.g., habitat loss or pesticides) is of much greater concern than sources of individual mortality (e.g., predation or vehicle collisions), as these former forces operate at a population, regional, or range-wide level.

Although the role of pesticides in the species' decline has been investigated in Canada and the eastern United States, there is no information on pesticide effects on shrikes in California. Pesticides not only eliminate much of the insect prey base but also may cause eggshell thinning and toxic effects on adult shrikes (summary in Yosef 1996). A study of shrikes in natural grasslands in Texas found that, in contrast to agricultural landscapes, manipulating perch densities and vegetation heights had no effect on shrikes (Chavez-Ramirez et al. 1994). These results indicate that management for shrike habitat should differ between grasslands and agricultural fields (Chavez-Ramirez et al. 1994). The relationship between pesticide use and the availability of suitable insect prey during different seasons in different agricultural crops and grassland habitats is not fully understood and may have strong effects on shrike physical condition and survivorship.

The status and current population trends of the loggerhead shrike have not been documented in Yolo County. Surveys should be conducted to determine the population size and status in the Capay Valley, Dunnigan Hills, Central Valley and the Yolo Bypass ecoregions. It is not known if a lack of nest sites (isolated shrubs and small trees) is limiting the species' population size in these ecoregions; however, establishment of trees and shrubs along fencerows, field borders, and roadsides where they are currently lacking would enhance the potential for population expansion in Yolo County. Movement patterns of shrikes in Yolo County are unknown, including the percentage of individuals migrating to the county in winter and the percentage of individuals that are year-round residents of the county. Because the dispersal distances of young birds are not known, the contribution of nest success of local breeders to local population trends is also unknown.

C.40.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.26.3, *Habitat Requirements and Ecology* (Figure A-26). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., UC Davis Museum of Wildlife and Fish Biology, California eBird, Avian Knowledge Network).
- Nesting/Perching Habitat: This habitat includes all potentially suitable nesting or perching habitat occurring below 300 feet elevation except for the Dunnigan Hills ecoregion where all elevations are included. Nesting/perching habitat was modeled in two stages. The first portion of nesting/perching habitat selects vegetation occurring within 100 feet of existing road features that sought to capture fence and utility lines, which are likely to be used as perching habitat. The fence and utility lines were modeled as potentially suitable perching habitat by

selecting all mapped annual grasslands, pastures, grain/hay crops, field crops, and truck/berry crops that occur within 100 feet of mapped roads (utility lines and fences typically occur along roadway corridors). The second portion of nesting/perching habitat included a combination of woodland vegetation types that consisted of eucalyptus, valley oak woodland, valley foothill riparian and remnant woody vegetation occurring in isolated patches or isolated trees in agricultural fields or field borders (Yolo County Remnant Woody Vegetation mapping project)[9] where shrikes can nest and perch for foraging. This selected habitat was required to occur within 500 feet of foraging habitat.

- Foraging Habitat: This habitat includes all grassland, pasture, and agricultural types listed below. This habitat was modeled by selecting all grassland pasture, and agricultural types within 500 feet of all modeled nesting/perching habitat vegetation types listed below, which were located within 100 feet of road features. The 500-foot distance is selected to incorporate the highest value foraging habitats based on accessibility from perches. The model underestimates the full extent of suitable foraging habitat in the Plan Area because other perch types are not mapped and thus were not included in the model.

C.40.6.1 Nesting/Perching Habitat – Vegetation Types

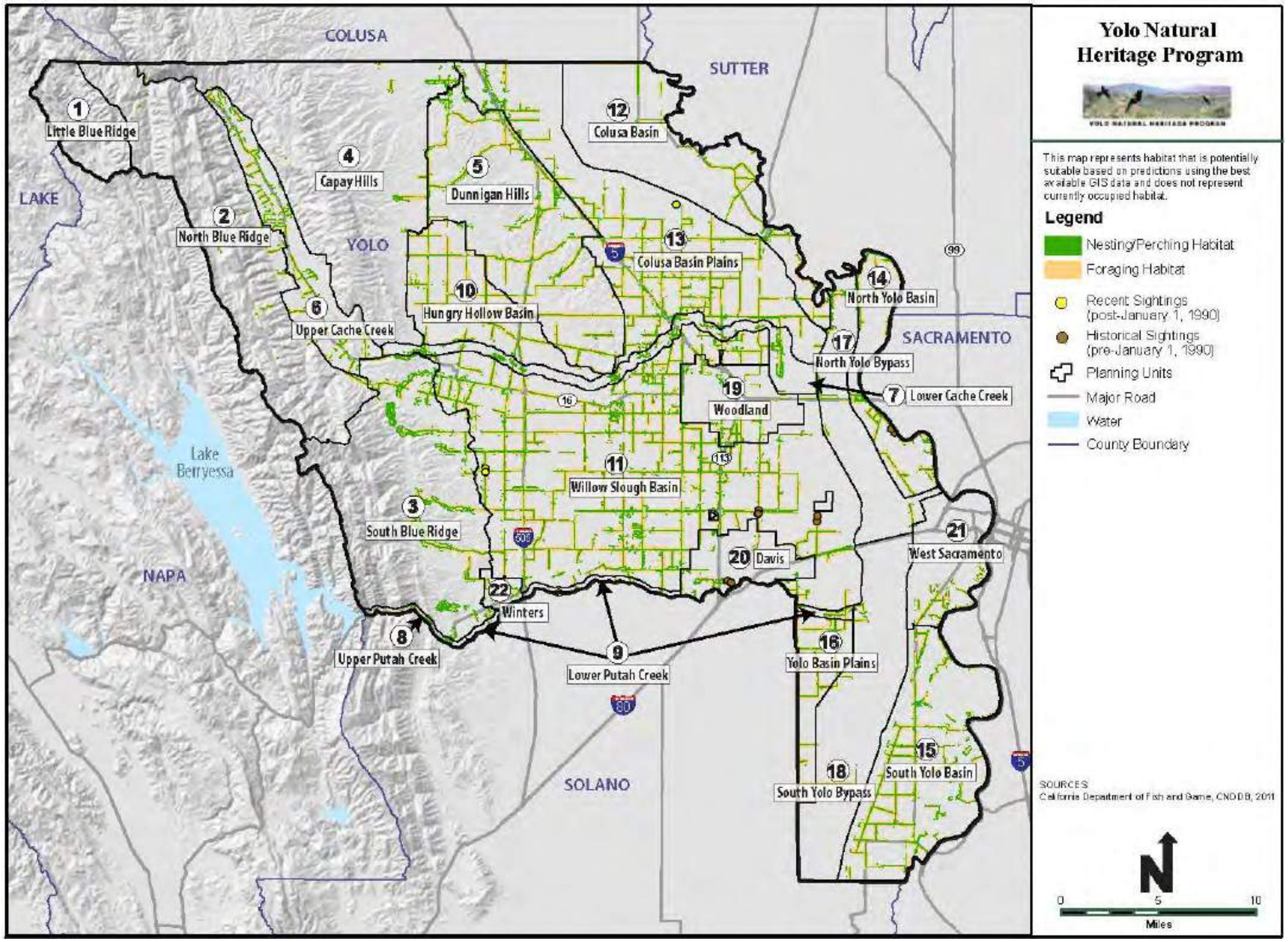
- All Blue Oak – Foothill Pine
- All Chamise Alliance
- All Closed-Cone Pine-Cypress
- Eucalyptus
- Juniper
- All Mixed Chaparral
- All Montane Hardwood
- All Serpentine
- Valley Oak Woodland
- Valley Foothill Riparian

C.40.6.2 Foraging– Vegetation Types

- All Annual Grassland
- All Pasture
- All Field Crops
- All Truck/Nursery/Berry Crops
- Grain/Hay Crops

[9] GIS layer prepared by J. Tuil in 2008 for Yolo County NHP.

1 **Figure C-33. Loggerhead Srike Mapped Habitat and Occurrences**

2 

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C.40.7.1 Personal Communications

Dan Cooper. Former Director of Bird Conservation, California Audubon Society; currently an Independent Wildlife Consultant. April 27, 2005 interview.

David Easterla. Professor of Biology, Northwest Missouri State University. Coauthor of *Birds of Missouri: Their Distribution and Abundance*. May 1, 2005 interview.

C.41 Yellow-Breasted Chat (*Icteria virens*)

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C.41.1 Conservation Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.41.2 Species Description and Life History

Yellow-breasted chats are very large, aberrant warblers with distinctive plumage. They have olive green to grayish upperparts with lemon-yellow chin, throat, and breast; the large bill has a strongly curved culmen. The face of the yellow-breasted chat is grayish with black lores, white supercilium, and white eye-crescent on lower eyelid (Eckerle and Thompson 2001).

C.41.2.1 Seasonal Patterns

Yellow-breasted chats are migratory and usually arrive to California breeding grounds in April from their wintering grounds in Mexico and Guatemala (Green 2005). In Santa Barbara County, breeding birds arrive in early to mid-April (Lehman 1994). Northern populations may arrive to breeding grounds from late April to early May (Ricketts and Kus 2000). In the Sierra Nevada, they may move upslope postbreeding (Gaines 1992). Departure for wintering grounds occurs from August to September (Ricketts and Kus 2000).

Little information is available on juvenile dispersal. Banding studies in Indiana showed that many juveniles moved away from the forests where they were born. Data on post-breeding dispersal are also scarce. Data from the eastern United States indicate an extremely low fidelity to breeding sites between years; however, in Southern California the limited amount of available habitat may foster a higher level of breeding site fidelity (Eckerle and Thompson 2001).

C.41.2.2 Reproduction

Yellow-breasted chats breed from early May to early August, with peak breeding activity occurring in June (Green 2005). Males arrive to breeding sites before females (Eckerle and Thompson 2001). Low site fidelity was reported in abandoned agricultural fields in southern Indiana (Thompson and Nolan 1973). Pairs are monogamous, although pairs may nest near one another (Ehrlich et al. 1988). Three to six eggs (Green 2005) are laid from mid-May to late July (Thompson and Nolan 1973). Females incubated eggs for 11 to 15 days (Green 2005). Once eggs hatch, both sexes tend to the nestlings until they fledge (Harrison 1978). Approximately eight to 11 days are required for fledging (Green 2005). They will occasionally produce a second brood in the season. Of 24 females nesting in southern Indiana for which all nesting attempts within a single year were known, only two (8 percent) had a second brood (Thompson and Nolan 1973). Survival rates of fledglings are unknown. The oldest recorded individual was eight years 11 months (Klimkiewicz et al. 1983).

C.41.2.3 Home Range/Territory Size

Yellow-breasted chat home ranges are likely the same as summer and winter territories (Eckerle and Thompson 2001). Thompson and Nolan (1973) reported 28 territories averaging 1.3 hectares (ha) (3.1 acres) in an abandoned field in Indiana. They also reported that territory sizes decreased as more males arrived (Thompson and Nolan 1973). Brewer (1955) reported territory averaging 0.12 ha (0.3 acre), and varying from 0.04 to 0.28 ha (0.1 to 0.7 acre), in an Illinois swamp thicket. Dennis (1958) reported territory varying from 0.5 to 1.0 ha (1.25 to 2.5 acres) in abandoned fields and fence rows in Virginia. Gaines (1974) reported 10 per 40 ha (100 acres) in riparian forests along the Sacramento River.

Male yellow-breasted chats maintain and defend individual territories during the breeding season (Dennis 1958; Thompson and Nolan 1973). Territorial defense appears to be less effective as population densities increase (Eckerle and Thompson 2001). Radio telemetry data suggested that females regularly left their mate's territory and visited neighboring males' territories (Dennis 1958).

C.41.2.4 Foraging Behavior and Diet

Yellow-breasted chats feed on a variety of arthropods, including beetles and weevils, true bugs, ants, bees, caterpillars, and spiders. They also eat fruit such as blackberry (*Rubus* spp.), elderberry (*Sambucus* spp.) and wild grape (*Vitis* spp.) (U.S. Department of Agriculture [USDA] Forest Service [USFS] 2008). They feed on insects and berries about equally (Ehrlich et al. 1988). They mostly glean from foliage of shrubs and low trees (Green 2005).

C.41.3 Habitat Requirements and Ecology

C.41.3.1 Nesting

In Northern and central California, yellow-breasted chats require riparian woodland or riparian shrub thickets with dense vegetation typically comprised of Himalayan blackberry (*Rubus discolor*), wild grape (*Vitis* spp.), and/or willows (*Salix* spp.) (Grinnell et al. 1930; Grinnell and Miller 1944; Comrack 2008). Tall willows, cottonwood (*Populus* spp.), and sycamore (*Platanus* spp.) are often used for song perches (Grinnell and Miller 1944; Dunn and Garrett 1997).

Yellow-breasted chats occur up to 1,450 meters (4,800 feet) in valley foothill riparian habitats and up to 2,050 meters (6,500 feet) east of the Sierra Nevada in desert riparian habitats (Gaines 1992; DeSante and Ainley 1980; Garrett and Dunn 1981). At the Lower Clear Creek Floodway in Shasta County, Burnett and DeStaebler (2003) found that most chat nests were associated with Himalayan blackberry. Other species used for nesting include California blackberry, California wild rose, and pipevine (Ricketts and Kus 2000). Additionally, they have been found to use saltcedar preferentially to native habitat (Hunter et al. 1988). During migration, yellow-breasted chats use habitat similar to its breeding habitat (Dunn and Garrett 1997).

C.41.3.2 Foraging

The yellow-breasted chat has been classified as an open-canopy obligatory species (i.e., preferred open overstory and brushy understory), with population density directly related to shrub density to a height of 4.5 centimeters (Crawford et al. 1981). The species is most often forages in areas in early stages of succession, as opposed to young and mature forests (Melhop and Lynch 1986). Kroodsma (1982) reported that chats preferred brushy areas within powerline corridors to forest edge or interior. Kroodsma also found that they prefer patches with high densities of blackberry vines (*Rubus* spp.) and avoided areas with high percentage of grass cover.

C.41.4 Species Distribution and Population Trends

C.41.4.1 Distribution

Yellow-breasted chats are widespread summer residents of eastern North America; however, they have a much more fragmented distribution in the western North America (USFS 2008). In western North America their range includes the Cascade Range, central Oregon valleys, southern Idaho and northern Nevada, and portions of California, Utah, western Colorado, and central Arizona (USFS 2008). In California, the species is most numerous in the northwest portion of the state from the Klamath Mountains region west to the inner Northern Coast Range and south to San Francisco Bay area (Eckerle and Thompson 2001). They are locally distributed throughout Southern Coast Range and Peninsular Range from Santa Clara County south to San Diego County (Eckerle and Thompson 2001; Comrack 2008).

C.41.4.2 Population Trends

There are few data available regarding population decreases or increases over large sections of the species' range (Eckerle and Thompson 2001). California Breeding Bird Survey data from 1966–1998 shows an increasing trend of 1.1 percent per year (Ricketts and Kus 2000; Sauer 2005). However, these data are not considered statistically significant and should be interpreted with caution (Ricketts and Kus 2000). The species has apparently declined dramatically in southern California (Garrett and Dunn 1981; Comrack 2008).

C.41.4.3 Distribution and Population Trends in the Plan Area

Yellow-breasted chats are spring and fall visitors to Yolo County (Yolo Audubon Society Checklist Committee 2004). Singing males can be found reliably in dense riparian tangles along Putah Creek, just downstream from Monticello Dam. While nests have been found in this area (Beedy pers. obs.), all were on the Solano County side of the creek, and nesting has not been confirmed in Yolo County in recent decades. Singing males also have been observed along Cache Creek, approximately 1 kilometer upstream from the County Road 89 bridge, but nesting there has not been confirmed. Spring and fall migrants have also been observed in riparian areas near Gray's Bend and along the Sacramento River at Elk Horn Slough (Beedy pers. obs.).

C.41.5 Threats to the Species

Habitat loss and alteration are major factors threatening yellow-breasted chat populations (Comrack 2008). Loss and degradation of riparian habitat have caused a marked decline in the breeding population in recent decades in California (Green 2005). Many factors contribute to the loss or alteration of habitat including levee development, reduced supply and delivery of water, urban and agriculture encroachment, and poor road and/or culvert design. Grazing can also have a negative impact yellow-breasted chat habitat. Yellow-breasted chats, along with common yellowthroats (*Geothlypis trichas*), may serve as good indicator species of the effects of grazing on riparian birds (Sedgewick and Knopf 1987).

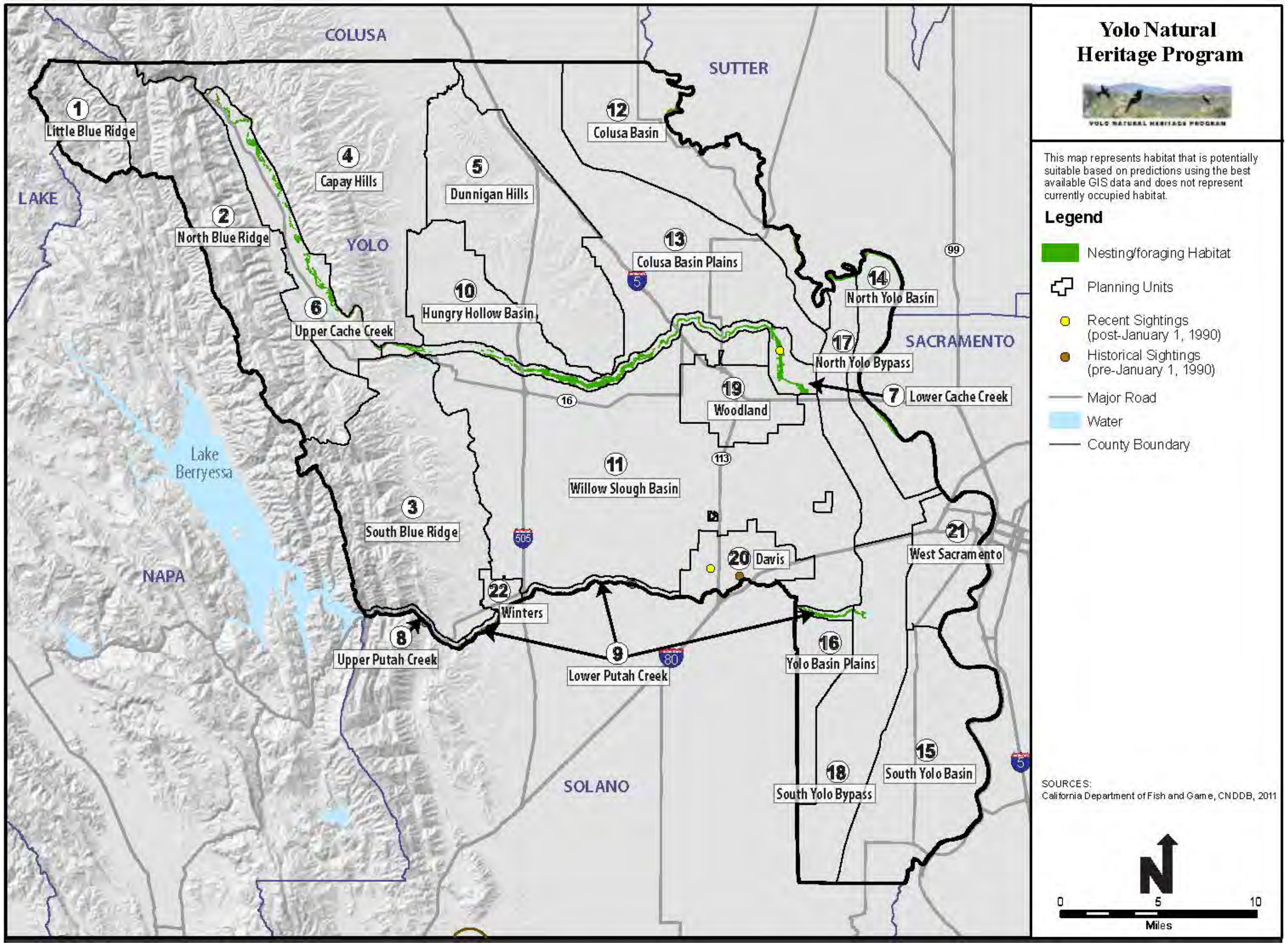
Brood parasitism from brown-headed cowbirds (*Molothrus ater*) may also significantly impact yellow-breasted chats (Gaines 1974; Remsen 1978). The chat is among the 17 hosts most parasitized by cowbirds (Ricketts and Kus 2000). In a three-year study in Missouri, 31 percent of nests were parasitized by cowbirds (Burhans and Thompson 1999). They also are subject to occasional predation by accipiters, small mammals, and snakes (Green 2005). Potential nest predators in California include western scrub-jays (*Aphelocoma californica*), dusky-footed woodrats (*Neotoma fuscipes*), raccoons (*Procyon lotor*), and several species of snakes (Ricketts and Kus 2000).

C.41.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.29.3, *Habitat Requirements and Ecology* (Figure A-29). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., University of California Davis Museum of Wildlife and Fish Biology).
- Nesting/Foraging Habitat: This habitat includes all potentially suitable breeding and foraging riparian areas along Cache Creek, Putah Creek, and Sacramento River north of Sacramento where the highest value yellow-breasted chat habitat is expected to occur (Beedy pers. comm.). This habitat was modeled by selecting all riparian vegetation types as listed below that occur within 1,000 feet of these streams and rivers.

Figure C-34. Yellow-Breasted Chat Mapped Habitat and Occurrences



C.41.6.1 Nesting/Foraging Habitat – Vegetation Types

- Blackberry Not Formally Defined (NFD) Super Alliance
- Fremont Cottonwood – Valley Oak – Willow (Ash – Sycamore) Riparian Forest NFD Association
- Mixed Fremont Cottonwood – Willow spp. NFD Alliance
- Mixed Willow Super Alliance
- White Alder (Mixed Willow) Riparian Forest NFD Association
- Undifferentiated Riparian Bramble and Other
- Undifferentiated Riparian Woodland/Forest

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C.41.7.1 Personal Communications

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C.42 Bank Swallow (*Riparia riparia*)


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C.42.1 Listing Status

Federal: None.

State: Threatened.

Recovery Plan: Recovery Plan: Bank Swallow *(Riparia riparia)* (California Department of Fish and Game [DFG] 1992).

C.42.2 Species Description and Life History

The bank swallow (*Riparia riparia*) breeds throughout much of the Northern Hemisphere and migrates to spend the winter months in South America, Africa, and southern Asia. It is the smallest of the North American swallows (approximately 13 centimeters [5.12 inches] long). Bank swallows are distinguished from other swallows by their distinctive, complete brown breast band, contrasted against white underparts and its dark brown upper parts. Sexes are similar and cannot be distinguished based solely on plumage characteristics (DFG 1992).

C.42.2.1 Seasonal Patterns

Bank swallows arrive in California from their wintering grounds in the southern Amazon basin from mid-March to May and reestablish breeding colonies shortly after arrival. During spring migration, the first individuals arrive in California in mid-March, with numbers peaking in May; during fall migration, the first individuals leave in late July, with a few birds remaining until mid-September (Humphrey and Garrison 1987; Garrison 1999; Garrison 2002). After breeding, bank swallows join mixed-species flocks of swallows that congregate at wetlands and other areas with high concentrations of aerial insect prey, until they depart California for their southward migration in August and September.

C.42.2.2 Reproduction

Bank swallows nest in colonies in vertical cliffs, most often in lowland riverbanks, coastal bluffs, open pit mines, and roadcuts (DFG 1992). Following a short courtship, both sexes spend four to five days digging a nest burrow in soft sand/loam strata. Females typically lay four or five eggs, and feed their young at the nest until the young fledge in 18 to 20 days later. Banks swallows are primarily monogamous, and each pair tends one nest. However, extra-pair copulations are frequent which enhances the genetic diversity of a brood and colony (Garrison 1999).

C.42.2.3 Home Range/Territory Size

Bank swallows actively defend nest burrows and the immediate vicinity of individual burrows. They defend the area around an occupied burrow early in the nesting period. Females select burrows and frequently reject burrows excavated by males until a burrow is suitable for nesting. Thus, typically the number of burrows outnumbers the pairs of bank swallows in a given colony (Garrison 1999).

C.42.2.4 Foraging Behavior and Diet

Bank swallows often join mixed-species flocks of swallows while foraging over water, meadows, bogs, and other sites where concentrations of aerial insects can be found. At nesting colonies, they forage mostly within 200 meters (656 feet) of their nesting burrows, but this range can vary depending on the distance to good foraging areas. Analysis of contents of 394 stomachs from throughout Canada and the United States disclosed 33.5 percent ants, bees, and wasps; 26.6 percent flies; 17.9 percent beetles; 10.5 percent mayflies; 8 percent bugs; and a few dragonflies, butterflies, and moths (Garrison 1999, 2002).

C.42.3 Habitat Requirements and Ecology

C.42.3.1 Nesting

Important breeding habitat characteristics include soil moisture, texture, orientation of bank face, bank height, verticality (slope) of the face, and proximity of the colony to foraging areas (DFG 1992). Bank swallow colonies are often found in fine silt and sandy loam soils (DFG 1992) represented as three main types: sea cliffs, or hard consolidated sand; river banks of sand and sandy earth; and actively worked sand and gravel pits (Hickling 1959 as cited in DFG 1992). In California, bank swallows most often nest in steep earthen riverbanks subject to frequent winter erosion events. Nest sites consist of burrows dug into a vertical earthen bank 45 to 90 centimeters (cm) (17.72 to 35.43 inches) deep, 5 cm (1.97 inches) high, and 7.6 cm (2.99 inches) wide (Garrison 1999). Sites with grassland adjacent to vertical banks are considered of highest suitability (Garcia et al. 2008).

Unique combinations of optimal habitat characteristics may dictate the size and success of individual bank swallow colonies. Burrows that remain available from a previous season may be used in subsequent years. Bank swallow nesting colonies range in size from relatively small (10 burrows) to very large (3,000 burrows) (DFG 1992). Suitable burrows for nesting are at least 1 meter (3.3 feet) above ground or water for predator avoidance, and heights of occupied colony banks in California averaged 3.3 meters (10.83 feet) (SD = 1.7, range 1.3 to 7.3, n = 23) (Garrison 2002).

C.42.3.2 Foraging

Bank swallows are aerial insectivores that forage over lakes, ponds, rivers and streams, meadows, fields, pastures, and bogs (Garrison 1999). Grasslands and croplands immediately adjacent to colonies also provide foraging habitat for bank swallows (DFG 1992). Adult birds foraging along the Sacramento River typically forage within 50 to 200 meters (164 to 656 feet) of the colony location (Garrison 1998), and the normal maximum foraging distance can be as great as 8 to 10 kilometers (5.0 to 6.2 miles) (Mead 1979).

C.42.4 Species Distribution and Population Trends

C.42.4.1 Distribution

During the summer months in the western hemisphere, bank swallows range throughout most of Alaska and Canada, southward from eastern Montana to Nevada, and eastward across the United States to Georgia. They are variably distributed throughout California, Texas, and New Mexico. Within California, regular breeding of the Bank Swallow occurs in Siskiyou, Shasta, and Lassen Counties, and along the Sacramento River from Shasta County south to Yolo County (DFG 2000). Other subspecies are also widespread and common in Europe, Asia, and Africa (Garrison 1999). Bank swallows winter primarily in South America, especially in the southern Amazon Basin and Pantanal (Garrison 1999), although a few winter along the Pacific coast of Mexico (Howell and Webb 1995).

C.42.4.2 Population Trends

Bank swallows historically nested throughout the lowlands of California (Grinnell and Miller 1944). The species once bred at coastal sites from Santa Barbara County south to San Diego County. They have now disappeared as a breeding bird from Southern California (Garrett and Dunn 1981). The historical population along the Sacramento River was most likely larger than it is today, but no population data exist from that era (DFG 1992).

The colonial nesting habits of the bank swallow and the short-lived nature of colony sites make it difficult to consistently census the species accurately from point counts on Breeding Bird Surveys (Garrison 1999), so trends reported from that data set are not informative. According to DFG (2000), estimates of breeding pairs in Sacramento River habitats dropped from 13,170 in 1986 to 5,770 in 1997. In 1998, the number of breeding pairs dropped to 4,990 before rebounding in 1999 to 8,210 pairs. Since 2000, numbers have fluctuated between 6,320 and 8,530 pairs (Garcia et al. 2008). Population size can vary greatly over relatively short time periods because of the poor durability of nesting sites and weather-influenced mortality on wintering grounds (Garrison 1999).

Distribution and Population Trends in the Plan Area

In Yolo County, colonies ranging from 10 to 400 burrows were observed along the Sacramento River and Cache Creek in 1987 (California Natural Diversity Database [CNDDB] 2005). Breeding occupancy was estimated as ranging 10 to 70 percent at the various colonies. However, many of the colonies were unoccupied or inactive. During a survey in 2000, four colonies totaling 488 burrows were found along the Sacramento River in Yolo County between Verona and Knight's Landing (R. Schlorff and C. Swolgaard unpublished data). Assuming an occupancy rate of 45 percent, as used by California Department of Fish and Wildlife (DFW) (Wright et al. 2011), this population was estimated at 202 pairs. An active colony persisted along Cache Creek in a gravel quarry until at least 2001 (Yolo Audubon Society 2004).

C.42.5 Threats to the Species

In California, the loss of nesting habitat is the most significant threat to bank swallows. Nesting habitat is lost through conversion of natural waterways to flood control channels, stabilization of riverbanks for flood control, and other activities that change the natural flow of rivers and prevent the creation of new nesting habitat. Bank stabilization projects are currently the single greatest threat to the state's largest bank swallow population, which breeds along the Sacramento River from Shasta to Yolo counties (Garrison 1998). These projects have had a significant effect on nesting habitat when banks are sloped to 45 degrees and include large rocks. Colony sites are also destroyed by road building and by increased regulation of water flow from reservoirs that can reduce needed winter bank erosion (to maintain vertical banks) or increase summer flows, which can flood nests and intensify erosion during the breeding season (Humphrey and Garrison 1987; Garrison 1999; Garcia et al. 2008). Destruction of nest sites or burrow collapse due to natural or human-related alteration of banks has been found to be the most significant, direct cause of mortality. Bank swallow young and eggs are the primary victims of this type of mortality (DFG 1992). In addition, gopher snakes (*Pituophis melanolencus*) are a significant predator of eggs and nestlings, and raptors such as peregrine falcons (*Falco peregrinus*) and American kestrels (*F. sparverius*) may take young and adults (DFG 1992).

Other factors that affect swallow populations include fluctuations in the genetic structure of a population; demographic factors such as recruitment rates, sex ratios, and survivorship; climate; and catastrophic events, including flooding, drought, fire, and epidemics (DFG 1992). Bank swallows are generally tolerant of human disturbance in the general vicinity of colonies (Garrison 1999).

A habitat suitability index model was developed to evaluate habitat for breeding colonies within the continental United States (Garrison 1989). The model assumed that a bank suitable for a nesting colony must be at least 5 meters (16.7 feet) long; that suitable foraging habitat occurs within 10 kilometers (6 miles) of the colony; that insect prey are not limited; and that optimal colony locations are in vertical banks, greater than 1 meter (3.3 feet) tall, greater than 25 meters (83 feet) long, and consisting of suitable soft soils (sand, loamy sand, sandy loam, loam, and silt loam) in strata greater than 0.25 meter (0.8 foot) wide. The habitat variables incorporated into the model included soil texture class and width in strata, slope of bank, height of bank, and length of bank.

A significant data gap exists in regard to locations of recently occupied bank swallow colony sites and population sizes in Yolo County, especially along Cache Creek. More information is also needed to assess the effects of pesticides and other contaminants, predation, and local river dynamics and flood control projects on the swallows and their nesting colonies.

Extinction probabilities of bank swallow colonies along the Sacramento River decreased with proximity to the nearest grassland, decreased with colony size, and increased with maximum water discharge (Moffatt et al. 2005). Creation of vertical banks in friable sandy soils and road cuts can directly benefit the bank swallow if large rocks (rip-rap) are not placed on the slopes. Artificial banks and enhanced natural banks were built along Sacramento River to mitigate loss of colony sites from flood control projects (Garrison 1991). The artificial banks provided some initial success in that bank swallows occupied artificial and enhanced sites for a few years following construction. Nestlings at the artificial and enhanced colonies were produced at levels similar to natural sites. However, these colonies were abandoned after three years because maintenance activities such as vegetation removal and bank maintenance were conducted on the sites, thereby rendering them unsuitable as bank swallow habitat (Garrison 1991).

Habitat enhancement is feasible, but to ensure suitable quality of artificial banks, the sites must be maintained. Habitat enhancement is currently considered inappropriate for the long-term maintenance of bank swallows because maintenance, such as excavation with hand tools, is costly to maintain and monitor over time (Garrison 1991; DFG 1992).

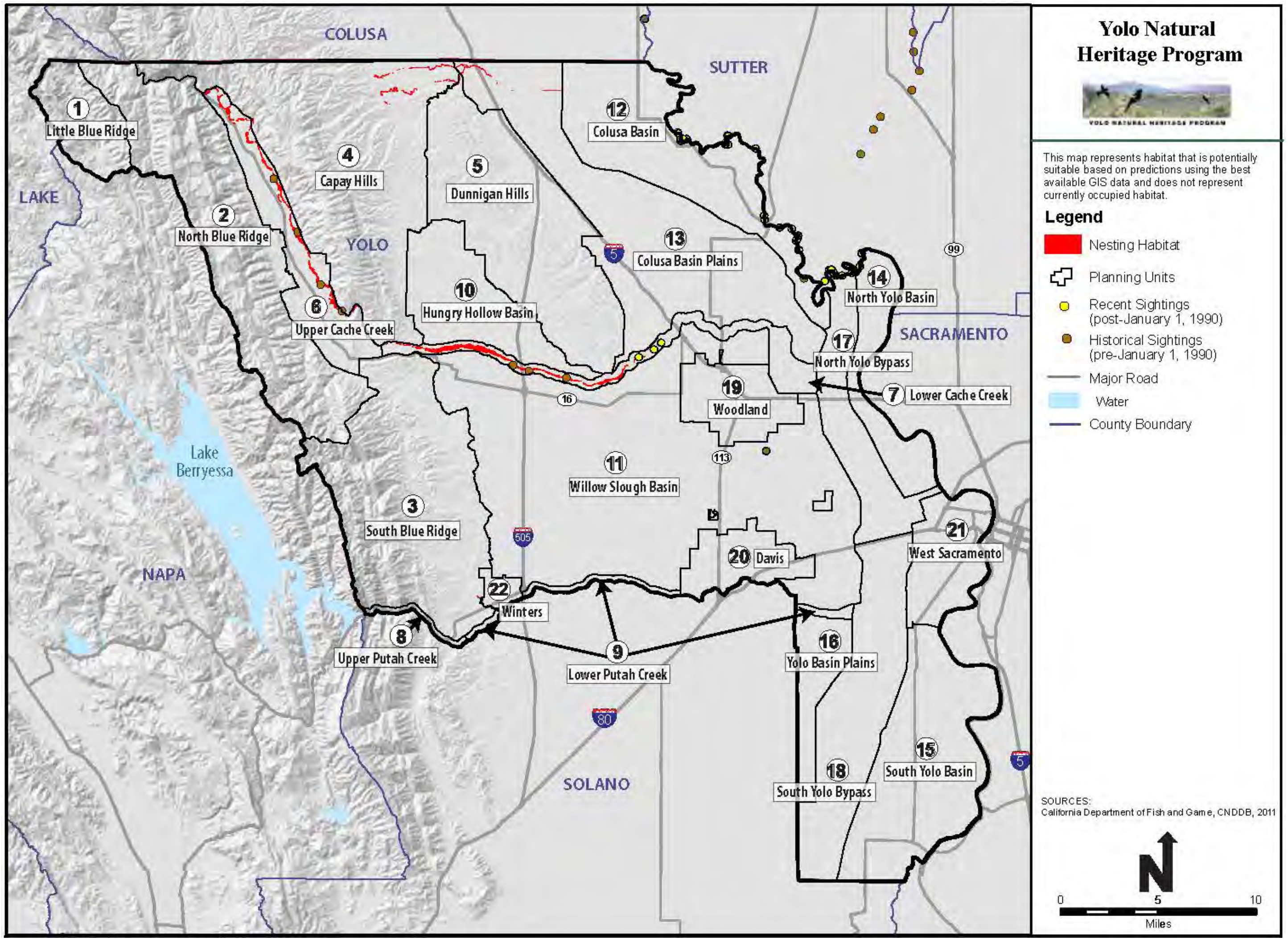
A recovery plan written for the bank swallow in California proposed long-term strategies to preserve bank swallow habitat including developing set-back levees and a riverine meander-belt, preserving major portions of remaining habitat, and developing reach-by-reach habitat maintenance strategies based on the results of a population analysis of the Sacramento River population outlined in the recovery plan (DFG 1992).

The population of bank swallows inhabiting the Sacramento River and its major tributaries are the core of the State's population. These areas, therefore, provide the most important habitat for the long-term maintenance and recovery of bank swallows (DFG 1992). The population analysis in the recovery plan (DFG 1992) indicated that "the risk of low numbers in some years was substantial for the Sacramento River bank swallow population and, under most modeled conditions, was considerably higher than the risk of near local extinction."

C.42.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.28.3, *Habitat Requirements and Ecology* (Figure A-28).

1
Figure C-35. Bank Swallow Mapped Habitat and Occurrences



2

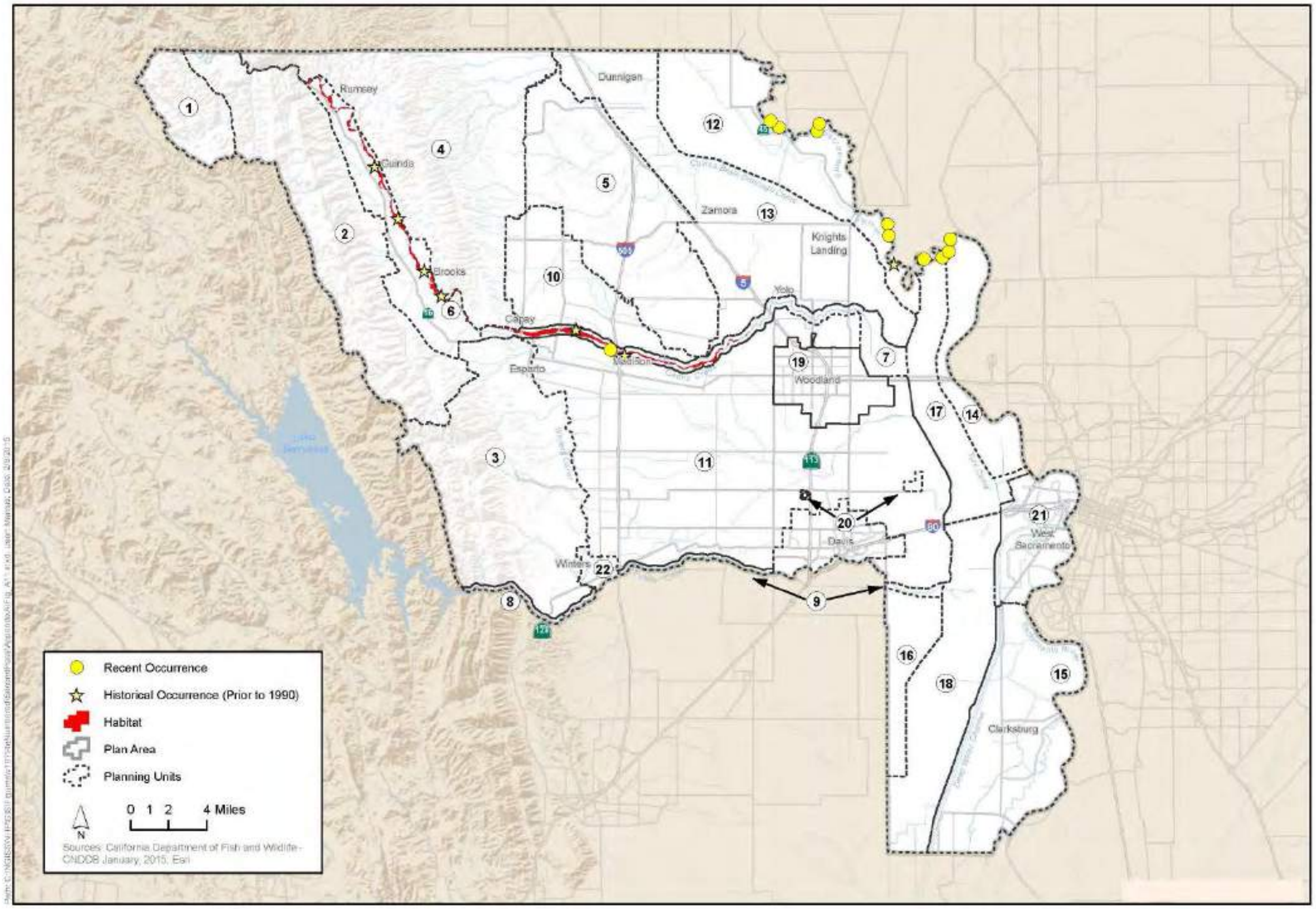
The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., California Natural Diversity Database [CNDDB], Ed Whisler, John Sterling, Chris Alford).
- Nesting Habitat: This habitat includes all potentially suitable breeding habitat in stream channels with suitable nesting substrate of vertical and friable river banks that are free of rip-rap. This habitat was modeled by selecting all mapped land cover types as listed below that occur in the Yolo Bypass, Central Valley and Capay Valley ecoregions.

C.42.6.1 Breeding – Land Cover Type

- Barren – Gravel and Sand Bars

Figure C-36. Bank Swallow Modeled Habitat and Occurrences



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C.42.7.1 Personal Communications

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R. Schlorff and C. Swolgaard unpublished data

C.43 Least Bell’s Vireo (*Vireo bellii pusillus*)

C.43.1 Listing Status

Federal: Endangered.

State: Endangered.

Recovery Plan: The U.S. Fish and Wildlife Service (USFWS) prepared a *Draft Recovery Plan for the least Bell’s Vireo (*Vireo bellii pusillus*)* in 1998 (USFWS 1998).

C.43.2 Species Description and Life History

Least Bell’s vireo is the smallest subspecies of the Bell’s vireo (*Vireo bellii*). The Bell’s vireo can range from 4.3 to 4.7 inches (11–12 centimeters) in length and has a wingspan of 7.1 inches (18 centimeters). It weighs approximately 0.2–0.4 ounce (7–10 grams) (Brown 1993). It is drably colored and indistinctly marked. The least Bell’s vireo is the grayest subspecies of Bell’s vireo and has very little yellow or green in its plumage.

C.43.3 Seasonal Patterns

Least Bell’s vireos are migratory and usually arrive to their California breeding grounds in mid-March to early April from their wintering grounds in Mexico. Observations of banded birds suggest that returning adult breeders may arrive earlier than first-year birds by a few weeks (Kus unpublished data in Kus 2002a). Least Bell’s vireos begin departing for their wintering grounds by late July but are generally present on their breeding grounds until late September (Garrett and Dunn 1981; Salata 1983).

C.43.3.1 Reproduction

Egg-laying begins one to two days after nest completion. Typically three to four eggs are laid. Average clutch sizes of nonparasitized nests observed with complete clutches have ranged from 3.1 to 3.9 in recent years. Both parents share in incubation, which takes approximately 14 days. After hatching, nestlings are fed by both parents for 10 to 12 days until fledging (USFWS 1998). Adults continue to care for the young at least two weeks after fledging when territorial boundaries may be relaxed as family groups range over larger areas. Fledglings usually remain in the territory or its vicinity for most of the season. Least Bell’s vireo pairs may attempt up to five nests in a breeding season, although most fledge young from only one or two. Few nests are initiated after mid-July. Long-term annual rates of hatching success (the percentage of eggs laid that hatch) have ranged from 53 to 83 percent in the major study populations at the San Luis Rey, Santa Margarita, and Tijuana Rivers. The annual average number of fledglings produced per pair has ranged from 0.9 to 4.5, with long-term averages ranging between 1.8 and 3.2 (USFWS 1998).

Nests are typically placed in the fork of a tree or shrub branch in dense cover within 3 to 6 feet (1 to 2 meters) of the ground. Both members of the pair construct the cup-shaped nest from leaves, bark, willow catkins, spider webs, and other material, in about four to five days. The female selects the nest site (Bent 1950; Barlow 1962). Nests are placed in a wide variety of plant species, but the majority are placed in willows (*Salix* spp.) and mule fat (*Baccharis glutinosa*). Nests tend to be placed in openings along the riparian edge, where exposure to sunlight allows the development of shrubs.

C.43.3.2 Home Range/Territory Size

Territory size ranges from 0.5 to 7.5 acres, but on average are between 1.5 and 2.5 acres in southern California (USFWS 1998). Newman (1992) investigated the relationship between territory size, vegetation characteristics, and reproductive success for populations in San Diego County, but found no significant factors that could account for the variability in territory size found at his sites. Spatial differences in riparian habitat structure, patch size, and numerous other factors result in differences in the density of territories within and between drainages. Embree (1992) concluded that patch size and crowding did not influence least Bell's vireo reproductive success, at least not through the mechanisms of singing rates and attraction of predators.

C.43.3.3 Foraging Behavior and Diet

Least Bell's vireos are insectivorous and prey on a wide variety of insects, including bugs, beetles, grasshoppers, moths, and especially caterpillars (Chapin 1925; Bent 1950). They obtain prey primarily by foliage gleaning (picking prey from leaf or bark substrates) and hovering (removing prey from vegetation surfaces while fluttering in the air). Foraging occurs at all levels of the canopy but appears to be concentrated in the lower to mid-strata, particularly when pairs have active nests (Grinnell and Miller 1944; Goldwasser 1981; Gray and Greaves 1981; Salata 1983; Miner 1989). Miner (1989) determined that least Bell's vireo foraging time across heights was not simply a function of the availability of vegetation at those heights; rather; it represented an actual preference for the 3-to-6–meter zone. Foraging occurs most frequently in willows (Salata 1983; Miner 1989), but occurs on a wide range of riparian species and even some non-riparian plants that may host relatively large proportions of large prey (Miner 1989).

C.43.4 Habitat Requirements and Ecology

C.43.4.1 Nesting

The least Bell's vireo is an obligate riparian breeder that typically inhabits structurally diverse woodlands, including cottonwood-willow woodlands/forests, oak woodlands, and mule fat scrub (USFWS 1998). Two features appear to be essential for breeding habitat: (1) the presence of dense cover within 3 to 6 feet (1 to 2 meters) of the ground, where nests are typically placed; and (2) a dense stratified canopy for foraging (Goldwasser 1981; Gray and Greaves 1981; Salata 1981, 1983; RECON 1989). While least Bell's vireo typically nests in willow-dominated areas, plant species composition does not seem to be as important a factor as habitat structure.

Early successional riparian habitat typically supports the dense shrub cover required for nesting and a diverse canopy for foraging. While least Bell's vireo tends to prefer early successional habitat, breeding site selection does not appear to be limited to riparian stands of a specific age. If willows and other species are allowed to persist, within five to 10 years they form dense thickets and become suitable nesting habitat (Goldwasser 1981; Kus 1998). Tall canopy tends to shade out the shrub layer in mature stands, but least Bell's vireo will continue to use such areas if patches of understory exist. In mature habitat, understory vegetation consists of species such as California wild rose (*Rosa californica*), posion oak (*Toxicodendron diversiloba*), California blackberry (*Rubus ursinus*), grape (*Vitis californica*), and perennials that can conceal nests. Nest site characteristics are highly variable and no features have been identified that distinguish nest sites from the remainder of the territory (Hendricks and Rieger 1989; Olson and Gray 1989; RECON 1989).

C.43.4.2 Foraging

Least Bell's vireos forage primarily within and at all levels of the riparian canopy (Salata 1983); however, they will also use adjacent upland scrub habitat, in many cases coastal sage scrub. In addition to use as foraging habitat, these areas also provide migratory stopover grounds and dispersal corridors for non-breeding adults and juveniles (Kus and Miner 1989; Riparian Habitat Joint Venture [RHJV] 2004). Vireos along the edges of riparian corridors maintain territories that incorporate both habitat types, and a significant proportion of pairs with territories encompassing upland habitat place at least one nest there (Kus and Miner 1989).

Little is known about least Bell's vireo wintering habitat requirements. They are not exclusively associated with riparian habitat during winter, and can occur in mesquite scrub vegetation to a greater degree than riparian areas in winter (Kus unpublished data in USFWS 2006). Least Bell's vireo may also occur in palm groves or along hedgerows associated with agriculture and rural residential areas.

C.43.5 Species Distribution and Population Trends

C.43.5.1 Distribution

The least Bell's vireo is one of four subspecies of Bell's vireo and is the only subspecies that breeds entirely in California and northern Baja California. *V. bellii arizonae* is found along the Colorado River and may occur on the California side, but otherwise occurs throughout Arizona, Utah, Nevada, and Sonora, Mexico.

A riparian obligate, the historical distribution of the least Bell's vireo extended from coastal southern California through the San Joaquin and Sacramento valleys as far north as Tehama County near Red Bluff. The Sacramento and San Joaquin valleys were considered the center of the species' historical breeding range supporting 60 to 80 percent of the historical population (51 FR 16474). The species also occurred along western Sierra foothill streams and in riparian habitats of the Owens Valley, Death Valley, and Mojave Desert (Cooper 1861 and Belding 1878 in Kus 2002a; Grinnell and Miller 1944). The species was reported in Grinnell and Miller (1944) from elevations ranging from -175 feet in Death Valley to 4,100 feet at Bishop, Inyo County. These and other historical accounts described the species as common to abundant, but no reliable population estimates are available prior to the species' federal listing in 1986. The last known nesting pair of LBVI in the Sacramento Valley was observed in 1958 (Cogswell 1958, Goldwasser 1978).

During 2010-2013, least Bell's vireo surveys were conducted in the Putah Creek Sinks located in the Yolo Bypass Wildlife Area (Whisler 2013, 2015). The focus of this study was to determine whether least Bell's vireos were breeding in the Putah Creek Sinks. The field survey methods were consistent with the U.S. Fish and Wildlife Service (2001) least Bell's vireo survey guidelines and the Yolo Audubon Society's Yolo County Breeding Bird Atlas survey methods.

Least Bell's vireos were observed during the 2010 and 2011 breeding seasons; none were detected during 2012, and one individual was observed in May 2013. Brown-headed cowbirds were common in the survey area during each year.

During 2010, two pairs of least Bell's vireos were observed in the survey area along with one or two additional individuals. Both pairs of vireos were observed performing courtship activities and territorial defense against other least Bell's vireos. On April 26, an adult least Bell's vireo was observed carrying nesting material. There was no evidence of successful nesting by least Bell's vireos. No obvious signs of nesting (e.g., active nests, fledglings, or adults carrying food) were observed during the surveys. The territories were occupied throughout the typical nesting season (April through mid-August).

In 2011**, t**he two 2010 least Bell's vireo territories were occupied by two least Bell's vireo pairs. The male in each pair was observed singing and defending the territory, signs of breeding behavior. Courtship activities were observed in one of the two pairs. One male was also defending its territory from a third adult. There were no further least Bell's vireo detections in late July or August of 2011.

There were no least Bell's vireo detections during 2012. Apparently the birds did not return to the survey area or they were not detected. One vireo was detected in 2013 on May 9, but none were detected after that date. 2015 surveys are ongoing (Whisler et al. 2015).

C.43.5.2 Population Trends

Coinciding with widespread loss of riparian vegetation throughout California (Katibah 1984), Grinnell and Miller (1944) began to detect population declines in the Sacramento and San Joaquin Valley region by the 1930s. Surveys conducted in late 1970s (Goldwasser et al. 1980) detected no least Bell's vireos in the Sacramento-San Joaquin Valleys, and the species was considered extirpated from the region. By 1986, the USFWS determined that least Bell's vireo had been extirpated from most of its historical range and numbered approximately 300 pairs statewide (51 FR 16474). The historical range was reduced to six California counties south of Santa Barbara, with the majority of breeding pairs in San Diego County (77 percent), Riverside County (10 percent), and Santa Barbara County (9 percent) (51 FR 16474).

Since federal listing in 1986, populations have gradually increased and the species has recolonized portions of its historical range. Increases have been attributed primarily to riparian restoration and efforts to control the brood parasite brown-headed cowbird (Kus 1998 and Kus and Whitfield 2005 in Howell et al. in press). By 1998, the total population was estimated at 2,000 pairs and recolonization was reported along the Santa Clara River in Ventura County, the Mojave River in San Bernardino County, sites in Monterey and Inyo counties (Kus and Beck 1998; Kus 2002a; USFWS 2006), and a single nest reported from Santa Clara County near Gilroy in 1997 (Roberson et al. 1997). Still, the distribution remained largely restricted to San Diego County (76 percent) and Riverside County (16 percent) (USFWS 2006).

By 2005, the population had reached an estimated 2,968 breeding pairs (USFWS 2006) with increases in most Southern California counties and San Diego County (primarily Camp Pendleton Marine Corps Base) supporting roughly half of the current population (USFWS 2006).

C.43.5.3 Distribution and Population Trends in the Plan Area

Two singing least Bell's vireo males were detected, positively identified, and photographed in the southern portion of the Yolo Bypass Wildlife Area in Yolo County in mid-April 2010 and have subsequently returned in the spring of 2011 (J. P. Galván pers. comm.). The next closest recent record occurred in June 2005 and was approximately 66 miles south of the current record at the San Joaquin River National Wildlife Refuge in the San Joaquin and Tuolumne River floodplain (Howell et al. in press). In June 2005, least Bell's vireos were detected nesting at the San Joaquin River National Wildlife Refuge, west of Modesto in Stanislaus County, the first nesting record of the species in the Central Valley in over 50 years (Howell et al. in press). A single breeding pair nested at the refuge in 2005, 2006, and 2007. The pair successfully nested in 2005 and 2006 and the nest was depredated in 2007. No least Bell's vireos were detected in 2008 or 2009 (Howell et al. in press).

C.43.6 Threats to the Species

A major factor leading to declines in populations of least Bell's vireo is the loss and degradation of riparian woodland habitat throughout the species' range. Habitat loss and degradation can occur through clearing of vegetation for agriculture, timber harvest, development, or flood control. Flood control and river channelization eliminates early successional riparian habitat that least Bell's vireo (and many other riparian focal species) use for breeding. Dams, levees and other flood control structures hinder riparian reestablishment, creating more "old-growth" conditions (dense canopy and open understory) that are unfavorable to breeding vireos. Finally, habitat degradation encourages nest predation and parasitism. Agricultural land uses and water projects not only directly destroy habitat, but may also reduce water tables to levels that inhibit the growth of the dense vegetation least Bell's vireo prefer (RJHV 2004). Grazing can also have a significant effect on riparian vegetation (Sedgwick and Knopf 1987). Cattle and other livestock can trample vegetation and eat seedlings, saplings, shrubs, and herbaceous plants. This can lead to a reduction in cover and nesting sites, and affect insect prey populations. Insecticides may also be a threat to this species since it is insectivorous and its greatest declines are in areas with intensive agriculture (Holstein 2003).

Brood parasitism from brown-headed cowbirds (*Molothrus ater*) has a major negative impact on least Bell's vireo. Livestock grazing has reduced and degraded the lower riparian vegetation favored by the Least Bell's Vireo (Overmire 1962) and provided foraging areas for the brown-headed cowbird. Row crops and orchards also provide feeding grounds for the parasite. By as early as 1930, nearly every least Bell's vireo nest found in California hosted at least one cowbird egg (USFWS 1998). Since a parasitized nest rarely fledges any vireo young, nest parasitism of least Bell's vireo results in drastically reduced nest success (Goldwasser 1978; Goldwasser et al. 1980; Franzreb 1989; Kus 1999; Kus 2002b).

Predation is a major cause of nest failure in areas where brown-headed cowbird nest parasitism is infrequent or has been reduced by cowbird trapping programs. Most predation occurs during the egg stage. Predators likely include western scrub jays (*Aphelocoma californica*), Cooper's hawks (*Accipiter cooperii*), gopher snakes (*Pituophis melanoleucus*) and other snake species, raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), coyotes (*Canis latrans*), long-tailed weasels (*Mustela frenata*), dusky-footed woodrats (*Neotoma fuscipes*), deer mice (*Peromyscus maniculatus*), rats (*Rattus* spp.), and domestic cats (*Felis domesticus*) (Franzreb 1989).

C.43.7 Species Habitat Model and Location Data

The habitat model for this species was based on known recent sightings and the distribution of land cover types that are known to support its habitat as described above in Section C.27.3, *Habitat Requirements and Ecology* (Figure A-27).

The model parameters include the following.

- Known Recent Sightings: Location where the species has relatively recently (post-January 1, 1980) been documented according to one or more species locality records databases (e.g., California Natural Diversity Database [CNDDB], BIOS, University of California, Davis Museums collections, etc.).
- Nesting/Foraging Habitat: This habitat includes all potentially suitable breeding and foraging riparian areas and was modeled by selecting all mapped vegetation types as listed below.
- Limited modeling to Planning Units: 7, 9, 12, 14, 17, 18.

C.43.7.1 Nesting/Foraging Habitat – Vegetation Types

- Blackberry Not Formally Defined (NFD) Super Alliance
- Coyote Bush
- Fremont Cottonwood – Valley Oak – Willow (Ash – Sycamore) Riparian Forest NFD Association
- Mixed Fremont Cottonwood – Willow spp. NFD Alliance
- Mixed Willow Super Alliance
- White Alder (Mixed Willow) Riparian Forest NFD Association
- Undifferentiated Riparian Bramble
- Undifferentiated Riparian Woodland/Forest

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C.44 Townsend's Big-Eared Bat (*Corynorhinus townsendii*)

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C.44.1 Listing Status

Federal: U.S. Department of Agriculture Forest Service (USFS): Sensitive; Bureau of Land Management (BLM): Sensitive. Formerly listed as U.S. Fish and Wildlife Service (USFWS) category 2 candidate (USFWS 1985; USFWS 1994) under the Endangered Species Act.

Recovery Plan: No species recovery plan has been written for the subspecies *C. t. townsendii* (occurring in Northern California), but both eastern subspecies *C. t. virginianus* and *C. t. ingens* are federally listed and have recovery plans. The Species Conservation Assessment and Conservation Strategy for the Townsend's big-eared bat (Pierson et al. 1999) provides conservation measures and a recovery plan for the western subspecies (*C. t. townsendii* and *C. t. pallescens*).

C.44.2 Species Description and Life History

The Townsend's big-eared bat (*Corynorhinus townsendii*) is a member of the taxonomic Order Chiroptera and Family Vespertilionidae. It is a medium-sized (8 to 14 grams) bat with rabbit-like ears, a small indistinct face and overall brownish coloration. This species is related in appearance to only one other bat with very large ears, the pallid bat (*Antrozous pallidus*), which is larger overall, light-colored, with large eyes and a distinct muzzle.

The life history of the Townsend's big-eared bat centers on reproduction and meeting the energetic demands of a small insectivorous mammal. Its annual cycle includes an approximate seven to eight-month period of peak activity in spring and summer when insects are most available and reproduction occurs. Pregnant females gather in maternity colonies which range in size from a few to several hundred individuals. Males usually roost elsewhere, singly or in small numbers. Maternity colonies form between March and June (based on local climatic factors), with a single pup born between May and July (Pearson et al. 1952). Maternity colonies cluster tightly together to share body heat and the appearance of the cluster is characteristic. Although roost site fidelity is variable in areas with many potential roost sites, it is quite high in California where roosting habitat is scarce (Sherwin et al. 2003).

The Townsend's big-eared bat uses daily and seasonal periods of hibernation to conserve energy when it is inactive. In winter months when insect prey is less available this species extends hibernation over weeks or months and it may migrate locally to suitable hibernation sites. In the Sacramento Valley, bats may hibernate, migrate, or reside year-round and alternate between activity and hibernation depending on weather and insect availability.

C.44.3 Habitat Requirements and Ecology

In California, this species occurs in many habitats including active agricultural areas, riparian communities, coastal habitat types, oak woodland, conifer forest, desert scrub, and native prairies. Pierson and Rainey (1998a) suggested that its distribution appears to be constrained primarily by the availability of suitable roosting sites and the degree of human disturbance at roosts.

C.44.3.1 Roosting Ecology

The roosting behavior of the Townsend's big-eared bat leaves it highly vulnerable to disturbance. Roosting habitat is limited to caves, mines, tunnels, and other features that mimic caves, such as large tree hollows, abandoned buildings with cave-like attics, water diversion tunnels, and internal spaces in bridges. For example, of the six maternity colonies known along the California coast, five colonies are in the attics of old buildings and one colony roosts in a cave-like feature of a bridge (Fellers and Pierson 2002). Open spaces under bridges are often used as night roosts by individual animals. Within these features (caves, mines, other structures) bats typically roost in highly visible areas on open surfaces, rarely seeking shelter in crevices as many other bat species do (Barbour and Davis 1969; Dalquest 1947). The distribution of the Townsend's big-eared bat is limited to regions with appropriate roosting habitat.

C.44.3.2 Foraging Ecology

Foraging occurs primarily along edges of wooded habitats and along streams (Kunz and Martin 1982). This species both feeds in the air and gleans insects off leaf surfaces. Radio-tracking and light-tagging studies have also documented it feeding in closed forest and woodland settings, within the canopy of oaks (Pierson and Rainey 1998b), particularly along vegetated stream corridors, over corn and alfalfa fields (Fellers and Pierson 2002), and occasionally over hay crops and vineyards. The Townsend's big-eared bat has also been captured while flying over damp, marshy patches of meadow and in willow riparian vegetation (Pierson pers. comm.). Commuting distances (from roost site to primary foraging area) known from telemetry studies conducted up to 2001 varied from 1 to 13 kilometers (Fellers and Pierson 2002). Commuting distances vary among individuals and within species based on season, sex, reproductive condition, and the availability of suitable foraging habitat (Fellers and Pierson 2002). Moths and butterflies comprise over 90 percent of the diet of this species and its guano has a distinctive golden-colored, fine-grained appearance due to the prevalence of wing scales comprising the pieces.

C.44.4 Species Distribution and Population Trends

In California, Townsend's big-eared bat populations have been concentrated in the limestone formations of the Sierra Nevada and Klamath mountain ranges, the volcanic formations in the Columbian Plateau (e.g., Lava Beds National Monument), and throughout mining districts. In Yolo County, this species is documented (California Natural Diversity Database [CNDDB] 2007) at three mine sites in the Little Blue Ridge, and likely occurs in other areas of the western portion of the County where caves and mines occur in the steeper canyons and rock outcrops. However, some populations of Townsend's big-eared bat may be located in buildings and other anthropogenic structures such as tunnels and bridges. Another CNDDB (2007) record occurs on the Yolo-Napa County border at the Homestake Mine. Although the mine is just inside of Napa County, Townsend's big-eared bats from this roost site forage and occur inside Yolo County, and others may occur at other mine sites or areas in the County with abandoned buildings. A Townsend's big-eared bat was collected and submitted to the Yolo County Health Department from the Rumsey area in 1993 (Constantine unpublished data). The only other health department record for Townsend's big-eared bat is from "Putah Canyon" in 1954 (Constantine unpublished data).

Pierson and Rainey (1998a) reported on the distribution, status and management of this species in California. They found that during the previous 40 years, there had been a 52 percent loss in the number of maternity colonies, a 45 percent decline in the number of available roosts, a 54 percent decline in the total number of animals, and a 33 percent decrease in the average size of remaining colonies for the species as a whole across the state. The populations that have shown the most marked declines are along the coast, in the Mother Lode country, and along the Colorado River. Townsend's big-eared bats have declined notably in San Francisco Bay area counties, where native habitat and rural land have undergone conversion for agriculture (i.e., wine production) or suburban/urban development. At the Homestake Mine near the Yolo County line, an adult female population of 140 and a winter population with both sexes of 166 noted in 1950 had declined to 105 and 27 (respectively) by 1987–1991 (Pierson and Rainey 1998a). Depressed populations may recover when roost sites are protected (e.g., gating a mine to prevent human entry) if suitable foraging habitat remains.

C.44.5 Threats to the Species

The cause of local population declines is most likely disturbance and the destruction of roost sites. Activities such as recreation in caves and mines, abandoned mine closure, and renewed mining at historical sites have all contributed to this species' decline. For example, roosting habitat in historical mine shafts is lost when renewed mining uses open pit methods. Dependence on abandoned mines puts this species at risk if mine reclamation and renewed mining projects do not mitigate for roost loss, or do not conduct adequate biological surveys prior to mine closure.

The Townsend's big-eared bat is vulnerable to human disturbance and colonies have abandoned roost sites after human visitation (Humphrey and Kunz 1976). Pierson (pers. comm.) stated that some maternity colonies have abandoned newborns after being disturbed. Pierson et al. (1999) also reported that Townsend's big-eared bats are threatened by the loss of clean water, loss of roosting and foraging habitat, and by the disturbance or destruction of winter roosts. The impacts on insect prey availability from the use of pesticides and herbicides may also threaten populations of this species. Bat biologists from the California Bat Working Group conducted a bat species status assessment workshop in Davis in 2007 as part of ongoing efforts to produce a California Bat Conservation Plan. This species was ranked in the top five species of conservation concern.

A species conservation assessment and conservation strategy for the Townsend's big-eared bat (Pierson et al. 1999) was produced as part of efforts to allow opportunities for state and federal agencies and other interested parties to stabilize and recover this species and its ecosystems. This species is at risk of being listed as threatened or endangered under the Endangered Species Act. The conservation strategy addressed cave and mine management, pesticides, vegetative conversions, timber harvest, and inventory, monitoring, and research protocols.

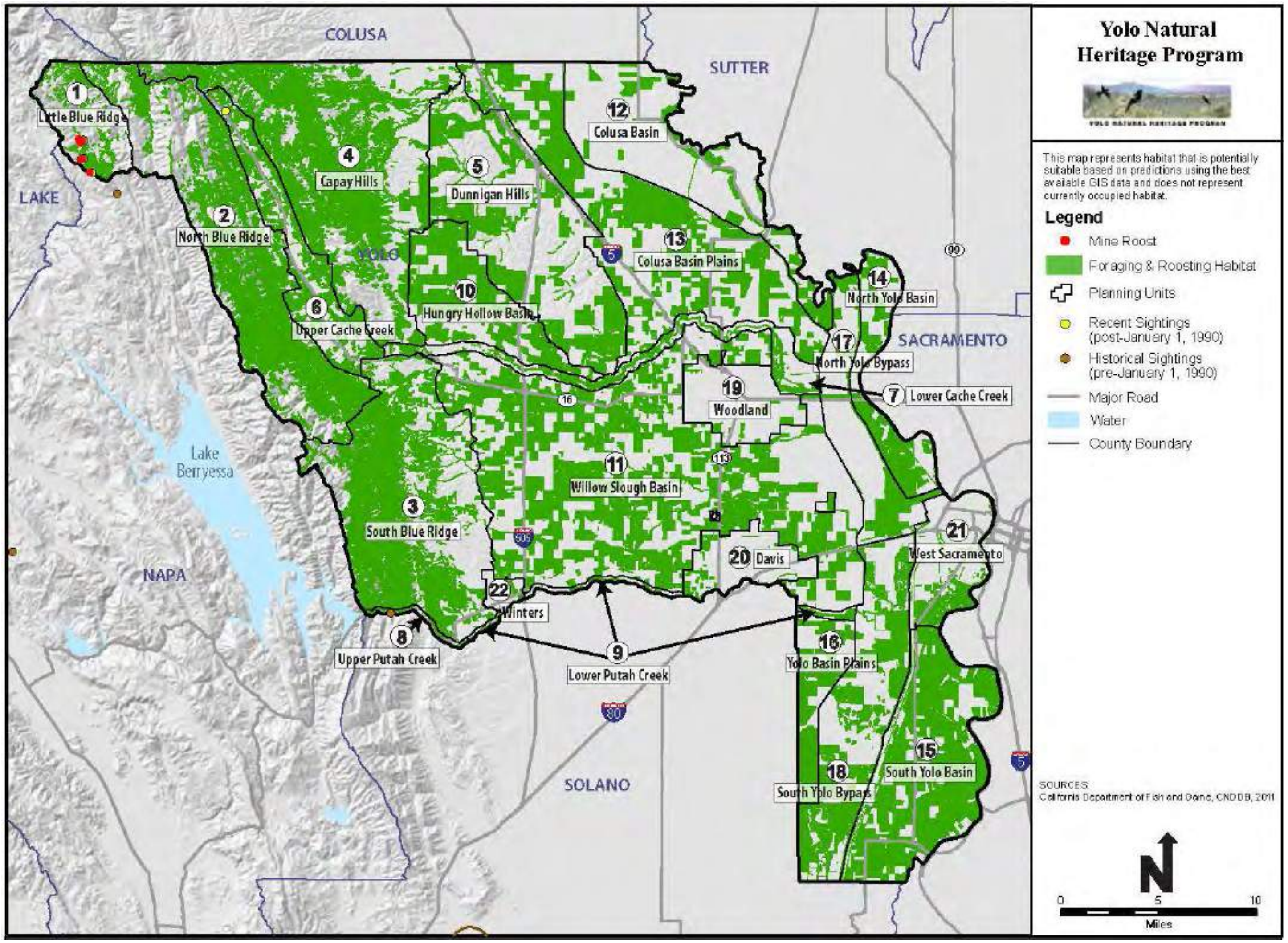
Monitoring is needed to determine current population trends and status. More information is needed to help determine the seasonal home ranges and movements, particularly during winter months, and the foraging requirements in different habitats. In addition, information is needed to determine the amount of relatedness within and between different populations to help conserve populations.

C.44.6 Species Habitat Model and Location Data

The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.32.3, *Habitat Requirements and Ecology* (Figure A-32). The model parameters include the following.

- Known Recent Sightings in Yolo NCCP/HCP Species Locality Database: Location where the species has relatively recently (post-January 1, 1990) been documented according to one or more species locality records databases (i.e., CNDDB, County Health Department Bat Records).
- Mine Roost: Mine roosts are mapped locations of mines and mine shafts in the Plan Area that are then buffered by 500 feet to include the area around the mine. Known recent sightings occur at all mapped mines in the Little Blue Ridge.
- Foraging and Roosting Habitat: Potential foraging and roosting areas were modeled by including areas of rock outcrop where suitable caves and crevices may occur, and rural residential areas from the existing land use data layer where barns, sheds, and other rural structures provide potential roost sites. Foraging habitat includes all potentially suitable foraging habitat in natural vegetation types and agriculture. This habitat was modeled by selecting suitable vegetation and agriculture types listed below.

Figure C-37. Townsend's Big-Eared Bat Mapped Habitat and Occurrences



C.44.6.1 Foraging and Roosting Habitat – Vegetation Types

- Valley Oak Woodland
- All Blue Oak – Foothill Pine
- Blue Oak Woodland
- All Closed-Cone Pine-Cypress
- *Carex* spp. – *Juncus* spp – Wet Meadow Grasses Not Formally Defined (NFD) Super Alliance
- Undetermined Alliance – Managed
- *Crypsis* spp. – Wetland Grasses – Wetland Forbs NFD Super Alliance
- Rock outcrop
- All Montane Hardwood
- All Valley Foothill Riparian
- Corn
- Mixed and Native Pasture
- Types
- Alfalfa
- Grain/Hay Crops
- Vineyards

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C.44.7.1 Federal Register Notices

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C.44.7.2 Personal Communications

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Appendix D
Pollinator Strategy

Yolo Natural Heritage Program (HCP/NCCP)

Pollinator Conservation Strategy

Prepared by
The Xerces Society for Invertebrate Conservation
Portland, Oregon / Sacramento, California

Yolo Natural Heritage Program (HCP/NCCP)

Pollinator Conservation Strategy

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Portland, OR / Sacramento, CA

November 2009

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EXECUTIVE SUMMARY

Pollination is "central to all human beings, livestock, and wildlife" (Kevan 1999). Plant pollination by insects is one of the most widespread and important ecosystem services and is essential in both natural and agricultural landscapes. It is estimated that 60 – 90% of the world's flowering plants depend on animals—most of them insects—for pollination.

Research shows that native bees contribute substantially to the pollination of many crops, including watermelon, canola, sunflower, and tomatoes. The value of crop pollination by native, wild bees in the United States is estimated at $3 billion. In Yolo County, extensive studies demonstrate the significant role of native pollinators in the economic viability of agriculture. In addition, native bees provide incalculable value as pollinators of native plants.

Animal pollinators in North America include bees, butterflies, moths, wasps, flies, beetles, ants, bats, and hummingbirds. Insects make up the vast majority of pollinator species, and bees are the most important pollinators in temperate North America.

There are approximately 4,000 species of native bees in North America. Bee habitat requires two basic components: flowers on which to forage and nest sites. Many pollinators are adapted to forage on particular plants, so a diverse community of pollinators requires a diverse array of flowers. Most native bees are solitary nesting. Around 70% of bee species nest in the ground, excavating shallow tunnels in patches of bare soil, with most of the remaining 30% nesting in cavities in old trees or plant stems. Bumble bees require a small cavity such as an abandoned rodent hole.

Foraging and nesting habitat needs to be within the flight range of a bee. Most solitary wild bees have maximum foraging ranges between 150 and 600 meters. Foraging ranges and species richness are strongly influenced by the landscape structure (habitat area and connectivity) within 250 meters of the location. The presence or absence of seminatural habitat has a dramatic effect on nesting and connectivity between habitats is critical for offspring production.

There is evidence of declines in both managed and wild pollinators. European pollinator monitoring programs have found significant declines in pollinators, and although pollinators have been monitored less intensively outside of Europe, declines of some prominent taxa such as bumble bees have been well-documented. Causes of declines are difficult to pinpoint, but loss of habitat due to increasing urbanization, expansion of intensive agriculture, invasive species, disease, parasites, and the widespread use of pesticides all negatively impact pollinator populations. Protecting, enhancing, or providing new habitat is the best way to conserve native pollinators.

Each of the six major landscapes in Yolo County—agriculture, grasslands, woodlands, shrubland and scrub, riparian and wetland, and urban and barren—are affected to a greater or lesser degree by one or more of these threats.

This paper outlines the importance of pollinators to these landscapes and the threats these animals face. It also identifies strategies that offer ways to halt or reverse pollinator declines.

SECTION 1
INTRODUCTION

Pollination is “central to all human beings, livestock, and wildlife” (Kevan 1999). Plant pollination by insects is one of the most widespread and important ecosystem services on the planet and is essential in both natural and agricultural landscapes. It is estimated that 60 – 90% of the world’s flowering plants depend on animals—most of them insects—for pollination (Kremen et al. 2007). Of the 124 most commonly cultivated crops in the world, eighty-seven are animal pollinated (Klein et al. 2007), and insect-pollinated forage plants such as alfalfa and clover also provide feed for the animals that give us dairy and meat products (Richards & Kevan 2002). Calculated by volume, roughly 35% of the food humans consume is dependent on pollination by animals (Klein et al. 2007).

Animal pollinators in North America include bees, butterflies, moths, wasps, flies, beetles, ants, bats, and hummingbirds. Insects make up the vast majority of pollinator species, and bees (Hymenoptera) are the most important pollinators in temperate North America. Although the nonnative honey bee (*Apis mellifera*) provides the bulk of crop pollination in the U.S., native bees are known to provide important pollination services to crops (e.g., Kevan et al. 1990, Ricketts 2004, Klein et al. 2007), and are estimated to contribute $3 billion worth of crop pollination annually to the U.S. economy (Losey & Vaughan 2006). In Yolo County, extensive studies of different crops demonstrate the significant role of native pollinators in the economic viability of those crops (Kremen et al. 2001, Kremen et al. 2002a, Kremen et al. 2002b, Kremen et al. 2004). In addition, native bees provide incalculable value as pollinators of native plants (Kearns et al. 1998, Kremen et al. 2002a).

Of the other orders of pollinating insects, flies (Diptera) provide substantial pollination services (Speight 1978, Kearns 2001, Larson et al. 2001) especially in alpine areas and tundra. Other insects such as beetles (Coleoptera) and wasps (Hymenoptera) provide pollination services, though to a lesser extent (e.g., Frankie et al. 1990, Irvine & Armstrong 1990, Kevan 1999). Most butterfly and moth species (Lepidoptera) visit flowers for nectar, although their contribution to pollination services may be limited (Jennersten 1988, Frankie et al. 1990, Allen-Wardell et al. 1998, Westerkamp & Gottsberger 2000).

Many of these same native pollinator species play a keystone species roll in the health and sustainability of native ecosystems, and are a critical resource for endangered Yolo County plant species such as palmate-bracted bird’s-beak, (*Cordylanthus palmatus*) (Saul-Gershenz et al. 2004).

Pollinating insects are necessary for wild plant reproductive success and fitness. Pollinator-plant interactions are seldom completely obligate, instead forming complex pollination webs in which a single plant may receive many visits from different pollinator species and each pollinator may, in turn, visit multiple plants of many different species (Kearns et al. 1998). This pollination web provides a degree of redundancy which may help buffer natural fluctuations in pollinator and/or plant populations. Despite this resiliency, research demonstrates that the loss or decline of pollinator populations can have direct effects on the plants they pollinate and vice versa.

In a review of research addressing the reproductive requirements of twenty-six rare or endangered plant species in the western United States, Tepedino et al. (1997) found that in order to set fruit most of the plants required pollination, usually by native bees. The authors suggest that any management plan hoping to aid in the recovery of an insect pollinated native plant must not only address the requirements of the plant itself, but the native pollinators that enable the plant to reproduce.

1.1 POLLINATORS AND WILDLIFE

The plant communities that pollinators sustain also provide food and shelter for many other animals such as birds, small mammals, and bears. Pollinators are important in wildlife food webs both as an essential step in the availability of seeds, nuts, fruit, and berries and as direct prey. Bears, rodents, small mammals, birds, and many terrestrial invertebrates all have significant dietary components that are attributable directly or indirectly to pollinators.

Pollinators also maintain vegetation communities which provide habitat for wildlife. While pollinator insects perform pollination services only as adults, their larvae are ecologically significant and can shape vegetation communities, provide food for songbirds, decompose detritus, and act as pest control agents. Very little research has been conducted to quantitatively assess the extent to which pollinators and pollination products contribute to the diet of wildlife, but qualitatively it is possible to recognize how important pollinators are in a functional ecosystem.

The following are examples of the importance of pollination to wildlands and wild animals.

- Many migratory songbirds require a diet of berries, fruits, and seeds from insect-pollinated plants, and pollinators (both adults and larvae) are an important component of the diet of many fledglings (Buehler et al. 2002).
- Summerville and Crist (2002) found that forest moths had "important functional roles as selective herbivores, pollinators, detritivores, and prey for migratory passerines."

Given the ecological services insect pollinators perform in natural ecosystems a strong case can be made for pollination being a keystone interaction in nearly all terrestrial ecosystems, necessary not only for plant reproduction, but forming the basis of an energy-rich food web that extends throughout trophic levels (Kearns et al. 1998, Vasquez & Simberloff 2003).

1.2 POLLINATORS AND AGRICULTURE

Honey bees provide the bulk of crop pollination in the U.S., yet the number of managed honey bee hives has declined by 60% in the U.S. since 1950 (Winfree et al. 2007b). In typical year, the U.S. beekeeping industry loses 15 – 20% of hives from a variety of problems, including diseases, pests, pesticide poisoning. Over the last three years, losses of 35% or more have been recorded due to Colony Collapse Disorder. Recent research (much of it in Yolo County) on crop pollination, however, has demonstrated that native bees also make a significant contribution to crop pollination—in some cases providing all of the pollination required when enough habitat is available (Greenleaf & Kremen 2006a, Klein et al. 2007). Today, habitat supporting these native pollinators is increasingly important as honey bee hives become more expensive and difficult to acquire.

Research demonstrates that native bees contribute substantially to the pollination of many crops, including watermelon (Kremen et al. 2002a; Kremen et al. 2004; Winfree et al. 2007b), canola (Morandin & Winston 2005), sunflower (Greenleaf & Kremen 2006b), tomatoes (Greenleaf and Kremen 2006a), and blueberry (Cane 1997; Javorek et al. 2002). The value of crop pollination by native, wild bees in the United States is estimated at $3 billion (Losey & Vaughan 2006).

1.3 POLLINATORS IN NATURAL AREAS: BENEFITS TO AGRICULTURE

The role that adjacent natural habitat plays in providing crop pollination services is increasingly well understood. Proximity to natural or semi-natural non-agricultural land is often an important predictor of pollinator diversity in cropland (Haughton et al. 2003; Bergman et al. 2004; Kim et al. 2006; Kremen et al. 2004; Morandin & Winston 2006; Hendrickx et al. 2007). Natural areas near to farms can also be important sources of pollinators that can recolonize agricultural areas that lost native pollinators due to a pesticide treatment or temporary habitat loss (Öckinger & Smith 2007).

In conjunction with on-farm habitat provided by untilled field margins, hedgerows, bare ground, and non-crop flowers in the agricultural fields, nearby natural habitat is integral to maintaining a long-term population of native pollinators in agricultural landscapes. Pollinators in these areas can provide valuable crop pollination services and add resiliency to the agricultural pollination system. So that natural areas and wildlands close to farms can provide these services, however, it is important that management of those non-arable lands takes into account native pollinators.

1.4 POLLINATORS IN DECLINE

There is ongoing debate in the scientific community as to whether pollinators, and in particular bees which are the most important crop pollinator taxon, are declining at a global scale (Kearns et al. 1998; Steffan-Dewenter et al. 2005; Biesmeijer et al. 2006; NRC 2007). Allen-Wardell et al. (1998) found evidence of declines in both managed and wild pollinators. European pollinator monitoring programs have found significant declines in pollinators as well as the plants they pollinate (Biesmeijer et al. 2006; NRC 2007). Although pollinators have been monitored less intensively outside of Europe, declines of some prominent taxa such as bumble bees have been well-documented (NRC 2007; Evans et al. 2008).

Causes of declines are difficult to pinpoint, but loss of habitat due to increasing urbanization, expansion of intensive agriculture, invasive species, disease, parasites, and the widespread use of pesticides all have negative impacts on pollinator populations (Kearns et al. 1998; Cane & Tepedino 2001; Spira 2001; Goulson 2003; Desneaux et al. 2007; Hendrickx et al. 2007; Steffan-Dewenter & Westphal 2008). As pressure on pollinators increases in developed and agricultural areas, the role that habitat in undeveloped areas can play as long-term refugia for pollinator populations is substantial. Protecting, enhancing, or providing new habitat is the best way to conserve native pollinators (Kremen et al. 2007).

SECTION 2
HABITAT NEEDS, LANDSCAPE STRUCTURE, AND THREATS

2.1 HABITAT NEEDS OF NATIVE POLLINATOR INSECTS

The first step in developing a conservation strategy that will provide for pollinators in Yolo County is to understand the habitat features required by bees and other insect pollinators. These can be divided into two main categories: a diversity of native flowers that will provide nectar and pollen, and egg-laying or nesting sites. Proximity of these resources to each other is also important to consider, as they need to be within the flight range of pollinators.

Diversity of native flowers

A plant community that will support an abundance of diverse pollinators should not only be rich in species but also bloom through a long season. Forage resources are necessary throughout a pollinator's adult life and most species benefit from a succession of blooming plants to provide adequate forage (Bowers 1985; Dramstad & Fry 1995; Kremen et al. 2002a). The wide variety of pollinators and their differing size and body morphology (for example, variations in tongue length between species) means that some species can reach the nectar or pollen in flowers that other pollinators cannot. Many pollinator species have morphological features specific to foraging on certain flower species (Speight 1978; Dramstad & Fry 1995; Thorp 2000; Thorp et al. 2002; Goulson & Darvill 2004). For example, there are short-, medium-, and long-tongued species of bumble bees that preferentially forage on plants with corresponding variations in corolla tube length (Pyke 1982). Flies also have tongues of varying lengths and can be quite specialized foragers (Kearns 2001; Larson et al. 2001). A diverse community of insect pollinators, therefore, requires a diverse array of floral resources (Bowers 1985; Dramstad & Fry 1995; Kremen et al. 2002a; Holzschuh et al. 2008; Wojcik et al. 2008).

Key Points

- *Pollinators need flowers on which to forage.*
- *The plant community should be diverse and bloom through a long season.*
- *Many pollinators are adapted to forage on particular plants.*
- *A diverse community of pollinators requires a diverse array of flowers.*

Nesting or egg-laying sites

<u>Bees</u>

Bees need nest sites. When supporting populations of native bees, protecting or providing nest sites is as important as, if not more important than, providing flowers (Tscharntke et al. 1998; Cane 2001; Potts et al. 2005).

Native bees often nest in inconspicuous locations. For example, many excavate tunnels in bare soil, others occupy tree cavities, and a few even chew out the soft pith of the stems of plants like elderberry or blackberry to make nests (O'Toole & Raw 1999, Michener 2000). It is important to retain as many naturally occurring sites as possible and to create new ones where appropriate.

North America has approximately 4,000 species of native bees (Winfree et al. 2007a). The majority, about 70% or very roughly 2,800 species, are ground nesters. These bees usually need

Table 1. General Habitat Requirements of Native Bees and Butterflies

Pollinator	Food	Shelter
Solitary bees	Nectar and pollen	Most nest in bare or partially vegetated, well-drained soil; many others nest in narrow tunnels in dead standing trees, or excavate nests within the pith of stems and twigs; some construct domed nests of mud, plant resins, saps, or gums on the surface of rocks or trees
Bumble bees	Nectar and pollen	Most nest in small cavities (approx. softball size), often underground in abandoned rodent nests or under clumps of grass, but can be in hollow trees, bird nests, or walls
Honey bees	Nectar and pollen	Hollow trees for feral colonies
Butterflies and Moths – larva	Leaves of larval host plants	Larval hostplants
Butterflies and Moths - pupa	Non-feeding stage	Protected site such as a bush, tall grass, a pile of leaves or sticks or, in the case of some moths, underground
Butterflies and Moths – adult	Nectar; some males obtain nutrients, minerals, and salt from rotting fruit, tree sap, animal dung and urine, carrion, clay deposits, and mud puddles	Protected site such as a tree, bush, tall grass, or a pile of leaves, sticks or rocks

(Adapted from: *Native Pollinators*. Feb. 2006. NRCS Fish and Wildlife Habitat Management Leaflet. No. 34.)

direct access to the soil surface (Potts et al. 2005) to excavate and access their nests. Ground-nesting bees seldom nest in rich soils, so poor quality sandy or loamy soils may provide fine sites. The great majority of ground-nesting bees are solitary, with one female excavating and provisioning her own nest. These may be in large aggregations with hundreds or thousands of bees excavating nests in the same area. Some species, however, will share the nest entrance or cooperate to excavate and supply the nest (Michener 2000).

Approximately 30% (around 1,200 species) of bee species in North America are wood nesters. These are almost exclusively solitary. Generally, these bees nest in abandoned beetle tunnels in logs, stumps, and snags. A few can chew out the centers of woody plant stems and twigs (Michener 2000), such as elderberry, sumac, and in the case of the large carpenter bee, agave or even soft pines. Dead limbs, logs, or snags should be preserved wherever possible. Some wood-nesters also use materials such as mud, leaf pieces, or tree resin to construct brood cells in their nests (O'Toole & Raw 1999).

Bumble bees are the native species usually considered to be social. There are about 45 species in North America (Kearns & Thomson 2001). They nest in small cavities, such as abandoned rodent nests under grass tussocks or in the ground (Kearns & Thompson 2001). Leaving patches of rough undisturbed grass in which rodents can nest will create future nest sites for bumble bees (McFrederick & LeBuhn 2006).

<u>Butterflies</u>
Lepidoptera lay their eggs on or close to the plant on which their larvae will feed once they hatch (Feber et al. 1996; Ries et al. 2001; Croxton et al. 2005). If conserving strong butterfly populations is a management goal, caterpillar hostplants are a necessary part of the habitat (Feber et al. 1996). Some butterflies may rely on plants of a single species or genus for host-plants (the monarch is an example, feeding only on species of milkweed, *Asclepias* sp.), whereas others may exploit a wide range of plants, such as some swallowtails (*Papilio* sp.), whose larvae can eat a range of trees, shrubs, and forbs (Scott 1986). In order to provide egg-laying habitat for the highest number of butterflies and moths, growers should first provide plants that can be used by a number of species. Later those plants can be supplemented with hostplants for more specialized species.

<u>Flies</u>
Several families of flies contain pollinating species. The most important are the families Syrphidae (syrphid or flower flies) and Bombyliidae (bee flies) (Speight 1978; Kearns 2001). Most syrphid flies are aphidophagous as larvae, and therefore require habitat that offers a sufficient abundance of aphids in addition to flowers for the nectar-feeding adults (Gilbert 1986; MacLeod 1999; Sutherland et al. 1999; Colley & Luna 2000). Bee fly larvae are, depending on species, parasites of larvae various insects, including solitary bees and wasps, beetles, moths, grasshoppers, and other flies (Marshall 2006). Larvae of other pollinating flies are predatory, saprophytic, or parasitic, depending on the species (Kearns 2001).

<u>Beetles</u>
The larval food of beetles is extremely variable depending on the species, and is too numerous to list here. The best strategy for attracting or retaining native beetle pollinators is to provide a variety of native plant species that will serve as food for herbivorous beetle larvae, as well as attract a variety of insects that will benefit insectivorous beetle larvae. However, specific requirements of immature stages should be identified when planning to protect the habitat of sensitive species. For example, larvae of the endangered molestan blister beetle (*Lytta molesta*) feed on the provisions and immature stages of ground nesting native bees in or near dried vernal pools (Selander 1960, Halstead & Haines 1992). Therefore, it is important to consider both native plant and bee species associated with their vernal pool habitat when designing a conservation strategy for this beetle.

Key Points

- *There are approximately 4,000 species of native bees in North America; most are solitary nesting.*

- *Nest sites are a key component of bee habitat.*
- *Around 70% of bees nest in the ground, excavating shallow tunnels in patches of bare soil.*
- *Around 30% of bees nest in cavities in old trees or plant stems.*
- *Bumble bees require a small cavity such as an abandoned rodent hole.*
- *Butterflies lay eggs on particular plants that their caterpillars eat.*
- *The egg laying needs of flies and beetles are more diverse, and vary between species.*

2.2 FLIGHT RANGE

How far a pollinator can fly is an important consideration for restoration and management of pollinator habitat. The foraging distance of a bee limits its capacity to move between nesting and foraging habitat. The limitation of foraging distance may be most important for bees. Most insects, including butterflies, flies, and beetles, find egg laying and feeding sites as they move across the landscape. Bees, on the other hand have a fixed location for their nest, collecting pollen and nectar from nearby habitat, and transporting it to that nest. Their nesting success is therefore dependent on the availability of resources within their flight range (Williams & Kremen 2007).

The ideal is to have nesting and forage resources in the same habitat patch, but bees are able to adapt to landscapes in which nesting and forage resources are separated (Cane 2001; Westrich 1996). How far apart habitat patches should be is defined by how far bees can fly on a foraging trip. In general, bigger bees can fly further than smaller bees. Reviewing the literature on sixteen European solitary bee species, Gathman & Tscharntke (2002) found that solitary wild bees generally have maximum foraging ranges between 150 and 600 meters, with the distance correlating positively with body length. They also found that foraging trip duration (6 to 28 minutes) correlated with body length. Foraging flights of bumble bees on a farm in Britain were tracked using harmonic radar by Osborne et al. (1999). In an arable landscape that included woodlands and hedgerows, the bumble bees' outward tracks averaged 275 meters in length, with a maximum recorded of 631 meters, however some flights went further, beyond the range of the radar. More recent work (Greenleaf et al. 2007) established that the best predictor for the foraging range of a bee was a measurement of body size, specifically the distance between the wing bases (intertegular span). However, they also recognize that the theoretical range and actual range differ. The actual foraging range is influenced by landscape factors, such as the density and distribution of flowers and how easy it is to cross other habitats.

The study by Gathmann and Tscharntke (2002) also investigated the distance bees travel between forage and nest sites; they found that the highest probability of a nest site being used was when the nest was less than 260 meters from a species' food plant. Kohler et al. (2008) found similar results for bees and hoverflies in the Netherlands, where both bees and hoverflies were primarily observed no further than 200 meters from their habitat. Considering flight distances does place some limits on how habitat is located in the landscape, but also means it does not need to be in one place. Taken together, a diversity of flowering crops, wild plants on field margins, and plants up to a half mile away on adjacent land can provide the sequentially blooming supply of flowers necessary to support resident populations of pollinators (Winfree et al. 2008)

Key Points

- *Foraging and nesting habitat needs to be within the flight range of a bee.*
- *The flight range of a bee relates directly to body size: larger bees can fly further than small ones.*
- *Most solitary wild bees have maximum foraging ranges between 150 and 600 meters*
- *Habitat patches should be no more than 600 meters from the crop*
    - *Shorter distances—250 to 300 meters— are optimal*
- *Foraging ranges are strongly influenced by the landscape structure.*

2.3 LANDSCAPE STRUCTURE

The work of Greenleaf et al. (2007) highlighted the influence of landscape structure on the flight range of bees, and thus their actual foraging distance. This influence of environmental condition is reinforced by research into how landscape structure influences the species richness of bees in fragmented grassland (Steffan-Dewenter 2003). The author concluded that the species richness of solitary bees at the study sites depended on the landscape structure (habitat area and connectivity) within 250 meters of the site, but that the abundance of honey bees, which have a much longer foraging distance, was influenced by the landscape structure within 3000 meters. In reviewing nearly two dozen studies that investigated crop pollination services and isolation from natural habitat, Ricketts et al. (2008) showed that visitation rates by native bees to crops declined rapidly as the distance from natural habitat increased. On average, visitation rates were at 50% of their maximum at 668 meters from habitat.

It is also likely that the scale of agriculture itself influences the presence and abundance of bees in the crop. Holzschuh et al. (2006) found that bee diversity was greater in organic wheat fields than conventional fields, due to the presence of more flowers. However, the difference between the farming methods was less pronounced in landscapes that had more habitat patches. This is corroborated by work by Winfree et al (2008) conducted in the border of New Jersey and Pennsylvania. In the study region, wild bees made the majority of visits to the four focal crops (watermelon, muskmelon, tomato, and pepper). Crop visitation by bees was not related to farming method (organic or conventional) but was most influenced by the presence of habitat in the landscape surrounding the fields. This landscape has high hetereogeneity with woodlands and other habitat widely dispersed. The woodland cover was 8 – 60% of the landscape within 2 kilometers of the field, which is comparable with the percentage of natural habitat in Yolo County (0 – 62%). The difference is the distance from the field to the nearest woodland. In this study area in New Jersey/Pennsylvania it was no greater than 343 meters, in Yolo County the maximum is 5980 meters. The heterogenous landscape of New Jersey/Pennsylvania, habitat is within the foraging distance of many bees.

Investigating the offspring production and survival of blue orchard bees (*Osmia lignaria*), Williams and Kremen (2007) concluded that the presence or absence of seminatural habitat had a dramatic effect on nesting and that connectivity between habitats is "critical for offspring production." The value of the surrounding landscape for bees depends on degree of habitat specialization of the bees, i.e., if bees have particular needs that are not met by landscape, it doesn't help them (Steffan-Dewenter 2003).

The influence of a mass-flowering crop on bumble bee populations has been studied in Germany. The research compared bumble bee diversity and abundance in agricultural regions growing oil seed rape (*Brassica napus*) and in regions without. Early colony growth of bumble bees was faster where the mass-flowering crop was a resource (Westphal et al 2003), but by the end of the season there was no difference in reproductive success between colonies in areas with the mass-flowering crop and areas without (Westphal et al 2009). Bumble bee colonies have a long season and require foraging resources all season to support them. The mass-flowering crop gave a short-lived abundance of foraging that could not be sustained by alternative sources in the landscape.

In modeling the optimal landscape design to provide crop pollination, Brosi et al (2008) created a framework for habitat creation in agricultural landscapes. The authors suggest that for bees with large foraging distances habitat should be placed in the center of the farm so that the bees are retained on the farm. Bees with short foraging distances require more of the farm to be habitat and for the habitat patches to be more evenly scattered across the farm. The best strategy may be to have a few larger habitat patches with smaller patches across the farm. These may be placed in low-fertility areas of the farm within foraging distance of crops. The authors do not address the size of habitat.

The suggestion that habitat can be in small patches is supported by the finding of Tscharntke et al (2002). They demonstrated that the fragmentation of habitat across an agricultural landscape significantly affects the number of butterfly species. Ten hectares of habitat in many small fragments can support more species of butterflies than the same size of habitat in one or two large patches. The authors concluded that a larger number of small habitat fragments can contain a wider range of conditions than a couple of large patches. However, Krauss et al (2009) found that size of the habitat and the diversity of flowers, not the age of the habitat, most strongly influenced the species richness of bees.

The impact of landscape change differs between bee species and is influenced by life history and habitat requirement. Ricketts et al. (2008) found that declines in visitation rates to flowers were steeper for social bees than solitary bees in the tropics, which was inconsistent with the findings of Steffan-Dewenter et al. (2006) studying bees in temperate grasslands. Social bees in the tropics are mainly stingless bees, which require cavities in mature trees, a feature that is generally missing from agricultural landscapes. Social bees in temperate regions are mainly bumble bees and halictids, which nest in the ground or under grass. These features often can be found in farmland.

Key Points

- *Species richness of solitary bees depends on the landscape structure (habitat area and connectivity) within 250 meters of the location.*
- *Abundance of honey bees influenced by the landscape structure within 3000 meters.*
- *Crop visitation by bees is not related to farming method (organic or conventional) but to the presence of habitat in the landscape surrounding the fields. Although organic farms often have more habitat available due to the lack of herbicide use.*
- *Presence or absence of seminatural habitat has a dramatic effect on nesting and connectivity between habitats is critical for offspring production.*

- *Early colony growth of bumble bees was faster where a mass-flowering crop was a resource but there is no difference in reproductive success between colonies in areas with a mass-flowering crop and areas without.*
- *Data suggests a larger habitat patch surrounded by smaller patches across the farm is more beneficial for pollinators than all smaller patches.*
- *There is not enough data to provide concrete prescriptions for the size or special arrangement of the habitat needed to support native bees.*
- *Recommendations need to be made at the site scale as quality (both nesting and floral resources) of habitat is extremely variable across the landscape.*

2.4 GENERALISTS OR SPECIALISTS?

When managing habitat for pollinators it is important to determine if there are any habitat specialists present. Generalists are considered species of pollinators that can easily find forage resources from a wide diversity of plant sources. Specialists are those species that use limited sources of nectar and pollen. Bees, for example, are usually defined as generalist or specialist based on the range of flowers from which they collect pollen (Michener 2000).

Some studies have found that management techniques that emphasize the broad habitat requirements of pollinators may preferentially select for generalist species, while ignoring the more specific and perhaps less standard requirements of specialist species (Swengel 1996, 1998; Winfree et al. 2007a). Unfortunately, there's no single management plan that can provide ideal habitat for all pollinator taxa. Instead, the conservation priority of specific pollinators in the management area should be considered, and since most generalist species can adapt to a broader range of habitat, specialist species are often higher priority.

Key points

- *Habitat specialists such as vernal pool obligate bees need directed management plans for the species/species groups.*
- *Land management should be tailored to specialist species when they are present.*

2.5 THREATS TO NATIVE POLLINATORS

There are many threats to native pollinators, including the loss, degradation, and fragmentation of habitat; introduced species; habitat disruption from grazing, mowing, and fire; the use of pesticides (herbicides and insecticides); and diseases and parasites (Kearns et al. 1998; Spira 2001; Steffan-Dewenter & Westphal 2008). A discussion of each of these threats follows.

Habitat loss, degradation, and fragmentation

In a synthesis of literature about impacts of human disturbances on bees, Winfree et al. (2009) identified habitat loss and fragmentation as the most significant factor in declines of abundance and species richness of bees. Factors causing habitat loss and fragmentation include increasing urbanization, expansion of intensive agriculture, invasive plants, and climate change. These reduce, degrade, and/or eliminate pollinator habitat. In some cases, however, the impact of urban and agricultural expansion can be reduced by providing alternative food resources and nesting sites for bees and other pollinators (Kremen et al. 2002b; McFrederick & LeBuhn 2006; Holzschuh et al. 2008; Rundlof et al. 2008b; Winfree et al. 2008).

Habitat loss, degradation, and fragmentation are linked to declines in pollinator diversity and abundance (Frankie et al. 1990; Allen-Wardell et al. 1998) that is followed by a reduction in pollination services (Kremen et al. 2002a). They also can cause decreased population size and/or low population densities of pollinator species (Kearns et al. 1998; Spira 2001) or changes in pollinator community composition (Brosi et al. 2008; Ricketts et al. 2008; Krauss et al. 2009). Diversity and reproduction of native flowering plants may also be affected by decreases in pollinator species diversity and population size (Jennersten 1988; Kearns et al. 1998; Spira 2001). The causes of pollinator declines are often difficult to identify, but are likely due to a combination of factors that include isolation time, isolation distance, size of the fragment, and the surrounding environment (Rathke & Jules 1993).

If habitat becomes fragmented and the distance between patches is greater than the foraging range of pollinators, patches too small to support their own pollinators will suffer from lack of pollination services (Kearns et al. 1998). Williams & Kremen (2007) found that in an agricultural landscape, increasing distance to natural habitat in conventional farms was correlated with decreased reproductive success in wild bees. Small scale experimental fragmentation of alpine meadows in Switzerland altered foraging behavior of bumble bees, with bees visiting the fragments 53.7% less than the control plots (Goverde et al. 2002). Because bumble bees tend to return to foraging sites, habitat fragmentation can result in repeated visits to specific fragments, which potentially limits the genetic diversity of the plant community due to a lack of pollen transfer between fragments (Osborne & Williams 2001). In tropical regions, habitat fragmentation impacts social bees more than solitary bees (Ricketts et al. 2008; Winfree et al. 2009), but in temperate areas solitary bees are more affected (Winfree et al. 2009; Krauss et al. 2009). This is due to differences in life history, especially nest site requirements, of stingless bees, the dominant social bee of the tropics, and bumble bees found in temperate regions.

Key Points

- *Habitat loss and fragmentation is considered to be the most significant threat to bees throughout most of Yolo County.*
- *Solitary and social bees respond differently to habitat fragmentation.*

Introduced plant species

Aside from comparisons of abundance and diversity between sites with nonnative and native plants, there are few studies of the direct effects of nonnative plants on native insects. Introduced nonnative plants compete with native plants for resources as well as alter habitat composition, and some cause significant reductions in the abundance and diversity of pollinators and other herbivorous insects (Samways et al. 1996; Kearns et al. 1998; Spira 2001; Memmott & Wasser 2002; Hopwood 2008; Zuefle et al. 2008,; Burghardt et al. 2009; Wu et al. 2009). There is also evidence that native pollinator insects prefer native plants (Hopwood 2008; Burghardt et al. 2009; Wu et al. 2009), even though many native insects will feed on nonnative plants when few natives are available (Zuefle et al. 2008; Burghardt et al. 2009; Wu et al. 2009).

Key Points

- *Introduced plants alter the habitat composition and can cause reduction in pollinator diversity.*
- *This is a serious threat to pollinators in natural habitat in Yolo County.*

Habitat disruption from grazing, mowing, and fire

The impacts of grazing, mowing, and fire are mixed. They can have damaging impacts on pollinators but when carefully managed, they can be beneficial. Historically, there were sufficient areas in various stages of succession to support populations of habitat specific pollinators. However, now that many of these areas exist only as fragments in larger agricultural or otherwise intensively managed landscapes, and consideration of pollinators is needed to ensure healthy populations.

<u>Grazing</u>

Grazing in natural areas and rangelands is a common practice throughout the United States. If not managed appropriately, the ecological impact of grazing can be severe (Bilotta et al. 2007). Livestock grazing can greatly alter the structure, diversity, and growth habits of the vegetation community, which in turn can affect the associated insect community (Kruess & Tscharntke 2002a). Grazing during periods when floral resources are already scarce (e.g., mid summer) may result in insufficient forage available for pollinators such as bumble bees which, in some areas, forage into late September (Carvell 2002). For example, Hatfield & LeBuhn (2007) found that uncontrolled sheep grazing in mountain meadows in the Sierra Nevada removed enough flowering plants to eliminate bumble bees from some study sites. Likewise, grazing during spring when butterfly larvae are active on hostplants can result in larval mortality or remove important vegetation and nectar resources (Smallidge & Leopold 1997).

Ways that grazing can harm pollinator habitat include: destruction of potential nest sites, destruction of existing nests and contents, direct trampling of adult bees, and removal of food resources (Sugden 1985). Studies of livestock grazing on bees also suggest that increased intensity of livestock grazing negatively affects the species richness of bees (Morris 1967; Sugden 1985; Carvell 2002; Vazquez & Simberloff 2003). In Arizona, Debano (2006) conducted one of the few studies that focused explicitly on the impacts of domestic livestock grazing on invertebrate communities in an area that had not been grazed historically. The results clearly show that invertebrate species richness, abundance, and diversity were all greater in the ungrazed sites. The author suggested that since insects in the Southwest had not evolved in the presence of buffalo or another large ungulate, adaptations to grazing pressure had not developed, making them more susceptible to the presence of cattle.

Though only limited research has been done on the impacts of grazing on pollinators in the United States, there is a considerable body of work from other countries on which we can draw. In Argentina, researchers compared insect communities in grazed and ungrazed areas and found that insect diversity, abundance, richness, and biomass were all lowest in intensively grazed areas (Cagnolo et al. 2002). In Australia, Hutchinson & King (1980) studied the impact of sheep grazing on sixteen groups of large invertebrates, and found that for most of them, including butterflies, moths, and flies, abundance and biomass decreased as grazing intensity increased. In a study of four different grazing regimes in Germany that varied from continuously intensively grazed areas to long-term ungrazed grassland, Kruess & Tscharntke (2002a, 2002b) found that the diversity of the invertebrate assemblage decreased as grazing intensity increased. This included pollinators such as butterflies and ground nesting bees. These findings are similar to Balmer & Erhardt (2000) who found that old fallow fields in Switzerland that had not been grazed harbored many more rare and specialist species of butterflies than managed pastures or early fallow land, most likely due to the reduction of nectar resources in grazed pastures.

In a study that directly addressed the usage of light grazing as a method of avoiding succession of grassland into forest, Schtickzelle et al. (2007) investigated the effect on the bog fritillary butterfly (*Proclossiana eunomia*) of the introduction of cattle into a wet meadow system. The study area was monitored for eleven years prior to cattle introduction and four years afterwards with a series of ungrazed controls. The negative effects light grazing had on the butterfly were significant. The butterfly visited grazed areas far less than ungrazed areas, and butterfly emergence in grazed areas was 74% less than in ungrazed areas. These effects are largely attributable to changes in vegetation structure, loss of preferred forage sources, and a decline of the hostplant in grazed plots.

Grazing is not necessarily harmful to a natural area. Many parts of the world have experienced grazing pressure from both domesticated and wild animals for millennia and the indigenous flora and fauna is adapted to grazing. Even in areas where grazing is not historically found, light levels of rotational grazing can have positive effects on maintaining an open, herbaceous-dominated plant community that is capable of supporting a wide diversity of butterflies and other pollinators (Smallidge & Leopold 1997).

Some research suggests that grazing can be beneficial for insect communities, especially by managing invasive plants and succession. Cattle grazing has successfully been used to control invasive plant species on degraded habitat of the Bay checkerspot butterfly (*Euphydryas editha bayensis*) (Weiss 1999). (It must be noted that this is a very site-specific case as the invasive plants were successfully colonizing the site because of excessive nitrogen deposition from automobile exhaust due to its proximity to a large urban area.)

Grazing does need to be carefully planned and implemented to be effective. A Swiss study found that while grazing was an effective management tool for limiting succession, responses to grazing varied greatly among butterfly species (Wettstein & Schmid 1999). The authors suggest that any management regime be attentive to historical and species-specific characteristics of the site, and that a diversity of management techniques be used on a regional scale in order to preserve the greatest diversity of insect pollinator habitat.

Grazing can be a valuable tool for limiting shrub and tree succession, providing structural diversity, encouraging the growth of nectar rich plants, and creating potential nesting habitat. However grazing is usually only beneficial at low to moderate levels and when the site is grazed for a short period followed by ample recovery time—and when it has been planned to suit the local site conditions.

Key Points

- *Grazing can have significant impacts on the habitat quality for bees through the* *destruction of nest sites and removal of forage plants.*

- *Grazing can greatly alters the structure, diversity, and growth habits of the vegetation community.*
- *Grazing can be used to maintain open, forb-dominated plant communities that support a diversity of pollinator insects, but only if the correct combination of timing, intensity of stocking rate are found.*
- *The threat of grazing to pollinators is most severe in grasslands and oak woodlands.*
- *At the most severely impacted sites, cattle should be excluded from the area to allow the habitat time to repair.*
- *Keep grazing periods short, with recovery periods for the habitat relatively long.*
- *Generally grazing that is of short intensity and duration in the fall (when there is less competition for floral resources with pollinators) is best.*

<u>Mowing</u>

Mowing is often used in place of grazing where site access and topography permit equipment access. Like grazing, mowing can alter grassland succession and species composition by suppressing growth of woody vegetation (Forrester et al. 2005). Mowing can have a significant impact on insects through direct mortality, particularly for egg and larval stages that cannot avoid the mower (Di Giulio et al. 2001). Mowing also creates a sward of uniform height and may destroy topographical features such as grass tussocks (Morris 2000) when care is not taken to avoid these features or the mower height is too low. Such features provide structural diversity to the habitat and offer potential nesting sites for pollinator insects such as bumble bees. In addition to direct mortality and structural changes, mowing can result in a sudden removal of almost all floral resources for foraging pollinators; therefore it should not be conducted when flowers are in bloom.

Key Points

- *Mowing has significant impacts on the habitat quality.*
- *Mowing will create a sward of uniform height and remove flowering resources.*
- *Mowing can be used to control shrubs and trees to maintain open conditions.*
- *No more than a third of habitat should be mown in one year.*
- *In Yolo County road edges may be an important resource for pollinators. Mowing management could be adapted to the maximum benefit of pollinators.*

<u>Fire</u>

Fire has played an important role in many native ecosystems, and controlled burns are an increasingly common management tool. Effects of fire management on arthropod communities are highly variable. If used appropriately, fire benefits many insect communities through the restoration and maintenance of suitable habitat (Huntzinger 2003; Hartley et al. 2007). Other studies have found a negative or mixed response of invertebrates to fire (e.g., Harper et al. 2000; Ne'eman et al. 2000; Moretti et al. 2006).

In Midwestern U.S. prairie systems, fire as a management tool is based on the supposition that prairie species are adapted to wildfires, and thus can cope with regular burns (e.g., Harper et al. 2000; Swengel 2001; Panzer 2002; Hartley et al. 2007). This is dependent, however, on there being adequate unburned adjacent areas that can provide sources of colonizers into the burned habitat. In small fragments where populations are more isolated, prescribed burning can have much more deleterious effects on the population due to a lack of colonizing capacity. For example, Harper et al. (2000) found that overall arthropod species richness decreased in burned prairie sites, as well as the abundance of all but one of the species measured. Their results suggest that burning a small habitat fragment in its entirety could risk extirpating some species because of limited recolonization from adjacent habitat. A study in Israel compared fruit set and bee visitation to four native plants in an unburned area with those in an area burned five to seven years previously (Ne'eman et al. 2000). They found that fruit set was much lower for the native plants in the burned area than in the adjacent unburned area. The authors ascribe this difference to the loss of pollinators, particularly solitary bees, due to the burn, either directly because of mortality during the fire or indirectly due to a reduction in nectar-rich flowers in the area post-fire. Furthermore, Moretti et al. (2006) found that it can take seventeen to twenty-four years for insect communities in burned areas in southern Switzerland to recover to pre-burn composition.

Fire can have serious impacts on population levels and unless there are adequate refuges from the fire or adjacent habitat, recolonization of a burned site may not be feasible. Timing of burns is also critical and should not be carried out when target pollinators are in a larval or critical foraging stage. Habitat patches should not be burned completely, but rather a mosaic of burned and unburned areas is ideal.

Key Points

- *Fire has played an important role in maintaining many native ecosystems.*
- *Bee populations are significantly lower in years following a burn.*
- *It can take two decades for insect communities to recover from a burn.*
- *Impacts of burning can be reduced if areas of habitat are left unburned.*
- *Fires should not burn more than 1/3 of habitat in any given year.*
- *A program of rotational burning where small sections are burnt every few years will ensure adequate colonization potential for pollinators.*
- *As a fire moves through an area it may leave small patches unburned. These skips should be left intact as potential micro-refuges.*
- *Not all sites within the same complex should be burned.*
- *Care must be taken to avoid actions that could degrade habitat and kill individual pollinators as a result of heavy equipment use or people trampling meadows.*

Pesticides

The use of pesticides, including insecticides and herbicides, is detrimental to a healthy community of pollinators. Insecticides not only kill pollinators (Johansen 1977), but sub-lethal doses can affect their foraging and nesting behaviors (Thompson 2003; Decourtye et al. 2004; Desneux et al. 2007), often preventing pollination. Herbicides can kill plants that pollinators depend on when crops are not in bloom, thus reducing the amount of foraging and egg-laying resources available (Kremen et al. 2002; Tscharntke et al. 2005).

In general, while pesticide labels may list hazards to honey bees, potential dangers to native bees and other pollinators are often not listed. For example, many native bees are much smaller in size than honey bees and are affected by lower doses. Pollinator larvae can also be negatively affected by consuming food contaminated with pesticides (Johansen & Mayer 1990; MacKenzie

1993; Abbott et al. 2008). In agricultural areas, field margins are increasingly cultivated (Dover et al. 1990; O'Toole 1993), and the use of pesticides in these areas can result in loss of native vegetation, fewer nesting areas, and overall loss of diversity and habitat structure, all of which impact bees and other pollinators.

<u>Herbicides</u>

Herbicides can kill plants that pollinators depend on, thus reducing the amount of foraging and egg-laying resources available (Kremen et al. 2002a; Tscharntke et al. 2005; Smallidge & Leopold 1997). Just as pollinators can influence the vegetation community, changes in vegetation can have an impact on pollinators (Kearns & Inouye 1997). A pollinator community requires consistent sources of nectar, pollen, and nesting material during those times adults are active. The broadcast application of a non-selective herbicide can indiscriminately reduce floral resources, hostplants, or nesting habitat (Smallidge & Leopold 1997). Such a reduction in resources can cause a decline in pollinator reproductive success and/or survival rates.

Moreby and Southway (1999) found that invertebrate abundance (notably species of Diptera and Heteroptera) was consistently higher in unsprayed plots than in plots that received a single autumn application of herbicides. Taylor et al. (2006) showed that herbicide applications in field margins reduced the number of arthropods (including Lepidoptera larvae) that were food sources for pheasant and partridge chicks. In a meta-analysis of twenty-three studies, Frampton and Dorne (2007) found that restricting herbicide inputs in the margins of crops benefited arthropod populations, including adult and larval Lepidoptera.

Other studies have addressed herbicide use and its effects on pollinators in general. In a review suggesting that pollinators are useful bioindicators, Kevan (1999) found that herbicides reduced Asteraceae and Lamiaceae flowers in France, contributing to a decline in bumble bee populations. Kevan (1999) also finds that herbicide applications have reduced the reproductive success of blueberry pollinators by limiting alternative food sources that can sustain the insects when the blueberries are not in bloom. Kearns et al. (1998) state "herbicide use affects pollinators by reducing the availability of nectar plants. In some circumstances, herbicides appear to have a greater effect than insecticides on wild bee populations … Some of these bee populations show massive declines due to the lack of suitable nesting sites and alternative food plants." In contrast, Russell et al. (2005) and Forrester et al. (2005) both found that the use of selective herbicide when combined with mechanical removal of shrubs and small trees was an effective method of maintaining power line corridors as effective pollinator habitat. In both studies, however, non-selective broadcast herbicides were prohibited as they not only suppressed management target plants, but important nectar resources as well.

While the majority of the effects herbicides have on pollinators are mediated through changes in vegetation, there is evidence that some herbicides such as paraquat, the organic arsenicals, and phenoxy materials can have lethal effects in bees, either through direct application or exposure by feeding (Johansen & Mayer 1990). There is also the potential for sub-lethal effects such as a decreased ability to fly and an increase in flower handling time. For example, hormonal herbicides alter the chemistry of plant secretions such as nectar which in turn may cause harmful effects to pollinators foraging on that contaminated nectar. Ingestion of herbicides by other insects, such as species of Coleoptera and Lepidoptera, has varying effects depending on the species, life stage of the species, and the chemical (Brown 1987; Kegal 1989; Kjaer and Elmegaard 1996; Kjaer and Heimbach 2001; Kutlesa and Caveney 2001; Russell and Schultz 2009). For example, in a laboratory study, Russell and Schultz (2009) showed that sethoxydim and fluazifop-p-butyl herbicides both reduce development time of Puget blue (*Plebejus icarioides blackmorei*) butterflies from the date of treatment to eclosure, and reduce survival, pupal weight, and wing size of cabbage white butterflies. A similar study by Kutlesa and Caveney (2001) found that glufosinate-ammonium is highly toxic to larvae of the Brazilian skipper (*Calpodes ethlius*).

Key Points

- *Herbicides kill plants on which pollinators depend for foraging or egg laying.*
- *Some herbicides can be lethal to bees by direct application or exposure during foraging.*
- *In crop fields, limiting herbicide applications in field margins benefits insect populations in field borders and adjacent habitats.*
- *During vegetation management, treat only the minimum area necessary for the control of weeds. Take care to minimize overspray to habitat around the weeds.*

<u>Insecticides</u>

Insecticides are widely used on agricultural lands and in natural areas throughout the United States to control both native and non-native species. In rangelands, native grasshoppers are targeted with a variety of pesticides (Alston & Tepedino 2000). In addition overspray and drift of agricultural insecticides can affect non-target organisms in field borders (Çilgi & Jepson 1994).

There are two general categories of effects that native pollinators may experience as a result of coming into contact with insecticides or insecticide residues, lethal and sub-lethal.

Lethal effects are most easily recognized: the dosage is sufficient to result in near immediate mortality of the insect. While there are reports of native pollinator die-offs in non-laboratory conditions, many such poisonings are assumed to go unreported because the bees are unmanaged and do not gather in large aggregations (Thompson & Hunt 1999). Low fecundity rates mean it can take many years for a native pollinator population to recover from a large reduction. For example, native bees in laboratory conditions were found to produce 15 – 20 offspring per year (Tepedino 1979). In a natural setting this number is expected to be less due to competition, predation and parasites (Kearns & Inouye 1997). Lethal effects on honey bees are often the primary focus of regulatory procedures for assessing the safety of a new insecticide for pollinators despite the enormous diversity of bees, butterflies, and other pollinating insects that may have a wide variation in their response to the same insecticide (Abramson et al. 2004; Morandin et al. 2005; Abbott et al. 2008). As a result, a pesticide that has been deemed safe for honey bees when used according to the bee label may not be safe for native bees or other pollinators.

Sub-lethal effects refer to a suite of impacts that may inhibit or degrade pollinator function and/or life history, possibly across multiple generations (Desneux et al. 2007). Sub-lethal effects are often difficult to measure and little work has been done to thoroughly investigate their significance in native pollinator populations (Alston & Tepedino 2000). Existing studies show sub-lethal effects impact native pollinator communities in many ways. These include a decrease in forage efficiency, decline of reproductive success and fitness, increase in immunological disorders, and a decrease in learning ability (Decourtye et al. 2004, 2005; Desneux et al. 2007; Morandin et al. 2005; Thomson 2003). Despite the long-term repercussions that these symptoms may have on an ecosystem few pesticides are tested for sub-lethal effects prior to regulatory approval.

One of the most robust case studies of ecosystem effects of insecticide use details the effects of forestry insecticides on pollinators, illustrating how the use of fenitrothion to control spruce budworm in Canadian forests devastated native bee populations. As summarized in Kevan (1999) and Kevan and Plowright (1989), the reduction of native pollinators due to fenitrothion caused a series of effects to ripple through the ecosystem. Similar effects were discussed by Alston and Tepedino (2000) for the application of broad spectrum insecticides in rangelands to control grasshoppers. The insecticides used, due to their high toxicity, are not permitted on blooming crops being visited by bees yet they were allowed to be sprayed on rangelands while native pollinators were foraging on wildflowers. The grasshopper spraying campaigns (generally from mid-April to late May) coincide with the flowering period of several endemic rangeland plants that grow among the grasses, a number of which are listed as endangered or threatened. This time period also overlaps the period of emergence and active foraging of many native bee species (Kearns & Inouye 1997). The usage of broadband insecticides in wild areas may potentially result in a number of ecosystem shifts due to pollinator limitation. These include "changes in future vegetation patterns via plant competition, reduction in seed banks, and influences on the animals dependent upon plants for food" (Alston & Tepedino 2000).

Key Points

- *Insecticides can be lethal to bees or have sublethal effects such as reducing foraging efficiency or reproductive success.*
- *A pesticide that has been deemed safe for honey bees may not be safe for native bees, even when applied according to label requirements.*
- *Pesticides not allowed on blooming crops due to high toxicity may be allowed to be used on rangeland while pollinators forage.*
- *Pesticide impacts are most severe within the agricultural matrix although spraying for mosquitoes or other insects may impact pollinators in a wide range of landscapes.*

Disease and parasites

Effects of pathogens and parasites on honey bees are well documented but there is less known about the impact on native pollinators (Kevan 1999).

The most studied group of native bees are bumble bees. In 2007, the National Research Council stated that a major cause of decline in several native bumble bees appears to be recently introduced nonnative fungal and protozoan parasites, including *Nosema bombi* and *Crithidia bombi*. A recent status review of three bumble bee species from both the eastern and western U.S. found that their decline is most likely caused by introduced diseases from commercial bee rearing and movement (Evans et al. 2008). These pests were probably introduced in the early 1990s when colonies of North American bumble bees were taken to Europe for rearing and then reimported to the U.S. for commercial greenhouse pollination. These pathogens were likely spread to wild populations of bumble bees in the late 1990s as commercial bumble bees were transported throughout the U.S. for pollination of greenhouse tomatoes and a variety of other crops. Commercially reared bees frequently harbor pathogens and their escape from greenhouses can lead to infections in native species (Colla et al. 2006; Otterstatter and Thomson 2008).

Currently, commercial bumble bee rearing facilities in North America breed just one species, the common eastern bumble bee (*Bombus impatiens*). These facilities are in Michigan. California state regulations only allow their importation into the state for use in glasshouses. Open-field pollination by these colonies is illegal. Limiting commercially reared colonies to glasshouses provides some control over the spread of pathogens. California regulations require the use of queen excluders on glasshouse bumble bee colonies to prevent the escape of queens and the possibility of them becoming established in the wild. Using colonies in glasshouses also protects them from vandalism and much accidental damage, two ways in which the bees can escape from the colony boxes.

Key Points

- *Diseases and parasites of native bees are less well studied than those of honey bees.*
- *Bumble bee populations have experienced serious declines, probably due to pathogens spread by commercially reared bumble bee colonies.*
- *Commercially reared bumble bees are used in glasshouses and should not be used for open-field pollination.*

Table 2: Summary of threats to pollinators in different landscapes of Yolo County

Landscape	Threats
Agriculture	1. Habitat loss and fragmentation 2. Pesticide use 3. Grazing, mowing, and fire 4. Disease and parasites from non-native commercially reared bees
Grassland	1. Habitat loss and fragmentation 2. Invasive exotic plants 3. Pesticide use 4. Grazing, mowing, and fire 5. Disease and parasites from non-native commercially reared bees used in agricultural areas
Woodland	1. Fragmentation by both agricultural and urban development 2. Over grazing in the understory 3. Fire, especially when fire suppression allows a build up in fuel loads and increased tree densities 4. Disease and parasites from non-native commercially reared bees used in agricultural areas
Shrubland & Scrub	1. Commercial livestock grazing 2. Burning, mowing and pesticides 3. Habitat fragmentation 4. Disease and parasites from non-native commercially reared bees used in agricultural areas
Riparian & Wetland	1. Livestock grazing in and near riparian and wetland areas can significantly damage stream banks and wetlands 2. Invasive species; management methods can cause further damage to pollinator populations if not used carefully 3. Pesticides are a significant threat, especially in areas with intensive agriculture 4. Disease and parasites from non-native commercially reared bees used in agricultural areas 5. Conversion of vernal pool landscapes to agriculture (primarily rice fields) and urban areas
Urban & Barren	1. Habitat loss and fragmentation are the most significant threats to pollinators 2. Invasive species 3. Use of pesticides.

SECTION 3
HABITAT CONSERVATION AND RESTORATION

This section focuses on pollinators in the Yolo County landscapes described on the Yolo Natural Heritage Program website, with special emphasis on wetland, grassland, and agricultural habitat types. For each landscape, we describe 1) how to recognize pollinator habitat, 2) potential threats to pollinators, and 3) actions to reduce or mitigate threats.

3.1 AGRICULTURE

Agricultural land is the predominant landscape type in Yolo County, covering 347,900 acres of the valley. Crops include over 138,000 acres of pasture, grain and hay, nearly 113,300 acres of field/truck/nursery/berry crops, over 45,000 acres of rice, 36,300 acres of fruit, nut, and citrus orchards, and 15,000 acres of vineyards. Agriculture is very important to Yolo County, contributing well over a billion dollars to its economy (Yolo County 2007 Agricultural Crop Report). Processing tomatoes is the most valuable crop in Yolo County ($100,012,325 in 2007). Field-grown tomatoes are generally considered to be self-pollinating (Delaplane & Meyer 2000; Greenleaf & Kremen 2006a), but a number of native bees visit the flowers and contribute to pollination (Greenleaf & Kremen 2006a). Other crops in Yolo County that rely on insect pollinators for all or some of their pollination include sunflower (seed crop: $9,355,318; field crop: $10,590,093), almonds ($28,914,985), miscellaneous melons and vegetables ($12,220,033), and organic crops ($19,475,512). Many studies show that native bees are more effective pollinators or can enhance pollination by honey bees in many crops, including tomatoes (Greenleaf & Kremen 2006a, Hogendoorn et al. 2006), watermelon (Kremen et al. 2002b), squash (Shuler et al. 2005), raspberries (Willmer et al. 1994), hybrid sunflower (Greenleaf & Kremen 2006b), and cherries (Bosch et al. 2006). In Yolo County, native pollinators can provide complete pollination for some crops in fields that offer proximity to sufficient natural habitat (Kremen et al. 2002b, Kremen et al. 2004).

Published research—much of it conducted in Yolo County—identifies ways in which native bees benefit pollination (e.g., Greenleaf & Kremen 2006a, b; Winfree et al 2008) and connects the presence of native bees to the proximity of natural habitat (e.g., Kremen et al 2004; Williams & Kremen 2007), but generally does not discuss the size of habitat required, nor the ratio of foraging habitat to nesting habitat. Kremen et al (2004) demonstrated that the pollen deposition by native bees in watermelon crops in California's Central Valley was significantly related to the proportion of riparian or upland habitat in the landscape. The authors estimated that complete pollination of watermelon by native bees could be achieved if at least 40% of the land within 2.4 kilometers (1½ miles) of the field or at least 30% of the land within 1.2 kilometers (¾ mile) of the field is habitat. They suggested that 10% of the landscape as habitat might be feasible if areas such as field margins, trackways, equipment areas, and ditchsides were enhanced.

Modeling of landscapes for their capacity to support bees by Lonsdorf et al (2009) can predict the relative abundance and richness of native pollinators in the landscape. This modeling does take into account an estimate of nest and floral resources provided by each habitat type. For each land parcel, the authors estimate the proportion of the parcel that is habitat and what type of nesting resources that habitat offers (cavity, ground). While this offers an estimate of the current nesting habitat (and from that a prediction of the pollinator abundance in a land parcel), it does not say how much of the habitat should be nesting to provide adequate pollination. The model cannot predict bee abundance over time (i.e., population fluctuations) or the pollination benefit (crop yield).

I. Recognizing pollinator habitat

Many growers may already have habitat for native pollinators on or near their land. Having semi-natural or natural habitat available significantly increases pollinator populations (Kremen et al. 2004, Williams & Kremen 2007). Marginal lands such as field edges, hedgerows, sub-irrigated areas, and drainage ditches mimic natural early successional habitat and can offer both nesting and foraging sites (Carvell 2002). Woodlots, conservation areas, utility easements, farm roads, and other untilled areas may also contain good habitat. Often, poor quality soils, unfit for crops, may be useful as pollinator habitat (Morandin and Winston 2006).

II. Potential threats to pollinators

The principal threats to pollinators in agricultural areas of Yolo County are:

1. Habitat loss and fragmentation,
2. Pesticide use,
3. Mowing, grazing, and burning, and
4. Disease and parasites.

Habitat loss including agricultural intensification is thought to be a primary cause of pollinator decline (Winfree et al. 2009). In Yolo County agricultural areas often lack the habitat resources necessary for native pollinators to exist because of intensive land use practices that are detrimental to pollinators (Kremen et al. 2002b; Kremen et al. 2004). Agricultural practices that harm pollinators include leaving no area of the farm uncultivated, treatment of field margins with herbicides and pesticides, and extensive cultivated regions where crops are large distances from natural habitat. Large scale cultivation in Yolo County has reduced pollinator habitat and increased the distance pollinators must travel between foraging and nesting resources (Kremen et al. 2002b; Kremen et al. 2004).

Pesticide use in intensively cropped agricultural areas is always a concern for pollinator populations. Pesticides applied to crops or fields in which bees are foraging, as well as drift over field margins and adjacent natural areas can have both lethal and sublethal impacts.

Mowing, grazing, and burning are common agricultural land management practices and are significant threats to pollinators. Use of these practices in field margins, along roads and adjacent to ditches have reduced pollinator habitat in the county (personal observation).

If open-field pollination by commercially reared bumble bees imported from east of the Rockies, native bumble bee populations may be put at greater risk through the spread of disease or pathogens.

III. Actions to reduce or mitigate threats

<u>A. Protect existing pollinator habitat</u>

The first priority in the Yolo County agricultural landscape should be to identify and protect existing pollinator habitat. When assessing pollen and nectar resources, it is important to look at all of the potential plant resources on and around a landowner or farmer's property, and which plants are heavily visited by bees and other pollinators. These plants include insect-pollinated crops, as well as the flowers – even "weeds" – in buffer areas, forest edges, hedgerows, roadsides, natural areas, fallowed fields, and other vegetated areas. Insect-pollinated crops may supply abundant forage for short periods of time, and such flowering crops should be factored into an overall farm plan if a grower is interested in supporting wild pollinators (Banaszak 1992). However, for pollinators to be most productive, nectar and pollen resources are needed outside the period of crop bloom.

As long as a plant is not a noxious weed species that should be removed or controlled, producers might consider allowing some of the native or nonnative forbs that are currently present onsite to bloom prior to their crop bloom, mow them during crop bloom, and then let them bloom again afterward. For example, dandelions, clover, and other nonnative plants are often good pollinator plants (Free 1968, Mosquin 1971). Growers may also allow some unharvested salad and cabbage crops to bolt. In addition to pollinators, the predators and parasitoids of pests are attracted to the flowers of arugula, chervil, chicory, mustards and other greens, supporting pest management.

When evaluating existing plant communities on the margins of cropland, a special effort should be made to conserve very early and very late blooming plants. Early-flowering plants provide an important food source for bees emerging from hibernation, and late-flowering plants help bumble bees build up their energy reserves before entering winter dormancy (Pywell et al. 2005).

B. Habitat restoration

Landowners intending to increase their pollinator populations may need to do more than simply curtail or alter current management practices that negatively impact pollinators or existing foraging or nesting sites. High quality foraging habitat may be limited, so action may be needed to increase the available foraging habitat and include a range of plants that bloom and provide abundant sources of pollen and nectar throughout spring, summer, and fall. Such habitat can take the form of designated pollinator meadows ("bee pastures"), demonstration gardens, orchard understory plantings, hedgerows and windbreaks with flowering trees and shrubs, riparian and rangeland re-vegetation efforts, flowering cover crops and green manures, and countless other similar efforts.

Where possible, planting local native plants is preferred for their ease of establishment, greater wildlife value, and their evolutionary mutualism with native pollinators (Kearns et al. 1998). Nonnative plants may be suitable, however on disturbed sites, for specialty uses such as cover cropping, and where native plants are not available. Mixtures of native and nonnative plants are also possible, as long as nonnative species are naturalized and not invasive.

Providing pollinator habitat in large cultivated regions of Yolo County will reduce the distance pollinators must travel to find suitable food and nesting resources. If managed properly, these habitat patches will not only protect native pollinators from population declines, but will also help maintain their crop pollination services (Kremen et al. 2002a). Plans to enhance existing habitat or develop new habitat for pollinators should include considerations for both forage and nesting resources. Establishing a diverse mix of plant species will ensure available floral resources through the foraging season of pollinator insects, as well as resources for larval butterflies, moths, and other foliage feeders. The size of restored habitat patches should be at least one-half acre area in size, with two acres or more providing even greater benefits (Morandin & Winston 2006; Kremen et al. 2004).

C. Protect Ground Nesting Bees

In order to protect nest sites of ground-nesting bees, avoid tilling (Shuler et al. 2005) and flood-irrigating (Vaughan et al. 2007) areas of bare, or partially bare ground that may be occupied by nesting bees. Grazing such areas can also disturb ground nests (Gess & Gess 1993; Vinson et al. 1993). Similarly, using fumigants like Chloropicrin for the control of soilborne crop pathogens (such as *Verticillium* wilt), or covering large areas with plastic mulch could be detrimental to ground nesting bees.

Weed control alternatives to tillage include the use of selective crop herbicides, flame weeders, and hooded sprayers for between row herbicide applications.

D. Protect Tunnel-Nesting Bees

Tunnel-nesting bees will make their homes in the abandoned tunnels of wood-boring beetles and the pithy centers of many woody plant stems. Allowing snags and dead trees to stand, as long as they do not pose a risk to property or people, and protecting shrubs with pithy or hollow stems, such as elderberry, blackberry, and box elder, will go a long way towards supporting these solitary bees.

E. Management considerations of pesticides

Given the risk of harm to pollinators the use of pesticides should be greatly reduced. Farmers who encourage native plants for pollinator habitat will inevitably be providing habitat that also will host many beneficial insects that help control pests naturally, and may come to depend less on pesticides. Studies show that organic crops support a higher abundance and diversity of pollinators than areas under conventional management, primarily because of the greater flower abundance in field margins that results from less disturbance and herbicide use (Kremen et al. 2002b; Belfrage et al. 2005; Holzschuh et al. 2008; Rundlof et al. 2008a, 2008b). In some of these cases, native pollinators provide most or all of the pollination services (Kremen et al. 2002b). When pesticide applications are necessary, they should be applied when pollinators are the least active: either in fall or winter months, or at night. Applications can also be scaled to target specific areas and avoid field margins and other areas of pollinator habitat.

F. Management considerations of mowing, grazing and burning

Only a portion of pollinator habitat should be burned, mowed, grazed, or hayed at any one time in order to protect overwintering pollinators and foraging larvae and adults (Black et al. 2008). This will allow for recolonization of the disturbed area from nearby undisturbed refugia, an important factor in the recovery of pollinator populations after disturbance (Hartley et al. 2007). In order to maximize foraging and egg-laying opportunities, maintenance activities should be avoided while plants are in flower (Smallidge & Leopold 1997).

[For more information on habitat restoration for pollinators in agricultural landscapes please see Vaughan and Black (2006) the NRCS technical Note: Pollinator Biology and Habitat in CA.]

IV. Conservation principles for agricultural landscapes

Pollinators are an essential part of Yolo County's agricultural landscape. Several major crops, including sunflowers, almonds, melons, and vegetables, require pollination for full harvests. In the west of the county, the Capay Valley retains many habitat features and is close to shrublands and woodlands in the hills above. However, much of the agricultural area is stripped of habitat, leaving riparian areas as the principal habitat type. There are also areas of wetlands and vernal pools. In these regions, conservation efforts should have a dual focus: protecting and retaining any pollinator habitat that remains, and creating or restoring habitat. Marginal areas like roadsides, ditches, field margins and fencerows, even barren lands have potential as pollinator habitat. Hedgerows rich in flowering shrubs and forbs can be planted and ditchsides restored with wide swathes of flowering plants. These linear habitats can connect with riparian areas and larger habitat patches to create a network of pollinator habitat across farmland.

The principal threats to pollinators in agricultural areas of Yolo County are habitat loss and fragmentation, pesticide use, mowing, grazing, and burning, and disease and parasites.

To maintain pollinator (especially native bee) populations within the agricultural landscape:

- Identify and protect existing pollinator habitat:
    - Areas of natural or seminatural habitat such as riparian areas, wetlands, species-rich grasslands, and vegetated roadside verges.
    - Areas supporting flowers such as buffer areas, forest edges, hedgerows, roadsides, ditchsides, and fallowed fields.
    - Potential bee nesting sites such as areas of untilled bare soil, snags, and pithy-stemmed shrubs.
- Create or restore habitat:
    - Such habitat can take the form of hedgerows, pollinator meadows ("bee pastures"), orchard understory plantings, riparian and rangeland re-vegetation, and flowering cover crops.
    - Have at least three plants blooming in each season (spring, summer, and fall).
    - Use native plants wherever possible.
    - Nonnative plants may be suitable on disturbed sites and for specialty uses such as cover cropping.
    - Include bee nest sites in habitat patches.
    - Restored patches should be a half-acre or more in size.
    - If crop pollination is the focus habitat patches should be no more than 600 meters from the crop (or from each other); shorter distances—250 to 300 meters—would be optimal.
    - Create linear habitats along roads and tracks, ditches, and field margins to increase connectivity across the landscape.
- Pesticide use should be minimized, especially adjacent to natural areas or known pollinator habitat:
    - Pesticides should not be applied when bees are actively foraging on flowers.
    - IPM principals should be followed when planning pest management.
    - If possible applications should be done in fall or winter, or at night.
    - Select the formulation and application method that will minimize overspray or drift into pollinator habitat.

  - Reduce spraying near field margins.
- Grazing, mowing, or the use of fire should be carefully planned in any pollinator habitat.
- Imported bumble bee colonies must be fitted with queen excluders and only used in glasshouses.
- Commercially reared bumble bees should not be used for open-field pollination.

3.2 GRASSLAND

Grassland is the second largest landscape type in Yolo County, and consists of over 93,000 acres of annual grasslands and serpentine habitat. Grasslands are scattered throughout the county, but the majority are located in the western half. The vernal pool complex is also a type of grassland, but will be discussed under the wetlands landscape section. Grassland is a valuable landscape because natural grassland habitat is often in close proximity to agricultural land in Yolo County, it can provide a reservoir of pollinators that provide additional pollination services to crops. The role that adjacent natural habitat plays in providing crop pollination services is increasingly well understood. Proximity to natural or semi-natural non-agricultural land is often an important predictor of pollinator diversity in cropland (Haughton et al. 2003; Bergman et al. 2004; Kim et al. 2006; Kremen et al. 2004; Morandin & Winston 2006; Hendrickx et al. 2007). Natural areas near to farms can also be important sources of pollinators that can recolonize agricultural areas that lost native pollinators due to a pesticide treatment or temporary habitat loss (Öckinger & Smith 2007).

I. Recognizing pollinator habitat

A diverse native grassland comprising of a variety of native grasses and forbs will provide habitat for native pollinators. Solitary ground nesting bees are likely the most common pollinators in grassland but flies, beetles, and butterflies are also likely prevalent. Most of North America's native bee species (about 70%) are ground nesters. These bees usually need direct access to the soil surface (Potts et al. 2005) to excavate and access their nests, which may sometimes be in huge aggregations of hundreds or thousands of nests. Ground-nesting bees seldom nest in rich soils, so poor quality sandy or loamy soils may provide fine sites. Bumble bees are also found in grasslands. They nest in small cavities, such as abandoned rodent nests under grass tussocks or in the ground (Kearns & Thompson 2001).

II. Potential threats to pollinators

The principal threats to pollinators in grasslands of Yolo County are:

1. Loss and fragmentation of grassland,
2. Exotic invasive species can reduce floral diversity,
3. Overgrazing, mowing, and burning, and
4. Pesticide use.

III. Actions to reduce or mitigate threats

<u>A. Protect existing pollinator habitat</u>

Protecting intact species-rich grassland habitats will provide resources for pollinators. Protecting existing nesting sites is also important. For instance, patches of rough undisturbed grass in which rodents can nest will create future nest sites for bumble bees (McFrederick & LeBuhn 2006). Management should be carefully planned and applied to minimize impacts on these species.

B. Habitat restoration

Removal of invasive species and restoration with native grasses and forbs will benefit pollinators. Emphasis should be placed on restoration to historic condition not on pollinator plants specifically. Nesting needs of ground nesting bees and bumble bees should be taken into consideration during restoration (also wood nesting bees if there is an appropriate place to include shrubs).

C. Management considerations of pesticides

Herbicide and insecticide applications in grasslands can be useful in controlling invasive species, but should be planned and carefully managed to avoid negative effects on native pollinators and other species. Targeted spraying should be used instead of broadcast spraying whenever possible, to avoid affecting pollinator species. Areas that are in bloom or have high densities of native pollinators should be avoided, or sprayed at times when the pollinators are not active, such as late fall, winter, and early spring. Timing applications to minimize spray drift is also important, and includes spraying on calm days with low temperatures.

[See Black et al. 2007 for more information.]

D. Management considerations of mowing, grazing and burning

Only a portion of pollinator habitat should be burned, mowed, grazed, or hayed at any one time in order to protect pollinators (Black et al. 2008). This will allow for recolonization of the disturbed area from nearby undisturbed refugia, an important factor in the recovery of pollinator populations after disturbance (Hartley et al. 2007). In order to maximize foraging and egg-laying opportunities, maintenance activities should be avoided while plants are in flower (Smallidge & Leopold 1997).

Mowing is an effective tool at limiting succession of shrubs and trees in grasslands (Forrester et al. 2005) and can be used in areas where other management options such as grazing or prescribed burning are impractical. With careful attention to timing and scale, mowing can be a successful management tool for insuring the long-term stability of pollinator populations and the plants and animals that depend on them. Mowing should not be conducted while flowers are in bloom, to avoid affecting pollinators both through direct mortality from the mower, and through the loss of their food source. Ideally, mowing should be done in the fall and winter to reduce effects on pollinators (Munguira & Thomas 1992). If mowing during spring and summer is necessary to control target weed species, mowing some patches and leaving others is the best method to reduce impacts on pollinators.

Grazing management should be adjusted as needed to maintain the majority of floral resources in an area throughout the seasons. The most effective time to graze varies depending on the site, but should be limited to times of low or no pollinator activity. Moderate levels of rotational grazing minimize negative impacts on pollinators and other native species.

In grassland regions, fire suppression can lead to invasion and maturation of shrubs and trees and an increase in invasive plant species. Eventually, continued succession results in the degradation and loss of the grasslands (Schultz & Crone 1998; Panzer 2003). Prescribed burning is therefore a useful tool for restoring and maintaining grassland habitat. Precautions for avoiding impacts on pollinators include only burning small sections of grassland, and rotating burned areas over several years, to allow sufficient time for the habitat to recover and pollinators to recolonize the burned sites.

[See Black et al. 2007 for more information on mowing, grazing and fire management.]

IV. Conservation principles for grasslands

The native grasslands in Yolo County could provide a valuable source of pollinators; a diverse native grassland comprising a variety of grasses and forbs will provide habitat for pollinators. As with agricultural areas, conservation should have a dual focus, protecting existing areas of good habitat and restoring degraded areas.

The principal threats to pollinators in grasslands of Yolo County are the loss and fragmentation of grassland; invasive species reducing floral diversity; overgrazing, mowing, and burning; and pesticide use.

To maintain pollinator (especially native bee) populations within the grassland landscape:

- Identify and protect existing pollinator habitat:
    - Areas of natural or seminatural grassland that support a diverse native flora.
    - Potential bee nesting sites such as areas of bare soil, snags, and pithy-stemmed shrubs.
- Restore degraded grasslands and create new grasslands:
    - Control and remove invasive weeds
    - Use native forbs to enhance diversity of grasslands.
- Use grazing, mowing, or fire carefully to avoid harming pollinators:
    - Treat only part of the area in one year.
    - Leave areas untreated as refugia for pollinators.
    - Time grazing to avoid periods of major bloom.
    - Rotate grazing to allow all patches to bloom.
    - Do not mow while flowers are in bloom.
    - Burning can be used to suppress shrubs and trees.
    - Allow habitat to recover fully between burns.
- Reduce spraying on grasslands and protected from drift from adjacent fields:
    - Pesticides that are not allowed on blooming crops may be allowed on grassland, despite the fact that they are no less damaging to bees.

3.3 WOODLAND AND FOREST

Woodlands and forests are primarily found in western Yolo County, and include several oak alliances, as well as foothill pine, knobcone pine, eucalyptus, cypress, and juniper alliances.
The open forest and woodland in Yolo County can provide significant habitat for pollinators. If managed properly they can provide a resource for nearby agricultural crops.

Oak woodlands, when relatively intact, contain a diverse flora interacting with a diverse pollinator fauna (Dobson 1993). In a study on the Greek Island of Lesvos, oak woodlands, pine forests and managed olive groves had the highest diversity of bees and oak woodlands had the highest levels of pollination from generalist species. In recent times, California's oak woodlands have experienced profound changes that have led to significant fragmentation of these habitats. These changes involve various combinations of grazing, conversion to agriculture, altered fire regimes, and fragmentation due to development. Although our understanding of the effects of fragmentation on vertebrate species in oak woodlands is increasing, we know very little about the effect of these changes on invertebrate communities (Block and Morrision 1998; Knapp et al. 2001). Recent work on solitary bees in oak woodlands suggests that there is a decrease in species diversity and number of species in habitats dominated by vineyards (LeBuhn, in prep) but other work showed little influence of this habitat fragmentation on bumble bees (LeBuhn and Fenter 2008).

I. Recognizing pollinator habitat

A diverse set of native plants in the understory of forests and woodlands can provide habitat for a variety of native bees. These will include ground nesting solitary bees. These bees usually need direct access to the soil surface (Potts et al. 2005) to excavate and access their nests. Ground nesting bees seldom nest in rich soils, so poor quality sandy or loamy soils may provide fine sites. Bumble bees are also found in forests and woodlands. They nest in small cavities, such as abandoned rodent nests under grass tussocks or in the ground (Kearns & Thompson 2001). Tunnel nesting bees will make their homes in the abandoned tunnels of wood-boring beetles in both conifers and a variety of deciduous trees and in the pithy centers of many woody plant stems.

II. Potential threats to pollinators

The principal threats to pollinators in woodlands of Yolo County are:

1. Fragmentation by both agricultural and urban development,
2. Over grazing in the understory is a significant threat to pollinators (personal observation), and
3. Fire also poses a threat, especially when fire suppression allows a build up in fuel loads and increased tree densities (Huntzinger 2003), both of which can lead to hotter and more widespread wildfires.

III. Actions to reduce or mitigate threats

<u>A. Protect existing pollinator habitat</u>

Providing a diverse understory of native grasses and native flowering forbs will provide significant habitat for a variety of native pollinators. Leaving patches of rough undisturbed grass in which rodents can nest will create future nest sites for bumble bees (McFrederick & LeBuhn 2006). Allowing snags and dead trees to stand, as long as they do not pose a risk to property or people, and protecting shrubs with pithy or hollow stems, such as elderberry, blackberry, and box elder, will go a long way towards supporting bees.

<u>B. Habitat restoration</u>

Removal of invasive species and restoration with native grasses forbs and shrubs will benefit pollinators. Emphasis should be placed on restoration to historic condition not on pollinator plants specifically. Nesting needs of ground nesting bees and bumble bees should be taken into consideration when restoring this habitat. Snags and other resources should be left for wood nesting bees.

C. Management considerations of pesticides

As in the other landscape types of Yolo County, herbicides are beneficial for invasive plant control, but should be used carefully to avoid harming native pollinators. The use of pesticides, particularly of insecticides, should be limited to small areas or applied at times when pollinators are inactive.

D. Grazing and fire

Only a portion of pollinator habitat should be burned, mowed, grazed, or hayed at any one time in order to protect pollinators (Black et al. 2008). This will allow for recolonization of the disturbed area from nearby undisturbed refugia, an important factor in the recovery of pollinator populations after disturbance (Hartley et al. 2007). In order to maximize foraging and egg-laying opportunities, maintenance activities should be avoided while plants are in flower (Smallidge & Leopold 1997).

Grazing management should be adjusted as needed to maintain the majority of floral resources in an area throughout the seasons. The most effective time to graze varies depending on the site, but should be limited to times of low or no pollinator activity. Moderate levels of rotational grazing minimize negative impacts on pollinators and other native species.

Fire is an important natural disturbance in the Yolo County forest and woodland landscape. Prescribed fire can help maintain these forest and woodland ecosystems, and if conducted regularly, can control the buildup of fuel loads and increased tree densities, as well as reduce the intensity and frequency of uncontrolled wildfires (Huntzinger 2003). Huntzinger (2003) evaluated adult butterfly species diversity in three types of prescribed burn treatments (forest burns, fuel breaks, and riparian burns) in formerly fire-suppressed forests in the Rogue River National Forest and Yosemite National Park. Butterfly species were higher in each of the treatments compared to the controls, with two to three times more species in forest burns, thirteen times more species in fuel breaks, and two times more species in riparian burns (Huntzinger 2003). However, several studies indicate that pollinators are negatively affected by fire (Harper et al. 2000; Swengel 2001; Potts et al. 2003). As with all potentially harmful management activities, care must be taken when using prescribed fire.

[See Black et al. 2007 for more information on grazing and fire management.]

IV. Conservation principles for woodland and forest

The open woodlands and forests of Yolo County can provide significant habitat for pollinators. The diversity of ground conditions combined with mixed ages of trees provides a rich nesting resource suited to ground-, wood-, and cavity-nesting bees. In addition, the ground flora can offer abundant flowers for foraging. These habitats are largely restricted to the hills and mountains in the west of the county, so any pollinator benefit to agricultural land is limited to farms in the Capay Valley and those close to the eastern fringe of the uplands.

The principal threats to pollinators in woodland and forest of Yolo County are fragmentation by both agricultural and urban development, overgrazing in the understory, and fire.

To maintain pollinator (especially native bee) populations within woodlands and forests:

- Reduce or prevent fragmentation of woodland and forest areas.
- Grazing should be adjusted to reduce the impact on flowering plants:
    - The best time to graze varies with the site but should be limited to periods of low pollinator activity.
    - Establish exclosures and rotate grazing to allow recovery of the vegetation community.
- Control invasive species.
- Fire is an important natural disturbance and prescribed fire can be used to manage the habitat:
    - Burn only small areas at one time.
    - Do not burn the same area more frequently than five years.
    - During burns, leave skips as refugia from which pollinators can recolonize.
- If pesticides are required for pest management:
    - Do not apply to significant patches of foraging flowers.
    - Do not apply while pollinators are active.
    - Choose least toxic option, such as pheromone traps.
- Habitat restoration should be done with native species only.

3.4 Shrubland and Scrub

Shrubland and scrub habitats are primarily located in western Yolo County and include various chamise and mixed chaparral alliances. In studies by Kremen et al. (2004), a common factor influencing native bee distribution appears to be areas of nearby natural habitat, particularly, in their study chaparral and oak woodland. Shrubland and scrub habitat offers a variety of flowering plants and nesting sites and can be very valuable habitat for native pollinators. Surveys of pollinators in different California plant communities show that the chaparral community has the largest diversity of bees per unit area (Moldenke 1976, as cited in Dobson 1993). Dobson (1993) recorded 73 bee species from six families visiting 11 shrub species in a Napa County, CA shrubland habitat, with *Ceanothus* sp. attracting the greatest diversity of bees.

I. Recognizing pollinator habitat

Bees are the most significant pollinators in chaparral communities (Moldenke 1976, as cited in Dobson 1993). Shrubland and scrub habitat provides the variety of dead, woody vegetation necessary for bees that nest in twigs and holes in shrubs and trees. The ground also provides good nesting habitat, in comparison to frequently disturbed soil in agricultural and urban areas. Flowering shrubs are the principle food source of bees in this habitat although some bees did visit other plants with low frequency (Dobson 1993). Most chaparral shrub species are self incompatible and depend on insects for pollination (Keeley and Keeley 1988, as cited in Dobson 1993). In mature chaparral flowering shrubs compromise the major food source for bees although herbaceous plants growing in shrub openings or adjacent habitats appear to play a role in maintaining populations of certain bee species (Dobson 1993).

II. Potential threats to pollinators

The principal threats to pollinators in shrubland and scrub of Yolo County are:

1. Commercial livestock grazing is common in this landscape type,

2. Burning, mowing and pesticides, and
3. Habitat fragmentation from conversion of the land to agriculture and urban areas.

III. Actions to reduce or mitigate threats

A. Protect existing pollinator habitat

Existing pollinator habitat should be identified and protected to help maintain native pollinator species and help supplement nearby agricultural and urban areas, as well as to protect threatened and endangered plant and animal species. Management should be carefully planned and applied to minimize impacts on these species.

B. Habitat enhancement and restoration

The value of the shrubland and scrub landscape, both to pollinator survival and as a source of pollinators for other landscapes, makes the enhancement and restoration of habitat important in pollinator conservation in Yolo County. In areas where habitat enhancement or restoration is planned, management practices such as pesticide use and grazing should be carefully managed.

C. Management considerations of pesticides

Insecticides should be avoided if at all possible, and herbicides should be applied at times and scales to minimize harmful effects on pollinators.

E. Management considerations of grazing and fire

Low to moderate levels of grazing can help maintain shrubland and scrub habitat. Some studies indicate that grazing has a beneficial effect on pollinator species (Smallidge & Leopold 1997; Vulliamy et al. 2006). However, if not managed carefully, livestock can severely damage the nests of ground nesting bees, as well as destroy floral and foliage resources of pollinators such as bees and butterflies (Kruess & Tscharntke 2002b; Debano 2006; Hatfield & LeBuhn 2007). Grazing should be limited to times when pollinators are not actively foraging or nesting, and should be rotated through areas in sufficient time intervals to allow recovery of grazed areas.

Fire is an important natural disturbance in the shrubland and scrub landscape. Prescribed burning can prevent the spread of large wildfires. A balanced plan for fire management should include reducing excess fuel loads and controlling vegetative succession, while allowing time between burns for the recovery of plant and wildlife populations.

[See Black et al. 2007 for more information on grazing and fire management.]

IV. Conservation principles for shrubland and scrub

Shrubland may support the richest and most diverse community of bees in Yolo County. Surveys done elsewhere in California identified chaparral as the plant community with the largest diversity of bees. Shrublands provide a diversity of nesting sites (twigs, stems, bare ground) as well as an abundance of flowering shrubs and forbs. Disturbance from fire is important to maintain the open conditions and diverse plant community. Like the woodlands and forest, shrublands are restricted to the western part of the county. Scrub habitat close to farms provides pollinators for crops.

The principal threats to pollinators in shrublands and scrub of Yolo County are commercial livestock grazing, burning, mowing, and pesticides, and habitat fragmentation.

To maintain pollinator (especially native bee) populations within shrublands and scrub:

- Protect existing shrublands and scrub to avoid loss or fragmentation.
- Manage grazing to avoid over grazing and damage to floral resources:
    - Keep grazing at low to moderate levels.
    - Establish exclosures and rotate grazing to allow recovery of grazed areas.
    - Avoid grazing when pollinators are active.
- Prescribed burning can lessen the chance of catastrophic wildfire by reducing the fuel load as well as control vegetation succession:
    - Burning should be done in small units to ensure that areas of scrub remain unburned.
    - During burns, leave skips as refugia from which pollinators can recolonize.
- If pesticides are required for pest management:
    - Do not apply to significant patches of foraging flowers.
    - Do not apply while pollinators are active.
    - Choose least toxic option, such as pheromone traps.

3.5 RIPARIAN AND WETLAND

Riparian and wetland habitat in Yolo County consists of fresh emergent wetland, saline emergent wetland, valley foothill riparian, alkali sink, and vernal pool complex.

Vernal pools

Vernal pools support many threatened and endangered species, and are of primary concern for restoration and conservation in this landscape. Areas that are seasonally flooded, such as the vernal pool complex, offer rich food and nesting resources for pollinators and other wildlife. The vernal pools of California provide critical habitat for a relatively large number of threatened and endangered species, many of which are quite specialized (Keeler-Wolf et al. 1998). The vernal pool region of Solano, Yolo, and Colusa counties hosts 16 sensitive plant species and 7 sensitive animal species (Keeler-Wolf et al. 1998). Several native solitary bee species are specialist pollen foragers on endemic vernal pool plants (Thorp & Leong 1995; Thorp & Leong 1998; Thorp 2007). Some species of vernal pool plants, many of which are threatened or endangered, are solely dependent upon specialized solitary bees for pollination (Thorp & Leong 1995).

For vernal pools in particular, many plants have bees that are specialists on that plant and have life cycles very closely associated with the host plant. Some vernal pool plants and their associated pollinators are listed in Table 2 below.

Many of the bees listed in Table 2 are oligolectic, i.e., they collect pollen from a limited range of flowers, and thus have a close association with the plants. Emergence and flight period of these bees is tightly synchronized with the bloom period of their host flower (Thorp 2007). Most of these species nest in upland areas next to the pools (rarely as far as 100 meters from the host plants) and some nest even closer in pool margins. At least one—a *Panurginus* associated with

Downingia—nests in the bottom of dried up pools. Females tend to forage in a single patch of flowers and nest near to their natal nest.

Table 3: Vernal pool plants and their flower visitors

Vernal pool plant	Specialist bee(s)	Other insect visitors
Blennosperma (stickyseed)	*Andrena blennospermatis*	Generalist visitors, including empidid and syrphid flies
Lasthenia (goldfields)	Six *Andrena* spp. (*puthua*, *submoesta*, *baeriae*, *duboisi*, *lativentris*, *leucomystax*)	Generalist bees and other visitors
Limnanthes (meadowfoam)	*Andrena puvlerea* *Panurgnius occidentalis*	
Downingia (calicoflower)	*Panurginus* sp.	Small sweat bees (Halictidae), and *Bombus vosnesenskii* (which buzzes flowers to gather pollen but doesn't pollinate)

(Pollinator information is from Thorp & Leong 1995 and Thorp 2007. Common plant names are from USDA-NRCS PLANTS database; accessed 10/12/09.)

In addition to nesting close to their host plants, these bees have limited ability to disperse to new sites. Thorp & Leong (1995) report a study conducted in a newly constructed vernal pool in which *Blennosperma* plants had been introduced. Over a period of two growing seasons, no specialist bees (*Andrena blennospermatis*) visited flowers of *Blennosperma*, though the blooms were visited by generalist sweat bees (*Halictus*) and empidid and syrphid flies.

For these specialist bees, protection of the existing vernal pool habitat, including upland areas, is the key to conservation (Thorp & Leong 1995, Thorp 2007). Do not excavate new pools in upland areas. The surrounding agricultural land provides little opportunity for ground nests (Lonsdorf et al 2009), and it is unlikely that flowering crops will contribute to conservation of these specialist bees.

The presence of flowering crops is likely to offer more foraging resources to the generalist visitors of vernal pool flowers. Unfortunately, there is little specific information published about these generalist insects which makes it difficult to assess the benefit that could accrue from crop flowers. Commercial crops of meadowfoam (*L. alba*) use honey bees and the blue orchard bee for pollination (Thorp 2007). It can be assumed that these bees must have some benefit as pollinators of vernal pool populations of *Limnanthes*. However, this is not true for all vernal pool flowers. Thorp (2007) also reports that *Downingia* growing in gardens rarely sets seeds, indicating that the generalist flower visitors are not effective.

The larvae of endangered molestan blister beetles (*Lytta molesta*) feed on the provisions and immature stages of ground nesting native bees, while the adults are flower feeders and potential pollinators (Selander 1960; Halstead & Haines 1992), and have only been collected on vernal pool vegetation, although records are limited. Conservation of native plant and bee species associated with vernal pools should be central to the conservation of this blister beetle, and will potentially benefit other plant and animal species as well.

Key Points

- *Important pollinators of vernal pool plants are mainly specialist, ground-nesting bees.*
- *These bees have a very close association with the plants, including life cycles synchronized with bloom of flowers, pollen collection from flowers, and nesting sites close to flower patches.*
- *These bees probably will not forage on crop flowers.*
- *Generalist pollinators such as bumble bees may use crops, but are not efficient pollinators of vernal pool plants.*
- *Conservation of vernal pool pollinators is best served by focusing on protecting existing vernal pools and the surrounding upland areas.*
- *There is not enough research on these systems to provide a proportion or ratio of pollinator habitat for rare plants.*
- *Generally the larger the upland area the more beneficial of pollinators.*

Riparian areas

The importance of riparian areas as pollinator habitat has been underscored by several studies, each of which identified the proximity of riparian areas as an important influence on the availability of native bees as crop pollinators (Kremen et al. 2002a, 2002b; Kremen et al. 2004) or influencing the reproduction of bees nesting on farms (Williams & Kremen 2007). Lonsdorf et al (2009) identify riparian as offering floral resources in spring but not summer. During this season, the main contribution of riparian zones may be in offering nest sites. Maximizing plant diversity along riparian corridors will result in more pollinators and other terrestrial insects to feed fish in the streams. In the agricultural areas of Yolo County, riparian areas may be the only significant areas of habitat.

I. Recognizing pollinator habitat

Most species of bees that rely on vernal pool habitat are solitary ground nesters. Most of these species nest in uplands close to vernal pools, while some species nest in the margins and sometimes the bottoms of evaporated vernal pools (Thorp & Leong 1995; Thorp 2007). Some of these species are also known to nest in stream banks (Saul-Gershenz et al. 2004). These bees have short flight ranges usually less than half a mile and are therefore often restricted to only a few vernal pools (Thorp & Leong 1995). Some species such as bumble bees also use vernal plants and may fly long distances from their nest to forage on vernal pool flowers (Thorp personal communication), underscoring the importance of landscape-wide conservation of pollinators.

II. Potential threats to pollinators

The principal threats to pollinators in riparian areas and wetlands of Yolo County are:

1. Habitat loss (vernal pools, in particular),
2. Grazing in or near riparian and wetland areas,
3. Pesticide use, and

4. Invasive exotic plants.

Livestock grazing in and near riparian and wetland areas can significantly damage stream banks and wetlands, affecting native species associated with this landscape type. Saunders and Fausch (2007) found that reduction of grazing intensity increased invertebrate inputs into streams which in turn increased trout biomass by more than 100%. Overgrazing can also reduce or eliminate plant species, and in habitat such as vernal pools, this can lead to the extirpation or extinction of specialized plants and animals.

Invasive species also threaten pollinators and other native species in these habitats, and management methods can cause further damage to pollinator populations if not used carefully.

Pesticides are a significant threat to native pollinators and other species in or near riparian areas and wetlands, especially in areas with intensive agriculture, where pesticides can build up in the water system, directly and indirectly affecting pollinators and their food plants.

Conversion of the landscape to agriculture (primarily rice fields) and urban areas has led to a significant loss of vernal pool habitat, which not only threatens pollinators, but other native species as well.

III. Actions to reduce or mitigate threats

A. Protect existing pollinator habitat

As in other landscapes, the first priority in pollinator conservation is to identify and protect existing pollinator habitat. This is especially important for the vernal pool complex, which is severely threatened by fragmentation and habitat loss, and is home to many species that are threatened or endangered in California.

B. Habitat restoration and conservation

Restoring and protecting vernal pool habitat and other sensitive riparian and wetlands areas is critically important for the survival of many threatened and endangered species in Yolo County. Vernal pools that are primarily impacted by overgrazing have the highest potential for habitat restoration, while restoration of agricultural areas such as rice fields is possible but not as feasible (Keeler-Wolf et al. 1998). Restoration of riparian and wetland habitat should include reintroduction of native plants associated with each site. As stated in the assessment of vernal pools in California done by Keeler-Wolf et al. (1998), conservation efforts should focus on the entire vernal pool complex, which includes the pools and their associated uplands, as well as considerations for both the wet and dry phases of the pools. Several native solitary bees are specialist pollinators of vernal pool plants, and have certain requirements that should be incorporated in conservation strategies for vernal pools. These bees primarily nest in uplands near vernal pools, although some species have been found nesting in the bottom of evaporated pools (Thorp 2007). These bees also have short foraging ranges and are therefore limited in how far they can travel to find forage plants (Gathmann & Tscharntke 2002, Thorp 2007). Restoration and conservation of vernal pools should also take into consideration the significant variation in the plant and animal species composition between individual pools (Keeler-Wolf et al. 1998). Management of riparian and wetland areas should use low-impact, targeted practices, and avoid grazing and pesticides.

C. Management considerations of pesticides

Pesticides should be used as little as possible in riparian and wetland areas to avoid compounding negative effects on plants and animals from the buildup of chemicals in the water system. Because so many threatened and endangered plant and animal species are associated with vernal pools, particular care should be taken when pesticide applications are necessary.

D. Management considerations of grazing and fire

Although grazing can be a beneficial disturbance, riparian and wetland areas are extremely sensitive to it and any grazing should be carefully managed. Grazing in wetlands can cause destruction of vegetation through trampling and consumption, high nutrient additions from manure that can alter plant composition in the wetlands, negatively impacting native plant and animal species, including pollinators, trampling nests of ground nesting bees and consuming and trampling foliage feeding larvae of pollinators such as butterflies and moths. But some studies have shown that some grazing can be beneficial to vernal pool habitats. One study on grazing of vernal pools in California (Marty 2005) showed that continuous grazing from October to June resulted in the highest cover of native plants compared to either no grazing or grazing for shorter periods. Grazing also affected the number of days for which the pools held water, which in turn influenced whether or not vernal pool flowers could complete their life cycle.

When burning is prescribed for areas with vernal pools, it should be carefully timed to avoid the key weeks when specialist bee species are active and threatened flower species are blooming. Other wetlands and riparian areas have longer bloom periods and corresponding pollinator activity, so burns in these areas should be timed to avoid these periods.

[See Black et al. 2008 for more information on grazing and fire management.]

IV. Conservation principles for riparian and wetland areas

This habitat category in Yolo County consists of a variety of wetland types, as well as riparian zones flanking many watercourses. This category also includes vernal pools, which support many threatened and endangered species, and are of primary concern for restoration and conservation. In the eastern part of the county, where the landscape is dominated by agriculture, riparian and wetland areas may be the only significant areas of seminatural habitat. As such, they form an important resource for pollinators and should be at the center of conservation efforts. In addition to the flowers and nesting opportunities they hold, riparian areas cross land holdings and ownership boundaries and provide valuable corridors. Pollinator habitat created in hedgerows or along ditchsides and field margins should connect with riparian areas to create a network of habitat.

The principal threats to pollinators in riparian areas and wetlands of Yolo County are habitat loss (vernal pools, in particular), grazing in or near riparian and wetland areas, pesticide use in adjacent fields, and invasive exotic plants.

To maintain pollinator (especially native bee) populations within riparian and wetland:

- Protect existing areas from habitat loss or fragmentation:
    - This is particularly important for vernal pools.
- Enhance current habitat or create new habitat:

  - Use native plants.
- Monitor and control invasive species.
- Manage grazing to avoid over grazing and damage to floral resources:
  - Keep grazing at low levels to reduce trampling and consumption.
- Pesticide use in riparian and wetland areas should be avoided:
  - Monitor pesticide use in adjacent fields.
  - Reduce spraying along field margins close to riparian zones.

For vernal pools in particular:
- Protect existing vernal pool habitat, including upland areas.
- Do not excavate new pools in upland areas.
- Carefully managed grazing may help maintain native plant communities and retain longer flooding periods.
- Avoid pesticide drift or overspray from adjacent crops.
- A buffer of 500 feet around the pools should be adequate to protect the specialist bees.
- A wider buffer (1 kilometer) should be used for aerial spraying of insecticides especially during the active flight period of the specialist bees (which coincides with bloom of the plants).

3.6 URBAN AND BARREN

Developed land in Yolo County is defined as urban. All other areas of unvegetated or vacant land are defined as barren, and include gravel bars, sand bars, and rock outcroppings. Major highways and associated verges are also included. Urban and barren areas are distributed throughout the county.

Pollinators are essential in urban areas for fruit and vegetable production of home and market gardeners, as well as for ensuring the continuation of flowering plants in gardens and parks, and the production of seeds for birds (Cane 2005). The need for pollinators in other urban and barren landscapes such as roadsides includes contributions to crops, especially in Yolo County where a majority of the county is agricultural land.

I. Recognizing pollinator habitat
Natural barren land such as gravel and sand bars can provide nesting sites to native bees. It has been demonstrated that some barren lands, particularly those due to human activities such as quarrying, can offer valuable habitat for pollinators (Benes et al. 2003; Krauss et al. 2009). Roadsides can also offer valuable habitat to pollinators if managed carefully and restored with native plants (Hopwood 2008). Roadside habitat is especially important for pollinators in areas of intensive agriculture with very little available habitat (Hopwood 2008). Urban gardens and parks also provide important habitat for pollinators in a fragmented landscape, and can serve as pollinator reservoirs if managed properly (e.g., McIntyre & Hostetler 2001; Tommasi et al. 2004; Wojcik et al. 2008). Studies of arthropods in Phoenix, Arizona indicate that while bees and other arthropods are often abundant in urban settings, the abundance and community composition differs depending on urban land use, such as residential and industrial use (McIntyre et al. 2001, Faeth et al. 2005). Ground-nesting bees are often more sensitive to urbanization because of

degraded nesting habitat, compared to cavity-nesting bees that can adapt to nesting in cavities in houses, fences, and woody landscape vegetation (Cane et al. 2006).

II. Potential threats to pollinators

The principal threats to pollinators in urban and barren areas of Yolo County are:

1. Habitat loss and fragmentation are the most significant threats to pollinators,
2. Invasive species, and
3. Use of pesticides. According to some studies more types of pesticides are detected in urban streams than in agricultural streams (Bortleson and Davis 1997) and more pounds of pesticides were applied in urban than in agricultural areas (Tetra Tech Incorporated, 1988) but urban use of pesticides are hard to track and no one has completed any analysis for Yolo County (http://agis.ucdavis.edu/pur/pdf/FlintPUR.pdf).

III. Actions to reduce or mitigate threats

A. Protect existing pollinator habitat

Existing pollinator habitat should be identified and protected to help maintain native pollinator species and provide patches of habitat in a highly fragmented and disturbed landscape. Management should be carefully planned and applied to minimize impacts on these species.

B. Habitat restoration

Restoration of roadside vegetation to native grasses can provide low-maintenance ground cover (Booze-Daniels et al. 2000; O'Dell et al. 2007). A survey of such restoration in Yolo County found that establishing native perennial grasses along roads was highly successful, with the grasses persisting under minimal maintenance for over ten years (O'Dell et al. 2007). Native broadleaf plants such as lupine and California poppy also colonized the restored roadsides (O'Dell et al. 2007), making these strips of land even more suitable for pollinator habitat. Restoration in urban areas should include establishing native flowering herbaceous plants and providing nesting materials for bees, as well as reducing pesticide use, to encourage bees and other insect pollinators to colonize parks, gardens, and other urban areas. Pavement, buildings, and turf eliminate habitat for ground nesting bees, as well as reduce the area available for flowering plants. If gardens and other potential habitat are too fragmented and widely spaced, they may not be able to support many pollinator species due to flight range restrictions.

C. Management considerations of pesticides

Pesticides are frequently used in urban areas, both to control weeds and insect pests. Pesticide use should be significantly reduced to lower the threat to pollinators and their host plants.

D. Management considerations of mowing

Mowing is a common practice in urban areas, usually to maintain the height of grasses in parks and lawns. Mowing should be avoided in areas where bees are actively foraging or nesting, or can be conducted in the evening when pollinators are less active.

IV. Conservation principles for urban and barren areas

This landscape category includes all developed land in Yolo County and any areas of unvegetated or vacant land, including gravel bars, sand bars, and rock outcroppings. Major highways and associated verges are also included. While these may not seem to be particularly attractive as pollinator habitat, the disturbed and marginal areas can be valuable as they often include a variety of flowering plants and range of ground conditions suited for bee nests. These areas are found throughout the county, offering small patches of habitat scattered across the landscape. In intensively cultivated agricultural areas, roadsides or abandoned land may be a significant habitat resource.

The principal threats to pollinators in urban and barren areas of Yolo County are habitat loss and fragmentation, invasive species, mowing, and the use of pesticides.

To maintain pollinator (especially native bee) populations within urban and barren areas:

- Identify and protect existing pollinator habitat:
  - Areas of natural or seminatural grassland that support a diverse native flora.
  - Species-rich hedgerows or scrub habitat.
  - Potential bee nesting sites such as areas of bare soil, snags, and pithy-stemmed shrubs.
- Restore degraded habitat (especially grasslands) and create new habitat patches:
  - Control and remove invasive weeds
  - Use native forbs and grasses to enhance diversity of grasslands.
  - Use flowering shrubs to create hedgerows.
  - In urban parks and gardens, flower borders, ecolawns, and ornamental plantings can be created that feature native plants.
- Use mowing carefully to avoid harming pollinators:
  - Mow only part of the area in one year.
  - Leave areas unmown as refugia for pollinators.
  - Time mowing to avoid periods of major bloom.
  - Allow habitat to recover fully between mowing.
- Reduce spraying on sites such as roadside verges and protect from drift from adjacent fields:
  - Pesticides that are not allowed on blooming crops may be allowed on verges, despite the fact that they are no less damaging to bees.

SECTION 5

RARE AND COVERED PLANTS

The issue with conserving the pollinators of rare plants is two-fold: often the pollinator of a particular plant is not known, and if it is, the biology and particular habitat needs of that pollinator may not be known.

A literature search for information about the pollination and pollinators of the covered plants in the Yolo HCP/NCCP yielded very little specific information. In some cases, for example, adobe-lily (*Fritillaria pluriflora*), pollinator information is only available for the genus or a different species, not the covered species itself. Given this it is difficult to make plant-specific suggestions or recommendations on management.

Table 4 (pages 50 – 54) summarizes what is known of the pollinators (or possible pollinators) of the covered plant species and their habitat needs.

There is limited published research on conserving pollinators related to rare plants. One exception is a paper by Sipes and Tepedino (1995) discussing the conservation of Ute lady's tresses (*Spiranthes diluvialis*), a rare orchid found in Colorado and Utah. The authors found that bumble bees were the most important pollinators, even though they visited for nectar only; the orchids' pollinaria were attached while the bees nectared. The authors recommended that management of the orchid must include consideration of bumble bees, particularly avoiding disturbance to habitat, protecting and retaining nest sites, providing flowers throughout bumble bee season (nectar and pollen when orchid not blooming, pollen while it is), and establishing an insecticide-free buffer during grasshopper control spraying. This last recommendation, obviously, is specific to the location of the orchid. Grasshopper control is likely not an issue for Yolo County, but pesticide use in the area adjacent to rare plants certainly is.

Key Points

- *Little is known about the pollinators of rare plants.*
- *Specific conservation strategies are hard to prepare without detailed information on the habitat needs of pollinators.*

Table 4. Yolo HCP/NCCP: Notes on pollinators of covered plant species

Plant	Likely pollinator	Source	Habitat notes
Adobe-lily, *Fritillaria pluriflora*	Bees	Krombein et al (1979) list *Fritillaria* as a pollen source for three spp. of Andrena. USFWS (2003) recovery plan for Gentner's fritillary mention *Lasioglossum* covered in pollen and "andrenid" bees visiting.	*Andrena* (mining bees): active in spring; solitary; excavates nests in sand or sandy loam; max foraging distance c. 300m. *Lasioglossum* (sweat bees): subsocial or solitary; excavates nests in sandy or silty loams; max foraging distance c. 150-200m.
Alkali milk-vetch, *Astragalus tener* var. *tener*	butterfly?, bees, moth?	Liston (1992) suggested butterflies due to flower morphology but there doesn't seem to be butterflies on the wing during bloom period. Also, *Astragalus* is generally pollinated by bees. Krombein et al (1979) list *Anthidium collectum*, *Hoplitis hypocrita*, and *Synhalonia tricinctella* as visitors to *A. tener*. Report on pollination of Lane Mountain milk-vetch prepared for Dept of Defense (2003) identified syrphid fly (*Eupeodes volucris*), *Anthophora* sp. (digger bees), and white-lined sphinx (*Hyles lineata*) as pollinators.	*Anthidium collectum* (carder bee): nests in abandoned burrows in the ground; lines cells with down from the leaves and stem of *Artemisia tridentata*; foraging distance likely to be 2-300m. *Hoplitis hypocrita*: nests in dead dry stems and also pre-existing tunnels in wood; likely foraging distance c. 200m. *Synhalonia tricinctella*: active in spring; solitary; ground nesting. *Anthophora* (digger bees): solitary; nests in loam or sandy loam soils; likely foraging distance 3-500m. Syrphid fly (*Eupeodes volucris*): larvae feed on aphids; adults drink nectar. White-lined sphinx (*Hyles lineata*): larvae feed on willow weed (*Epilobium*), four o'clock (*Mirabilis*), apple (*Malus*), evening primrose (*Oenothera*), elm (*Ulmus*), grape (*Vitis*), tomato (*Lycopersicon*), purslane (*Portulaca*), and fuschia.
Baker's navarretia, *Navarretia leucocephala* ssp. *bakeri*	Bees, bee flies, flower flies?	Grant (1965) lists many genera of bees visiting other species of *Navarretia*, also bee flies to two species and flower flies to one. The bee genera listed are *Andrena*, *Ancylandrena*, *Ashmeadiella*, *Anthophora*, *Exomalopsis*, *Osmia*, *Oreopasites*, and *Perdita*. Bee fly genera include *Anastoechus*, *Bombylius*,	See above for *Andrena* and *Anthophora*. *Ancylandrena*: similar to *Andrena* in nesting habitats and flight range. *Ashmeadiella*: solitary; different species nest in a variety

		Lepidanthrax, and *Lordotus*.	of substrates, including pre-existing tunnels in wood, spaces under rocks, and burrows in the ground; cells are lined with chewed leaf or petal pieces; foraging range unknown, but probably 3-500m. *Osmia* (mason bees, metallic leafcutter bees): solitary; most species nest in pre-existing tunnels in wood or crevices in rocks, divided with mud or chewed leaf pieces; likely foraging distance 150-600m. *Oreopasites*: cleptoparasites in nest of various species in the andrenid subfamily Panurginae. *Perdita*: solitary; nests in sandy soils, creating unlined cells; foraging range likely to be no more than 100m. Bee flies (Bombyliidae): egg laying needs vary between genera, but several, including *Bombylius*, lay eggs near ground-nesting bees; their larvae area external parasites of bee larvae.
Bent-flowered fiddleneck, *Amsinckia lunaris*	Bees, butterfly?	Krombein et al (1979) list numerous species from the following genera as pollen collectors from *Amsinckia*: *Andrena*, *Anthidium*, *Anthophora*, *Chelostoma*, *Duforea*, *Emphoropsis*, *Synhalonia*. Erhardt and Baker (1990) identify *A. lunaris* as an important nectar source for pipevine swallowtails.	See above for *Andrena*, *Anthophora*, and *Synhalonia*. *Anthidium* (carder bees): nests in pre-existing cavities in wood, rocks, walls, or in the ground; cells lined with down from the leaves and stem hairy plants; foraging distance likely to be 2-300m. *Chelostoma*: solitary; nests in abandoned beetle-tunnels in wood or hollow stems, divided into brood cells with soil or sand; likely foraging distance 150-300m. *Duforea*: solitary; nests in ground, lining cells with waxy substance. *Emphoropsis*: solitary; excavates nests in ground.
Brittlescale, *Atriplex depressa*	Wind	Freeman et al (2007): *Atriplex* are wind-pollinated, a feature common to most members of the Chenopodiaceae (goosefoot) family.	N/A
Colusa grass, *Neostapfia colusana*	Wind	Colusa grass is a member of the Poaceae. (USDA-PLANTS database; last accessed 10/16/09.) Grasses	N/A

		are all wind pollinated.	
Colusa layia, *Layia septentrionalis*	Bees?	Krombein et al (1979) list numerous species from the following genera as pollen collectors from *Layia*: *Colletes*, *Andrena*, *Nomadopsis*, *Perdita*, *Duforea*, *Augochlorella*, *Chelostoma*, *Osmia*, *Synhalonia*, and *Anthophora*	See above for *Andrena*, *Perdita*, *Duforea*, *Chelostoma*, *Osmia*, *Synhalonia*, and *Anthophora*. *Colletes* (polyester bees): solitary; excavates nests in sand or loamy sand, lines brood cells with cellophane-like material; likely foraging distance 3-400m. *Nomadopsis* (now a subgenus of *Calliopsis*): solitary; nests in sandy loam soils.
Delta tule pea, *Lathyrus jepsonii* var. *jepsonii*	Bees	No specific information. Nature Serve profile states "Zygomorphic flowers are probably adapted to bee pollination." Godt & Hamrick (1993) state that bumble bees are primary pollinator of *L. latifolius*.	N/A
Drymaria-like western flax, *Hesperolinon drymarioides*	small bees?, flies?	No specific information. Jepson manual (http://ucjeps.berkeley.edu/cgi-bin/get_JM_treatment.pl?4965,4966,4975; accessed 10/16/09) states that dwarf flax (*Hesperolinon*) is "Generally self-pollinated."	N/A
Ferris's milk-vetch, *Astragalus tener* var. *ferrisiae*	Bees	Liston (1992) suggested butterflies due to flower morphology but there doesn't seem to be butterflies on the wing during bloom period. Also, *Astragalus* is generally pollinated by bees. Krombein et al (1979) list *Anthidium collectum*, *Hoplitis hypocrita*, and *Synhalonia tricinctella* as visitors to *A. tener*. Report on pollination of Lane Mountain milk-vetch prepared for the U.S. Army (Charis Professional Services Corp 2003) identified syrphid fly (*Eupeodes volucris*), *Anthophora* sp., and white-lined sphinx (*Hyles lineata*) as pollinators.	See above (alkali milk-vetch) for notes.
Hall's harmonia, *Harmonia hallii*	Insect?	No information. Flower structure suggests it is visited by insects, probably small bees and flies.	N/A
Heckard's pepper-grass, *Lepidium latipes* var.	Bees, syrphid flies?	No information on this species or subspecies.	N/A

heckardii		Robertson & Klemash (2003) recorded insects from 25 families visiting slickspot peppergrass (*Lepidium papilliferum*). Bees in the families Colletidae, Halictidae, Apidae, and Anthophoridae (now a subfamily of Apidae) were considered to be the most significant pollinators. Syrphid flies (Syrphidae) were also recorded carrying pollen.	
Mason's lilaeopsis, *Lilaeopsis masonii*	Reproduction is primarily vegetative (ramets).	No information on this species. COSEWIC (2004) report on eastern lilaeopsis (*Lilaeopsis chinensis*) states: "Most plants are thought to arise from a rhizome through vegetative reproduction, which is thought to be the main means of reproduction necessary for maintaining populations. Self-pollination of flowers is also known to occur in a controlled environment, without artificial manipulation (Affolter 1985). Mechanisms of cross-pollination are not known."	N/A
Morrison's jewelflower, *Streptanthus morrisonii* spp. *morrisonii*	Bees, beefly	Krombein et al (1979) list many *Osmia* as visitors to *Streptanthus*, also *Anthidium* and *Dianthidium*. Dieringer (1991) says *Megachile comata* is effective pollinator of *S. bracteatus*.	See above for *Osmia* and *Anthidium*. *Dianthidium*: solitary; nests made of pebbles stuck together with resin, usually on the surface of a rock or twig; some species make nests in hollow twigs or under ground. *Megachile* (leafcutter bees): generally active in late-spring - summer; solitary; most species nest in pre-existing tunnels in wood, a few in loose soil; brood cells made from carefully cut leaf pieces; likely foraging distance 200-1000m.
Palmate-bracted bird's beak, *Cordylanthus palmatus*	Bees	Saul-Gershenz et al (2002): *Bombus vosnesenskii*, *Halictus tripartitus*, *Lasioglossum* sp.	See above for *Lasioglossum*. *Bombus vosnesenskii* (yellow-faced bumble bee): social, living in colonies of dozens of bees; nests in abandoned rodent nests under tussocky grass or in ground; colony founded in late winter by single female, grows through several generations during summer; workers active Feb - Oct; likely foraging distance 500-1500m. *Halictus* (sweat bee): solitary or subsocial; excavates nest

			in ground (sandy loam or loamy sand).
Rose mallow, *Hibiscus lasiocarpus*	Bees?	Krombein et al (1979) list *Melissodes agilis* as *Hibiscus* visitor with range to West Coast. *Melissodes bimaculata bimaculata* visits *H. lasiocarpus*, but is not found west of North Dakota. On the East Coast, *Ptilothrix bombiformis* and *Svastra atripes atrimitra* visit *Hibiscus*.	*Melissodes*: solitary; excavates nest in ground. *Ptilothrix*: solitary; excavates nests in sandy loam. *Svastra*: solitary; excavates nest in ground.
San Joaquin spearscale, *Atriplex joaquiniana*	Wind	Freeman et al (2007): *Atriplex* are wind-pollinated, a feature common to most members of the Chenopodiaceae (goosefoot) family.	N/A
Snow Mountain buckwheat, *Eriogonum nervulosum*	Bees, flies?	*Eriogonum* are widely recognized as important bee plants. Panjabi (2004) recorded bees (*Halictus*, *Lasioglossum*), flies (Bombylidae, Tachinidae), and wasps (*Euceceris*) visiting *Eriogonum brandegei* (Brandegee wild buckwheat).	See above for *Lasioglossum* and *Halictus*.
Solano grass, *Tuctoria mucronata*	Wind	Solano grass is a member of the Poaceae. (USDA-PLANTS database; last accessed 10/16/09.) Grasses are all wind pollinated.	N/A

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SECTION 5
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The Xerces Society for Invertebrate Conservation

The Xerces Society for Invertebrate Conservation is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection worldwide, harnessing the knowledge of scientists and the enthusiasm of citi zens to implement conservation programs. Our work focuses on three principal issues: endangered species, healthy waters, and pollinator conservation.

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Cover photos
Main: pollinator habitat created on farmland in Yolo County; top left: yellow-face bumble bee approaching tomato flower; lower left: foraging sweat bee. (All photos by Mace Vaughan/Xerces Society.)

Appendix E
Consistency with Other Plans

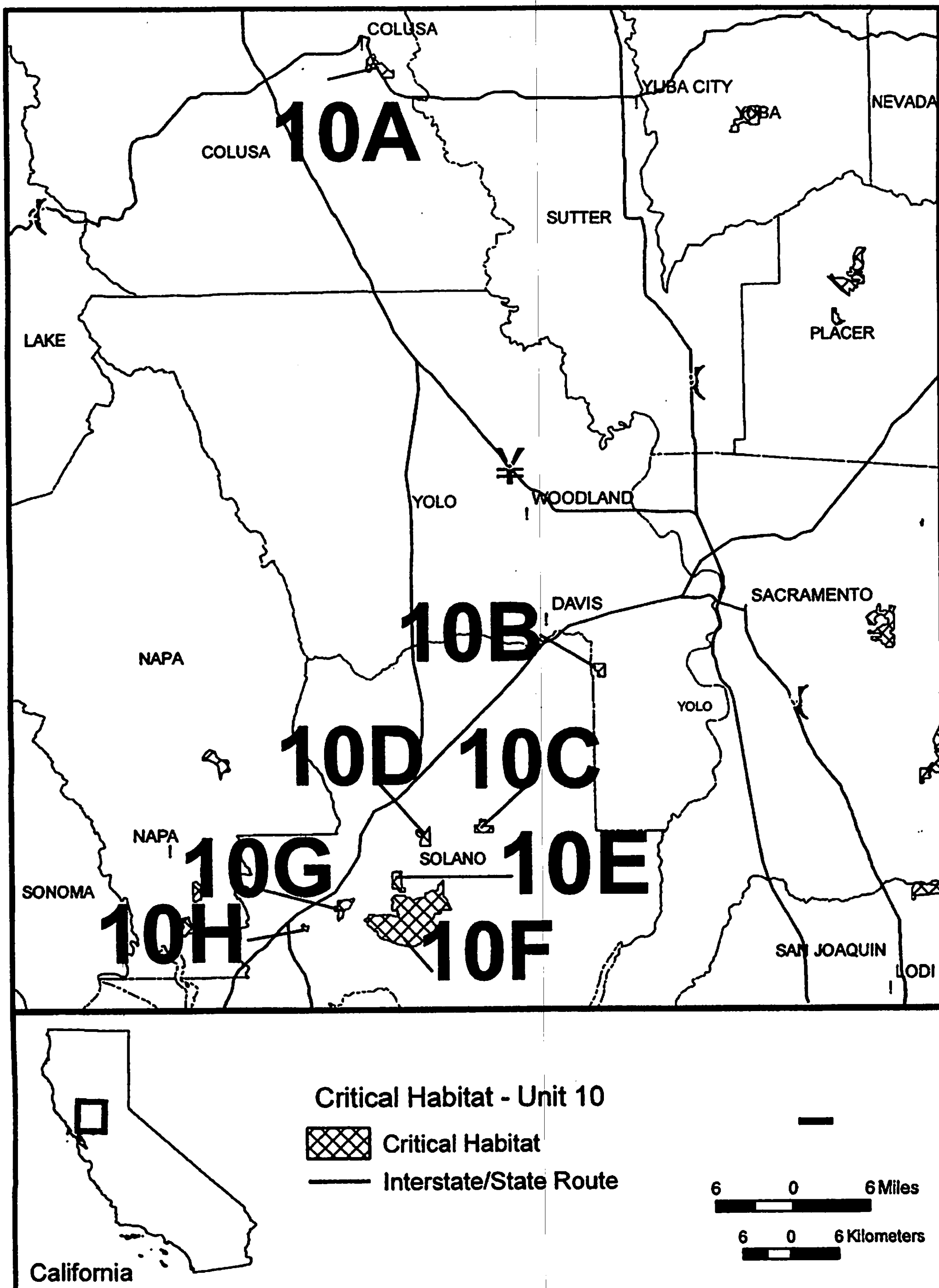
Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

Title:	Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions from August 2003 Final Designation		**Binder:**	1 web
Lead Agency: **Completed By:**	Federal Register: Department of the Interior, U.S. Fish and Wildlife Service 2003, updated in 2005, map locations refined in 2006			
Goals & Purpose:	Updated the 2003 critical habitat designation for 4 vernal pool crustaceans' species, and 11 vernal pool plants this includes a new total of 858,846 acres designated for critical habitat. To be included in a critical habitat designation, the habitat within the area occupied by the species must first have features that are ''essential to the conservation of the species.'' Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas on which are found those physical and biological features essential to the conservation of the species (primary constituent elements), as defined at 50 Code of Federal Regulations (CFR) 424.12(b)).			
Status:	Completed 2006			
LCP/RCIS **Species Covered:**	*Group 1* Conservancy fairy shrimp Vernal pool fairy shrimp Vernal pool tadpole shrimp Colusa grass Solano grass	*Group 2*	*Group 3*	
Plan/Program Boundaries:	The State of California and Southern Oregon			
Yolo County Conservation Target Locations:	Attached maps for one area in Yolo County that contains critical habitat for Solano grass, Colusa grass and vernal pool tadpole shrimp			
LCP/RCIS **Natural Communities Covered:**	Vernal pool complex natural communities, and fresh emergent wetland (they call it ephemeral freshwater habitat)			
Implementation Timeline:	Final Rule adopted in 2006			
Governance:	Section 7 requires consultation on Federal actions that could affect critical habitat.			
Funding:	No funding needed, must consult with U.S. Fish and Wildlife Service before impacting critical habitat.			

2

Doc 2005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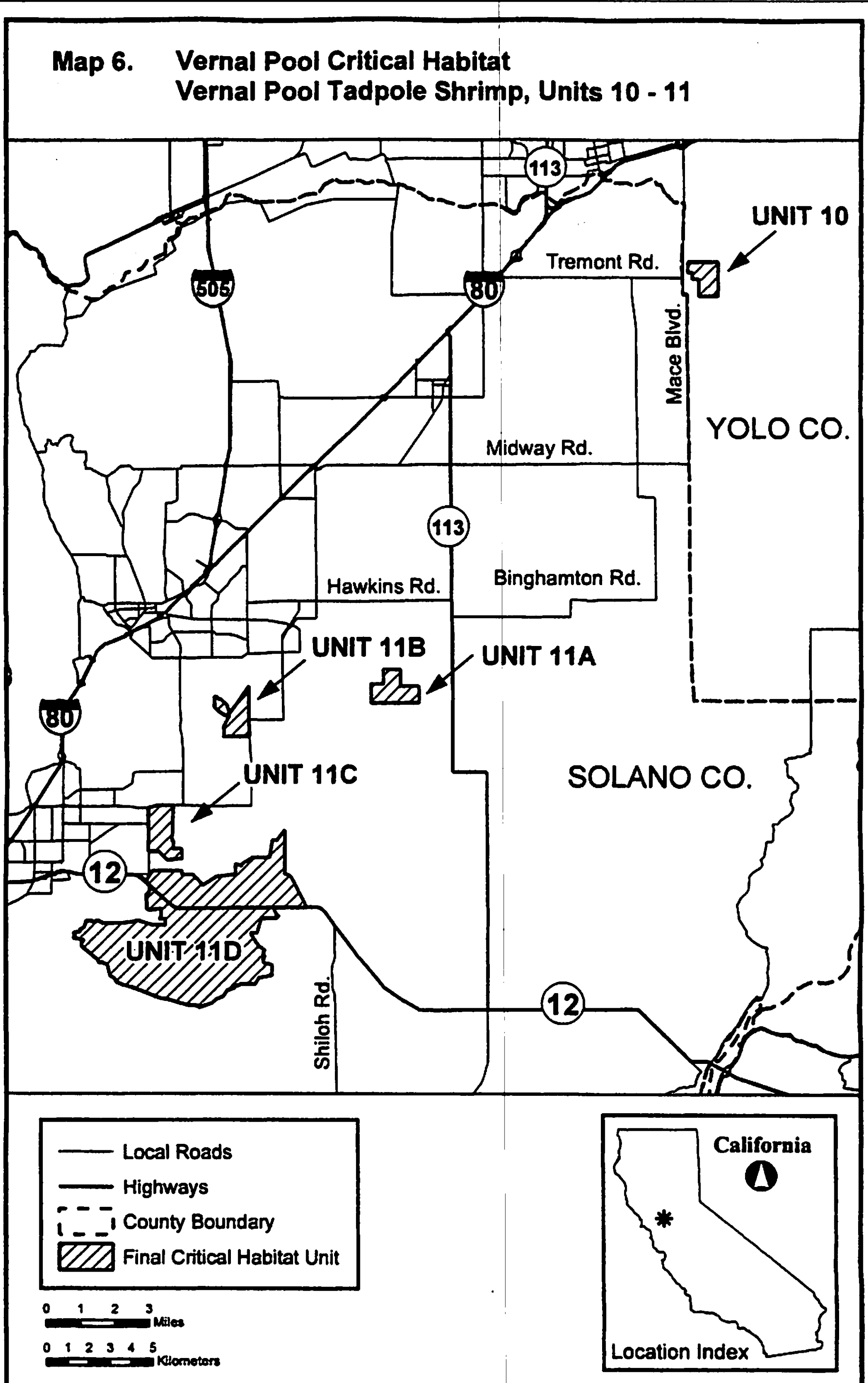
Doc 2006



BILLING CODE 4310–55–C

(15) Unit 13: Stanislaus County, California.

(i) Unit 13A: Stanislaus County, California. From USGS 1:24,000 scale quadrangle Paulsell. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 703100, 4177500; 703000, 4177300; 702911, 4177359; 702906, 4177503; 703100, 4177507; returning to 703100, 4177500;

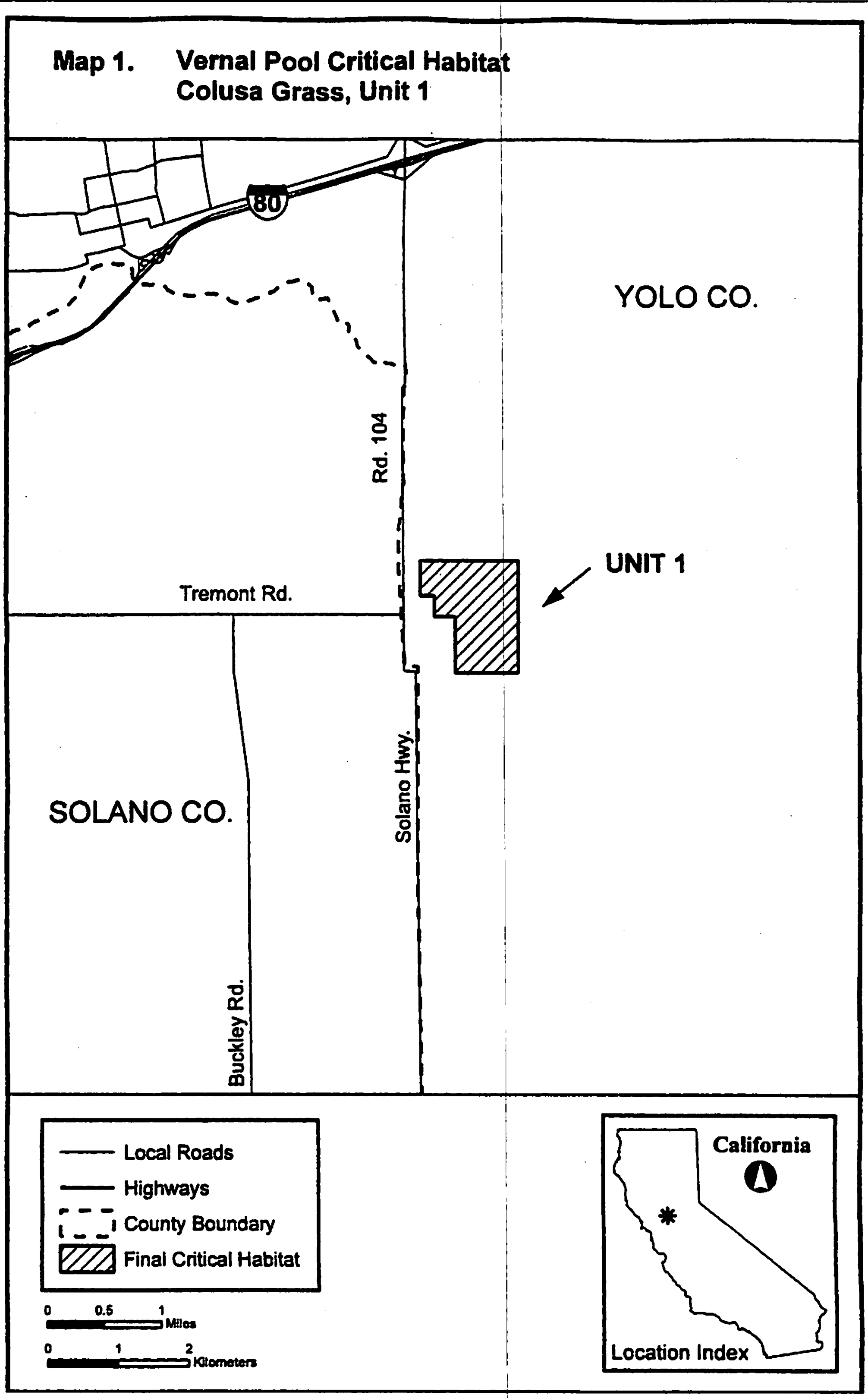
(ii) Unit 13B: Stanislaus County, California. From USGS 1:24,000 scale quadrangle Paulsell and Waterford. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 701282, 4176830; 701345, 4176765; 701756, 4176778; 701600, 4176700; 701600, 4176500; 701600, 4176200; 701700, 4175900; 701800, 4175800; 702000, 4175800; 702000, 4175100; 701600, 4175100; 701600, 4174200; 701900, 4173700; 701800, 4173600; 701700, 4173500; 701700, 4173300; 701700, 4173200; 701600, 4173200; 701500, 4173100; 701500, 4173000; 701600, 4173000; 701600, 4172800; 701500, 4172600; 701300, 4172500; 701100, 4172600; 700700, 4172600; 700600, 4172600; 700500, 4172700; 700500, 4172900; 700400, 4172900; 700400, 4172800; 700100, 4172700; 699600, 4172700; 699500, 4172800; 699300, 4172800; 699100, 4172500; 698800, 4172500; 698700, 4172600; 698400, 4172400; 698100, 4172800; 698200, 4173000; 697400, 4174300; 697300, 4174300; 697300, 4174500; 697800, 4174500; 697800, 4176300; 697700, 4176300; 697700, 4176437; 698090, 4176397; 698085, 4176613; 698084, 4176642; 699300, 4176684; 700500, 4176726; 701204, 4176750; returning to 701282, 4176830;

(iii) Unit 13C: Stanislaus County, California. From USGS 1:24,000 scale quadrangle Paulsell. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 702000, 4171800; 702000, 4169800; 702000, 4169700; 701000, 4169700; 700700, 4169700; 700700, 4170400; 700700, 4170500; 700550, 4170500; 700500, 4170500; 700500, 4170533; 700500, 4170900; 700300, 4170900; 700300, 4171100; 700300, 4171800; 701200, 4171800; returning to 702000, 4171800.

(iv) **Note:** Unit 13 (Map 7) follows:

BILLING CODE 4310–55–P

Doc 2006



BILLING CODE 4310–55–C

(6) Unit 4: Tuolumne and Stanislaus Counties, California.

(i) Unit 4A: Tuolumne and Stanislaus Counties, California. From USGS 1:24, 000 topographic quadrangles Knights Ferry and Keystone. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 709919, 4186841; 709913, 4186795; 709477, 4187175; 709275, 4187351; 708435, 4188084;

708351, 4188158; 708264, 4188233; 708132, 4188349; 707999, 4188465; 707639, 4188779; 707607, 4188807; 707900, 4189100; 708400, 4189600; 708700, 4190000; 709200, 4189300; 709200, 4188600; 710100, 4188200; returning to 709919, 4186841.

(ii) Unit 4B: Stanislaus County, California. From USGS 1:24,000 topographic quadrangles Waterford and Paulsell. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 701282, 4176830; 701345, 4176765; 701756, 4176778; 701600, 4176700; 701600, 4176500; 701600, 4176200; 701700, 4175900; 701800, 4175800; 702000, 4175800; 702000, 4175100; 701600, 4175100; 701600, 4174200; 701900, 4173700; 701800, 4173600; 701700, 4173500; 701700, 4173300; 701700, 4173200; 701600, 4173200; 701500, 4173100; 701500, 4173000; 701600, 4173000; 701600, 4172800; 701500, 4172600; 701300, 4172500; 701100, 4172600; 700700, 4172600; 700600, 4172600; 700500, 4172700; 700500, 4172900; 700400, 4172900; 700400, 4172800; 700100, 4172700; 699600, 4172700; 699500, 4172800; 699300, 4172800; 699100, 4172500; 698800, 4172500; 698700, 4172600; 698400, 4172400; 698100, 4172800; 698200, 4173000; 697400, 4174300; 697300, 4174300; 697300, 4174500; 697800, 4174500; 697800, 4176300; 697700, 4176300; 697700, 4176437; 698090, 4176397; 698085, 4176613; 698084, 4176642; 699300, 4176684; 700500, 4176726; 701204, 4176750; returning to 701282, 4176830.

(iii) Unit 4C: Stanislaus County, California. From USGS 1:24,000 topographic quadrangle Paulsell. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 702000, 4171800; 702000, 4169800; 702200, 4169800; 702200, 4169700; 702200, 4169658; 701000, 4169612; 701000, 4169700; 700700, 4169700; 700700, 4170400; 700700, 4170500; 700550, 4170500; 700500, 4170533; 700500, 4170900; 700300, 4170900; 700300, 4171100; 700300, 4171800; 701200, 4171800; returning to 702000, 4171800.

(iv) Unit 4D: Tuolumne County Stanislaus Counties, California. From USGS 1:24,000 topographic quadrangles Paulsell, Cooperstown, La Grange, Keystone. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 715600, 4180900; 715400, 4180400; 716600, 4180400; 716900, 4179900; 717482, 4180046; 717700, 4180100; 718500, 4180000; 718700, 4179200; 719300, 4178700; 719455, 4178273; 719700, 4177600; 720126, 4177671; 720300, 4177700; 720700, 4177700; 720745, 4177115; 720800, 4176400; 721400, 4175900; 722200, 4175300; 722700, 4175200; 722800, 4173600; 723000, 4173500; 723200, 4173600; 723700, 4173600; 724000, 4173300; 724100, 4172300; 722800, 4172200; 721700, 4171200; 721571, 4170643; 721500, 4170500; 721400, 4170400; 721200, 4170300; 721000, 4170100; 721000, 4169600; 720900, 4169600; 720000, 4168500; 718900, 4168000; 718700, 4168100; 718100, 4168500; 718000, 4168500; 717900, 4168600; 716200, 4168600; 715900, 4168500; 715600, 4168300; 715500, 4168200; 715400, 4168300; 715400, 4169400; 714900, 4169900; 714900, 4170000; 715100, 4170000; 715200, 4170200; 715300, 4170200; 715300, 4170400; 715300, 4170407; 715300, 4171200; 715200, 4171200; 715200, 4171000; 715100, 4171000; 715100, 4170700; 714900, 4170700; 714900, 4170300; 713900, 4169800; 713800, 4169900; 713000, 4169500; 712500, 4169400; 712200, 4169400; 712000, 4169600; 711500, 4169900; 711300, 4169900; 710500, 4169100; 709300, 4169100; 709100, 4169500; 709100, 4169700; 708900, 4169700; 708800, 4169900; 708700, 4169900; 708600, 4169800; 708500, 4169900; 708400, 4170000; 708700, 4170200; 708800, 4170300; 708900, 4170400; 709100, 4170500; 709200, 4170600; 709400, 4170600; 709400, 4170800; 709300, 4170800; 709200, 4170900; 709100, 4170800; 708800, 4170700; 708800, 4170600; 708500, 4170500; 708400, 4170300; 708100, 4170200; 707900, 4170200; 707900, 4170300; 708100, 4170500; 708200, 4170500; 708200, 4170600; 708000, 4170600; 708200, 4170800; 708200, 4170900; 708100, 4170900; 707900, 4170700; 707700, 4170700; 707700, 4170800; 707600, 4170900; 707400, 4170900; 707100, 4171100; 707100, 4171200; 707200, 4171300; 707300, 4171200; 707500, 4171300; 707800, 4171600; 707900, 4171600; 708100, 4171600; 708200, 4171700; 708100, 4171800; 708100, 4171900; 708300, 4171900; 708300, 4172100; 708400, 4172100; 708500, 4172200; 708500, 4172300; 708700, 4172400; 708800, 4172500; 708800, 4172600; 708700, 4172700; 708500, 4172700; 708400, 4172800; 708300, 4172700; 708200, 4172700; 708100, 4172600; 708000, 4172500; 707900, 4172500; 707800, 4172700; 707600, 4172600; 707400, 4172500; 707400, 4172600; 707200, 4172700; 707100, 4172300; 707000, 4172200; 706700, 4172200; 706700, 4172300; 706500, 4172300; 706400, 4172300; 706400, 4172400; 706200, 4172600; 706300, 4172700; 706400, 4172800; 706300, 4172800; 706200, 4172800; 706100, 4172900; 705900, 4173100; 705800, 4173300; 705800, 4173500; 706000, 4173800; 705900, 4173900; 705800, 4174100; 705700, 4174200; 705500, 4174200; 705400, 4174100; 705400, 4173700; 705200, 4173200; 705100, 4173200; 705100, 4172600; 704900, 4172400; 704800, 4172100; 704600, 4172100; 704500, 4171900; 704400, 4171800; 704500, 4171600; 704600, 4171400; 704700, 4171500; 704900, 4171200; 704700, 4171100; 704900, 4171000; 704800, 4170900; 704600, 4170900; 704600, 4170700; 704800, 4170200; 705100, 4170200; 705000, 4170100; 705000, 4169600; 705000, 4169500; 704900, 4169400; 704800, 4169300; 704100, 4169300; 703500, 4169500; 703400, 4169600; 703400, 4170100; 703600, 4170200; 703600, 4170300; 703500, 4170300; 703500, 4170600; 703500, 4170700; 703500, 4170800; 703400, 4170900; 703400, 4171300; 703300, 4171400; 703200, 4171500; 703400, 4171500; 703400, 4171800; 703600, 4171800; 703600, 4174000; 704300, 4174000; 704300, 4173700; 705167, 4173700; 705167, 4173700; 705100, 4174700; 705400, 4175400; 705000, 4175900; 705300, 4176300; 705700, 4176700; 705700, 4177000; 705700, 4177500; 705100, 4177500; 705000, 4177300; 704800, 4177300; 704800, 4177100; 704600, 4177100; 704500, 4177200; 704500, 4177400; 704300, 4177500; 704200, 4177300; 704000, 4177300; 703800, 4177100; 703500, 4177300; 703500, 4177650; 703661, 4177654; 703645, 4177993; 703800, 4178200; 704000, 4178200; 704100, 4178100; 704200, 4178100; 704200, 4178400; 703900, 4178400; 703900, 4178800; 703800, 4178900; 703900, 4179100; 703900, 4179200; 703588, 4179200; 703586, 4179240; 704434, 4179184; 705229, 4179481; 706142, 4179326; 708062, 4179408; 708659, 4178568; 709277, 4179043; 709879, 4179505; 709905, 4179525; 711259, 4179578; 711250, 4179933; 711628, 4179987; 711599, 4180753; 711578, 4180885; 713039, 4181325; 713440, 4181474; 714003, 4181741; 714540, 4182019; 714627, 4182073; 714700, 4182000; 715200, 4181600; returning to 715600, 4180900.

(v) Unit 4E: Stanislaus County, California. From USGS 1:24,000 topographic quadrangle Paulsell. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 703100, 4177500; 703000, 4177300; 702911, 4177359; 702906, 4177503; 703100, 4177507; returning to 703100, 4177500.

(7) Unit 5: Stanislaus County, California

(i) Unit 5A: Stanislaus County, California. From USGS 1:24,000 topographic quadrangles Paulsell and

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Montpelier: Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 704200, 4166200; 704000, 4166200; 703800, 4166400; 703400, 4166600; 703400, 4166800; 703500, 4166800; 703600, 4166900; 703700, 4167000; 703700, 4167200; 704600, 4167600; 704700, 4167600; 704800, 4167500; 705000, 4167400; 705300, 4167400; 705300, 4166400; 705000, 4166300; 704400, 4166300; returning to 704200, 4166200.

(ii) Unit 5B: Stanislaus and Merced Counties, California. From USGS 1:24,000 topographic quadrangles Paulsell, Cooperstown, La Grange, Montpelier, Turlock Lake, Snelling, Merced Falls. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 720900, 4167500; 721100, 4167400; 721300, 4167700; 721700, 4167700; 722000, 4167600; 722500, 4167600; 723200, 4167100; 723500, 4166300; 723000, 4166100; 723200, 4165600; 723400, 4165700; 723600, 4165600; 723600, 4165100; 723700, 4164900; 724300, 4164900; 725000, 4163700; 725300, 4163800; 724900, 4162800; 725100, 4162700; 725400, 4162700; 726000, 4164100; 726300, 4163500; 726200, 4163100; 726000, 4163000; 726100, 4162700; 726199, 4160629; 726200, 4160600; 725800, 4160600; 725000, 4160200; 725300, 4159800; 726300, 4160200; 727000, 4159500; 727000, 4160400; 727223, 4160623; 727246, 4160646; 727300, 4160700; 727312, 4160647; 727317, 4160625; 727500, 4159800; 727600, 4159800; 727800, 4160400; 728300, 4160400; 728752, 4160658; 728773, 4160670; 729000, 4160800; 729244, 4160678; 729261, 4160670; 730400, 4160100; 730300, 4160500; 730600, 4160600; 730905, 4160871; 731500, 4161400; 731900, 4161400; 732000, 4160800; 731700, 4160700; 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719800, 4166100; 719900, 4166300; 719900, 4166200; 720700, 4166200; 720700, 4163700; 721533, 4163700; 721700, 4163700; 722400, 4164100; 722400, 4164155; 722400, 4165300; 722200, 4165300; 722200, 4165400; 721500, 4165400; 721500, 4166100; 721000, 4166300; 720700, 4166500; 720900, 4166600; 721000, 4166700; 721100, 4166900; 721000, 4167000; 720300, 4167000; 720100, 4166900; 720200, 4166700; 720200, 4166600; 720100, 4166500; 720000, 4166500; 719800, 4166800; 719500, 4167400; 719500, 4167600; 719700, 4167800; 720500, 4167800; 720700, 4167700; returning to 720900, 4167500.

(iii) Unit 5C: Merced County, California. From USGS 1:24,000 topographic quadrangle Turlock Lake. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 713800, 4155400; 712600, 4155200; 712600, 4156800; 712900, 4156800; 712900, 4157100; 714800, 4157200; 714800, 4156800; 714300, 4156300; 714200, 4156200; 714000, 4155500; 714000, 4155400; returning to 713800, 4155400.

(iv) Unit 5D: Merced County, California. From USGS 1:24,000 topographic quadrangle Merced Falls. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 734700, 4158000; 734500, 4157900; 734700, 4158000; 734900, 4158300; returning to 734700, 4158000.

(v) Unit 5E: Merced County, California. From USGS 1:24,000 topographic quadrangles Merced Falls. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 735600, 4158100; 736171, 4157529; 735600, 4158100; returning to 735600, 4158100.

(8) Unit 6: Merced and Mariposa Counties, California. From USGS 1:24,000 topographic quadrangles Winton, Yosemite Lake, Snelling, Merced Falls, Haystack Mtn., Indian Gulch. Land bounded by the following UTM Zone 10, NAD 83 coordinates (E,N): 737800, 4155000; 738200, 4154200; 738300, 4153300; 739000, 4152800; 739100, 4152200; 740200, 4151800; 740800, 4151500; 740800, 4150300; 741100, 4149900; 741700, 4149400; 742100, 4148500; 742100, 4147100; 743400, 4146100; 744000, 4145600; 744400, 4144600; 744300, 4143900; 743900, 4142700; 744000, 4142000; 744200, 4141700; 745500, 4140300; 745504, 4139577; 745500, 4139576; 745490, 4139575; 745422, 4139619; 745281, 4139676; 745269, 4139653; 745219, 4139621; 745324, 4139603; 745368, 4139567; 745432, 4139432; 745432, 4139432; 745433, 4139429; 745469, 4139385; 745412, 4139359; 745339, 4139307; 745338, 4139306; 745334, 4139300; 745299, 4139239; 745171, 4139174; 745038, 4139064; 744922, 4139007; 744890, 4138973; 744873, 4138873; 744852, 4138807; 744854, 4138756; 744892, 4138670; 744893, 4138653; 744895, 4138606; 744895, 4138606; 744830, 4138711; 744596, 4139085; 744234, 4139637; 744233, 4139645; 744162, 4139744; 744162, 4139744; 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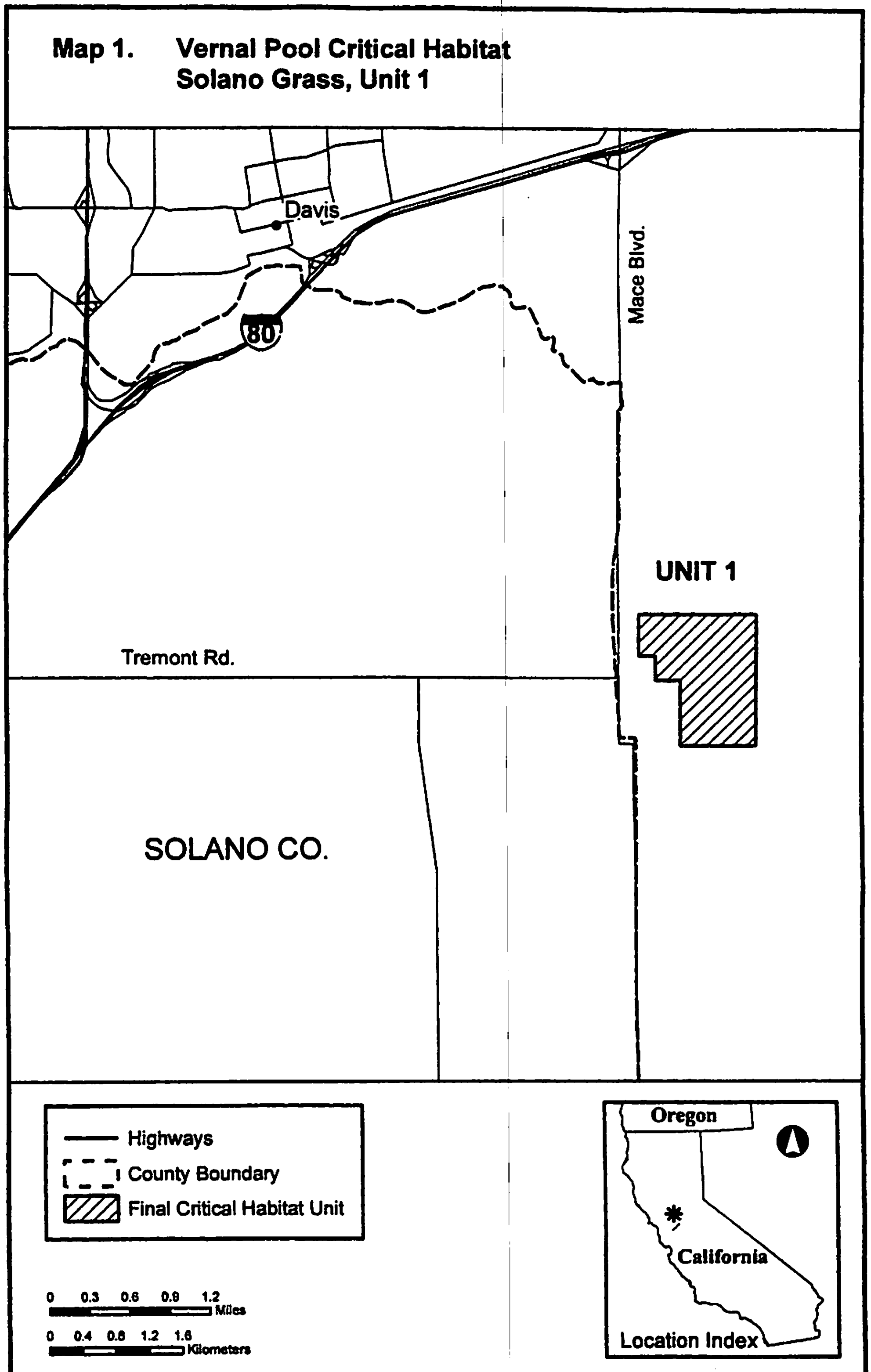


BILLING CODE 4310–55–C

§ 17.97 [Reserved].

■ 6. Remove and reserve § 17.97.

Dated: January 25, 2006.

Matt Hogan,

Acting Assistant Secretary for Fish and Wildlife and Parks.

[FR Doc. 06–1080 Filed 2–9–06; 8:45 am]

BILLING CODE 4310–55–C

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

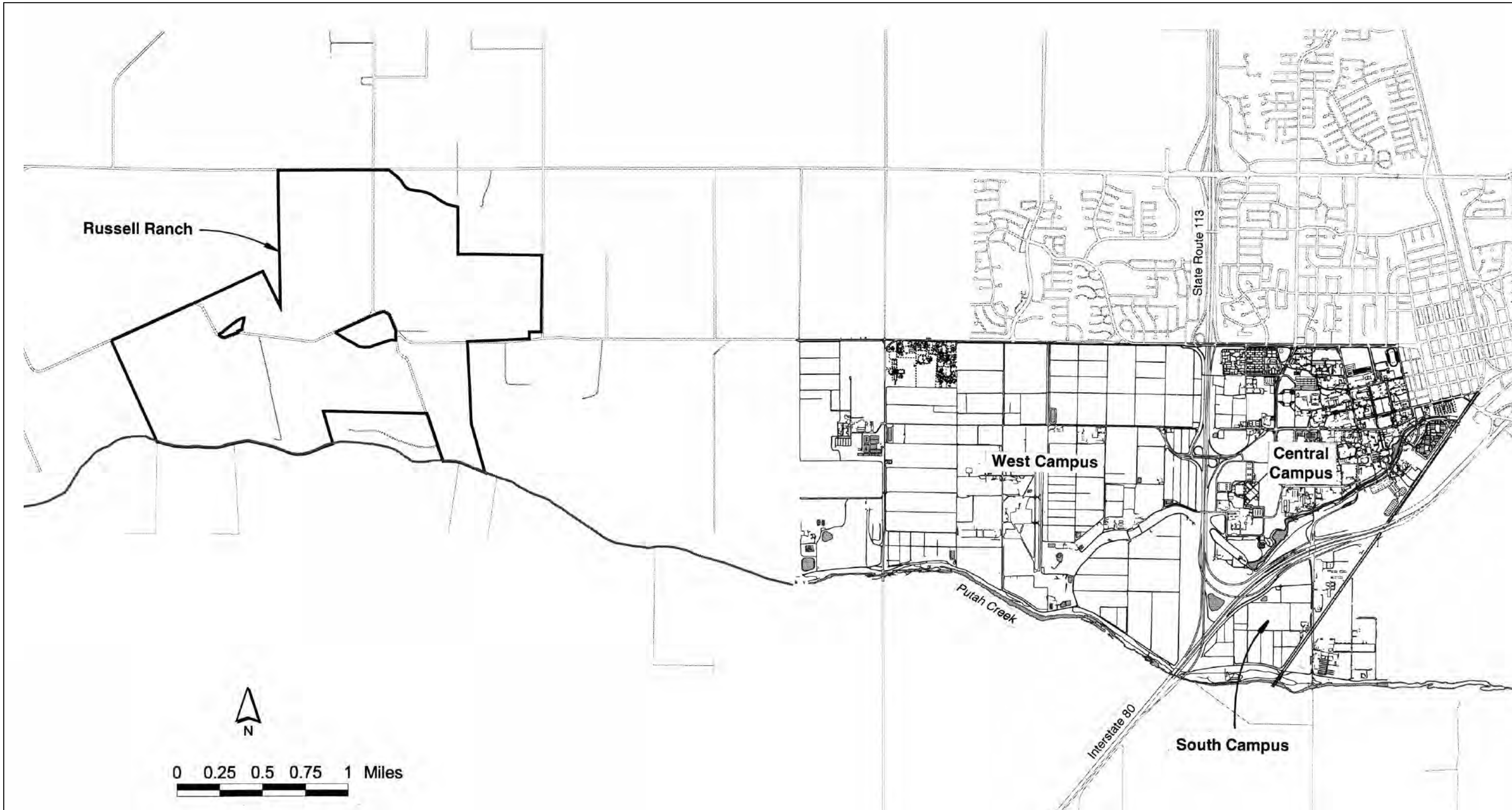
Title:	2002 Campus Projects Habitat Conservation Plan	**Binder:**	1
Lead Agency: **Completed By:**	University of California, Davis Jones & Stokes		
Goals & Purpose:	The Board of Regents of the University of California constructed five capital improvement and maintenance projects at the University of California, Davis (UC Davis) campus. Among the projects constructed in fiscal year 2001-2002 are five projects that could have potentially impacted valley elderberry longhorn beetle (VELB) through the removal of elderberry shrubs: • Genome Launch Facility • Cole Facility Stormwater Improvements • Center for Companion Animal Health (CCAH) • NEES Centrifuge Support Building • Phase 2B Electrical Improvement Project As a condition of these and other project approvals, UC Davis committed to (1) conduct project-specific surveys of VELB habitat; (2) avoid and protect VELB habitat where feasible; and (3) where avoidance is infeasible, develop and implement a VELB mitigation plan in accordance with the most current U.S. Fish and Wildlife Service (Service) Compensation Guidelines for unavoidable take of VELB (Service 1999) pursuant to Section 10(a) of the federal Endangered Species Act (ESA). Mitigation included an additional 18 acres added into UC Davis' La Rue/Bowley Center HCP mitigation (140 acres) for a combination of 158 acres of mitigation between this HCP and the La Rue Housing/Bowley Center HCP. The combined impact of the two HCPs is 27 acres (17 from La Rue).		
Status:	Plan completed and permit issued in July 2002.		

	Group 1	*Group 2*	*Group 3*
LCP/RCIS Species Covered:	Valley elderberry longhorn beetle		

Plan/Program Boundaries:	All five project construction sites are within an approximately one square mile area of the UC Davis West and Central Campuses. General characteristics of each site and surrounding land uses are similar. The area is a combination of campus facilities: laboratory and office buildings, recreational facilities, small pastures for livestock grazing, teaching and research fields, roads, and other infrastructure. In general, the project areas support existing facilities intermixed with lawns, open grassland fields, and ruderal vegetation. Project site locations can be seen in Figure 2 (pg.6); Location of elderberry shrubs on project sites can be seen in Figures 3 (pg.14), 4 (pg.14) and 5 (pg.15).

Yolo County Conservation Target Locations:	The total project area is approximately 12.25 acres. Habitat consists of blue elderberry shrubs in previously disturbed riparian habitat. Project will result in removal of 12 elderberry shrubs, with 157 stems greater than 1-inch diamter at ground level. Mitigation includes transplanting 10 of the 12 elderberry shrubs, and planting 243 elderberry seedlings and 243 native riparian plant shrubs on 2.01 acres of the 158-acre Russell Ranch conservation area (Fig.6, pg. 23).
LCP/RCIS Natural Communities Covered:	Riparian natural community
Implementation Timeline:	Permit duration is 10 years or until 2012.
Governance:	UC Davis is solely responsible for implementing the HCP with oversight from the Service. The ESA and its implementing regulations prohibit the take of any fish or wildlife species that is federally listed as threatened or endangered without prior approval pursuant to either Section 7 or Section 10(a)(1)(B) of the Act. Preparation of a conservation plan, generally referred to as an HCP, is required for all Section 10(a) permit applications. The Service and the National Marine Fisheries Service (NMFS) have joint authority under the Endangered Species Act for administering the incidental take program. NMFS has jurisdiction over anadromous fish species and the Service has jurisdiction over all other fish and wildlife species.

Costs and Funding:	UC Davis owns the VELB mitigation site, known as Russell Ranch. Its land use designation is open space/research, and it has been identified as a mitigation site in the UC Davis LRDP EIR. A deed restriction (Appendix 5) was placed on the site in March 2002 to ensure it will continue to be used as a mitigation site. This deed restriction cannot be altered without the written permission of the Service. The Regents have sufficient financial assets to implement the terms of this HCP, will be responsible for funding the HCP, and understand that failure to provide adequate funding and a consequent failure to implement the terms of this HCP in full could result in temporary permit suspension or permit revocation. UC Davis provided funding for mitigation activities described in the HCP from funding for individual capitol projects. If these funds are not adequate, UC Davis committed to provide additional funding from the Russell Ranch Management Funds from the Office of Administration (approximately $300,000 currently available) and/or from planning and mitigation funds in the Office of Resource Management and Planning (approximately $300,000 per year). These two sources of funds are part of the UC Davis operating budget. Consistent with the terms of this HCP, these funds will be used to cover the costs of relocating the shrubs, planting the replacement plantings, maintaining the mitigation site, and fulfilling monitoring requirements. UC Davis will ensure that funding will be available to meet the 60 percent success criteria for elderberry and native plant success. UC Davis will ensure that funds are available to cover all changed circumstances above the estimated costs displayed for each changed circumstance. Estimated mitigation costs included the following: • Relocating/Removing 12 shrubs: $40,000 • Site Preparation and Layout: $10,000 • Planting elderberry and native seedlings: $40,000 • Irrigation System: $40,000 • Maintenance (per year): $10,000 • Monitoring and Reporting (per year): $5,000



Source: UC Davis Planning and Budget Office 1989.

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Jones & Stokes

Figure 1
University of California, Davis

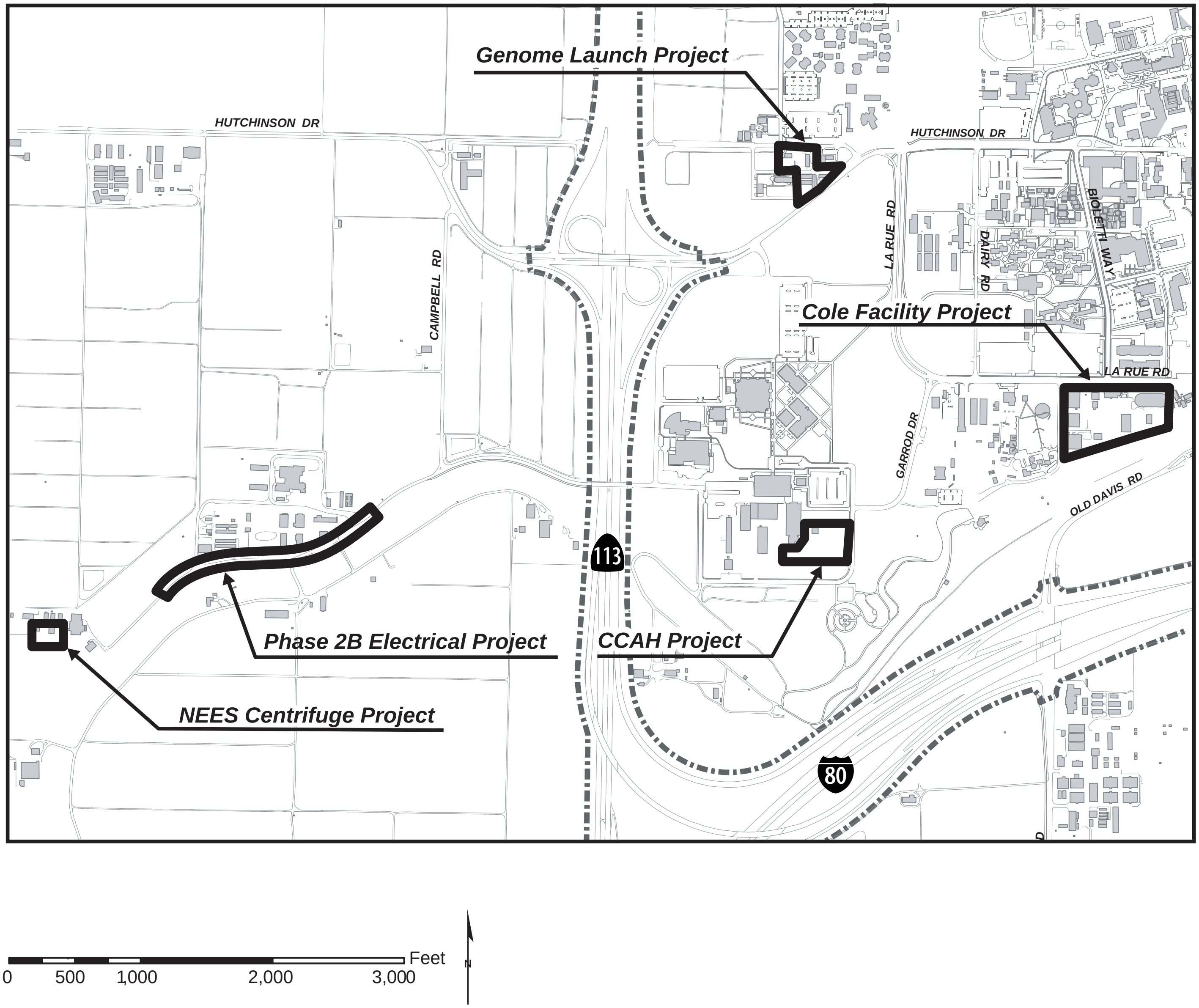

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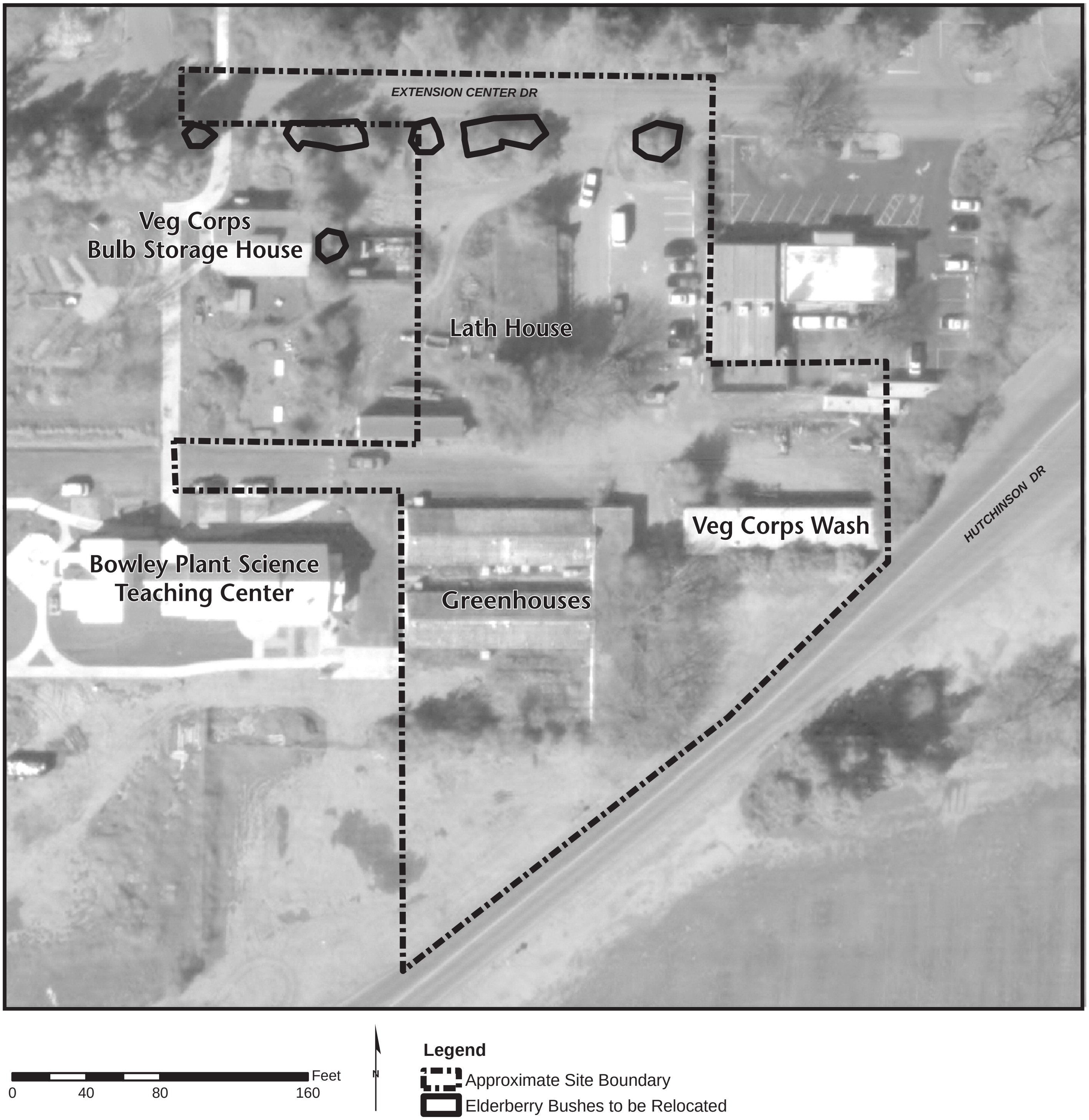
Figure 2
Location of the Project Sites on the UC Davis Campus



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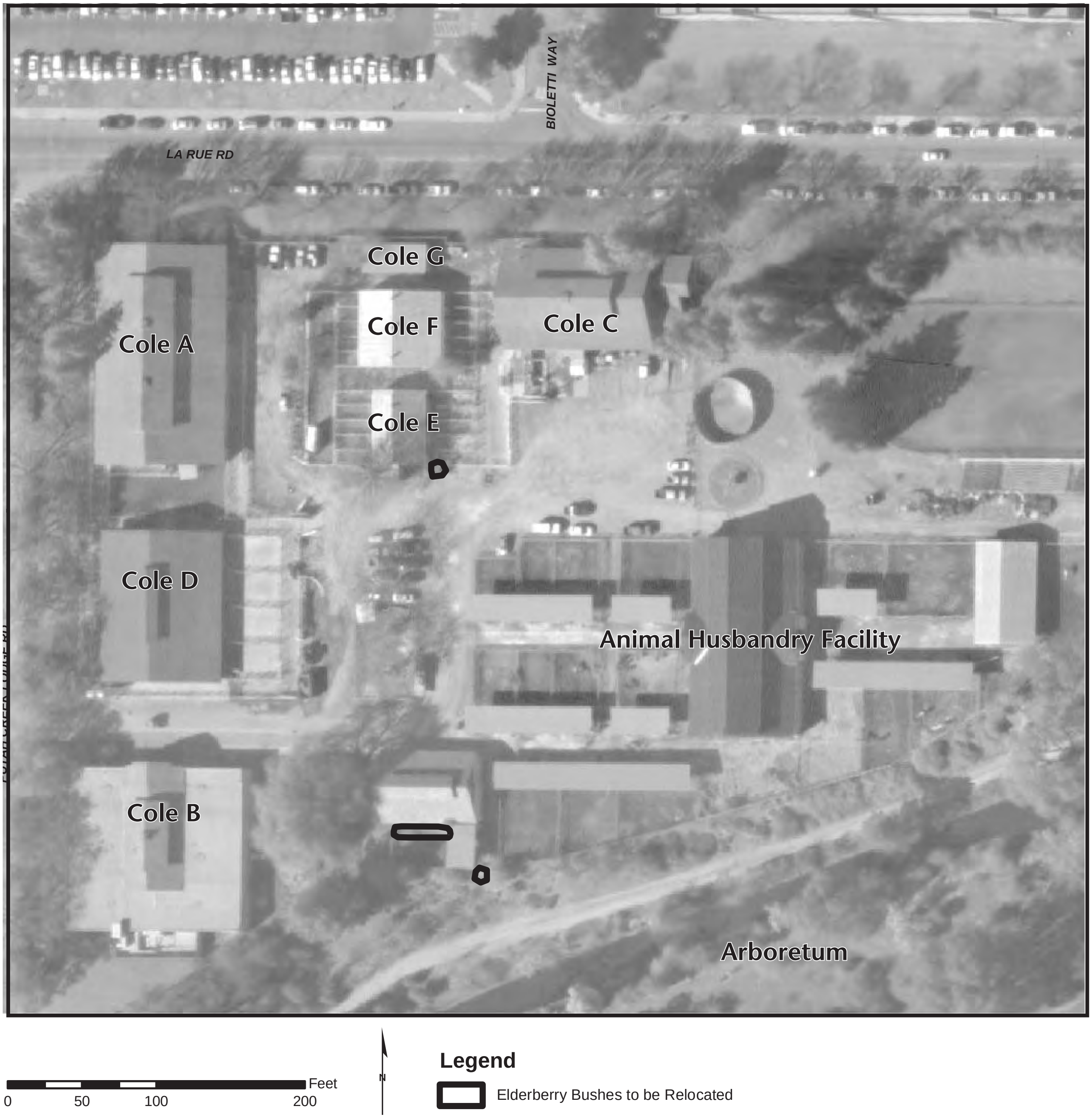
Jones & Stokes

Figure 3
Location of Elderberry Shrubs on the Genome Launch Facility Project Site



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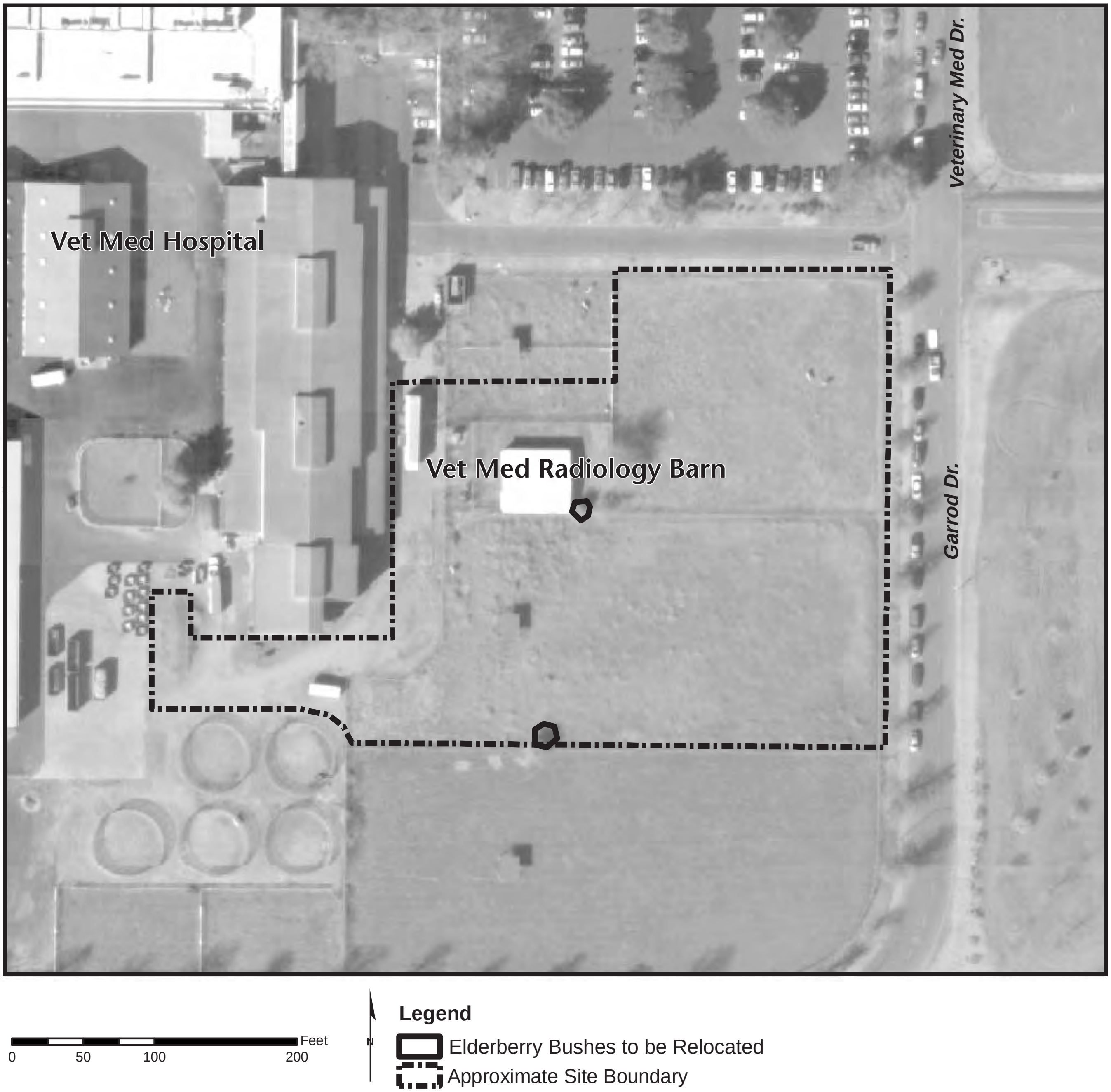
Jones & Stokes

Figure 4
Location of Elderberry Shrubs on the Cole Facility Project Site



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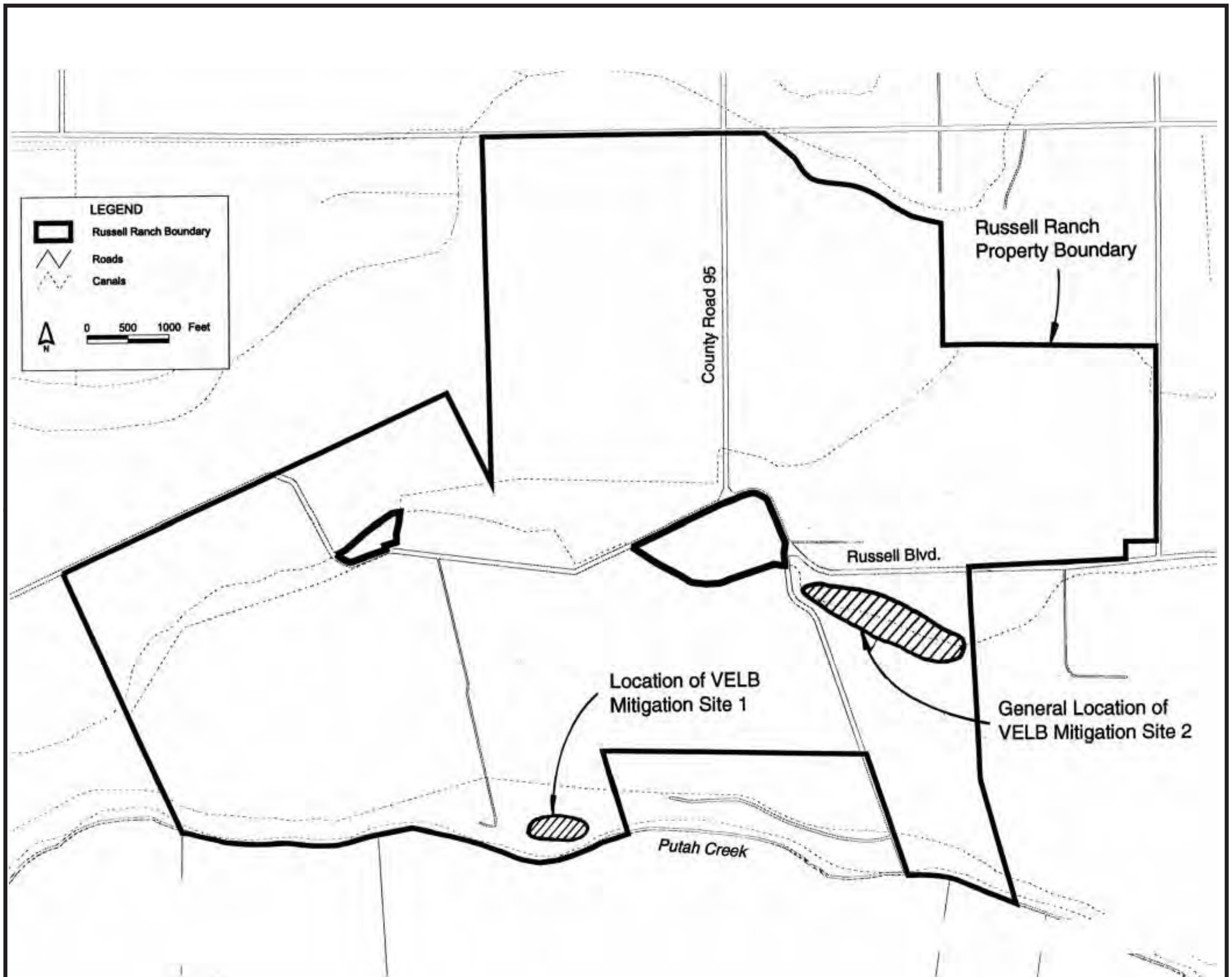
Jones & Stokes

Figure 5
Location of Elderberry Shrubs on the Center for Companion Animal Health Facility Project Site



Source: UC Davis Planning and Budget Office 1989.

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Jones & Stokes

Figure 6
Location of Russell Ranch Mitigation Sites

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

<table>
<tr><td>Title:</td><td colspan="2">Cache Creek Resources Management Plan (CCRMP) / Cache Creek Improvement Program (CCIP)</td><td>Binder:</td><td>6</td></tr>
<tr><td>Lead Agency:
Completed By:</td><td colspan="4">Yolo County
Yolo County</td></tr>
<tr><td>Goals & Purpose:</td><td colspan="4">In June of 1994, the Board of Supervisors adopted a framework of goals and objectives for the CCRMP. The document adopted a comprehensive outlook that was reflected in overall goals, which were based on the assumption that “the Creek must be viewed as a total system, as opposed to a singular focus on the issue of mining”… [this covers] agriculture (pg.88), aggregate resources (pg. 76), riparian and wildlife resources (pg. 55), floodway and channel stability (pg. 32), open space and recreation (pg. 71), and the cultural landscape (pg. 43?). Specific goals and objectives were adopted for each of the elements, with suggested policies for implementation – see the page numbers associated with each element above.

Yolo County Community Development Agency (now the Yolo County Planning, Public Works and Environmental Services Department, developed the Cache Creek Improvement Program (CCIP) to implement the goals, objectives, actions, and performance standards of the Cache Creek Resource Management Plan (CCRMP) as it relates to the stabilization and maintenance of the Cache Creek channel. The Board of Supervisors adopted the CCIP as a component part of the CCRMP. The CCIP provides the structure and authority for a Technical Advisory Committee (TAC), defines the procedures and methodologies for stream monitoring and maintenance activities, and defines an ongoing process for identifying desirable in-channel projects including erosion control, flood conveyance, open space/passive recreation, and habitat restoration.</td></tr>
<tr><td>Status:</td><td colspan="4">Draft CCRMP and CCIP are anticipated for completion in May 2017.</td></tr>
<tr><td rowspan="2">RCIS/LCP Species Covered:</td><td>Group 1</td><td>Group 2</td><td colspan="2">Group 3</td></tr>
<tr><td>N/A</td><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td>Plan/Program Boundaries:</td><td colspan="4">Cache Creek Channel – Along Cache Creek from the Capay Dam to just upstream of the I-5 bridge at Yolo, CA (CCIP Fig. 1, pg. 49)</td></tr>
<tr><td>Conservation Target Locations:</td><td colspan="4">N/A</td></tr>
<tr><td>RCIS/LCP Natural Communities Covered:</td><td colspan="4">None</td></tr>
<tr><td>Implementation Timeline:</td><td colspan="4">The CCRMP should be updated every ten years, at minimum; Yolo County finalized the CCIP August 1996.

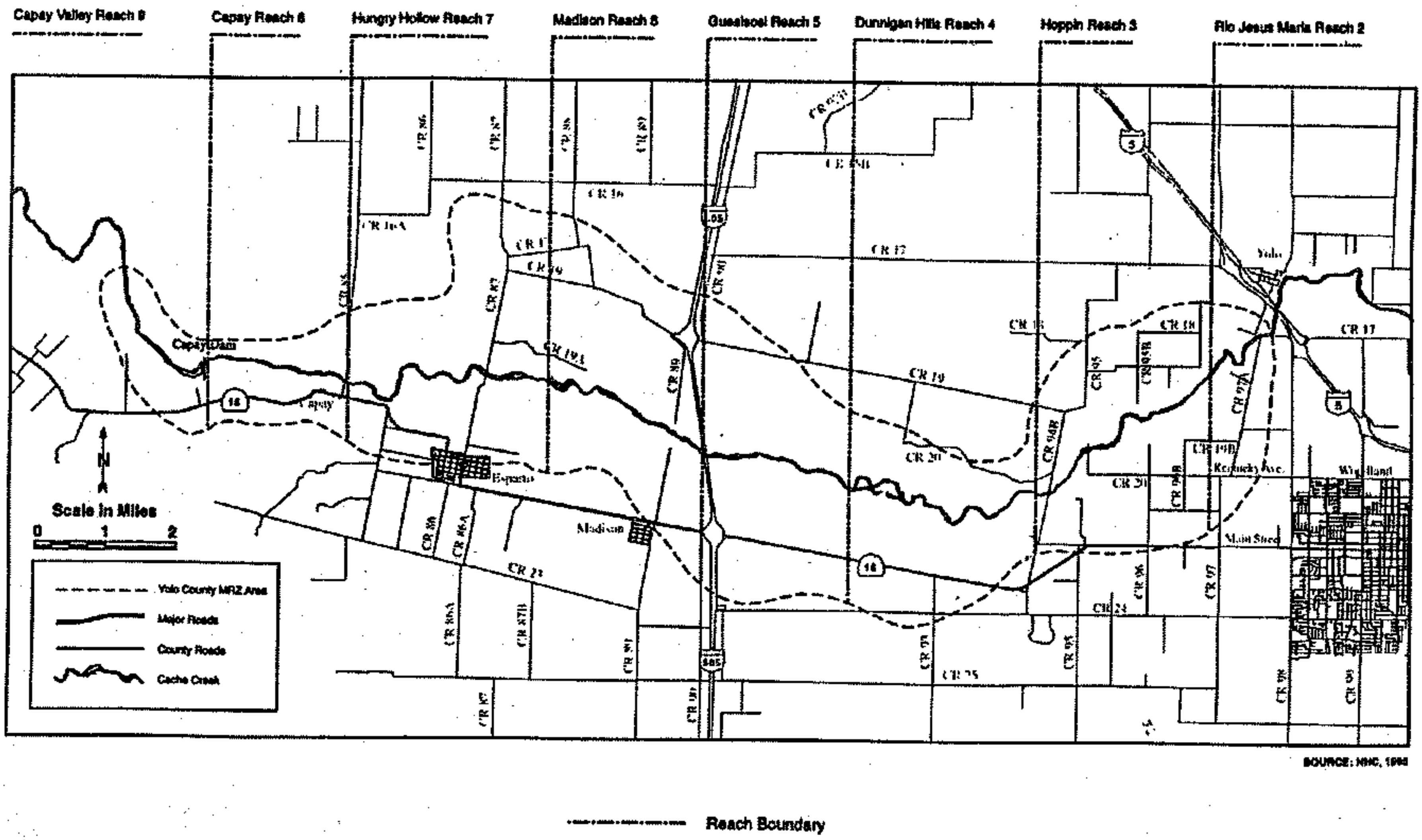
Draft CCRMP and CCIP are anticipated for completion in May 2017.</td></tr>
<tr><td>Governance:</td><td colspan="4">Yolo County manages modifications and maintenance of the Cache Creek channel, with input from the TAC, consistent with the review and guidance procedures described in the CCIP. The improvements and maintenance projects recommended as a result of the CCIP process could require excavation and filling of areas under the jurisdiction of the following local, State, and Federal authorities:

• Yolo County Community Development Agency, now the Yolo County Planning, Public Works and Environmental Services Department
• U.S. Army Corps of Engineers (COE)</td></tr>
</table>

	• California Department of Fish and Wildlife (CDFW) • Central Valley Regional Water Quality Control Board (CVRWQCB) *See pages 1-2 for additional information* *See 'Funding' section below for additional information*
Funding:	The implementation of the CCIP is partially funded through fees generated by a surcharge on the weight of aggregate resources sold within the County. A $0.10 surcharge is charged for each ton of processed aggregate to fund the CCIP. In addition, the County and partners (eg Cache Creek Conservancy) pursues other potential sources of funding, including state and federal grants.

CACHE CREEK GEOMORPHIC SUBREACHES

Figure 1



Appendix F
Conservation Strategy Rationale

Appendix F
Conservation Strategy Rationale

This document provides the rationale for the RCIS/LCP conservation strategy, focusing on information supporting the conservation objectives. For the focal species, this document also describes how landscape- and natural community-level objectives contribute to the conservation of each species. After the goal and objective rationale for each focal species, a section is provided describing how the goals and objective address climate change for each focal species. See Chapter 5, *Literature Cited*, for all citations provided in this appendix.

F.1 Landscape-Level Strategy, Rationale

F.1.1 Goal L1: Large interconnected landscapes

F.1.1.1 Objective L1-1: Landscape Connectivity

Rationale. Generally, large, interconnected blocks of land are preferred for conservation. The connectivity may include smaller habitat corridors or "stepping stones", however, where broader connections are infeasible or constrained due to incompatible land uses. The RCIS Program Guidelines define *habitat connectivity* as "the capacity of areas of intact habitat to facilitate the movement of species and ecological processes." The RCIS/LCP seeks to conserve continuous and contiguous habitat areas that span elevations from the valley floor into the mountains, and provide adequate cover and feeding habitat for dispersing or migrating species.

Rivers and creeks in Yolo County provide important connections and are shown in Figure 3-3. The Sacramento River, Putah Creek, and Cache Creek are primary landscape connections at local, regional, and statewide scales. To provide major landscape connections, the Sacramento River (including Yolo Bypass and Tule Canal/Toe Drain), Putah Creek, and Cache Creek require habitat areas that are adequately wide and contiguous. Some of the elements in these connections will provide riparian functions related to the river/stream zones; other elements may be oak woodlands, chaparral, California prairie, or other upland natural community types that support local and regional wildlife movements. Secondary landscape connections include Enos Creek/Dry Creek, Dry Slough, Salt Creek/Chickahominy Slough, Cottonwood Creek, Willow Slough, Thompson Canyon/Salt Creek, Oat Creek, Bird Creek, and Buckeye Creek.

The California Essential Habitat Connectivity Project (Spencer et. al 2010) identifies, at a coarse spatial scale, several linkages between large blocks of intact habitat or natural landscapes that could provide wildlife movement corridors in Yolo County (Figure 3-3). These consist of the following Essential Connectivity Areas (ECA): the English Hills - Blue Ridge/Rocky Ridge ECA; Blue Ridge/ Rocky Ridge-Capay Hills ECA; Dunnigan Hills/Smith Creek-Dunnigan Hills ECA; Stone Lake-Yolo Bypass ECA; Yolo Bypass-Sacramento Bypass ECA; and the Little Holland Tract/Yolo Bypass-Yolo Bypass ECA.

Important connectivity within the Yolo Bypass-Sacramento Bypass ECA is related not only to connectivity of land cover types that support natural communities and focal and conservation species, but also aquatic connectivity. Tule Canal is a critical habitat corridor that provides the primary north-south aquatic linkage in the Yolo Bypass. The CVFPP Conservation Strategy emphasizes the need to maintain flows to provide connectivity for fish species, improve connectivity to the Tule Canal, and to eliminate barriers to fish passage (DWR 2016).

F.1.1.2 Objective L1-2: Areas to support sustainable populations

Rationale. Larger land areas provide for species, such as large mammals and raptors, with more extensive home range sizes (tens to hundreds of acres, depending on the species), and also tend to protect a diverse array of species habitats at varied elevations. Selecting larger land areas also provides more interior land area that protects conservation resources from potential detrimental effects of adjacent land uses, minimizing potential conflicts between conservation management activities and other uses on adjacent lands. Large units are often better buffered from adjacent land use disturbance (for example, developed uses) and can be managed more efficiently and effectively.

F.1.1.3 Objective L1-3: Environmental Gradients

Rationale: Achieving this objective will provide a range of habitat characteristics, food resources, and complexity for native species, including focal and conservation species. A variety of environmental gradients may allow shifting species distributions in response to potential future environmental changes, such as climate change, and can facilitate species' responses to transformative events such as high-severity fire or extreme environmental fluctuations such as flood or drought.

Protecting a variety of environmental gradients in the reserve system is an important strategy to adapt to the expected effects of climate change (Theobald et al. 2015; Nunez et al. 2013; Beier 2012; Spencer et al. 2006). Changes in temperature range and precipitation patterns resulting from climate change may cause some areas of currently suitable habitat to become unsuitable for some species, while other areas of currently unsuitable habitat may become suitable. Climate change is expected to affect many habitats and species such that temporal dynamics and spatial distributions change in unpredictable ways. Faced with large, uncertain, and dynamic responses, it is important that a broad range of habitat characteristics is available (i.e., elevation, water depth, slope, aspect) within an interconnected reserve system (Nunez et al. 2013; Brost and Beier 2012). This is intended to ensure that, while some current habitat may be lost or altered as a result of climate change, sufficient suitable habitat will be available in response to climate change to sustain focal and other native species; in addition, a broad range of habitat elements (facets) within landscape linkages is associated with increased functional connectivity for a variety of species (Crooks and Sanjayan 2007).

F.1.1.4 Objective L1-4: Natural Community Restoration

Rationale. Many natural communities in Yolo County are severely diminished in extent as a result of human-caused conversion to development or agricultural crops. The RCIS/LCP seeks to restore natural communities to their historic conditions, where feasible, while taking into account that the species composition and processes within natural communities and their distributions in the landscape may be shifting with climate change. The intent of the RCIS/LCP conservation strategy is to restore natural communities in locations where restoration is most likely to be successful, given the soils, hydrology, other physical factors, and likely future conditions.

F.1.1.5 Objective L1-5: Ecotone Conservation

Rationale. Ecotones are areas of transition between ecological communities, ecosystems, or ecological regions (Kark 2013). Ecotones often occur along ecological gradients created as a result of spatial shifts in elevation, climate, soil, and other environmental factors. Some areas in Yolo County that are best defined as ecotones do not fall neatly into any of the RCIS/LCP natural community categories, but their conservation may be very important. Studies have shown that species richness and abundances tend to peak in ecotonal areas, although exceptions to these patterns do occur. Ecotones are often small in size and relatively rich in biodiversity; therefore, conservation efforts in these areas may prove to be an efficient and cost-effective conservation strategy (Kark 2013).

F.1.2 Goal L2: Ecological Processes and Conditions

F.1.2.1 L2-1: Hydrologic and Geomorphic Processes

Rationale. Important geomorphic processes in riparian areas include lateral channel migration, channel cutoff and formation of multiple channels, bed mobility, and fine and coarse sediment transport. These processes influence floodplain dynamics such as channel, bank, and floodplain formation (CVFPP 2016). Sediment scouring, erosion and deposition, and prolonged inundation disturb existing vegetation. These disturbances create opportunities for cottonwoods, willows, and other early successional riparian species to establish from seed, thus promoting establishment of riparian vegetation, addressed in Section 1.1.1.6, *Riparian* (DWR 2016). All these processes influence habitat conditions for fish and other aquatic and riparian species, as described in Section 3.3.2, *Focal Species.*

As described in the CVFPP Conservation Strategy, natural, eroding banks often have cavities, depressions, and vertical faces that support bank-dwelling species such as bank swallow, northern rough-winged swallow, belted kingfisher, mink, and river otter, and that provide cover and shelter for fish. Bank-dwelling species may use these banks and their cavities to access the water or for nesting. Erosion of natural bank substrates provides instream spawning substrate for aquatic species, including salmonids. Natural fluvial processes also result in diverse substrate sizes and irregular banks that provide habitat complexity for fish and wildlife, and can support a high diversity and abundance of invertebrate and fish species.

The CVFPP Conservation Strategy also describes how a diversity of flows, suitable sources of sediment, and a sufficiently broad river corridor to allow stream meandering are necessary to sustain riverine habitats and the wildlife species that depend on them. The targeted CVFPP ecosystem processes for this objective are floodplain inundation and riverine geomorphic processes (DWR 2016).

Floodplain inundation occurs when river flows exceed channel capacity and water overflows onto adjacent land. The ecosystem responses to floodplain inundation depend on flow timing, frequency, magnitude, and duration. Floodplain inundation helps create side channels, sloughs, and oxbow lakes through erosion and deposition of fluvial sediments. Sustained overbank flows also generate food for downstream aquatic wildlife. Floodplain inundation for 1–2 weeks or longer allows for the growth of microorganisms and the animals that feed on them (Opperman 2012, in DWR 2016), including anadromous fish and other native aquatic species.

F.1.2.2 Objective L2-2: Fire

Rationale. The ability to maintain, reestablish, or mimic natural disturbance is important to maintaining biological diversity and habitat conditions for specific species. Fire, in particular, is a source of natural disturbance in the Hill and Ridge Landscape Unit. Disagreement over the natural role and frequency of fire is the main impediment to the application of prescribed fire regimes. The use of prescribed fire for ecosystem management also is constrained by the presence of human assets, such as adjacent development, low-density homesteads, and agricultural development, which increase risk of loss and the cost of protection during prescribed fire. The relevance of herbivory as a disturbance factor has changed since precolonial conditions. Increased intensity and duration of grazing by domestic livestock contributed to a higher proportion of grazing-adapted nonnative species in grassland communities. When properly managed, grazing can be a useful tool to control undesirable nonnative species (See RCIS/LCP Objective CP1.3, *Grazing regimes*).

F.1.3 Goal L3: Landscape-level Stressors

F.1.3.1 Objective L3-1: Invasive Species

Rationale. Achieving this objective will minimize the spread of invasive species and thereby promote species diversity and contribute to natural community resilience and resistance to disturbances.

F.1.3.2 Objective L3-2: Pollutants and Toxins

Rationale. As stormwater runoff flows through watersheds in Yolo County, it accumulates sediment, oil and grease, metals (e.g., copper and lead), pesticides, and other toxic chemicals. Unlike sewage, stormwater is often not treated before discharging to surface water. Despite stormwater regulations limiting discharge volumes and pollutant loads, many pollutants still enter Strategy Area waterways in stormwater. Of particular concern for focal species is the overuse of pesticides, some of which can have deleterious effects on the aquatic food chain (Weston et al. 2005; Teh et al. 2005). For example, pyrethroid chemicals are used as pesticides on suburban lawns. Even at very low concentrations, these chemicals can have lethal effects on low trophic levels of the food chain (plankton), and mainly sublethal effects on the focal fish species (Weston and Lydy 2010). Pesticide use is also thought to be responsible for the decline of tricolored blackbird populations in California (Meese 2013). Other urban pollutants that can be transported to the waterways directly or indirectly by stormwater runoff include nutrients from failing septic systems and viruses and bacteria from agricultural runoff.

Mercury present in watersheds in Yolo County has been deposited by tributaries and rivers that drain former mining areas in the mountains. While mercury in its elemental form does not pose a risk to aquatic organisms, exposing soils to periodic wetting and drying results in a process called methylation, which converts mercury to a more toxic form, methylmercury. Restoration actions may increase the acreage of intermittently wetted areas in Yolo County (particularly in Yolo Bypass) by converting cultivated lands and other upland areas to open water and floodplain habitats, potentially increasing methylmercury production. Some of this increased production is likely to be taken up by organisms and to bioaccumulate through the food web. However, some of it will also be sequestered within the restored natural communities.

F.1.3.3 Objective L3-3: Hazardous Human Land Uses

Rationale. Human land uses can have many adverse effects on natural communities and focal and conservation species. These may include, but are not limited to, noise, lighting effects, visual disturbance, harassment by humans or pets, pollution from run-off, impediments to wildlife movement, and mortality due to vehicle strikes or predation by domestic pets.

F.1.4 Goal L4: Biodiversity, Ecosystem Function and Resilience

Maintain and improve biodiversity, ecosystem function, and resilience across landscapes, including agricultural and grazed lands. Maintain landscape elements and processes that are resilient to climate change which will continue to support a full range of biological diversity in Yolo County.

Rationale. The RCIS/LCP bases this goal on the principles for maintaining biodiversity, ecosystem function, and resilience in landscapes that include agricultural use (Fischer et al. 2006; Wiens et al. 2011; Lawler et al. 2014; Theobald et al. 2015). Agricultural landscapes should include patches of native vegetation with corridors and stepping stones distributed throughout a structurally complex landscape matrix, and provide buffers around sensitive areas.

The RCIS/LCP envisions a program of adaptive management, based on best available science in combination with research, to monitor developing conditions in the strategy. The RCIS/LCP focuses predominantly on effects of climate-driven changes on focal species as an indication of effects on other species in Yolo County; on changes in habitat areas and habitat values within Yolo County; and on elements and processes occurring at a landscape level, which determine the countywide and regional applicability and utility of the RCIS/LCP conservation program.

F.1.4.1 Objective L4-1: Heterogeneity within Agricultural Matrix

Rationale. While the Hill and Ridge Landscape Unit consists mostly of natural lands, the Valley Landscape Unit has mostly been converted to agricultural uses. To prevent local extinctions and promote biodiversity and ecological resilience in a fragmented landscape such as this unit, it is important to maintain a landscape that includes natural lands within the agricultural matrix, which allows wildlife movements between patches of natural lands, both within and outside protected lands (Rouget et al. 2006; Vandermeer and Perfecto 2007; Green et al. 2005; Fischer et al. 2008; Lawler et al. 2015). Natural habitat areas within agricultural landscapes have been shown to be associated with enhanced pollination services for agriculture in Yolo County (Kremen et al. 2007; Morandin and Kremen 2013). This objective differs from the objectives under RCIS Goal AG1, *Cultivated land habitat conservation,* in that it focuses on nonagricultural lands within a larger agricultural matrix.

F.1.4.2 Objective L.4-2: Resilience to Climate Change

Rationale. Climate change is predicted to alter characteristics of California landscapes, changing large-scale patterns in fire, rainfall, and other factors (Cayan et al. 2006; Ackerly et al. 2915;

Thorne et al. 2015). This is expected to change landscape connectivity and permeability for wildlife movements and ecological processes (Thorne et al. 2016). Climate change is predicted to alter characteristics of natural communities and species habitat in Yolo County (Stralberg et al. 2009; Wiens et al. 2009; Sork et al. 2010; Barbour and Kueppers 2012; McLaughlin and Zavaleta 2012; Ackerly et al. 2015; Thorne et al. 2016). An adaptive strategy for providing landscape, natural community, and species-level conservation benefits is needed in order to provide landscape resilience (Wiens et al. 2011; Lawler et al. 2015; Theobald et al. 2015). The RCIS/LCP establishes a framework for conservation throughout Yolo County based on existing conditions and climate.

F.1.4.3 RCIS/LCP Objective L4.3: Population viability and biodiversity resilience with climate change

Rationale. Climate change is predicted to adversely affect populations of focal and conservation species in Yolo County (Gardali et al. 2012; Langham et al. 2015; Shuford and Dybala 2017). An adaptive strategy may be needed for maintaining viability in these populations and the resilience of native biodiversity in Yolo County.

F.2 Natural Community-Level Strategy, Rationale

F.2.1 Goal CL1: Cultivated land habitat conservation

F.2.1.1 Objective CL1.1: Mixed agricultural uses with habitat values

Rationale. Cultivated lands in Yolo County consist of a dynamic matrix of different land cover types, including perennial, semiperennial, and seasonally or annually rotated crops. The large extent of rotated crops results in a cover type matrix that is subject to change based primarily on agricultural economic conditions.

Although the conversion of natural vegetation to cultivated lands has eliminated large areas of native habitats, some agricultural systems continue to support wildlife with compatible habitat needs, and can still meet important breeding, foraging, and roosting habitat needs for some resident and migrant wildlife species. Upland and seasonally flooded cultivated lands and wetlands in Yolo County, for example, support waterfowl populations that annually winter in California (CALFED 1998; Central Valley Joint Venture 2006; Shuford and Dybala 2017). Covered species that use cultivated lands include Swainson's hawk, giant garter snake, and sandhill crane. These species have come to rely on the habitat value of certain cultivated lands, farming practices, and crop types. Swainson's hawks in the Central Valley and Delta rely on cultivated lands for foraging, given the lack of grassland foraging habitat remaining in California (Hartman and Kyle 2010). Cultivated lands, however, support a less diverse and less dense community of wildlife compared with natural communities (Fleskes et al. 2005; EDAW 2007; U.S. Fish and Wildlife Service 2007; Kleinschmidt Associates 2008).

The dynamic cropping patterns in Yolo County result may result in changes in habitat values at the site level for cultivated land-associated covered species. These dynamic cropping patterns can be compatible with wildlife use as long as the overall acreage of crops and types of agricultural practices that provide high-value habitat for covered species remain relatively constant at the regional scale. Major regional shifts in crop types or agricultural practices may diminish wildlife habitat values at a regional level. Changes in crop production can have substantial effects on the habitat value of cultivated lands for wildlife, particularly birds. Hay, grain, row crops, and irrigated pastures support abundant rodent populations, providing a prey base for many wildlife species. Conversion of these cultivated lands to orchards and vineyards has been noted as a factor adversely affecting native wildlife, including raptors such as Swainson's hawk (Estep Environmental Consulting 2008). Orchards and vineyards develop a dense overstory canopy that generally precludes access to ground-dwelling prey by foraging Swainson's hawks, white-tailed kites, western burrowing owls, and other covered species associated with cultivated lands.

F.2.1.2 Objective CL1.2: Incorporation of habitat features

Rationale. Natural habitat elements add resilience to the agricultural landscape by enhancing the ability of the landscape matrix to provide habitat values and functions within the lands not specifically not protected by conservation easements. The RCIS/LCP defines a "landscape matrix" as the dominant land cover type in any defined (or bounded) land area (Forman 1995). With elements of these habitat functions provided by the matrix, the integrity of the reserve system elements is augmented by a matrix that is permeable to mobile species, and the matrix can also provide additional habitat values.

Achieving this objective involves incorporating habitat enhancements such as hedgerows along field edges, broadened areas of natural vegetation (for example, widened riparian vegetation areas along rivers, creeks, and irrigation canals and drainages), and other natural habitat elements into areas where connections have been weakened. The LCP may achieve this through landowner incentives provided through grant programs or mitigation funds.

F.2.1.3 Objective CL1.3: Cultivated land pollinators

Rationale. Although honey bees provide most of the crop pollination in the U.S., the number of managed honey bee hives has declined by over 60 percent in the U.S. since 1950 due to colony collapse disorder and other factors. Research on crop pollination in Yolo County (e.g., Kremen et al. 2002; Morandin and Kremen 2013) has demonstrated that native bees also make a significant contribution to crop pollination—in some cases providing all required pollination when sufficient habitat is available. Native pollinators that support habitat are increasingly important as honey bee hives become more expensive and difficult to acquire. Research demonstrates that native bees contribute substantially to the pollination of many crops, including watermelon, canola, sunflower, tomatoes, and blueberry (Appendix E, *Pollinator Conservation Strategy*).

F.2.2 Goal CP1: Large contiguous patches of California prairie to support native species

F.2.2.1 Objective CP1.1: California prairie protection

Rationale. With implementation of the Yolo HCP/NCCP, 16 percent of the California prairie in Yolo County will be protected. Lands to be protected through the Yolo HCP/NCCP will focus on areas that support covered species, particularly California tiger salamander and western burrowing owl. The Yolo HCP/NCCP emphasizes grassland conservation in the Valley Landscape

Unit, but does not conserve grassland areas in the Hill and Ridge Landscape Unit or in the southern portion of planning unit 5, where California tiger salamander is absent, but there are large intact stretches of grassland supporting a diversity of native species.

F.2.2.2 Objective CP1.2: Restore and enhance California prairie.

Rationale. The California prairie natural community contains about 40 percent of California's native plant species (Wigand 2007). This natural community has, however, declined dramatically in California as a result of changes in grazing patterns, introduction of invasive plant species, and conversion to agriculture and urban development.

F.2.2.3 Objective CP1.3: Burrowing rodents

Rationale. Colonial (social) burrowing rodents are important ecosystem engineers in grassland ecosystems, important in maintaining the functional capacity and resilience of prairies (Davidson et al. 2012). Habitat functions provided by social burrowing rodents in California prairie communities include providing food, thermal and predator cover, and nesting/seasonal habitat for a variety of covered vertebrate and other native wildlife species (e.g., rodents, grasshopper sparrow, western meadowlark, horned lark, northern harrier, and insects, including native pollinator species).

F.2.2.4 Objective CP1.4: Grazing regimes.

Rationale. California prairies may have evolved with intense levels of grazing and browsing. In prehistoric times, they were grazed by large herbivores including mammoths, horses, camels, llamas, and bison that became extinct in the late Pleistocene. In the last 10,000 years, tule elk, black-tailed deer, and pronghorn antelope grazed California prairies in large numbers. With the decline in native grazers such as tule elk and pronghorn antelope, cattle and sheep now often fulfill the grazing role of native ungulates. Grazing can have positive, negative, or neutral effects on grassland plants and animals, depending on species and grazing management (Hatch, et al. 1999; Hayes and Holl 2003).

F.2.2.5 Objective CP1.5: California prairie pollinators

Rationale. Pollinators in California prairies have been reduced as a result of habitat loss and fragmentation; invasive exotic plants; pesticide use; grazing, mowing, and fire; and disease and parasites from nonnative commercially reared bees used in agricultural areas (Appendix D, *Pollinator Conservation Strategy*). Pollinators are essential to a healthy California prairie natural community.

F.2.3 Goal CH1: Chaparral conservation

Ecological relationships in chaparral communities in the northern Coast Ranges are poorly understood ecologically, particularly the role of fire and disturbances (Keeley 2002). Conservation actions for chaparral in this region will incorporate increased knowledge resulting from encouraged research about the roles of fire and climate change on chaparral communities.

F.2.3.1 Objective CH1.1: Protect chamise chaparral for connectivity.

Protect chamise chaparral as needed to achieve landscape connectivity.

Rationale. Chaparral communities provide habitat and migratory linkages for a diverse assemblage of wildlife species. California yerba santa, pitcher sage, and deerweed commonly occur within chamise chaparral, including the focal plant species Colusa layia and drymaria-like western flax. This natural community supports common wildlife species such as western scrub-jay, wrentit, California thrasher, and California towhee. Achieving this objective will contribute to providing a network of habitat patches that adequately represents the diversity of ecosystem functions across the landscape and contribute to achieving the landscape-level habitat corridor objectives. An estimated 49 percent of this natural community in Yolo County already occurs on protected lands, and although chamise chaparral has high wildlife value, the natural community does not provide key habitat for focal species. Accordingly, protection of this natural community is a priority primarily for landscape connectivity purposes.

F.2.3.2 Objective CH1.2: Protect Mixed Chaparral.

Rationale. Mixed chaparral supports several common wildlife species (e.g., western fence lizard, western skink, gopher snake, common kingsnake, black-tailed deer, coyote, gray fox, California and mountain quail, mourning dove, Anna's hummingbird, western scrub-jay, oak titmouse, Bewick's wren, California thrasher, wrentit, California towhee, rufous-crowned sparrow, sage sparrow, and lesser goldfinch). No wildlife species are known to be restricted to mixed chaparral (CDFW 2014). Focal species that occur in mixed chaparral are listed in Section 2.4.4.4, *Mixed Chaparral Natural Community*. The Yolo HCP/NCCP does not include protection commitments for mixed chaparral. An estimated 27 percent of this natural community in Yolo County is currently protected (Table 3-2). Protection of this natural community is not a high priority except when it supports focal species and for connectivity purposes.

F.2.3.3 Objective CH1.3: Manage Chaparral

Rationale. Promoting native plant and wildlife diversity in chaparral will maximize its resilience in the face of climate change and other stressors.

CH1.4: Chaparral pollinators

Rationale. Maintaining pollinator populations in the chaparral natural community will help optimize the health and resiliency of the natural community and the focal and conservation species it supports. In addition, when chaparral occurs in wildlands close to agricultural lands, chaparral is a source of pollination services for croplands within the agricultural areas (Morandin and Kremen 2013).

F.2.4 Goal WF1. Valley oak protection and restoration

The goals and objectives below focus primarily on oak woodland, oak dominated forest, savanna, and individual oak trees. Other forest natural communities in Yolo County are sufficiently widespread and/or sufficiently protected such that specific biological goals are not necessary, although these forest natural communities may be conserved as needed to meet the landscape level goals and objectives. Oak woodland and forest sometimes occur in association with drainages and therefore overlap with the riparian natural community. Section 3.4.2.6, *Riparian,* includes goals and objectives relevant to oaks in riparian areas. Also, oak savanna includes California prairie as a component; therefore Section 3.4.2.2, *California Prairie,* includes goals and objectives for the prairie component of oak savanna.

As described in the State Wildlife Action Plan, the primary conservation planning target for the **Northern California Interior Coast Ranges Ecoregion** (the USDA Ecoregion that includes western Yolo County) is "*California Foothill and Valley Forests and Woodlands*" (see SWAP section 5.1 and especially Table 5.1-1 on page 5.1-10). This SWAP conservation target identifies several CWHR habitat types that occur in the ecoregion; the majority of these CWHR habitat types are oak-dominated or co-dominated plant associations that are elements of this Woodland and Forests natural community (e.g., Blue Oak Woodland; Blue Oak–Foothill Pine; Montane Hardwood; and Valley Oak Woodland).

F.2.4.1 Objective WF1.1: Increase valley oaks

Rationale. Early maps and relict vegetation clearly indicate that woodlands dominated by valley oaks were once widespread in the county where abundant groundwater and porous soil were present; valley oak forest or woodland was formerly a more common habitat type in the county for many RCIS/LCP focal and conservation species. In addition, genetic evidence (e.g., Grivet et al. 2007, 2008; Gugger et al. 2013) suggests that valley oak forests in eastern Yolo County were part of a biogeographically and evolutionarily significant linkage between valley oak populations in the Coast Ranges and the Sierra Nevada foothills to the east. This indicates the importance of maintaining the viable valley oak populations throughout the lowlands in Yolo County, particularly with respect to climate change adaptation (Sork et al 2010; McLaughlin and Zavaleta 2012).

F.2.4.2 Objective WF1.2: Protect valley oaks

Rationale. The RCIS/LCP prioritizes protection of valley oaks because of their rarity in Yolo County compared with historic conditions, and their ecological importance (see above).

F.2.5 Goal WF2. Upland oak protection and restoration/enhancement

Upland oak habitats include combinations of oak species; in Yolo County woodlands and savannas dominated by blue oak provide habitat for many wildlife and plant species (see Chapter 2). The majority of these upland oaks are not a component of the riparian natural community; that is, they are not directly associated with rivers, creeks, or other aquatic areas, although oaks occurring in sites with adequate surface water or groundwater often achieve larger statures and higher stand densities than oaks elsewhere. Oak-dominated woodlands and savannas occupy much of the landscape in the Hill and Ridge Landscape Unit. These upland oak-dominated habitats are an element in a landscape mosaic that also includes prairies and chaparral/shrublands, in which elements dynamically merge or locally replace one another through time as a result of fire, drought, and other natural stressors,

The status of upland oak habitats in Yolo County is a conservation concern owing to projections in regional climate models (e.g., Kueppers et al. 2005; Barbour and Kueppers 2012; Hannah et al.

2012) that oak woodlands (particularly those dominated by blue oak, but also including upland valley oak-dominated woodlands and savannas) are unlikely to remain a dominant element in western Yolo County, or could largely disappear from the county, based on the projected future lack in the county of the ecological conditions to which these species are currently adapted.

F.2.5.1 Objective WF2.1: Protect Upland Oaks

Rationale. Upland oaks occur in larger, intact tracts of land in the Hill and Ridge Landscape Unit than in the Valley Landscape Unit. These oaks in association with natural lands and on lands that provide habitat connectivity have more ecological value than those in developed areas.

F.2.5.2 Objective WF2.2: Restore Upland Oaks

Rationale. This objective is consistent with the RCIS/LCP goal of providing large, interconnected habitat areas.

F.2.6 Goal WF3. Riparian Oak Protection and Restoration

Oaks in riparian areas are likely to be the most resilient to climate change. For additional goals and objectives related to riparian areas, see Section 3.4.2.6, *Riparian,* below.

F.2.6.1 Objective WF3.1: Protect Riparian Oaks and Oak Woodlands

Rationale. In the Hill and Ridge Landscape Unit, many of the riparian areas are dominated by oaks, particularly valley oak, interior live oak, and some oracle oak. These oaks support a diversity of riparian wildlife species, contribute to structural diversity and cover along habitat corridors, and provide shade and structure to adjacent aquatic areas.

F.2.6.2 Objective WF3.2: Restore and Enhance Riparian Oaks and Oak Woodlands.

Rationale. Oak woodland and forest in riparian areas have diminished in extent since historical times as a result of land conversion, overgrazing, and other factors. These oaks support a diversity of riparian wildlife species, contribute to structural diversity and cover along habitat corridors, and provide shade and structure to adjacent aquatic areas

F.2.7 Goal WF4. Oak woodland management

Manage oak woodland and forest natural communities outside of riparian areas to enhance habitat quality supporting native biodiversity, and to provide enhanced ecosystem functions and services.

F.2.7.1 Objective WF4.1. Manage and Enhance Oak Woodlands

Rationale. Oak woodlands are vulnerable to loss of native biodiversity due to competition from invasive species; lack of regeneration caused by factors such as overgrazing and disturbance of the soil profile; and changing climatic conditions such as increased temperature, reduced water availability, and increased frequency and/or severity of fire and other stressors (Barbour and Kueppers 2012; McLaughlin et al. 2014; Davis et al. 2016). Climate change may be associated with the development of new associations of plant and wildlife species ("novel ecosystems"), with consequent ecological effects on native species (Langham et al. 2015).

F.2.7.2 Objective WF4.2. Oak Woodland Pollinators

Rationale. Maintaining pollinator populations in the oak woodland natural community will help optimize the health and resiliency of the natural community and the focal and conservation species it supports. Where oak woodlands occur near agricultural areas, protecting pollinator habitat provides beneficial ecosystem services to the agricultural land uses.

F.2.7.3 Objective WF4.3: Burrowing rodents

Rationale. Many of the animal species that inhabit the oak woodlands are either fossorial (i.e., adapted to digging and life underground) or burrow-dependent, attributes that require access to constant underground habitats, presumably for temperature regulation and for protection from fire and predators. California ground squirrels and pocket gophers excavate burrows that provide substantial benefits to covered species, such as California tiger salamander (upland aestivation sites). However, ground squirrels and pocket gophers have been the target of widespread poisoning campaigns in California, where they threaten levees or are perceived as pests. By increasing the abundance and distribution of host burrows, many native species will benefit.

F.2.7.4 Objective WF4.4: Grazing regimes

Rationale. The grassland understories that occur with oak woodland have many of the same species as California prairie, as described in Section 3.4.2.2, and may similarly respond to grazing. An inappropriate grazing regime, however, can result in loss of oak seedlings and lack of oak regeneration.

F.2.8 Goal FW1: Fresh Emergent Wetland Conservation

As described in the State Wildlife Action Plan, the eastern two-thirds of Yolo County is identified in the USDA classification as Great Valley Ecoregion, The SWAP identifies "Freshwater Marsh" as one of the two primary priority conservation targets for this ecoregion (SWAP Table 5.4-1, p. 5.4-12). The single corresponding priority CWHR habitat element identified in the SWAP is "Fresh Emergent Wetland."

F.2.8.1 Objective FW1.1: Protect fresh emergent wetlands.

Rationale. With implementation of the Yolo HCP/NCCP, 59 percent of the fresh emergent wetlands in Yolo County will be protected. This is a relatively high percentage of protection for a natural community; therefore, the RCIS/LCP only prioritizes protection of fresh emergent wetlands where they support focal or conservation species and would not otherwise be protected under the Yolo HCP/NCCP.

F.2.8.2 Objective FW1.2: Increase fresh emergent wetland areas

Rationale. The Central Valley, including the Yolo County, historically supported vast areas of fresh emergent wetlands that were subsequently lost, largely as a result of conversion of wetland areas to uplands to support agriculture and residential development. Increasing the acreage of fresh emergent wetlands will benefit giant garter snake, western pond turtle, California black rail, tricolored blackbird, and a diversity of native species that use this natural community.

Marsh restoration will generally consist of intensive actions involving grading (e.g., creating depressions, berms, and drainage features) to create topography that supports marsh plants, provides habitat elements for focal and conservation species, and allows fish to exit as floodwaters recede. Marsh restoration also involves planting vegetation and constructing water management facilities. Within the Lower Sacramento River and Upper Sacramento River CPAS, fresh emergent wetland restoration will generally occur in the bypass system and will be implemented in conjunction with bypass expansion and construction. (from CVFPP Conservation Strategy [DWR 2016])

F.2.9 Goal R1: Riparian conservation

As described in the State Wildlife Action Plan, the eastern two-thirds of Yolo County is identified in the USDA ecoregion classification as the Great Valley Ecoregion, The SWAP identifies “American Southwest Riparian Forest and Woodland” as one of the two primary priority conservation targets for this ecoregion (SWAP Table 5.4-1, p. 5.4-12). The single corresponding priority CWHR habitat element/natural community identified in the SWAP is “Valley Foothill Riparian.” As noted in Chapter 2, riparian areas in Yolo County vary considerably in structure and species composition. The RCIS/LCP incorporates most riparian areas into this single natural community type, although “Valley Oak Riparian” habitat is also included as an element in the Oak Woodlands natural community.

Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota (National Research Council 2002). They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams and lakes, and estuarine-marine shorelines, and often occur within a mosaic of patches of wetlands, California prairie, open water, barren soil, sand, gravel, cobble, or rock outcrop areas.

Riparian habitats associated with streams and other waterways throughout Yolo County are among the most significant natural communities in the region, and are an essential element in interconnecting the conserved landscape consistent with the landscape objectives of the LCP. Achieving this goal will contribute to maintaining the diversity of ecosystem functions across the Yolo County landscape, as well as providing functional landscape connectivity. In addition, riparian habitat is an important element in maintaining fluvial processes in watersheds throughout Yolo County.

Functional riparian habitat values are directly related to the structure and continuity of the habitat (Hilty and Merenlender 2004; Hilty et al 2006; Merritt and Bateman 2012). The functional utility of riparian habitat associated with a watercourse is directly related to: (1) the height and structural complexity of the riparian vegetation, (2) the extent of the riparian vegetation corridor extending laterally out from the watercourse, and (3) the continuity of the riparian vegetation corridor along the length of the watercourse. The utility of a riparian habitat corridor in linking landscape elements in a conservation framework is directly proportional to the functional value of the habitat. Thus the conservation value provided by riparian habitat in Yolo County is increased when the structural complexity and continuity of the habitat is increased.

Climate-change effects on Central Valley landscapes have been projected to further fragment residual natural habitat values for native species, including those in Yolo County. Riparian habitat areas, which are associated with watercourses throughout the landscape, can provide a functional linkage network within these landscapes, Riparian habitat associated with watercourses is naturally resilient to climate change impacts owing to readily available water, is inherently linearly distributed, links the aquatic environment with the terrestrial environment, and functions as a thermal refugium for wildlife (Seavy et al. 2009a), factors which elevate the importance of riparian habitats in responding to climate change in Yolo County. Riparian areas provide a framework for uniting ecosystems at landscape scales, enhancing regional ecological resilience (Fremier et al. 2015).

See Goal WF3, above, for objectives related to oaks in riparian areas.

F.2.9.1 Objective R1.1: Protect riparian areas

Rational. Riparian communities provide habitat for many native plant and wildlife species that occur in Yolo County and the surrounding region. Achieving this objective will assist in securing habitat connectivity for native species, as well as maintaining habitat functions on adjacent agricultural lands within Yolo County for numerous focal species and other native wildlife species.

F.2.9.2 Objective R1.2: Increase Riparian Habitat Areas

Rationale. Achieving this objective will enhance the functional utility of riparian areas in Yolo County by extending the riparian vegetation corridor laterally from the watercourses, and enhancing the continuity of the riparian vegetation corridor along the length of the watercourses. Additionally, the Independent Science Advisors' Report (Spencer et al 2006) for the Yolo HCP/NCCP recommends establishing wide riparian habitat nodes along habitat corridors.

Riparian restoration actions can be either intensive (such as actions that involve grading) or less intensive. Less intensive efforts, which may still require considerable resources, involve facilitating the dispersal and establishment of native plants through maintenance practices, such as removing competing invasive plants. (from CVFPP Conservation Strategy [DWR 2016])

F.2.9.3 Objective R1.3: Maintain or enhance riparian habitat areas

Rationale. Structural complexity, including understory (low shrubs), midstory (large shrubs and small trees), and overstory (upper canopy formed from large trees), is important to meet habitat requirements for a diversity of wildlife species. Different bird species nest and forage at different vegetation heights, necessitating the presence of multiple vegetation layers. Low shrubs provide cover for many wildlife species, tall trees provide perching opportunities, and canopy cover provides shading. Multiple vegetation layers also enhance hydrologic functions, including rainfall interception, filtration of floodwaters, and flood-stage desynchronization (Collins et al. 2006). Horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands increases opportunities for insects produced in riparian vegetation to be distributed into channels and other communities, contributing to aquatic and terrestrial food webs (Naiman et al. 1993; Naiman and Decamps 1997; National Research Council 2002).

Wildlife species respond to vegetation structure for breeding, foraging, and nesting. Vegetation structure can be defined as the foliage volume (or cover of foliage) by height for a given area (Riparian Habitat Joint Venture 2009). Where natural processes dominate (as in intact floodplains), riparian natural communities tend to vary widely in terms of both vegetation structure and composition, representing areas that are at different successional (temporal) stages. To meet the ecological requirements of a variety of wildlife species, riparian communities should include the full range of seral stages that are characterized by a mixture and diversity of vegetative cover at a wide range of heights and volumes (Riparian Habitat Joint Venture 2009; Seavy et al. 2009b). For example, least Bell's vireo is more likely to occur in willow-dominated, early seral stage riparian forest, whereas yellow-billed cuckoo is more likely to occur in a relatively dense, mature cottonwood/willow forest with light gaps and a heavy shrub component (Efseaff et al. 2008).

Riparian habitat in the Sacramento River Valley provides significant habitat values for a variety of resident wildlife species, and additionally supports highly diverse and abundant populations of migratory birds (Seavy et al. 2009a). Riparian habitat in Yolo County supports substantially different groups of migratory bird species during the breeding season, when most migrant species are Neotropical migrants, and winter season, when most migrants are short-distance Northern Hemisphere migrants (Motroni 1985; Dybala et al. 2015). The food requirements of the two groups differ substantially, with Neotropical migrants primarily insectivorous and the wintering migrants primarily feeding on plant seeds or fruits. Fully addressing riparian habitat needs for both groups depends on assuring that riparian habitats include a diversity of plant species, particularly shrubs and grass-like plants that produce fruits and seeds during the winter.

F.2.10 Goal LR1: Stream conservation

See also RCIS/LCP Objective L2.1, *Hydrologic and geomorphic processes in floodplains,* regarding landscape level ecological needs within floodplains, with a focus on the Sacramento River and Yolo Bypass, consistent with the CVFPP Conservation Strategy.

F.2.10.1 Objective LR1.1. Fluvial equilibrium

An equilibrium exists when channels are neither aggrading nor degrading and maintain stable channel cross-sectional and longitudinal profiles through time, where "equilibrium" reflects a dynamic balance between erosion and deposition through time, rather than a static, unchanging condition.

F.2.10.2 Objective LR1.2. American beavers

American beavers provide a number of ecosystem services in streams. Their dams collect and slowly release water downstream throughout the year, and filter sediment and improve water quality downstream. They also produce aquatic and wetland habitat.

F.2.10.3 Objective LR1.3: Native vegetation

Rationale: Vegetation shades and cools streams, maintains streambanks and channel forms, and provides organic material that maintains instream ecological dynamic processes.

F.2.10.4 Objective LR1.4: Stream processes and conditions

Rationale: Conservation of stream processes is related to maintaining subsurface flow and groundwater that are hydrologically part of the streamflow in each watershed (Winter et al 1998). Appropriate streamflows should be encouraged to maintain aquatic life in Yolo County streams. Maintenance or reestablishment of streamflow dynamics that resemble the natural runoff patterns that sustain instream and riparian/floodplain ecosystems in Yolo County, including flow dynamics, will help support the reproduction of desired native riparian plant species. This will also encourage habitat conditions that favor native fish species.

F.2.11 Goal AP1: Alkali Prairie Conservation

F.2.11.1 Objective VP1.1: Protect Alkali Prairie

Alkali prairie is a rare natural community that supports numerous rare plant species, including palmate-bracted bird's beak, alkali milk-vetch, Heckard's pepper-grass, brittlescale, spearscale, and Baker's navarretia.

F.2.12 Goal VP1: Vernal pool conservation

Conserve vernal pool complexes in Yolo County.

96 percent of the vernal pools in Yolo County are already protected (Table 3-2), therefore the strategy for vernal pools focuses on management.

F.3 Focal Species Strategies

F.3.1 Focal Plant Species

F.3.1.1 Rationale for Goals and Objectives

Goal PLANT1: Conserve Focal Plant Species Populations

Landscape and natural community-level objectives that contribute to the conservation of focal plant species:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations;* and *L1.3, Environmental Gradients,* provide for the conservation of large interconnected areas across environmental gradients to support sustainable focal plant species populations and provide for shifts in distribution with climate change.

- *Objective L3.1, Invasive Species*, provides for control of invasive plant species, such as Italian ryegrass and perennial pepperweed, that threaten the focal plant populations in vernal pool and alkali prairie natural communities.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change;* and *L4.4, Population Viability and Biodiversity Resilience with Climate Change,* will further provide for monitoring and adaptive management to address threats to the focal plant species from climate change. These plant species occur in vernal pool and alkali prairie natural communities, both of which are highly restricted in distribution and particularly vulnerable to the effects of climate change.
- *Objectives VP1.1, Protect Vernal Pools,* will benefit the focal plant species dependent on vernal pools by increasing the level of protection on the species' habitat.
- *Objectives VP1.2, Vernal Pool Pollinators,* may benefit the focal plant species dependent on vernal pools by maintaining important pollinators for these species.

Objective PLANT1.1: Protect focal plant species habitat and occurrences

Rationale. Habitat protection will ensure significant patches of habitat in Yolo County will be available to support existing occurrences and any future expansion of occurrences.

Although an estimated 77 percent of the alkali milk-vetch and Heckard's pepper-grass habitat is protected on Category 1–3 lands, only an estimated 25 percent of this habitat is fully protected on Category 1 lands (Table 3-3). These species would benefit by increasing the level of protection on the Category 2 and 3 lands, with an emphasis on protecting lands that support occurrences of alkali milk-vetch and Heckard's pepper-grass.

Although an estimated 76 percent of the brittlescale and spearscale modeled habitat is protected on Category 1–3 lands, only an estimated 24 percent of this habitat is fully protected on Category 1 lands. These species would benefit by increasing the level of protection on the Category 2 and 3 lands, with an emphasis on lands that support occurrences of brittlescale and spearscale.

All of the Baker's navarretia modeled habitat is protected on Category 1–3 lands, but less than one percent is fully protected on Category 1 lands. This species would benefit by increasing the level of protection on the Category 2 and 3 lands, with an emphasis on lands that support occurrences of Baker's navarretia.

The only known occurrence of palmate-bracted bird's-beak in Yolo County is in Woodland Regional Park, a property owned by the City of Woodland, and on two adjacent private parcels protected by conservation easement and managed by the Center for Natural Lands Management. The Woodland Regional Park site will be protected, managed, and enhanced for palmate-bracted bird's-beak as part of the Yolo HCP/NCCP. No further protection is needed for this species.

An estimated 96 percent of the Solano grass and Colusa grass habitat is protected on Category 1–3 lands, less than 1 percent of which is fully protected on Category 1 lands. These species would benefit by increasing the level of protection on the Category 2 and 3 lands, prioritizing those lands that support occurrences of Solano grass and Colusa grass.

Objective PLANT1.2. Maintain or increase focal plant species abundance

Rationale. Increasing the abundance of the focal plant species on protected habitat will help ensure the species' ongoing existence in Yolo County with any future changes in environmental conditions (e.g., climate change).

F.3.1.2 Climate Change

Focal Plant Species Vulnerability to Climate Change

Like all organisms, for populations of the focal plant species to survive climate change-related stress, they need to be able to adapt to (or tolerate) stress caused by climate change, or move away from stress caused by climate change into areas that are either still suitable or newly suitable under changed climate conditions. In general, the predicted consequence of climate change will result in shifts of suitable habitat to higher elevations and latitudes (Jump and Penuelas 2005). For example, changes in precipitation and temperature patterns could change the critically timed filling and drying periods of vernal pools that most of focal plants species rely on; changes in monthly timing of precipitation has been identified as causing decreases in species richness and germination (Bliss and Zedler 1997, Kneitel 2014). Although the specific effects of climate change are unknown, the effects of increased winter flooding and drought conditions in the spring and summer have the potential to adversely affect the focal plant species (U.S. Fish and Wildlife Service 2008). If climate change causes current habitat to become unsuitable, populations will have to either 1) migrate to suitable habitat, 2) adapt to the new conditions, or 3) go extinct. If the climate changes more rapidly than either #1 or #2, then extinction will be inevitable (Thomas et al. 2004). Under climatic changes, temperature and water availability are the two variables most often documented as influencing either genetic change or physical movement (summarized in Jump and Penuelas 2005). Where plant populations persists on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has creased (U.S. Fish and Wildlife Service 2008).

How individual species or populations are affected by changed conditions under a different climate are largely influenced by their phenotypic plasticity and their ability to move. Phenotypic plasticity can accommodate short-term changes and potentially lead to long-term genetic change, but if changes are drastic, the ability of plasticity to accommodate the change will reach its limit and dispersal will be necessary (Murren et al. 2015). The ability to move is influenced by dispersal methods (e.g., can dispersal occur fast enough to outpace threats) and barriers, either natural barriers (e.g., ecotones, change in soil type) or human-made barriers (e.g., developed landscapes). This conservation strategy facilitates adaptation to climate change by recommending conservation actions that facilitate dispersal across the landscape.

Anacker et al. (2013) conducted a climate vulnerably assessment of 156 plant species in California. Of the eight focal plant species in the strategy area, only brittlescale and San Joaquin spearscale were included in this analysis (Table X). Both species were determined to be highly vulnerable to climate change based on life history attributes and distribution model results, as specified by the Climate Change Vulnerability Index of NatureServe. Factors considered in evaluating species' responses to climate change can be divided into four categories: direct exposure (i.e., temperature and precipitation), indirect exposure (i.e., effects due to landscape configuration and human action), sensitivity (i.e., life history) and modeled response (i.e., species distribution models). For direct exposure on brittlescale and San Joaquin spearscale, the temperature across approximately 90 percent of their ranges is expected to increase by between 3.9 and 4.4 degrees Fahrenheit by 2080 and the net change in moisture is expected to be reduced by 0.028 to 0.05 (with the remainder of their ranges being increasingly hot and dry). Factors in the other three categories that are predicted to increase climate change vulnerability on brittlescale and San Joaquin spearscale include barriers, land use changes, reliance of specific thermal and hydrologic conditions, geological restrictions, and changes in range or abundance (Table X). Although the other six focal plant species were not included in the climate vulnerability analysis, they would be expected to be affected by the same or similar factors and have a similar vulnerability rating because they have similar life histories, occur in the same locations in the RCIS strategy area, and would be subject to the same threats and stressors. All of the focal plant species are restricted to certain types of habitats which have a limited distribution in the strategy area. In addition, the large expanses of surrounding unsuitable agriculture and urban development leave these species with little ability to shift their ranges in response to climate change.

Table F-1. Climate Vulnerability Scoring for Brittlescale and San Joaquin Spearscale (Source: Anacker et al. 2013)[1]

Criteria	Effect on Vulnerability	
	Brittlescale	**San Joaquin spearscale**
Direct Exposure		
Temperature	+3.9 and 4.4 degrees (91 % of range)	+3.9 and +4.4 degrees (88% of range)
Moisture	-0.028 to -0.05 (84% of range)	-0.028 to -0.05 (92% of range)
Indirect Exposure		
Natural barriers	Somewhat increase	N/A
Anthropogenic barriers	Increase	Somewhat Increase
Land use changes	Increase	Somewhat increase and increase
Sensitivity		
Historical thermal niches	Neutral, somewhat increase, and increase	Neutral, somewhat increase, and increase
Historical hydrologic niches	Somewhat increase	Somewhat increase
Restrictions to uncommon geological features or derivatives	Somewhat increase	Somewhat increase
Modeled Response		
Modeled future (2050) change in population or range size	Increase	Increase
Overlap of modeled future (2050) range with current range	Increase	Increase

[1] Definition for each criteria and additional information the vulnerability assessment can be found at https://www.wildlife.ca.gov/Data/Analysis/Climate

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The RCIS conservation strategy for focal plant species recommends permanent protection (via conservation easements) of habitat occupied by focal plant species, as well as suitable but unoccupied habitat, and maintaining or increasing the abundance of known populations in the strategy area through monitoring and adaptive management. Achieving these objectives will ensure that populations are large enough to persist as climate conditions change and have the ability to shift their distribution into suitable but unoccupied habitat if portions of their range are no longer suitable, as predicted by the modeled response. Protection of the largest blocks of habitat possible for the focal plant species will help ensure their long-term survival. Further, the focus of this RCIS' natural community conservation strategy is to protect additional vernal pool complexes (Goal VP1, *Vernal Pool Conservation)* and alkali prairie (Goal AP1, *Alkali Prairie*), and work to control or eradicate invasive plant species (Objective L3.1, *Invasive Plant Species*), which will enhance suitable (but potentially unoccupied) habitat for the focal plant species in the RCIS area and providing future migration opportunities.

F.3.2 Focal Vernal Pool Invertebrates

F.3.2.1 Rationale for Goals and Objectives

Goal VPI1: Vernal Pool Invertebrate Conservation

Landscape and natural community-level objectives that contribute to the conservation of vernal pool invertebrate species:

- *Objectives L1.1, Landscape Connectivity*; *L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients,* provide for the conservation of large interconnected areas across environmental gradients to support sustainable focal species populations and provide for shifts in distribution with climate change, if possible given narrow range of environmental requirements.
- *Objective L3.1, Invasive Species*. Achieving the objective will provide for control of invasive plant species, such as Italian ryegrass and perennial pepperweed, which degrade vernal pool habitat.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity resilience with climate change.* Achieving the objective will further provide for monitoring and adaptive management to address threats to the focal invertebrate species from climate change. Vernal pools are highly restricted in distribution and particularly vulnerable to the effects of climate change.
- *Objectives VP1.1, Protect Vernal Pools.* Achieving the objective will benefit the vernal pool invertebrate species dependent on vernal pools by increasing the level of protection on the species' habitat.

Objective VPI1.1: Maintain or Increase vernal Pool Invertebrate Populations

Rationale. Increasing the abundance of the vernal pool invertebrates on protected habitat will help ensure the species' ongoing existence in Yolo County with any future changes in environmental conditions (e.g., climate change).

F.3.2.2 Climate Change

Vernal Pool Invertebrate Vulnerability to Climate Change

No species-specific vulnerability analysis has been conducted for the focal vernal pool invertebrates. However, the U.S. Fish and Wildlife Service 5-Year Review for vernal pool fairy shrimp (U.S. Fish and Wildlife Service 2007a) and vernal pool tadpole shrimp (U.S. Fish and Wildlife Service 2007b) include an analysis of the effects of climate change on vernal pool invertebrates in California.

The life history of the vernal pool invertebrates (i.e., shrimp species) in the strategy area are inextricably tied to California's climate. The vernal pool invertebrates require shallow pools that fill (i.e., precipitation) and dry (i.e., temperature) over short periods of time; climate change is expected to affect vernal pool inundation patterns and temperature regimes (U.S. Fish and Wildlife Service 2007a). Vernal pools in California's Central Valley are particularly sensitive to slight increases in evaporation or reductions in rainfall due to their shallowness and seasonality (Field et al. 1999). Climate change could have a number of other effects on vernal pools including altering marginal pools towards more of less favorable periods of inundation, changes to water chemistry, decreases in water depth, and occupation by non-native species (U.S. Fish and Wildlife Service 2007a and U.S. Fish and Wildlife Service 2007b).

The ability of the vernal pool invertebrates to survive is likely to depend on their ability to disperse to pools where conditions are suitable (Bohanak and Jenkins 2003, Bonte et al. 2004). Loss and fragmentation of vernal pool habitat is thought to decrease dispersal ability (U.S. Fish and Wildlife Service 2007a). The vernal pool invertebrates may disappear from some areas to be replaced by more tolerant species or rapid extinctions of populations could occur (McLaughlin et al. 2002). Changes to water depth and the inundation period could cause pools to dry before shrimp have completed their life cycle, or cause pool temperatures to exceed those suitable for hatching or species persistence (U.S. Fish and Wildlife Service 2007c).

How the RCIS/LCP Conservation Strategy Addresses Climate Change

Although the exact future effects of climate change on shrimp species cannot be determined, as described above, habitat variability and connectivity are expected to be key to their survival. Protecting existing occurrences and large blocks of occupied and unoccupied habitat that provide shrimp with a range of conditions will buffer against the effects of climate change. For example, larger and deeper vernal pools will hold water even during periods of drought and can act as source populations for other shallower vernal pool. Through the conservation strategy, vernal pool shrimp will have access other habitat areas, should conditions at occupied locations change. Since the exact effects of climate change on vernal pool invertebrates are unclear (as described above), the conservation strategy recommends monitoring and adaptively managing populations of vernal pool invertebrates in the strategy area in order to most effectively maintain populations over time as conditions change.

F.3.3 Valley Elderberry Longhorn Beetle

F.3.3.1 Rationale for Goals and Objectives

Goal VELB1. Maintenance of Valley Elderberry Longhorn Beetle Populations.

The following landscape and natural community objectives contribute to the conservation of valley elderberry longhorn beetle in Yolo County.

- *Objectives L1.1, Landscape Connectivity*; *L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients*. Achieving the objective will provide for the conservation of large interconnected areas across environmental gradients to support sustainable valley elderberry longhorn beetle populations and provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species*. Achieving the objectiveprovides for control of invasive plant species that may otherwise outcompete elderberry shrubs.
- *Objectives L4.2, Landscape Resilience with climate Change*; *L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving the objectivewill further provide for monitoring and adaptive management to address threats to valley elderberry longhorn beetle from climate change.
- *Objectives WF1.1, Manage and Enhance Oak Woodlands*, may benefit valley elderberry longhorn beetle if enhancement includes planting elderberry shrubs in the oak woodland understory.
- RCIS/LCP Objectives R1.1, *Protect Riparian Areas;* R1.2, *Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas,* may benefit valley elderberry longhorn beetle if elderberry shrubs are present in the protected, restored, and/or enhanced riparian areas.

Objective VELB1.1: Protect and Manage Valley Elderberry Longhorn Beetle Populations

Increase protection and management of valley elderberry longhorn beetle colonies in Yolo County.

Rationale. Protecting valley elderberry longhorn beetle colonies on conservation easements will help reduce the stressor of habitat loss, and enable the protected colonies to be managed for sustainability.

Objective VELB1.2: Valley elderberry longhorn beetle habitat amount, connectivity, and quality

Increase the amount, connectivity, and quality of valley elderberry longhorn beetle habitat.

Rationale. This species has distinct, relatively isolated populations in individual drainages, likely due to the beetle's limited dispersal capability (Collinge et al. 2001). The species is unlikely to colonize unoccupied drainages, even if suitable habitat is present. This necessitates siting habitat restoration within or in the vicinity of occupied drainages, consistent with Objective VELB1.1. Known occupied habitat in the Plan Area occurs in Conservation Zones 2 and 7 in three occurrences, but additional known occurrences are expected to be found as the reserve system is assembled. Some occurrences are known from agricultural ditches and railroad tracks; however, these locations do not provide opportunities to restore dense patches of elderberry shrubs within a riparian matrix directly adjacent to occupied areas. In these cases, restoration should be located within reasonable dispersal distance for the valley elderberry longhorn beetle from known occurrences.

F.3.3.2 Climate Change

Valley Elderberry Longhorn Beetle Vulnerability to Climate Change

No species-specific vulnerability analysis has been conducted for valley elderberry longhorn beetle. However, in the report to document to withdraw the proposed removal of the valley elderberry longhorn beetle as an endangered species (U.S. Fish and Wildlife Service 2014), the U.S. Fish and Wildlife Service discusses climate change in the Central Valley and California and the effects of these changes related to valley elderberry longhorn beetle. The findings in this document are discussed in the following paragraph.

The valley elderberry longhorn beetle is reliant on the availability of its host plants, blue elderberry (*Sambucus nigra* ssp. *caerulea*) and red elderberry (*Sambucus racemosa*), for its survival and reproduction. Like any insect-host plant relationship, the persistence of this species requires not only healthy populations but also accessible, high-quality habitat. At the natural community level, riparian ecosystems and the elderberry shrubs therein, are dependent upon the ecological processes supported by climate conditions. Climate change is predicted to change the hydrological patterns in the Central Valley due to changes in temperature and precipitation. Snowpack and snowmelt, which drives California's watersheds, is expected to be reduced and the frequency and duration of drought conditions is expected to increase. Thus, as the intensity of both wet and dry periods change, streamflow patterns and flow regimes (both in volume and timing) in California's watersheds for riverine systems, including riparian vegetation, will be altered. As the groundwater and surface water level inputs to riparian systems are modified, shifts in location and species composition of riparian vegetation can occur (U.S. Fish and Wildlife Service 2014).

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for valley elderberry longhorn beetle is to protect known populations, increase habitat availability and improve habitat quality. Protecting existing occurrences, enhancing those habitats to improve productivity, and protecting and managing larger blocks of habitat so that individuals will have access to other habitat areas - should conditions at historical locations change - are all important tools for land managers to provide adaptations to climate change. Because this species occurs in isolated populations in individual drainages, focusing on the protection of known occurrences and suitable habitat within and adjacent to known occurrences is a sufficient strategy for allowing valley elderberry longhorn beetle to adapt to climate change. Furthermore, habitat restoration will help to offset the effects of any habitat loss in the strategy area. The RCIS will concentrate on restoration and enhancement efforts of valley elderberry longhorn beetle habitat that will connect existing colonies to create more robust colonies that can expand and interact in the face of climate change. Shifts in habitat are expected to occur and valley elderberry long beetle may need to shift to new habitat areas, provided they are protected and accessible.

The conservation strategy recommends actions to manage riparian and stream habitat in the RCIS area (Chapter 3, Table 3-2), which will also serve to buffer these habitats from climate change. Achieving Goal R1, *Riparian Conservation*, will protect, increase, enhance riparian habitat, all of which will serve to maintain functional riparian habitat for the valley elderberry longhorn beetle in the RCIS area. Similarly, RCIS/LCP Goal LR1, *Stream Conservation*, if achieved, will conserve and enhance stream systems, including stream processes and conditions, which will help to counter the effects of climate change on hydrological processes in the RCIS area.

F.3.4 Focal Fish Species

F.3.4.1 Rationale for Goals and Objectives

Goal CVS1: Protected and Enhanced Focal Fish Species Habitat

The following landscape and natural community objectives contribute to the conservation of focal fish species.

- *Objectives L1.1*, *Landscape Connectivity*; *L1.2*, *Areas to Support Sustainable Populations*; and *L1.3*, *Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to support sustainable populations of focal fish and their food sources, and provide for shifts in distribution with climate change. Providing a range of environmental gradients will ensure the long-term persistence of a diversity of spawning and rearing conditions for delta smelt in Yolo County.

Providing a range of environmental gradients within floodplains will ensure that diverse rearing and migration conditions exist for Chinook salmon in Yolo County. Maintaining or increasing life-history diversity is particularly applicable to species such as Chinook salmon. Three races of Chinook salmon occur within Yolo County (winter-run, spring-run, and fall-run/late fall–run), each of which exhibits different life-history strategies, such as duration of rearing in freshwater environments before smoltification and migration from fresh water to the ocean. Providing a range of environmental gradients is intended to provide a range of suitable habitat conditions for the varied life-history strategies exhibited by the covered species.

- *Objective L1.4*, *Natural Community Restoration.* Achieving this objective will provide for restoration of vegetation communities associated with aquatic habitat (i.e., riparian and fresh emergent wetland) to provide cover, habitat complexity, and food sources for the focal fish species.
- *Objective L2.1*, *Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will restore natural fluvial processes to improve habitat conditions through increased lateral river channel migration and floodplain connectivity/inundation, which can increase sediment inputs. Increased sediment inputs can increase turbidity, which facilitates delta smelt foraging effectiveness and predator avoidance (Nobriga and Herbold 2009). Floodplain inundation may also contribute to a seasonal increase in primary productivity and invertebrate production (Müller-Solger et al. 2002; Lehman et al. 2008) that will contribute to a more diverse and robust forage base for adult and juvenile delta smelt.
- *Objective L3.2, Pollutants and Toxins*. Achieving this objective may benefit focal fish species by reducing pesticides and herbicides that can be highly toxic to plankton. Plankton form the base of the focal fish species' foodweb. Achieving this objective may also reduce sublethal effects (e.g., effects on behavior, tissues and organs, reproduction, growth, and immune system) (Connon et al. 2010), of contaminants such as pyrethroids and other chemicals from urban stormwater runoff. Decreasing the discharge of these contaminants is intended to improve water quality conditions in Yolo County and thereby benefit the focal species. These water quality

improvements may also support a more robust foodweb and contribute to increasing food resources for focal fish species.

- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to the focal fish species from climate change.
- *Objectives WF3.2, Restore and Enhance Riparian Oaks; R1.1, Protect Riparian Areas;* and *R.2, Increase Riparian Areas.* Achieving this objective will contribute directly and indirectly to the production of food available to focal fish species in the aquatic system, which is expected to contribute to an increase in survival. It also has other benefits, such as increasing habitat complexity and thermal insulation, known to be important to juvenile salmonids. Riparian natural community contributes important functions to the aquatic system by providing large woody debris recruitment, increased bank stability, reduced erosion, flow attenuation during flood events, organic inputs, and shade and thermal insulation, all of which provide benefits to focal fish species.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands;* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will help to increase primary productivity, which could result in more food available to the focal fish species. It could also provide delta smelt spawning and early rearing habitat. Fresh emergent wetland protection and restoration may also promote effective exchange throughout the marsh plain to increase transport and delivery of food to habitats occupied by focal fish species. Increasing the transport of food is anticipated to contribute to an increase in growth and fecundity.
- *Objective FW1.3, Minimize Submerged Aquatic Vegetation.* Achieving this objective will reduce invasive species in shallow areas that provide predatory fish an advantage over the focal fish species (Santos et al. 2011). Additionally, it may reduce the adverse effects of lowered turbidity that results from submerged aquatic vegetation, as delta and longfin smelt have evolved in and adapted to turbid waters.
- *Objective LR1.1, Fluvial Equilibrium.* Achieving this objective will improve hyporheic processes, such as groundwater recharge, which can improve water quality, provide cool water inputs, and maintain flow inputs to surface waters to benefit the focal fish species.
- *Objective LR1.3, Native Vegetation.* Achieving this objective will provide shaded cover along waterways that may support focal fish species. Achieving this objective may also contribute to an increase in organic inputs, such as terrestrial insects and plant matter, to provide a nutrient source increase for the productivity of aquatic systems. This increase in productivity may contribute to a more diverse and robust forage base.
- *Objective LR1.4, Stream Processes and Conditions.* Achieving this objective will contribute to an increase in river-floodplain connectivity and potentially improved hyporheic processes, such as groundwater recharge, which can improve water quality, provide cool water inputs, and maintain flow inputs to surface waters.

Objective FISH1.1: Shaded riverine aquatic habitat

Increase the area of shaded riverine aquatic habitat in Yolo County that supports focal fish species.

Rationale: Shaded riverine aquatic habitat is important for fish species because overhanging riparian vegetation provides several types of habitat values (from CVFPP Conservation Strategy [DWR 2016]):

Objective FISH1.2: In-stream marsh habitat

Increase the area of in-stream marsh habitat in Yolo County that supports the focal fish species.

Rationale. Increasing in-stream marsh habitat will increase primary productivity, which could result in more food available to the focal fish species. It could also provide delta smelt spawning and early rearing habitat. This may also promote effective exchange to increase transport and delivery of food to habitats occupied by focal fish species. Increasing the transport of food is anticipated to contribute to an increase in growth and fecundity. Increasing in-stream marsh habitat will also provide rearing habitat and refuge from larger predators for several focal fish species.

Objective FISH1.3: Passage barriers

Remove or modify passage barriers that prevent access of focal fish species to spawning and rearing habitat, and build or modify barriers to prevent passage into detrimental locations.

Rationale. Barriers to fish passage are prevent migration through Yolo County and prevent individuals from completing critical stages of their life cycle, including spawning. Several passage barriers have been identified in Putah Creek (DWR 2005, NMFS 2014).

In addition, some barriers should be constructed to prevent individuals from entering detrimental areas. The Wallace Weir Fish Rescue Facility and Knights Landing Outfall Gate projects are two recent examples of projects completed in Yolo County to block Chinook salmon from entering areas where they would become trapped and unable to reach spawning grounds. A potential project in Yolo County for consideration is the leaky lock at the northernend of the Sacramento Deep Water Ship Channel in which adults are trapped due to their immigration into the Deep Water Ship Channel due to false cues from the Sacramento River (NMFS 2014).

Objective FISH1.4: Large Woody Material

Increase large woody material in focal fish species habitat to provide complexity and predator refuges for focal fish species in streams in Yolo County.

Rationale. Channelization and clearing of vegetation along levees has led to loss of large woody material input to streams and rivers. Large woody material provides habitat complexity and cover for the focal fish species.

Objective FISH1.5: Yolo Bypass inundation

Increase inundation in the Yolo Bypass so that it reaches an optimized magnitude, frequency, and duration that will benefit native fish while using an Integrated Water Management (IWM) approach. An IWM approach utilizes a system-wide perspective and considers all aspects of water management, including public safety and emergency management, environmental sustainability, and the economic stability of agricultural and recreational uses of the Bypass.

Rationale. The Yolo Bypass is an important area for multiple uses, including but not limited to flood control, agriculture, and wildlife habitat. The RCIS/LCP must therefore balance actions that benefit the focal fish species with other uses in the Yolo Bypass.

The Yolo Bypass, found at the eastern edge of Yolo County on the lower Sacramento River, is one of the largest contiguous floodplains in California. The bypass is a critical feature of the Sacramento River Flood Control Project, which conveys floodwaters from the Sacramento and Feather Rivers and their tributary watersheds. Unlike conventional flood control systems that frequently isolate rivers from their ecologically essential floodplain habitats, the Yolo Bypass has been engineered to allow the Sacramento River Valley floodwaters to inundate a broad floodplain 40 miles long across 59,000 acres.

Yolo Bypass provides aquatic habitat for 42 fish species, 15 of which are native (Sommer et al. 2001a). The bypass seasonally supports several endangered fish species, including delta smelt and longfin smelt (both of which are found only in the lower bypass, in the Cache Slough area), Sacramento splittail, steelhead, and several runs of Chinook salmon. Typical winter and spring spawning and rearing periods for native Delta fish coincide with the timing of the flood pulse (Sommer et al. 2001b). Unlike much of the rest of the Sacramento-San Joaquin Delta (Delta), which is dominated by nonnative fish, the Yolo Bypass is less likely to be dominated by nonnative fish species because the majority of the floodplain habitat is seasonally dewatered, creating unfavorable conditions for many nonnative fish.

Fisheries biologists have noted that floodplain inundation during high-flow years may favor native aquatic species in the estuary. The Yolo Bypass is an important nursery for young fish, and may help to support the foodweb of the San Francisco Estuary. Adult fish use the Yolo Bypass as a migration corridor (i.e., Chinook salmon and sturgeon) and for spawning (i.e., Sacramento splittail) (Harrell and Sommer 2003).

Increased frequency of Yolo Bypass inundation will enhance the existing connectivity between the Sacramento River and the Yolo Bypass floodplain habitat. It can increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production, with conditions suitable for spawning, egg incubation, and larval stages for covered fish species such as Sacramento splittail (if inundation is greater than 30 days). Seasonal flooding in the Yolo Bypass should occur when it will be most effective at supporting native fish species (i.e., when it is in synchrony with the natural timing of seasonally occurring hydrologic events in the watershed).

Increased magnitude of Yolo Bypass inundation has the potential to increase primary and secondary aquatic productivity. Flooding increases the volume of water (areal extent and depth) in the photic zone, allowing for conditions that can result in increases in phytoplankton biomass. Increased biomass may lead to an increase in the abundance of zooplankton and planktivorous fish. This increase in primary and secondary productivity in the foodweb is expected within the immediate Yolo Bypass area, but may also be exported downstream with the phytoplankton and zooplankton.

lncreased duration of inundation is expected to increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production. For example, in the winter of 2012, a partnership of organizations led by CalTrout conducted a replicated experiment in which active, fallow, and tilled rice fields on Knaggs Ranch in the upper Yolo Bypass were flooded and over 10,000 hatchery stock juvenile Chinook salmon were "planted" in the fields (Katz et al. 2017). After six weeks, the fish were caught and measured to determine their growth. A subset of individuals were tagged with tracking devices that measured their growth frequently during the study period. The study documented remarkably fast growth of these juvenile salmon in almost all treatment conditions, showing that flooding the upper Yolo Bypass can produce dramatic benefits to native fish. A current proposal would expand this experiment to approximately 4,000 acres of the upper Yolo Bypass, flooding fallow fields for longer durations from November through February. A similar proposal is described as Alternative 4 in the 2017 Draft EIS/EIR for the *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project*.

Short-duration flood inundation (less than 30 days) is expected to result in relatively small benefits to juvenile salmon growth when compared to inundation that extends longer than 30 days (BDCP Integration Team 2009).

Modifications to topography and weirs are expected to improve fish passage and reduce the risk of migration delays and stranding of adult fish. Stranding of fish and subsequent predation by birds and piscivorous fish have been identified as sources of mortality for juvenile salmon rearing within the floodplain habitat (Sommer et al. 2001b, 2005; BDCP Integration Team 2009). Illegal harvest of covered fish species may also be a potential source of mortality that could be exacerbated by existing migration delays, low flows, and stranding caused by shorter inundation periods.

Objective FISH1.6: Restore Putah Creek Fish Habitat

Support and partner with existing efforts to restore Putah Creek habitat in Yolo County to enhance spawning, rearing, and migration of focal fish species.

Rationale. The restoration of Putah Creek for fish benefit has been the focus of several stakeholder groups, such as the Putah Creek Council and the Lower Putah Creek Coordinating Committee. These groups have identified several restoration projects to undertake in Putah Creek. Many have not been funded or completed but could be completed with additional support.

Objective FISH1.7: Non-native predators

Reduce non-native predator habitat by restoring more natural hydrologic and geomorphologic processes in streams.

Rationale. Although a natural part of the estuarine ecosystem, predation has been identified as a stressor to the focal fish species (Essex Partnership 2009). Fish and wildlife whose habitats have been greatly simplified and fragmented cannot sustain naturally occurring predation rates. Habitat for fish predators generally provides a specific suite of attributes that allow them to forage more efficiently, such as dark locations adjacent to light locations or deep pools that allow the predator to hide and ambush their prey from below. Different predators each have their niche, however, so most habitats have some kind of predator that can take advantage of elevated prey vulnerability. The key examples are extensive steeply banked and riprapped channels and large beds of Brazilian waterweed (*Egeria densa*) and similar invasive submerged aquatic vegetation that have overgrown shallow areas (Santos et al. 2011).

Fish predators tend to be attracted to instream structures (Gingras 1997), and new diversion structures in the Sacramento River may attract predators (Essex Partnership 2009). Striped bass, for example, have been shown to aggregate around instream structures in the Sacramento River from Red Bluff to the Delta. New intake structures in the Sacramento River may create a local hydraulic discontinuity that may provide ambush sites for striped bass. Predation rates on Chinook salmon, steelhead, white sturgeon, and Sacramento splittail may increase as a result of installing intake structures and other instream structures (Essex Partnership 2009).

Objective FISH1.8: Research

Support short-term research projects to gain an understanding of multiple benefits of seasonal inundation on agricultural lands, including providing focal fish species spawning and rearing habitat.

Rationale. Recent work has demonstrated that flood control, agriculture, and fish and wildlife habitat can co-exist in the Yolo Bypass (Katz et al. 2013). There are several unknowns regarding the benefits to fish and wildlife on agricultural lands, including understanding the dynamics of fish survival on and emigration from managed agricultural floodplains and refining timing and duration of inundation to maximize fish benefits.

F.3.4.2 Climate Change

Focal Fish Species Vulnerability to Climate Change

Moyle et al. (2012) ranked the climate vulnerability of 164 California fish species (121 native fishes and 43 alien (i.e., non-native fish species). Those rankings were divided into two 10-metric modules which evaluated baseline vulnerability (Module 1) and life history characteristics (Module 2). Module 1 was based on existing environmental changes; that is, species already in decline would be more vulnerable to climate change. Module 2 evaluated those life history characteristics that would make a species more or less vulnerable to climate change. The evaluation identified the following ranges of climate vulnerability scores, with the lower values indicating greater vulnerability:

- Module 1 – scores between 18 and 42
- Module 2 – scores between 17 and 32

The combined vulnerability score indicates the degree of vulnerability (Table X); species with combined scores of 35 or less are considered extremely likely to become extinct in the wild by the year 2,100. The results of the analysis (Moyle et al. 2012) indicate that most of the focal fish species are vulnerable to climate change, with salmon and delta smelt being critically vulnerable. Sacramento splittail and both sturgeon species had scores that indicate lower vulnerability to climate change.

Table F-2. Climate Vulnerability Scoring for the Focal Fish Species as Described in Moyle et al. 2012.

Criteria	Module 1 Score Range	Module 2 Score Range	Combined Score (Vulnerability)
Chinook Fall Run Salmon	17-21	12-17	29-38
Chinook Late-Fall Run Salmon	18-24	11-15	29-39
Chinook Spring Salmon	17-22	11-16	28-38
Chinook Winter Salmon	16-18	10-14	26-32
Delta Smelt	13-17	11-13	24-30
Green Sturgeon	27-33	15-21	42-54
Sacramento Splittail	25-30	17-26	42-56
Central Valley Steelhead	--	--	--
White Sturgeon	22-29	17-24	39-53

[1] 1.0-1.9 indicates the species is endangered, 2.0-2.9 indicates the species is vulnerable to becoming endangered
[2] EN= Endangered
VU= Vulnerable

In the strategy area, there is little to no spawning habitat accessible for focal fish species; Chinook fall-run salmon may spawn in Putah Creek (but are likely strays). Access to most historical upstream spawning habitat has been eliminated or destroyed by artificial structures (e.g., dams and weirs) associated with water storage and conveyance, flood control, and diversions and exports. The focal fish species already occur at low levels in the other large rivers and streams in the strategy area, with the most limited distributions being delta smelt in the Sacramento River and Stockton Deepwater Ship Channel, steelhead in the Sacramento River and green and white sturgeon in the Sacramento River, Yolo Bypass, and Stockton Deepwater Ship Channel. Much of the remaining accessible habitat has been degraded with the installation of levees, channelization, and riprap or island reclamation. For example, Chinook fall-run salmon can only migrate upstream in Cache Creek under really wet conditions using a complicated migration route and the upstream habitat is unsuitable for successful spawning.

When considering climate change, the biggest concern for fish species generally, and anadromous species specifically, is that there will be less precipitation, and thus less stream flow, or that precipitation will fall in patterns different from how it has fallen historically, and that stream flow will not be adequate during key migration and spawning periods (Moyle et al. 2012). For example, if peak flows flush young salmon from rivers to estuaries before they are physically mature, their chances of survival is greatly reduced (Thomas et al. 2009). Also, there is a concern that if the climate is drier and warmer, that will reduce in-stream habitat quality for fish, especially fish that require cold water habitats, as water temperatures become warmer. Secondarily, in a drier climate, there is the potential for an increase in fire frequency and intensity, which can result in an increased sediment load reaching streams during storm events, further reducing in stream habitat quality for fish species.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for the focal fish species in the strategy area is to enhance and restore habitat for the focal fish species, as well as target particular areas with site-specific actions that can greatly improve localized fish habitat. Although the anadromous fish species utilize multiple types of habitat, the oceanic portion of their life history is beyond the scope of the conservation strategy. The focus in the strategy area is where fish habitat can be increased along rivers and streams, and in the Delta, by creating more fish-friendly water release practices in the Yolo Bypass and through stream and riparian restoration actions. Riparian restoration along fish-bearing streams, for example, will provide shade, helping to moderate water temperatures even under scenarios where the temperature is warmer than in the past. Another focus of the conservation strategy is to increase access to stream habitat through removal of barriers. The conservation strategy also recommends short-term research projects to better understand the benefits to the focal fish species of inundation on agriculture lands. All of these actions are aimed at improving existing habitat or increasing access to new stream reaches and will help to mitigate the effects of declining habitat conditions due to climate change.

F.3.5 California Tiger Salamander

F.3.5.1 Rationale for Goals and Objectives

Goal CTS1: California Tiger Salamander Conservation

How the landscape and natural community-level objectives contribute to California tiger salamander conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the California tiger salamander population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in California tiger salamander habitat. Increasing native vegetative cover has been shown to increase pond hydroperiod (Marty 2005), thus making aquatic habitat more suitable for California tiger salamander breeding. Additionally, consistent with this objective, the introduction and proliferation of nonnative bullfrogs and other nonnative aquatic wildlife that prey on California tiger salamanders may be reduced. Bullfrogs and predatory fish are a primary source of mortality for this species (Fisher and Shaffer 1996).
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect California tiger salamanders from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of California tiger salamander.
- *Objectives L4.2*, *Landscape Resilience with Climate Change;* L4.3, *Natural Community and Habitat Resilience with Climate Change*; and L4.4, *Population Viability and Biodiversity resilience with*

climate change . Achieving this objective will further provide for monitoring and adaptive management to address threats to California tiger salamander from climate change.

- RCIS/LCP Objectives CP1.1, *California Prairie Protection;* CP1.2, *Burrowing Rodents;* CP1.3, *Grazing Regimes;* and CP1.4, *Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides upland habitat for California tiger salamander in Yolo County. CP1.2 provides for burrows, which California tiger salamanders require for shelter in upland habitat.

Objective CTS1.1: Protect Upland Habitat

Increase protection of grassland providing California tiger salamander upland habitat (within 1.3 miles of aquatic habitat) in the Dunnigan Hills Planning Unit, in addition to the 2,000 acres of upland habitat protected under the Yolo HCP/NCCP. Prioritize protection in designated critical habitat.

Rationale. The Dunnigan Hills Planning Unit is the planning unit where most of the California tiger salamander population occurs in Yolo County. This planning unit also supports all the formally designated critical habitat for this species in Yolo County.

Objective CTS1.2: Protect and Restore Aquatic Habitat

Increase protection and restoration of aquatic habitat for California tiger salamander in the Dunnigan Hills planning unit, in addition to the at least 36 acres of aquatic habitat protected and 36 acres restored by the Yolo HCP/NCCP. Prioritize protection in designated critical habitat. Within the protected and restored aquatic habitat, include California tiger salamander breeding pools that are found to support all life stages of the salamander through all water year types.

Rationale. The California tiger salamander depends on aquatic habitat for breeding and its larval stage of development. In Yolo County, the aquatic habitat consists almost entirely of stock ponds within a matrix of California prairie.

F.3.5.2 Climate Change

California Tiger Salamander Vulnerability to Climate Change

California tiger salamanders have adapted a life history strategy to deal with variable environmental conditions because they evolved in an environment that experiences highly variable annual rainfall events and droughts, (U.S. Fish and Wildlife Service 2017). California tiger salamander breeding success is tied very closely to rainfall amounts and timing, however, and different breeding locations may serve as population sources in different years, buffering the overall population against inter-annual variability (Cook et al. 2005). Despite these life history strategies, climate change could result in even more erratic weather patterns to which California tiger salamanders cannot adapt quickly enough. Drought or considerable changes in rainfall amounts or timing could be detrimental to California tiger salamander populations in the RCIS area if those conditions persist over multiple breeding years.

Wright et al. (2013) estimated that the California tiger salamander was at “intermediate risk” from climate change. They based that estimate on the likelihood of persistence of current species locations in 2050 and the amount of currently suitable habitat that is likely to remain suitable by 2050. They examined both eventualities under four climate change scenarios, so there is considerable variability in their predictions. They estimated that 20% - 80% of current California tiger salamander occurrences would persist through 2050 but that 20% - 99% of modeled suitable area would no longer be suitable. They identified the following bioclimatic factors as affecting the California tiger salamander.

- Annual mean temperature
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Minimum temperature of coldest month (i.e., the minimum monthly temperature over a given year)
- Annual temperature range
- Precipitation of the wettest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)
- Precipitation of the driest quarter (3 months) (i.e. total precipitation during the driest quarter)

Across the four climate change scenarios, the prediction of future habitat varies from much of the current habitat in the strategy area remaining suitable, to scenarios where hardly any of it remains suitable and habitat is much patchier.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the Yolo RCIS/LCP conservation strategy for California tiger salamander is to protect existing occurrences, enhance habitats to improve productivity, and protect and manage larger blocks of habitat so that individuals will have access to other habitat areas, should conditions at historical locations change. Since most of the habitat and many of the known occurrences in the strategy area are located in the Dunnigan Hills Planning Unit, this area is the focus of the conservation strategy. Since they are likely to persist through at least 2050, focusing on the protection of known occurrences, suitable habitat, and designated critical habitat, this is a sufficient strategy for allowing California tiger salamander to adapt to climate change. The conservation strategy includes objectives for both upland and aquatic habitat to support all life stages of California tiger; however restoration actions will focus on aquatic habitat to improve breeding and larval development. Aquatic habitat restoration is critical because providing for enough duplication of breeding sites on protected lands will ensure that in any given year there will be source populations of California tiger salamander, even when some breeding sites may be too dry. The RCIS recommends protecting and restoring California tiger salamander habitat in the Dunnigan Hills Planning Unit. Achieving this objective will ensure enough variability across the landscape that the population as whole will persist, even is some locations become less suitable.

F.3.6 Foothill Yellow-Legged Frog

F.3.6.1 Rationale for Goals and Objectives

Goal FYFL1: Maintenance of Foothill Yellow-Legged Frog Distribution and Abundance

Maintenance of the distribution and abundance of foothill yellow-legged frogs within their range in Yolo County.

How the landscape and natural community-level objectives contribute to foothill yellow-legged frog conservation.

- *Objectives L1.1, Landscape Connectivity;* L1.2, *Areas to Support Sustainable Populations*; and L1.3, *Environmental gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the foothill yellow-legged frog population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in foothill yellow-legged frog habitat.. Additionally, consistent with this objective, the introduction and proliferation of nonnative bullfrogs and other nonnative aquatic wildlife that prey on foothill yellow-legged frogs may be reduced.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect foothill yellow-legged frogs from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of foothill yellow-legged frogs.
- RCIS/LCP Objectives L4.2, *Landscape Resilience with Climate Change;* L4.3, *Natural Community and Habitat Resilience with Climate Change*; and L4.4, *Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to foothill yellow-legged frog from climate change.

Objective FYLF1.1: Protect Aquatic and Upland Habitat

Increase protection of foothill yellow-legged frog habitat distributed among the planning units 1, 2, 4, 6, and/or 8, prioritizing occupied habitat.

Rationale. Protection of aquatic breeding habitat for foothill yellow-legged frog is necessary to ensure ongoing reproduction. Protecting adjacent uplands will provide for foothill yellow-legged frog hibernation and movement between aquatic areas.

F.3.6.2 Climate Change

Foothill Yellow-Legged Frog Vulnerability to Climate Change

Wright et al. (2013) identified foothill yellow-legged frog as a species that will likely experience overall reduction in habitat suitability in California, with much of its suitable habitat along the northern Coast Range and Sierra foothills being reduced and patchy. The models estimate that 80% to 100% of the current foothill yellow-legged frog occurrences would remain suitable and persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat. Although there is some variability across the four climate change scenarios, in general, the prediction of future habitat suitability varies from the current habitat suitability in the strategy area, where remaining suitable habitat is reduced or entirely disappears. The model identified the following bioclimatic factors as affecting habitat suitability for the foothill yellow-legged frog.

- Mean diurnal range (mean of monthly [max temp – minimum temp])

- Isothermality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Minimum Temperature of Coldest Month
- Mean Temperature of Warmest Quarter (3 months)
- Precipitation Seasonality
- Precipitation of the Driest Quarter
- Precipitation of the Coldest Quarter

Climate models predict the Sacramento Valley Ecoregion will experience warmer temperatures, more variable precipitation, and decreased spring and summer runoff from lower annual snowpack (PRBO 2011). Low-stream flow seasons may result in higher water temperatures, which may result in stress for the foothill yellow-legged frog, a species adapted to more moderate temperatures. Changes in frequency, duration, and severity of drought and severe winter may also negatively affect yellow-legged frogs (Jennings and Hayes 1994). Changes in temperature may also affect prevalence of pathogens and parasites (U.S. Forest Service 2016). The foothill yellow-legged frog is vulnerable to climate change because of climate change effects on stream flow and hydrological changes that chronically affect several aspects of the species' life history. Overall, climate change is predicted to reduce the habitat suitability for foothill yellow-legged frogs at lower latitudes and elevations (U.S. Forest Service 2016).

How the Yolo RCIS/LCP Addresses Climate Change

To offset the negative effects of climate change the conservation strategy for foothill yellow-legged frog is to maintain existing occurrences and abundance in Yolo County. The conservation strategy includes objectives to restore the hydrologic attributes (e.g. flow and thermal regimes of regulated rivers) of aquatic habitat, and restoration of associated uplands and connecting riparian corridors, to support all life stages of yellow-legged frog. Managing habitat to create larger blocks of contiguous habitat (Objective L1.1, *Landscape Connectivity)*, reduces habitat fragmentation and facilitates the dispersal and genetic exchange of yellow-legged frog from current habitat to more suitable habitat under changing climate conditions. Achieving this objective will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change. Additionally, achieving Objectives L4-2, *Resilience to Climate Change* and Objectives L4.3, *Natural Community and Habitat Resilience with Climate Change*, will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable foothill yellow-legged frog populations in the strategy area. The RCIS recommends FYLF1, *Protect Aquatic and Upland Habitat*, which, if achieved, protects yellow-legged frog breeding habitat and adjacent upland habitat, prioritizing occupied habitat, provides for foothill-yellow legged frog hibernation and movement between aquatic areas. Likewise, achieving Objective L1-4, Natural Community Restoration, Objective WF3.1 *Protect Riparian Oaks and Oak Woodland*, Objective WF3.2 *Restore and Enhance Riparian Oaks and Oak Woodland*, and XLR1.4 *Stream Processes and Conditions*, will protect, increases, and maintains the availability of frog habitat by restoring aquatic and adjacent upland habitat for the species, thereby reducing stressors on these natural communities and making the natural communities more resilient to climate change and providing favorable habitat conditions for foothill yellow-legged frog.

F.3.7 Western Spadefoot

F.3.7.1 Rationale for Goals and Objectives

Goal WS1: Maintenance of Western Spadefoot Distribution and Abundance

Maintain the distribution and abundance of western spadefoot within its range in Yolo County.

How the landscape and natural community-level objectives contribute to western spadefoot conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the western spadefoot population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in western spadefoot habitat. Increasing native vegetative cover has been shown to increase pond hydroperiod (Marty 2005), thus making aquatic habitat more suitable for western spadefoot breeding.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western spadefoots from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of western spadefoot.
- *Objectives L4.2*, *Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to western spadefoot from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides upland habitat for western spadefoot in Yolo County.

Objective WS1.1: Habitat Protection.

Increase protection of western spadefoot habitat in ponds and associated uplands distributed among planning units 2 – 6 and/or 8, prioritizing occupied habitat.

Rationale. Protection of aquatic breeding habitat for western spadefoot is necessary to ensure ongoing reproduction. Protecting adjacent uplands will provide for western spadefoot aestivation and movement between aquatic areas.

F.3.7.2 Climate Change

Western Spadefoot Vulnerability to Climate Change

Wright et al. (2013) assessed the conservation risk posed by climate change of 153 California reptile and amphibians species in California. Using species distribution modeling programs Wright et al. created species distribution models to forecast the distribution of climatically suitable habitat under four future climate scenarios for 2050. From the projects, they calculated the percentage of currently occupied localities remaining suitable in the future, the change in suitable area within currently occupied localities, and identified the species most and least vulnerable to climate shifting away from conditions that the species is known to tolerate. Vulnerability was calculated as the combined metric of numerous attributes including sensitivity to climates, dispersal ability, and the distribution of available future habitat. Depending on the ranking metric, the assessment identified approximately 60-75% of reptile and amphibian species were predicted to experience <20% direct loss of climatically suitable habitat by 2050 (Wright et al. 2013). Additionally, species ranked highest for risk include many species that are already of conservation concern and tend to be endemic species with small ranges. Wright et al. (2013) identified western spadefoot toad as an 'at-risk' species that the species will likely experience overall reduction in habitat suitability. Two of the climate models estimated that 80% to 100% of the current western spadefoot toad occurrences would remain suitable and persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat, while two other climate models estimated approximately 70% of the current toad occurrences would remain and a 30% decrease in predicted suitable habitat within currently occupied habitat. Although there is some variability across the four climate change scenarios, in general, the prediction of future habitat suitability varies from the current habitat suitability in the strategy area, where remaining suitable habitat is reduced.

The model identified the following bioclimatic factors as affecting habitat suitability for the western spadefoot toad.

- Mean annual temperature
- Mean diurnal range (mean of monthly [max temp – minimum tem])
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Precipitation of the wettest month
- Precipitation of the driest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)
- Precipitation of the warmest quarter (3 months) (i.e. total precipitation during the quarter with the highest temperature)

Projected effects of climate change in the Sacramento Valley Ecoregion are warmer temperatures, drier conditions with more variable precipitation (PRBO 2011). Potential effects of climate change leading to increased frequency and severity of droughts, as well as intense or extreme precipitation events, can affect the resiliency of small, isolated western spadefoot toad populations, especially those that inhabit ephemeral aquatic environments. Though all wildlife species may experience problems related to seasonal precipitation changes, species that rely on seasonal aquatic habitats for breeding are especially vulnerable. The western spadefoot toad is vulnerable to climate change because of its poor ability to disperse long distance and to colonize new sites and its dependence on specific hydrologic threshold.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for western spadefoot toad is to maintain existing occurrences and abundance in Yolo County. The conservation strategy includes objectives for both upland and aquatic habitat to support all life stages of western spadefoot toad. Adult spadefoot toad spend the majority of their lives in underground burrows in upland habitat until heavy spring rains. After the first rains the toads will imitate surface movements to breeding pools. Moving to find more suitable breeding pools poses increased predation risk from birds and mammals (California Department of Fish and Wildlife 2018). Managing habitat to create larger blocks of contiguous habitat (Objective L1.1, *Landscape Connectivity)*, reduces habitat fragmentation and facilitates the movement of spadefoot toad from current habitat to more suitable habitat under changing climate conditions. This will also serve to better link aquatic breeding habitat and upland habitat. In a warmer, drier climate, the quality and quantity of aquatic habitat may be diminished. Achieving Objective L3-1*, Invasive Species*, controls non-native vegetation, improving the aquatic habitat suitability for spadefoot toad breeding. Achieving Objective CP1.1, *California Prairie Protection*, and Objective CP1.2, *Restore and Enhance Native Prairie*, protects, increases, and maintains the availability of western spadefoot toad habitat by restoring upland habitat for the toads, thereby reducing stressors on these natural communities and making the natural communities that spadefoot toads use more resilient to climate change. Likewise, achieving WS1.1, *Habitat Protection*, protects spadefoot habitat in ponds and associated uplands, prioritizing occupied habitat. Additionally, achieving Objectives L4-2, *Resilience to Climate Change* and Objectives L4.3, *Natural Community and Habitat Resilience with Climate Change*, will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable spadefoot toad populations in the strategy area. Since western spadefoot toad are likely to persist in the conservation strategy area through at least 2050, focusing on the protection of known occurrences and suitable habitat is a sufficient strategy for allowing spadefoot toad to adapt to climate change.

F.3.8 Western Pond Turtle

F.3.8.1 Rationale for Goals and Objectives

Goal WPT1: Maintenance of Western Pond Turtle Distribution and Abundance

Maintain the distribution and abundance of western pond turtle within its range in Yolo County.

How the landscape and natural community-level objectives contribute to western pond turtle conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3*, *Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the western pond turtle population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.

- *Objective L1.5, Ecotone Conservation.* Achieving this objective provides for protection of a gradient of uplands adjacent to streams, which may provide upland habitat for western pond turtle.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western pond turtles from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of western pond turtles.
- *Objectives L4.2, Landscape Resilience with Climate Change;* L4.3, *Natural Community and Habitat Resilience with Climate Change*; and L4.4, *Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to western pond turtles from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and CL1.2, *Incorporation of Habitat Elements.* Achieving this objective provides for patches of marsh and other suitable western pond turtle habitat within the agricultural matrix and on agricultural fields, where western pond turtles often occur in association with irrigation and drainage channels.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and FW1.2, *Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of western pond turtle aquatic habitat.
- *Objectives R1.1*, *Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving this objective will provide for the protection and restoration of western pond turtle upland habitat, and for woody riparian vegetation that will contribute to stream systems, providing western pond turtles with cover and basking sites.

Objective WPT1.1: Protect and Enhance Habitat

Increase protection and restoration of western pond turtle habitat in riverine and lacustrine and associated upland areas distributed among planning units 2-6 and/or 8.

> ***Rationale.*** Protection of aquatic breeding habitat for western pond turtle is necessary to ensure ongoing reproduction. Protecting adjacent uplands will provide for western pond turtle nesting and movement between aquatic areas.

Western pond turtles spend much of the warmer months in aquatic habitats throughout their range. Aquatic habitat provides favorable environments for foraging, mating, basking, and predator avoidance (Vander Haegen, Clark, Perillo, Anderson, & Allen 2009). Access to high-quality, disturbance-free basking sites is crucial in determining the overall health of a western pond turtle population because such sites allow the species to carry out activities necessary for survival and reproduction (Germano & Rathbun 2008). Emergent basking sites are usually composed of exposed logs, rocks, and emergent vegetation, which can be affected by altered flow regimes from dams.

F.3.8.2 Climate Change

Western Pond Turtle Vulnerability to Climate Change

Wright et al. (2013) assessed the conservation risk posed by climate change of 153 California reptile and amphibians species in California. Using species distribution modeling programs Wright et al.

created species distribution models to forecast the distribution of climatically suitable habitat under four future climate scenarios for 2050. From the projects, they calculated the percentage of currently occupied localities remaining suitable in the future, the change in suitable area within currently occupied localities, and identified the species most and least vulnerable to climate shifting away from conditions that the species is known to tolerate. Vulnerability was calculated as the combined metric of numerous attributes including sensitivity to climates, dispersal ability, and the distribution of available future habitat. Depending on the ranking metric, the assessment identified approximately 60-75% of reptile and amphibian species were predicted to experience <20% direct loss of climatically suitable habitat by 2050 (Wright et al. 2013). Additionally, species ranked highest for risk include many species that are already of conservation concern and tend to be endemic species with small ranges. They estimated that generally less than 100% but great than 80% of the current Western pond turtle occurrences would persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat. Based on the models, Western pond turtle falls between low to intermediate risk from climate change. Wright et al. (2013) identified the following bioclimatic factors as affecting the western pond turtle.

- Mean diurnal range (mean of monthly [max temp – minimum tem])
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Minimum temperature of coldest month (i.e., the minimum monthly temperature over a given year)
- Mean temperature of the warmest quarter (3 months)
- Precipitation of the wettest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)
- Precipitation of the driest quarter (3 months) (i.e. total precipitation during the driest quarter)

Across the four climate change scenarios, the prediction of future habitat suitability varies from the current habitat in the strategy area remaining suitable, where much of the remaining suitable habitat is reduced and habitat is much patchier.

Limited information exists regarding the sensitivity of western pond turtles to climate change. This species can tolerate periods of periodic drought but severe and/or multi-year drought can impact western pond turtle populations (Hallock et al. 2016). Projected effects of climate change in the Sacramento Valley Ecoregion are warmer temperatures, drier, and reduced annual streamflows (PRBO Conservation Science 2011). Potential effects of climate change leading to increased frequency and severity of droughts can affect the resiliency of small, isolated western pond turtle populations, especially those that inhabit ephemeral aquatic environments. Though all wildlife species may experience problems related to drought conditions, species that rely on aquatic habitats are especially vulnerable. The overall intent of the conservation strategy for western pond turtle is to protect existing occurrences, enhance habitats to improve productivity, and protect and manage larger blocks of habitat so that individuals will have access to other habitat areas, should conditions at historical locations degrade and become unsuitable.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy includes objectives for both upland and aquatic habitat to support all life stages of pond turtle; however, restoration actions will focus on increasing the availability of riverine and lacustrine aquatic and associated upland nesting/wintering habitat (Objective WPT1.1). When an aquatic habitat dries, the western pond turtle must either estivate under dry conditions or seek out more suitable habitat. Moving to find more suitable habitat poses increased predation risk, risks of dehydration, and starvation (Purcell et al. 2017). Managing habitat to create larger blocks of contiguous habitat (Objective L1.1, *Landscape Connectivity*, *L1.2, Areas to Support Sustainable Populations*; and *L1.3*, *Environmental Gradients)*, reduces habitat fragmentation and facilitates the movement of pond turtles from current habitat to more suitable habitat under changing climate conditions. Achieving *Objective L1.5, Ecotone Conservation,* provides for protection of a gradient of uplands adjacent to streams, which may provide upland habitat for western pond turtle, which will also serve to better link aquatic habitat and nesting habitat.

In a warmer, drier climate, the quality and quantity of aquatic habitat may be diminished. Achieving Objective FW1.1, *Protect Fresh Emergent Wetlands* and FW1.2, *Increase Fresh Emergent Wetland Areas*, and Objective R1.3, *Maintain or Enhance Riparian Habitat Areas*, protects, increases, and maintains the availability of Western pond turtle habitat by restoring riparian and freshwater emergent wetland habitat, thereby reducing stressors on these natural communities and making the natural communities that pond turtle uses more resilient to climate change. Likewise, achieving Objectives L4.2, *Resilience to Climate Change*, and Objectives L4.3, *Natura Community and Habitat Resilience with Climate Change*, will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable pond turtle populations in the strategy area. With a decrease in water availability, there is a potential for decrease in suitable habitat within working lands due to changes in agricultural practices and land uses. Loss of suitable habitat in the strategy area would negatively impact western pond turtle population in the strategy area. Actions in the conservation strategy focused on working with private land owners on working lands, including Objective L4.1*, Heterogeneity within Agricultural Lands,* and CL1.2, *Incorporation of Habitat Features,* if achieved, would provide for patches of marsh and other suitable western pond turtle habitat within the agricultural matrix and on agricultural fields, where western pond turtles often occur in association with irrigation and drainage channels, will offset these effects. Since Western pond turtle are likely to persist in the conservation strategy area through at least 2050, focusing on the protection of known occurrences and suitable habitat is a sufficient strategy for allowing Western pond turtle to adapt to climate change.

F.3.9 Giant Garter Snake

F.3.9.1 Rationale for Goals and Objectives

Goal GGS1: Giant Garter Snake Conservation

Conserve giant garter snake in Yolo County, including the Willow Slough/Yolo Bypass subpopulation and a segment of the Colusa Basin subpopulation, and connectivity between the two subpopulations.

How the landscape and natural community objectives contribute to giant garter snake conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the giant garter snake population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L1.4, Restore Natural Communities.* Achieving this objective will ensure habitat is restored in a manner that maximizes their success and long-term value for giant garter snake.
- *Objective L3.1*, *Invasive Species.* Achieving this objective will diminish non-native plants and wildlife in Yolo County, thus making aquatic habitat more suitable for giant garter snake. While invasive aquatic plants such as water primrose provide cover for the giant garter snake, they can impede snake movement if they become too dense. Control efforts will take into consideration the cover needs for giant garter snake. Nonnative wildlife species such as bullfrog and largemouth bass prey on young giant garter snakes and may threaten local populations. Consistent with this objective, nonnative invasive plant species that degrade giant garter snake habitat or nonnative wildlife species that prey on the giant garter snake should be controlled if monitoring determines that giant garter snake populations on managed lands are threatened by these factors.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect giant garter snakes from adverse effects of light, vibrations, and human and pet activity from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of giant garter snakes.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity resilience with climate change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to giant garter snakes from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix;* CL1.1, *Mixed Agricultural Uses with Habitat Values;* and CL1.2, *Incorporation of Habitat Elements.* Achieving this objective will encourage agricultural use that is compatible with giant garter snake habitat. Such use consists mainly of rice lands with irrigation and drainage channels that hold water during the snake's active season, and other habitat elements such as patches of fresh emergent wetland and grassland areas.
- *Objectives CP1.1, California Prairie Protection*; *CP1.2, Burrowing Rodents*; *CP1.3, Grazing Regimes*; and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective willprovide for the protection, restoration, and enhancement of the natural community that provides upland habitat for California tiger salamander in Yolo County. CP1.2 provides for burrows, which giant garter snakes require for shelter in upland habitat.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of giant garter snake aquatic habitat.

Objective GGS1.1: Protect and Restore Large Interconnected Blocks of Giant Garter Snake Habitat.

Build on existing protected habitat and habitat protected by the Yolo HCP/NCCP, to increase protected areas and to create habitat blocks at least 539 acres[2] in size, within five miles of larger areas of perennial wetland, and connected by corridors of aquatic and upland habitat of at least 0.5 mile wide.

Rationale. Rice lands are one of the primary land cover types that sustain giant garter snakes in Yolo County. This objective provides for the protection of uplands necessary for the giant garter snakes to move between sites, bask, and seek refuge in terrestrial burrows during the active season, and to seek refuge in burrows during their dormant period in the winter. This objective is consistent with the USFWS' draft recovery plan for giant garter snake (USFWS 2016), and with the CVFPP Conservation Strategy (DWR 2016).

Objective GGS1.2: Manage and Enhance giant garter snake habitat

Enhance giant garter snake habitat by providing sufficient water during the active season, improving water quality, and incorporating refugia from floodwaters and basking sites for improved thermoregulation.

Rationale. This objective helps to ensure that protected habitat in Yolo County will continue to sustain giant garter snakes.

F.3.9.2 Climate Change

Giant Garter Snake Vulnerability to Climate Change

Wright et al. (2013) assessed the conservation risk posed by climate change of 153 California reptile and amphibians species in California. Using species distribution modeling programs Wright et al. created species distribution models to forecast the distribution of climatically suitable habitat under four future climate scenarios for 2050. From the projects, they calculated the percentage of currently occupied localities remaining suitable in the future, the change in suitable area within currently occupied localities, and identified the species most and least vulnerable to climate shifting away from conditions that the species is known to tolerate. Vulnerability was calculated as the combined metric of numerous attributes including sensitivity to climates, dispersal ability, and the distribution of available future habitat. Depending on the ranking metric, the assessment identified approximately 60-75% of reptile and amphibian species were predicted to experience <20% direct loss of climatically suitable habitat by 2050 (Wright et al. 2013). Additionally, species ranked highest for risk include many species that are already of conservation concern and tend to be endemic species with small ranges.

The models estimated that generally less than 100% but great than 80% of the current giant garter snake occurrences would persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat. Based on the models, giant garter snake falls between low to intermediate risk from climate change. Wright et al. (2013) identified the following bioclimatic factors as affecting the giant garter snake.

- Mean annual temperature

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[2] Based on the giant garter snake recovery plan

- Mean diurnal range (mean of monthly [max temp – minimum tem])
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Precipitation of the wettest month
- Precipitation of the driest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)

Across the four climate change scenarios, the prediction of future habitat suitability tends to decrease overall in the Sacramento Valley Ecoregion for giant garter snake; although, much of the current natural wetlands and aquatic agricultural habitats in the strategy area remains generally suitable for giant garter snake.

However, because water availability will likely change with changing climate, and water availability is a critical part of the giant garter snake's ecological requirements, there is potential for the loss or reduction of suitable giant garter snake habitat due to actions such as water transfers in the Sacramento Valley (Shuford 2017), crop conversion of rice fields to incompatible crops (e.g. orchards, vineyards). Furthermore, the Giant Garter Snake Recovery Plan (U.S. Fish and Wildlife Service 2017) states that focused research on the impacts of climate change and drought for giant garter snake is still lacking.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

Many of the conservation actions in this conservation strategy address appropriate habitat management for the benefit of giant garter snake. Achieving *Objectives L4-1, Heterogeneity within Agricultural Lands;* CL1.1, *Mixed Agricultural Uses with Habitat Values*, maintains, enhances, and encourages habitat features within the agricultural habitat to support giant garter snake. Likewise, achieving Objectives *FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas, Objectives CP1.1, California Prairie Protection, and CP1.2, Restore and Enhance Native Prairie* will protect, restore, as well as expand emergent wetland habitat and prairie upland habitat for giant garter snake; increased habitat availability allows garter snakes to respond to stressor by shifting distribution with climate change. Achieving Objective *L1-4, Restore Natural Communities*, will protect, increase, and maintains the availability of natural communities, thereby reducing stressors on habitats used by the snakes and make the natural communities more resilient to climate change. Achieving Objective *L1-1, Landscape Connectivity; L122, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients* increases the functional availability of suitable habitat by connecting these habitat patches, facilitating the movement of giant garter snake from current habitat to more suitable habitat under changing climate conditions. The conservation strategy also builds upon existing protected habitat and habitat protected by the Yolo HCP/NCCP with Objective GGS1.1, *Protect and Restore Large Interconnected Blocks of Giant Garter Snake Habitat*. This is consistent with the Giant Garter Snake Recovery Plan (U.S. Fish and Wildlife Service 2017), which states that preserved perennial marshes and ricelands must be maintained and host stable populations of giant garter snake during adverse climate conditions, such as drought and extreme temperatures. Achieving *Objectives L4-2, Landscape Resilience to Climate Change and L4.3, Natural Community and Habitat Resilience with Climate Change* will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable giant garter snake populations in the conservation strategy area. Focusing on the protection of known nesting locations and improving suitable habitat within and adjacent to known occurrences will allow giant garter snake to respond to the effects of climate change in Yolo County.

F.3.10 Tricolored Blackbird

F.3.10.1 Rationale for Goals and Objectives

Goal TRBL1: Tricolored Blackbird Conservation

How the landscape and natural community objectives contribute to tricolored blackbird conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and L1.3, *Environmental gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the tricolored blackbird population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3*, *Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect tricolored blackbirds from adverse effects of noise, light, and vibrations from nearby developed areas..
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to tricolored blackbirds from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements.* Achieving this objective provides for patches of marsh and other suitable tricolored blackbird habitat within the agricultural matrix and on agricultural fields, where tricolored blackbirds often forage.
- *Objectives FW1.1*, *Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of tricolored blackbird nesting and roosting habitat.
- *Objectives R1.1, Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat areas.* Achieving this objective will provide for the protection and restoration of riparian habitat that may provide nesting and roosting habitat for tricolored blackbirds.

Objective TRBL1.1: Protect Nesting and Foraging Habitat, and Nesting Colonies.

Increase protection of nesting and foraging tricolored blackbird habitat, beyond what is protected by the Yolo HCP/NCCP, prioritizing areas supporting nesting colonies.

Rationale. Tricolored blackbirds are well adapted to rapidly changing environments where the locations of secure nesting habitat and rich insect food supplies fluctuates (Orians 1961; Collier 1968; Payne 1969). One of the stressors for tricolored blackbirds is the loss of suitable breeding sites that provide the required combination of tall emergent vegetation above standing water connected to highly productive foraging areas with high densities of arthropods. Sites with tall emergent vegetation over standing water may become increasingly unviable for tricolored blackbirds, however, because they are often subject to severe predation by black-crowned night herons. Protecting a sufficient amount of habitat to support tricolored blackbird will ensure that nesting colonies and their surrounding foraging habitat are protected across a wide portion of Yolo County and across fluctuating foraging conditions from year to year. Nesting tricolored blackbirds can be vulnerable to disturbances from adjacent activities. Central Valley populations of tricolored blackbirds demonstrate chronic poor reproductive success relative to populations in other portions of the species' range, and this is correlated with low insect abundance. The low reproductive success in the Central Valley may be the result of the widespread use of neonicoinoid insecticides (Meese 2014). Providing foraging habitat free of insecticides for the tricolored blackbird will help reduce this potential threat on the species.

Objective TRBL1.5: Manage and enhance habitat

Manage and enhance protected tricolored blackbird habitat to maintain habitat value for this species.

Rationale. High-value breeding habitat for the tricolored blackbird is represented by suitable nesting substrate, such as cattail/bulrush emergent wetland, in close association with highly productive foraging areas that support abundant insect prey, such as grasslands, seasonal wetlands, pasture lands, alfalfa and other hay crops, and some croplands. Tricolored blackbirds are highly dependent on disturbance events to maintain suitable nesting conditions at nesting colony sites. Ideal nesting substrate is represented by young, actively growing stands of bulrush/cattail emergent vegetation. As stands age, they develop an abundance of dead and dying stems and leaves, and become less attractive to the species for nesting. Under natural conditions, periodic disturbance from flooding, alluvial scouring, wildfire, and other landscape altering events serve to rejuvenate aging stands. Since much of Yolo County is isolated from the floodplain and unlikely to experience natural disturbances, active management is likely needed to sustain suitable nesting habitat characteristics for tricolored blackbirds (Kyle 2011). Therefore, mechanical habitat manipulation may be used to sustain nesting substrate for tricolored blackbirds in areas targeted to conserve this species as deemed necessary depending on habitat conditions.

F.3.10.2 Climate Change

Tricolored Blackbird Vulnerability to Climate Change

The Climate Vulnerability Assessment gave tricolored blackbird a score of 25, and the species is not considered a priority with respect to climate vulnerability (Table 3-1). Despite the assessment that tricolored blackbird may not be among the most vulnerable bird species to climate change, water availability and precipitation is predicted to decrease in the future, thus likely reducing fresh emergent wetlands throughout California (PRBO Conservation Science 2011). In the strategy area, a reduction of fresh emergent wetlands would result in reduced nesting and foraging habitats that the tricolored blackbird relies upon.

Table F-3. Climate Vulnerability Scoring for Tricolored Blackbird as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	2 – moderate; taxon is expected to be exposed to some increase in extreme weather events
Sensitivity	
Habitat specialization	2 – moderate; taxon that tolerates some variability in habitat type or element
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	1 - low; year-round resident
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

Climate change impacts to wetlands may also include alterations of recharge timing, changes in plant communities, and changes in the abundance of prey, further stressing the blackbirds. Marshes with emergent wetland, blackberry thickets, and riparian bramble are the primary breeding habitats in the strategy area; fresh emergent wetlands could become more ephemeral under drier conditions, reducing the availability of nesting habitat. With drier conditions and increase water demands, land use and agricultural practices are likely to change; some agricultural practices that support tricolored blackbird colonies, such as rice croplands that are abundant in insects, or dairy farms with consistent water sources (e.g. stock ponds), may be reduced. This could decrease foraging habitat for tricolored blackbird. Extreme weather, including flooding, wind, and severe spring storms may cause the mass mortality of nests, reducing or eliminating colony reproductive success.

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of tricolored blackbird occurrence in the strategy area would decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Models predict a decreased distribution throughout the Sacramento Valley, with a range shift into the foothills east of the strategy area and west of the strategy area into parts of the Coast Range, with a lower overall probability of occurrence (40-60%, down from 60-80%) in the strategy area. Audubon's Climate Report (National Audubon Society 2015) similarly predicts that tricolored blackbird's range will likely decrease in the Central Valley, shifting to the hills of the Coast Range by 2080. Areas in the strategy area that are predicted to be more resilient to climate change (i.e., have a higher probability of occurrence under future climate change scenarios) and more likely to provide habitat for tricolored blackbird than other parts of the strategy area are located generally southeast of Knight's Landing.

How the RCIS/LCP Addresses Climate Change

The conservation strategy aims to reduce the stressors of climate change by protecting known nesting locations and suitable nesting habitat, and protecting and managing foraging habitat surrounding those nesting locations. Achieving Goal L1, *Large interconnected landscapes*, aims to reduce habitat fragmentation, providing larger blocks of contiguous nesting and foraging habitat that can support tricolored blackbird. As described above, changes in hydrologic conditions could affect tricolored blackbird habitat; achieving Goal L2, *Ecological Processes and Conditions*, would restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing blackbird populations from climate change stressors. Achieving Goal L4, Biodiversity, *Ecosystem Function, and Resilience*, aims to conserve and enhance landscapes to increase its habitat value under changing climate conditions. Similarly, Goal CL1, *Cultivated land habitat conservation*, aims to provide habitat values and features for foraging and nesting tricolored blackbird. Achieving Goal FW1, *Fresh Emergent Wetland Conservation*, aims to protect, increase, and enhance emergent wetland habitat, all of which will serve to maintain and expand functional nesting habitat for tricolored blackbird in the strategy area. Actions to actively manage ponds and wetlands to ensure that the proper nesting substrate is present and that ponds retain the proper ponding duration will help to offset negative effects that warmer and drier conditions might have on nesting habitat. Achieving Goal TRBL1, *Tricolored Blackbird Conservation*, will protect and restore occupied or recently occupied nesting tricolored blackbird habitat and manage foraging habitat for the benefit of the species, buffering the existing species population from the stressors of climate change. Achieving this goal will expand protection to recently occupied habitat surrounding known nest colony sites; doing so will build repetition into the region so that if historic nest locations are no longer viable due to warmer and drier conditions, other ponds and wetlands that remain viable, will be protected and managed for the species.

F.3.11 Grasshopper Sparrow

F.3.11.1 Rationale for Goals and Objectives

Goal GRSP1: Maintenance of Grasshopper Sparrow Distribution and Abundance

Maintain the distribution and abundance of grasshopper sparrows within Yolo County.

How the landscape and natural community objectives contribute to grasshopper sparrow conservation

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the grasshopper sparrow population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in grasshopper habitat.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect grasshopper sparrows from adverse effects of noise or light from nearby developed areas.

- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to grasshopper sparrows from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides habitat for grasshopper sparrow in Yolo County.

Objective GRSP1.1: Protect Habitat

Increase the protection of habitat with known grasshopper sparrow nesting occurrences.

Objective GRSP1.2: Maintain and enhance habitat

Maintain and enhance the habitat functions of protected grasshopper sparrow habitat.

Rationale. Protecting and managing grasshopper sparrow habitat will help maintain or increase grasshopper sparrow nesting success by maintaining nesting habitat and prey availability necessary to rear and fledge young and provide for the potential future expansion of the breeding population in Yolo County. Maintaining and enhancing vegetation composition and structure will increase the likelihood for occupancy of protected California prairie by grasshopper sparrow, and increase nesting success by providing cover conditions that reduce the likelihood of nest site detection by predators.

F.3.11.2 Climate Change

Grasshopper Sparrow Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), grasshopper sparrow is not considered a priority with respect to climate vulnerability, receiving a climate vulnerability score of 24 (Table 3-2). However, grasshopper sparrow could be vulnerable to the effects of climate change due to a reduction of large patches of grassland (its preferred nesting habitat), changes in land management and land use, as well as potential increased fire threats in natural vegetation (PRBO Conservation Science 2011).

Table F-4. Climate Vulnerability Scoring for Grasshopper Sparrow as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	2 – moderate; taxon that tolerates some variability in habitat type or element
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	2 – moderate for short-distance migrants (movements primarily restricted to the nearctic zone)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of grasshopper sparrow occurrence in the strategy area will not significantly change over time as a consequence of climate change, with a stable probability of 0-20% (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). The models also predict that the distribution of grasshopper sparrow will remain the same through the Sacramento Valley floor, suggesting the habitat type utilized by grasshopper sparrow in the strategy area is somewhat less vulnerable to the effects of climate change as compared to other habitat types (e.g., wetlands). Recent climate change projections indicate that grasslands in the Sacramento Valley region could, however, decline up to approximately 20% by 2070 (PRBO Conservation Science 2011). The primary impact of climate change on this natural community is likely driven by increased variability in precipitation. Changes in perception may result in changes in vegetation community composition and structure, invasion of nonnative species, and overall changes in prey abundance. These stressors may affect grasshopper sparrow populations in the strategy area.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for grasshopper sparrow is to protect known nesting locations, increase habitat availability and improve habitat quality. Because the grasshopper sparrow avoids highly fragmented grasslands and breeding habitat may be degraded by invasive nonnative vegetation, achieving Objective L1-4, *Natural Community Restoration*, will restore native species composition and ecological processes in grasslands to maximize ecological function, taking into consideration potential future conditions with climate change. Achieving Objective L3-1, *Invasive Species*, will manage invasive plant species and will help control the spread of invasive grassland species, reducing a significant stressor on native grasslands and further enhancing the climate resilience of this community, improving habitat quality for the species. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving *Goal CP1, Large contiguous areas of California prairie to support native species,* will maintain and improve the extent, distribution, and density of native California prairie by restoring native grassland in areas that are degraded and dominated by exotic species, thereby improving the availability and quality of nesting habitat for grasshopper sparrow. Protecting and managing larger blocks of habitat ensures grasshopper sparrow populations will have access to other habitat areas, should conditions at historical locations degrade. Successful grassland planting, under Objective CP1.2, *Restore and enhance California prairie*, will create large areas of grassland vegetation alliances, ensuring that different species are supported by variations in water availability, soil moisture, disturbance regimes, and other conditions potentially affected by climate change. Achieving Goal GRSO1, *Maintenance of Grasshopper Sparrow Distribution and Abundance*, will protect existing occurrences and enhance those habitats utilized by grasshopper sparrow to improve productivity. Because grasshopper sparrow nests semi-colonially and irregularly breeds in Yolo County, focusing on the protection of known occurrences and improving habitat within and adjacent to known occurrences is a sufficient strategy for allowing grasshopper sparrow to adapt to the effects of climate change.

F.3.12 Western Burrowing Owl

F.3.12.1 Rationale for Goals and Objectives

Goal WBO1: Western Burrowing Owl Conservation

How the landscape and natural community objectives contribute to western burrowing owl conservation

- *Objectives L1.1, Landscape Connectivity; L1.2*, *Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the western burrowing wol population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in western burrowing owl habitat.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western burrowing owls from adverse effects of noise, light, human and pet activity, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with*

Climate Change. Achieving this objective will further provide for monitoring and adaptive management to address threats to western burrowing owls from climate change.

- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides habitat for western burrowing owl in Yolo County.

Objective WBO1.1: Protect Habitat and Active Nest Sites

Increase protection of western burrowing owl primary habitat in Yolo County, in addition to the habitat protected by the Yolo HCP/NCCP, prioritizing areas with active nest sites.

Rationale. Protecting modeled western burrowing owl primary habitat (grasslands) will help maintain or increase western burrowing owl nesting success, by maintaining nesting habitat and prey availability necessary to rear and fledge young. It is important to focus protection on active western burrowing owl nest sites, as most of the suitable habitat in Yolo County is not occupied and therefore protection of suitable habitat alone would not be expected to benefit the species.

Objective WBO1.2: Manage and enhance habitat

Implement management and enhancement practices to encourage burrowing owl occupancy on protected lands.

Rationale. Burrowing owls have very specific habitat requirements in order to successfully nest, hunt, and avoid predation. Vegetation height and presence of potential burrows are essential elements of burrowing owl occupancy. If modeled habitat does not meet these requirements, burrowing owls are less likely to occur. Habitat management and in some cases, enhancement, are therefore important to ensure that lands conserved for burrowing owls are actually providing conditions that meet habitat requirements. Vegetation management around occupied and potentially occupied burrows is key to maintaining suitable habitat conditions. Management should be designed to enhance vegetation conditions in the immediate vicinity of nesting burrows in order to maintain and encourage occupancy. Among the enhancement practices is the creation of artificial nest sites and debris piles. These practices, along with habitat management, are designed to encourage owl occupancy by augmenting natural habitat elements, to maintain and expand burrowing distribution and abundance in Yolo County.

F.3.12.2 Climate Change

Western Burrowing Owl Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), grasshopper sparrow is not considered a priority with respect to climate vulnerability, receiving a climate vulnerability score of 24 (Table 3-2). However, grasshopper sparrow could be vulnerable to the effects of climate change due to a reduction of large patches of grassland (its preferred nesting habitat), changes in land management and land use, as well as potential increased fire threats in natural vegetation (PRBO Conservation Science 2011).

Table F-5. Climate Vulnerability Scoring for Grasshopper Sparrow as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	2 – moderate; taxon that tolerates some variability in habitat type or element
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	2 – moderate for short-distance migrants (movements primarily restricted to the nearctic zone)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of grasshopper sparrow occurrence in the strategy area will not significantly change over time as a consequence of climate change, with a stable probability of 0-20% (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). The models also predict that the distribution of grasshopper sparrow will remain the same through the Sacramento Valley floor, suggesting the habitat type utilized by grasshopper sparrow in the strategy area is somewhat less vulnerable to the effects of climate change as compared to other habitat types (e.g., wetlands). Recent climate change projections indicate that grasslands in the Sacramento Valley region could, however, decline up to approximately 20% by 2070 (PRBO Conservation Science 2011). The primary impact of climate change on this natural community is likely driven by increased variability in precipitation. Changes in perception may result in changes in vegetation community composition and structure, invasion of nonnative species, and overall changes in prey abundance. These stressors may affect grasshopper sparrow populations in the strategy area.

How the RCIS/LCP Addresses Climate Change

The overall intent of the voluntary actions recommended in the conservation strategy for grasshopper sparrow is to protect known nesting locations, increase habitat availability and improve habitat quality. Because the grasshopper sparrow avoids highly fragmented grasslands and breeding habitat may be degraded by invasive nonnative vegetation, achieving Objective L1-4, *Natural Community Restoration*, will restore native species composition and ecological processes in grasslands to maximize ecological function, taking into consideration potential future conditions with climate change. Achieving Objective L3-1, *Invasive Species*, will manage invasive plant species and will help control the spread of invasive grassland species, reducing a significant stressor on native grasslands and further enhancing the climate resilience of this community, improving habitat quality for the species. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving *Goal CP1, Large contiguous areas of California prairie to support native species,* will maintain and improve the extent, distribution, and density of native California prairie by restoring native grassland in areas that are degraded and dominated by exotic species, thereby improving the availability and quality of nesting habitat for grasshopper sparrow. Protecting and managing larger blocks of habitat ensures grasshopper sparrow populations will have access to other habitat areas, should conditions at historical locations degrade. Grassland planting, as proposed under Objective CP1.2, *Restore and enhance California prairie*, will create large areas of grassland vegetation alliances, ensuring that different species are supported by variations in water availability, soil moisture, disturbance regimes, and other conditions potentially affected by climate change. Achieving Goal GRSO1, *Maintenance of Grasshopper Sparrow Distribution and Abundance*, will protect existing occurrences and enhance those habitats utilized by grasshopper sparrow to improve productivity. Because grasshopper sparrow nests semi-colonially and irregularly breeds in Yolo County, focusing on the protection of known occurrences and improving habitat within and adjacent to known occurrences is a sufficient strategy for allowing grasshopper sparrow to adapt to the effects of climate change.

F.3.13 Swainson's Hawk

F.3.13.1 Rationale for Goals and Objectives

Goal SWHA1: Swainson's Hawk Conservation

Conserve Swainson's hawks in Yolo County.

How the landscape and natural community objectives contribute to Swainson's hawk conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect Swainson's hawks from adverse effects of noise, light, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with climate change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to Swainson's hawks from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the

protection, restoration, and enhancement of the natural community that provides grassland habitat for Swainson's hawks and their prey in Yolo County.

- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and CL1.2, *Incorporation of Habitat Elements.* Achieving this objective provides for patches of woodlands and other suitable Swainson's hawk habitat within the agricultural matrix and on agricultural fields, for Swaison's hawk nesting. While cultivated landscapes have become essential for the continued survival of Swainson's hawks in the Central Valley, agricultural practices have also historically removed other important habitats such as riparian forest, woodlands, savannahs, and grasslands that supported nesting and foraging habitat for the species. Today, other than narrow riparian corridors, nesting habitat for Swainson's hawks consists of isolated trees, tree rows along field borders or roads, or small clusters of trees in farmyards or at rural residences. Maintaining these small, isolated nesting habitats is also essential to maintaining the distribution and abundance of the species in Yolo County. Swainson's hawks also benefit from remnant patches of grassland or other uncultivated areas. These areas provide additional foraging habitat and a source of rodent prey that can recolonize cultivated fields. Swainson's hawks use grassland remnants in the cultivated lands matrix for foraging early in the season, before cultivated lands provide peak foraging value; grasslands also provide a stable habitat that is accessible during times when the management of cultivated lands results in lower prey abundance and availability. This objective is designed in part to provide a means to protect these small but essential habitats that occur within the agricultural matrix.
- *Objective CL1.1, Mixed Agricultural Uses with Habitat Values.* Achieving this objective provides for the maintenance of crop types that provide foraging value for Swainson's hawk. This includes a variety of crop types that may provide foraging habitat values during different stages of the breeding season. Foraging studies indicate a positive association with alfalfa, tomato, wheat, oat, and other annually rotated crops that maintain a relatively low vegetation profile and that are harvested during the breeding season. Availability of these suitable crop types to foraging Swainson's hawks is a function of their height and density, which changes during the course of the breeding season as crops mature and are then harvested. As a result, these types and others provide value at different times of the breeding season. Much of the agricultural landscape in Yolo County consists of annually rotated irrigated cropland interspersed with alfalfa fields, which typically remain uncultivated for 3 to 5 years. Due to seasonal and annual rotations, this results in a very dynamic, ever-changing foraging landscape. Swainson's hawks respond to these changes with highly elastic foraging ranges as they seek out suitable sites to hunt (Estep 1989, Babcock 1995). High densities of nesting Swainson's hawks, as we have in Yolo County, are generally associated with a very diverse agricultural landscape. They respond to a variety of farming activities such as cultivating, disking, mowing, harvesting, and irrigating. A less diverse landscape, such as those that are dominated by pasturelands or less crop diversity, generally support fewer nesting Swainson's hawks (Anderson et al. 2007).
- *Objectives WF1.1, Increase Valley Oaks; WF1.2, Protect Valley Oaks; WF2.1, Protect Upland Oaks; WF2.2, Restore Upland Oaks; WF3.1, Protect Riparian Oaks;* and *WF3.2, Restore and Enhance Riparian Oaks.* Achieving these objectives will benefit Swainson's hawk by providing nesting habitat.
- *Objectives R1.1, Protect RiparianAareas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving this objective will provide for the protection and restoration of riparian habitat that provides nesting habitat for Swainson's hawks.

Objective SWHA1.1: Protect Agricultural and Natural Foraging Habitat and Associated Nest Trees.

Increase protection of cultivated lands with crops that support Swainson's hawk foraging habitat, grasslands, and associated nest trees in addition to the habitat protected by the Yolo HCP/NCCP.

As described above, Swainson's hawks benefit from a variety or cultivated land crop types. Annually rotated irrigated cropland provides the bulk of the suitable foraging landscape in Yolo County, which includes a variety of field and vegetable crops subject to these seasonal changes in structure and value to foraging Swainson's hawks. For example, among these crop types are tomatoes and wheat, both historically important crop types in Yolo County, which together comprise an average of approximately 95,000 acres, or 24 percent of the available habitat in the plan area each year (Estep 2015). These types are particularly important to foraging Swainson's hawks because of their time of harvest, which increases prey accessibility. Most wheat is harvested in June during the late incubation/early fledging period, and most tomatoes are harvested in August just prior to migration (Estep 2015).

Alfalfa is considered the highest value crop type due to its more consistent vegetation structure, its semi-perennial regime (typically 3-5 years between cultivation events), and its management (mowing and irrigating) that enhances prey accessibility (Estep 1989, 2009, 2015). Other types, including irrigated pastures and dry pastures or grasslands, are also moderately suitable habitats for foraging. Perennial crop types, such as vineyards, orchards, and rice that do not support accessible prey receive significantly less use (Estep 1989, Estep 2015, Swolgaard et al. 2008) and are considered unsuitable.

Rationale. Swainson's hawks rely on grassland foraging habitats, which provided the primary foraging habitat for Swainson's hawks prior to agricultural conversion. While some cultivated types are today regarded as having greater foraging value, grasslands remain an important component of the foraging landscape.

Objective SWHA1.2: Maintain or Enhance Nest Tree Density.

Maintain or enhance the density of Swainson's hawk nest trees on cultivated land foraging habitat to provide a minimum density of one tree suitable for Swainson's hawk nesting (native trees at least 20 feet in height, particularly valley oaks if conditions are suitable) per 10 acres of cultivated lands in the reserve system. Where existing protected trees do not meet that minimum requirement, plant suitable nest trees to meet this density requirement.

Rationale. In the absence of a comprehensive effort to maintain habitat diversity, cultivated lands tend to lose diversity over time as trees are lost and not replaced, cultivated fields are extended further into riparian corridors and oak woodlands, wetlands are plowed, and edge habitats are cultivated. Eventually, cultivated lands can become entirely devoid of trees, shrubs, or any uncultivated habitats. As this process continues, nesting opportunities for Swainson's hawks are reduced and the quality of agricultural foraging habitat declines. Where these elements have persisted within the agricultural matrix, Swainson's hawk populations have also persisted. Therefore, to successfully maintain Swainson's hawks in Yolo County, these essential habitat elements must be maintained on the landscape.

F.3.13.2 Climate Change

Swainson's Hawk Vulnerability to Climate Change

Swainson's hawk was given a score of 42 and moderate climate priority in the Climate Vulnerability Assessment (Gardali et al. 2012) and was therefore considered a priority with respect to climate vulnerability. Swainson's hawk is vulnerable to the effects of climate change due to an expected loss of nesting habitat in the Central Valley, loss of foraging habitat to urban development and to conversion to unsuitable agricultural practices, along with a potential increase in exposure to extreme weather events because it is a long-distance migrant.

Table F-6. Climate Vulnerability Scoring for Swainson's Hawk as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	3 – high; habitat suitability is expected to decrease by >50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	2 – moderate; taxon is expected to be exposed to some increase in extreme weather events
Sensitivity	
Habitat specialization	2 – moderate; taxon that tolerates some variability in habitat type or element
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	3 - high; long-distance migrants (migrates at least to the neotropics)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of Swainson's hawk occurrence in the strategy area could decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011) and with a range contraction across the western U.S. (National Audubon Society 2015). The models predict significant decrease in probability of occurrence throughout the strategy area, from 60-80% currently, around Knights Land, Davis, and Esparto to an overall probability of occurrence in the future of 0-20%.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

There are ample opportunities for implementation of the conservation strategy to lessen the potential impacts of climate change, facilitating continued nesting in the strategy area. Achieving Objective L1-4, *Natural Community Restoration*, will restore the species composition and ecological processes in a manner that maximizes their long-term function, taking into consideration potential future conditions with climate change. Achieving Goal L2, *Ecological Processes and Conditions*, will restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing Swainson's hawk nesting habitat from climate change stressors. Achieving Objective L4-2, *Resilience to Climate Change*, and Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance landscapes to increases habitat values under changing climate conditions. Similarly, Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat (nesting habitat for Swainson's hawk), which will serve to maintain and expand functional riparian habitat for the Swainson's hawk in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes in the RCIS area, reducing stressors on riparian communities, making the natural community more resilient to climate change. Additional protection, restoration, and management of riparian nesting habitat will retain, if not increase, suitable habitat for Swainson's hawk in the strategy area. Swainson's hawk have also successfully adapted to certain agricultural landscapes. With a decrease in water availability, and a potential decrease in the profitability of some crop types (e.g., alfalfa) agricultural practices and land uses may change. Loss of foraging habitat in the strategy area would make nesting attempts less successful. Actions recommended in the conservation strategy focused on working with private land owners on cultivated lands, including Goal CL1, *Cultivated land habitat conservation*, would include creating incentive programs to encourage planting of good forage crops will offset these effects. Achieving Goal 1, *Swainson's Hawk Conservation*, protects, increases, and manages agricultural and natural foraging habitat for the benefit of the species. Likewise achieving this goal maintains and enhances associated nesting tree density. Focusing on the protection of known nesting locations and improving suitable habitat within and adjacent to known occurrences will allow Swainson's hawk to respond to the effects of climate change in the strategy area.

F.3.14 Greater Sandhill Crane

F.3.14.1 Rationale for Goals and Objectives

Goal GSHC1: Protection and Expansion of Greater Sandhill Crane

Protect and expand the greater sandhill crane winter range in Yolo County.

How the landscape and natural community objectives contribute to greater sandhill crane conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change, including sea level rise.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect greater sandhill cranes from adverse effects of noise, light, and other disturbances from nearby developed areas..
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to greater sandhill cranes from climate change.

- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements .* Achieving this objective provides for patches of marsh and other suitable greater sandhill crane habitat within the agricultural matrix and on agricultural fields, where greater sandhill cranes forage and roost.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of greater sandhill crane roosting habitat.

Objective GSHC1.1: Protect foraging habitat

Increase protection of high- to very high-value foraging habitat for greater sandhill crane, with at least 80 percent maintained in very high-value types in any given year. Protected habitat should be in planning unit 15, within 2 miles of known roosting sites, and should consider sea level rise and local seasonal flood events. Patch size of protected cultivated lands should be at least 160 acres.

Rationale. Since the most important stressor on greater sandhill crane in its wintering grounds is the conversion of suitable crops to unsuitable crops, the key to long-term conservation of the winter population is sustaining sufficient amounts and types of suitable cultivated lands.

Since crop patterns are subject to agricultural economic influences, the extent of the landscape that provides suitable habitat for the crane is uncertain over time. Additionally, many of the cultivated lands in the greater sandhill crane's wintering areas in the Central Valley have been converted from crop types that provide habitat for the species to unsuitable vineyards. Therefore, the strategy for the greater sandhill crane is focused on conserving cultivated lands that provide high-value habitat for the crane, to increase the stability and certainty of compatible crops in the greater sandhill crane's wintering area.

Objective GSHC1.1 requires that conservation lands providing foraging habitat be within 2 miles of known roost sites: This is because the highest levels of use are typically within approximately 2 miles of known roosts, and use (measured as a function of observed crane density) decreases beyond approximately 2 miles of a roost (Ivey pers. comm.). Objective GSHC1.1 also specifies that 80 percent of this foraging habitat will be managed at the highest habitat value in any given year (Table 3-X). Waste corn is the key food item for wintering greater sandhill cranes; therefore corn is considered the highest-value crop type. Rice is also a very high-value type. Managing protected lands to maximize food value for cranes could be important in sustaining the winter population.

Sea level rise and local seasonal flood events will be considered when siting conservation lands, because crane foraging habitat is likely to become unsuitable at lower elevations with sea level rise as these areas become flooded. Additionally, crane habitat may become unsuitable as a result of large flood events within river floodplains. The minimum patch size is relatively large (160 acres) to minimize the potential effects of human-associated visual and noise disturbances.

Objective GSHC1.2: Create high-value foraging habitat

Increase the acres of high-value greater sandhill crane winter foraging habitat by protecting low-value habitat or nonhabitat areas and converting it to high- or very high-value habitat. Created habitat should be in Planning Unit 15, within 2 miles of known roosting sites, and should consider sea level rise and local seasonal flood events.

Rationale. Creating or enhancing foraging habitat by converting unsuitable crops to high-value crops will help to redress the past conversion from high-value to low-value crop types. Sea level rise and local seasonal flood events should be considered when siting conservation lands because crane foraging habitat is likely to become unsuitable at lower elevations with sea level rise as these areas become flooded. Additionally, crane habitat may become unsuitable as a result of large flood events within river floodplains.

Objective GSHC1.3: Create managed wetland roosting habitat

Increase the acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the Greater Sandhill Crane Winter Use Area[3] *in planning unit 15, with consideration of sea level rise and local seasonal flood events. The wetlands should be located within 2 miles of existing permanent roost sites and protected in association with other protected natural community types at a ratio of 2:1 upland to wetland to provide buffers around the wetlands.*

Rationale. Managed wetlands provide suitable foraging habitat and potential roosting habitat for greater sandhill cranes. The managed wetlands should be conserved in association with other natural community types at a ratio of 2:1 upland to wetland to provide buffers around the wetlands that will protect cranes from the types of disturbances that would otherwise result from adjacent roads and developed areas (e.g., roads, noise, visual disturbance, lighting). This is the average upland to wetland ratio for crane roosting habitat on Stone Lakes National Wildlife Refuge (McDermott pers. comm.).

RCIS/LCP Objective GSHC1.4: Create flooded cornfield roosting and foraging habitat

Increase the acres of roosting habitat within 2 miles of existing permanent roost sites, consisting of active cornfields that are flooded following harvest to support roosting cranes and that provide highest-value foraging habitat. Individual fields should be at least 40 acres and can shift locations throughout the Greater Sandhill Crane Winter Use Area (see species account, Figure A).

Rationale. This type of crane roosting habitat is usually temporary as a result of seasonal changes in farm practices, crop rotational changes, or other management. This habitat type supplements the more static managed wetlands that serve as the primary roosting areas for cranes. These temporary roosting/foraging habitats allow cranes to vary their seasonal movement patterns and spread out into otherwise underused areas; it also reduces opportunities for excessively dense roosting concentrations. This objective is designed to provide similar function by allowing fields to rotate through the crane's winter use area. This can serve as a secondary source of high-value crane roosting/foraging habitat and provide a dynamic element to crane conservation.

3 Important geographically defined greater sandhill crane wintering areas in the Central Valley (Pogson and Lindstedt 1988; Littlefield and Ivey 2000; Ivey pers. comm.) (Figure 2A.19-2).

Table F-7. Assigned Greater Sandhill Crane Foraging Habitat Value Classes for Agricultural Crop Types

Foraging Habitat Value Class	Agricultural Crop Type
Very high	Corn, rice
High	Alfalfa, irrigated pasture, wheat
Medium	Other grain crops (barley, oats, sorghum)
Low	Other irrigated field and truck crops
None	Orchards, vineyards

F.3.14.2 Climate Change

Greater Sandhill Crane Vulnerability to Climate Change

According to the Climate Vulnerability Assessment, greater sandhill crane is not considered a priority with respect to climate vulnerability, receiving a climate vulnerability score of 28 (Table 3-5); however greater sandhill crane may be vulnerable to the effects of climate change due to drier conditions from less precipitation, predicted decrease in grasslands up to 20% by 2070 (PRBO Conservation Science 2011), and changes in water management decisions that affect the availability of fresh emergent wetlands and agricultural types (e.g., moist croplands with rice or corn stubble) used by sandhill cranes.

Table F-8. Climate Vulnerability Scoring for Greater Sandhill Crane as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	3 – high; taxon uses only specific habitat type or elements
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	2 - moderate; short distance migrant (movement primarily restricted to the nearctic zone)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

Models used to predict future habitat distributions affected by climate change predict that sandhill crane winter range in the Central Valley will decrease in extent and shift northward (National Audubon Society 2015). Greater sandhill crane winters in the strategy area where it frequents annual and perennial grassland habitats, moist croplands with rice or corn stubble, and open, emergent wetlands (Appendix C Covered Species Account). Habitat for the sandhill crane, (e.g., native prairie, floodplains, and wetlands) are likely to be impacted by climate change as drier conditions and more demand for water may result in changes in agricultural practices that result in fewer rice fields, fewer flooded fields, and potential conversion of privately managed wetlands into other land uses. Loss of wintering habitat may be a limiting factor on population growth of sandhill cranes, which could become more limiting with a changing climate.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The voluntary actions recommended in the conservation strategy aim to reduce the stressors of climate change by protecting known winter roosting locations, providing suitable roosting and foraging habitat, and expanding protections and management of foraging habitat surrounding roosting locations. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function, taking into consideration potential future conditions with climate change. Achieving Objective L2-1, *Hydrologic and Geomorphic Process*, would increase natural floodplains and increase the availability of suitable roosting and foraging habitat for cranes by restoring riverine hydrologic and geomorphic processes. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. To offset the potential loss of foraging habitat due to decreased water availability, achieving actions in the conservation strategy promote working with private land owners on cultivated lands, including Goal CL1, *Cultivated land habitat conservation*, and creating incentive programs to encourage planting of good forage crops to offset effects of climate change. Additional protection, management, and restoration of California prairie (Goal CP1) and fresh emergent wetland (Goal FW1) will retain, if not increase, suitable habitat for greater sandhill cranes in the strategy area, allowing the cranes to adapt to changing habitat conditions under climate change. Achieving Goal GSHC1, *Protection and expansion of greater sandhill crane*, will protect, maintain, and create high value foraging habitat near roosting sites, as well as increase the availability of wetland roosting habitat, buffering the existing population from the stressors of climate change. By increasing the amount of protected habitat, and restoring foraging and roosting habitat surrounding roosting sites, the conservation strategy builds repetition into the region so that if historic roosting and foraging habitats are no longer viable due to warmer and drier conditions, other agricultural fields and wetlands, that remain viable, will be protected and managed for greater sandhill crane.

F.3.15 Northern Harrier

F.3.15.1 Rationale for Northern Harrier Goals and Objectives

Goal NH1: Protected Northern Harrier Habitat

How the landscape and natural community objectives contribute to northern harrier conservation:

- *Objectives L1.1*, *Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3, Hazardous Human Uses*. Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect northern harriers from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving this objective will further provide for monitoring and adaptive management to address threats to northern harriers from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements*. Achieving this objective provides for patches of marsh and other suitable northern harrier habitat within the agricultural matrix and on agricultural fields.
- *Objectives CL1.1, Mixed Agricultural Uses with Habitat Values; CP1.1, California Prairie Protection; FW1.1, Protect Fresh Emergent Wetlands*; *FW1.2, Increase Fresh Emergent Wetland Areas;* and *VP1.1, Protect Vernal Pool Complexes*. Achieving this objective will provide for protection and restoration of northern harrier nesting and foraging habitat.
- *Objectives CP1.2, Burrowing Rodents;* and *CP1.3, Grazing Regimes*. Achieving this objective will provide for increases in northern harrier rodent prey on California prairie and managing these lands to optimize foraging value for the species.

The landscape and natural community objectives will provide for the conservation of northern harrier in Yolo County, and no species-specific conservation goals and objectives are necessary for this species.

F.3.15.2 Climate Change

Northern Harrier Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), northern harrier was given a score of 12, and was not considered a priority with respect to climate vulnerability (Table 3-6); however, the northern harrier continues to show local population declines due to extensive habitat loss, as grasslands and wetland communities are converted to agriculture or development (California Partners in Flight 2000). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows (PRBO Conservation Science 2011) affecting grassland, pastureland, and wetland habitat available to the northern harrier in the strategy area.

Table F-9. Climate Vulnerability Scoring for Northern Harrier, as Described in Gardali et al. (2012)[1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	1 – low; taxon uses a wide variety of habitat types
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	1 - low; year-round resident
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of northern harrier occurrence in the strategy area could decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Similarly, the Audubon Climate Report predicts the winter range of northern harrier to be stable, though its breeding range is predicted to contract and shift northward (National Audubon Society 2015). The Point Blue Conservation Science model predicts that areas currently with higher probability of occurrence, such as Knights Landing, Kings Farm, and northeast of Yolo (with 60-80% probability) could decrease to 0-40%, depending on the climate model used to predict future distributions. Parts of the strategy area that may be more resilient to climate change impacts (i.e., those that retain a relatively higher probability of occurrence with climate change) include areas west of Prospect Slough and east of Saxon in the southern portion of the strategy area. Additionally, a small area west of the Sacramento River, near Tule Jake Road, maintains higher probability of occurrence than the surrounding areas.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The voluntary actions recommended in the conservation strategy aim to reduce the stressors of climate change on northern harrier by protecting and enhancing occupied habitat and protecting, enhancing, and restoring otherwise suitable nesting and foraging habitat. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term ecological function, taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change.

Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases habitat values under changing climate conditions. Goal CP1, would protect, restore, and enhance California prairie through appropriate grazing management, implementing beneficial management techniques, and promoting prairie pollinators, reducing stressors on native grasslands and further enhancing the climate resilience of this natural community that provides habitat for northern harrier. This will also provide beneficial conditions for burrowing mammals and an improved prey base for northern harriers. Similarly, achieving Goal FW1, will protect, restore, and enhance fresh emergent wetlands, which will retain, if not increase suitable nesting and foraging habitat for harriers in the strategy area, allowing northern harrier populations to respond to changing habitat conditions under climate change. Achieving Goal NH1, *Northern harrier habitat*, protects habitat in and near occupied habitat and manages agricultural and natural foraging habitat for the benefit of the species. Focusing on the protection of nesting locations and improving suitable habitat within and adjacent to known occurrences will allow the northern harrier to respond to the effects of climate change in the strategy area.

F.3.16 Bank Swallow

F.3.16.1 Rationale for Goals and Objectives

Goal BS1: Bank Swallow Conservation

How the landscape and natural community-level objectives contribute to the conservation of bank swallow:

- *Objectives L1.1, Landscape Connectivity*; *L1.2, Areas to Support Sustainable Populations*; and L1.3, *Environmental Gradients*. Achieving this objective provide for the conservation of large interconnected area across environmental gradients to support sustainable populations of bank swallow and their food sources, and provide for shifts in distribution with climate change.
- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains*. Achieving this objective will restore natural fluvial processes to improve habitat conditions, including natural, eroding banks that include cavities, depressions, and vertical faces to support bank swallow.
- *Objective L3.1, Invasive Species*. Achieving this objective provides for control of invasive plant species that outcompete native grasses and forbs providing the highest value foraging habitat for bank swallow (Bank Swallow Technical Advisory Committee 2013).
- *Objective L3.3, Hazardous Human Uses*. Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect bank swallows from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving this objective will further provide for monitoring and adaptive management to address threats to the bank swallow from climate change.

Objective BS1.1: Protect habitat

Increase protection of floodplain habitat for bank swallow along Cache Creek and the Sacramento River, prioritizing protection of occupied sites.

Rationale. Bank swallows depend on floodplains, which provide foraging habitat and actively erode to form steep cut-banks, the nesting habitat for nest cavity construction. Protecting channel banks from anthropogenic alterations (predominantly bank stabilization and rip-rapping) ensures that natural processes of bank habitat creation continue and bank swallow nesting habitat is maintained. Habitat formation and degradation is a natural process of stream bank cutting and channel erosion and deposition. Including channel banks that support suitable bank swallow nesting substrate and channel banks that are actively eroding within the reserve system will help ensure the continued availability of nesting habitat to support the existing breeding population. Covered activities will avoid bank swallow nests.

Objective BS1.2: Manage and enhance habitat

Manage and enhance bank swallow habitat to improve bank swallow foraging habitat values.

Rationale. Achieving the objective will improve bank swallow foraging habitat on the Cache Creek floodplain. The Bank Swallow Technical Advisory Committee recommends management of floodplains supporting bank swallow to promote open grass and forb vegetation, including management actions that stimulate new plant growth and reduce invasive plant species to enhance production of insects that provide high-value food for bank swallows (Bank Swallow Technical Advisory Committee 2013).

F.3.16.2 Climate Change

Bank Swallow Vulnerability to Climate Change

The Climate Vulnerability Assessment gave bank swallow a score of 32, and the species is considered a low priority with respect to climate vulnerability. Bank swallow is vulnerable to the effects of climate change due to its high degree of habitat specialization and an expected decrease of habitat along all major streams in the strategy area.

Table F-10. Climate Vulnerability Scoring for Bank Swallow as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10-50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	3 – high; taxon that use only specific habitat types or elements
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions

Criteria	Score[2, 3]
Migratory status	3 - high; long-distance migrants (migrates at least to the neotropics)
Dispersal ability	1 – low; taxa with high dispersal ability

[1] Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

[2] Scores range from 1 – 3; generally low, medium, and high

[3] Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

In the strategy area, bank swallow is known to nest along Cache Creek and Sacramento River (Appendix C, *Species Accounts*). Already limited breeding habitat could be further stressed under hotter and drier conditions. Less water availability could result in reduced riparian and floodplain habitat, the primary breeding and foraging habitats for bank swallow. Extreme weather events may further decrease habitat suitability for bank swallow.

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of bank swallow occurrence in the strategy area would decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011) and the species may shift its range northward (National Audubon Society 2015). The models predict significant decrease in probability of occurrence throughout the strategy area, down from 60-80% along Cache Creek and Sacramento River to an overall 0-20% probability of occurrence in the future. Pockets of habitat remain, with 20-40% probably of occurrence in the western portion of the strategy area in the Upper Cache Creek watershed near Wilbur Springs and south of Guinda, 20-40% probability of occurrence near El Rio Villa in the southwestern portion of the strategy area, and 20-40% near the confluence of the Feather and Sacramento River in the eastern portion of the strategy area.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The primary threat to bank swallow in the strategy area from climate change are continued human population growth and increasing water demand, which could result in permanent or semi-permanent loss of nesting habitat from bank armoring and changes in river systems leading to the loss of nesting habitat. Nesting habitat is already limited in the strategy area, so further loss would make nesting less successful. RCIS recommended voluntary actions in the conservation strategy focused on large interconnected landscapes (Objectives L1-1 through L1-5) provides for nesting and foraging habitat connectivity and maintenance and restoration of interconnected suitable habitat. Restoring riverine hydrologic and geomorphic processes (Objective L2-1) would create nesting habitat in the strategy area and control of invasive species (Objective L3-1) would benefit existing populations, facilitating future population growth. The conservation strategy promotes landscape and natural community resilience to climate change by recommending and prioritizing strategies that (Objective L4-2 and L4-3), if followed through voluntary actions, will result in certain conservation outcomes. Voluntary actions include restoring degraded areas to desired habitat conditions, maintaining those habitat values under changing climate, and incorporating redundancies into protect areas; these actions support future habitat needs and allow bank swallow the opportunity to move from one refuge to another as climate conditions change. Bank swallows have highly specialized habitat requirements, and achieving the conservation strategies' objectives of protecting, increasing, and enhancing riparian habitat as well as stream systems in Yolo County

(Objective R1.1 through R1.3 and Objective LR1.1 and LR1.4) would improve and expand nesting and foraging habitat for bank swallow. Actions protecting channel banks from anthropogenic alterations and prioritizing protection of occupied sites, would provide suitable nesting habitat where this species is known to occur (Objective BS1.1). By strategically managing and enhancing bank swallow habitat (Objective BS1.2), the conservation strategy aims to improve and expand existing habitat so that if current nesting locations are no longer suitable due to changing climate conditions, other stream reaches will now be managed and protected for the species. Further actions to remove unnecessary rip-rap on the banks of the Sacramento River (Objective BS1.2-5) further creates suitable nesting substrate and will help offset the negative effects that climate change might have on the species.

F.3.17 Black Tern

F.3.17.1 Rationale for Goals and Objectives

Goal BT1: Sustain Black Tern Habitat

How the landscape and natural community objectives contribute to black tern conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients*. Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving this objective will further provide for monitoring and adaptive management to address threats to black terns from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements*. Achieving this objective provides for patches of marsh and other suitable black tern habitat within the agricultural matrix and on agricultural fields.
- Objectives *CL1.1, Mixed Agricultural Uses with Habitat Values; FW1.1,* and *Protect Fresh Emergent Wetlands*; and *FW1.2, Increase Fresh Emergent Wetland Areas*. Achieving these objectives provide for protection of rice lands and protection and restoration marsh providing habitat for black tern.

The landscape and natural community objectives will conserve black tern in Yolo County, and no species-specific conservation goals and objectives are necessary for this species.

F.3.17.2 Climate Change

Black Tern Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), black tern was given a climate vulnerability score of 40, and was considered a moderate priority with respect to climate vulnerability (Table 3-7). Black tern is vulnerable to the effects of climate change, primarily because it is a long distance migrant, with a highly specialized habitat preference for inland freshwater wetlands.

Table F-11. Climate Vulnerability Scoring for Black Tern, as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	2 - moderate; food availability for taxon may decrease
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	3 – high; taxa use only specific habitat types or elements
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	3 - high; long-distance migrants (migrates at least to the neotropics)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

Models used to predict future habitat distributions affected by climate change predicts a modest loss of breeding habitat, with black tern's range shifting northward (National Audubon Society 2015). Formerly nesting in ephemeral seasonal marshes, populations of black tern have declined throughout its range, especially in the Central Valley, where black terns nest adjacent to rice fields due to the lack of suitable freshwater habitat in most national wildlife refuges and state wildlife areas during the summer in the Sacramento Valley (Appendix C Species Account). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows (PRBO 2011). Changes in the amount of precipitation, and changes in water management practices could reduce the extent of land used to grow rice, and potentially could result in the conversion of privately managed wetlands into other land uses that are incompatible with black tern habitat use. Additionally, black tern is an area-dependent species that requires large or isolated marsh complexes for nesting (Appendix C Species Account); this sensitivity makes black tern further vulnerable to the effects of climate change and habitat fragmentation.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy aims to reduce the stressors of climate change on black tern by recommending and prioritizing strategies protecting and enhancing occupied habitat, and protecting, enhancing, and restoring otherwise suitable nesting and foraging habitat. Achieving Objectives L1-1, *Landscape Connectivity*, and L1-3, *Environmental Gradients*, will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change and reduce the stressors of habitat fragmentation. Achieving Objective L4-2, *Landscape Resilience with Climate Change* and Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will further provide for monitoring and adaptive management to address threats to black terns from climate change. Achieving Goal CL.1, *Cultivated Land Habitat Conservation*, will incorporate heterogeneity within the agricultural matrix to provide habitat elements, such as patches of marsh and other suitable black tern habitat, on agricultural fields, ensuring black terns have suitable nesting and foraging opportunities. In the likely event current habitat conditions degrade under climate change scenarios, achieving Goal FW 1, *Fresh Emergent Wetland Conservation*, will protect, maintain, enhance, and increase the extent of wetlands in the strategy area, with a goal to maintain habitat values under changing climate conditions. Protecting nesting habitat and enhancing habitat within and adjacent to occupied habitat will provide opportunities for black tern to respond to the effects of climate change in the strategy area.

F.3.18 Western Yellow-Billed Cuckoo

F.3.18.1 Rationale for Goals and Objectives

Goal WYBC1: Sustain or Increase Western Yellow-billed Cuckoo Habitat

How the landscape and natural community objectives contribute to western yellow-billed cuckoo conservation:

- *Objectives L1.1, Landscape Connectivity,* and L1.3, *Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will benefit western yellow-billed cuckoo by restoring natural fluvial processes to floodplains. Because western yellow-billed cuckoo habitat is typically associated with the primary floodplain, floods may regularly reduce the cuckoo's prey base. The western yellow-billed cuckoo prey base, largely katydid and sphinx moth larvae, winters underground. In wet years, cuckoos must forage in upland areas until the prey base in the lower floodplain recovers (Riparian Habitat Joint Venture 2004). Setting back levees to provide wide floodplains is expected to provide areas in the upper floodplain that do not flood as frequently and are refuges for western yellow-billed cuckoo prey.

Natural fluvial disturbances promote regeneration of riparian structural diversity, which is expected to improve western yellow-billed cuckoo habitat. Breeding habitat for the cuckoo typically has high structural diversity, with relatively closed primary canopy and a dense shrub layer (Hammond 2011). Continuing habitat succession is identified as important in sustaining breeding populations (Laymon 1998). Riparian systems subject to natural erosional and depositional processes and channel cut-off to create oxbow lakes provide conditions conducive to the establishment of new stands of willow, which create high-value nesting habitat (Laymon 1998; Greco 2012). Habitat along channelized streams or levied systems that restrict these natural processes may become over-mature and less optimal.

- *Objective L3.1*, *Invasive Species.* Achieving this objective provides for control of invasive plant species that may degrade western yellow-billed cuckoo habitat by diminishing riparian structural diversity. This species requires structural diversity in its breeding habitat. Large, monotypic stands of invasive plants can diminish this structural diversity and render habitat unsuitable for the western yellow-billed cuckoo. The nonnative invasive Himalayan blackberry, for example, often invades riparian restoration sites and does not provide the same habitat structural complexity as other riparian plant species: this invasive species may inhibit establishment of other understory species that form important structural components of western yellow-billed cuckoo habitat (Hammond 2011).

- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western yellow-billed cuckoos from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change; and L4.4, Population Viability and Biodiversity Resilience with Climate Change*.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to western yellow-billed cuckoos from climate change.
- *Objectives R1.1, Protect Riparian Areas; R1.2, Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas.* Achieving this objective will benefit western yellow-billed cuckoo by conserving, increasing, and maintaining and enhancing habitat for this species. This objective stresses the need for structural complexity, including understory (low shrubs), midstory (large shrubs and small trees) and overstory (upper canopy formed from large trees) in riparian vegetation. The best habitats for nesting western yellow-billed cuckoos are those with moderately large and tall trees and high canopy cover and foliage volume (Laymon et al. 1997).

Objective WYBC1.1: Protect western yellow-billed cuckoo habitat

Increase protection of western yellow-billed cuckoo habitat, in addition to the 500 acres protected by the Yolo HCP/NCCP.

Objective WYBC1.2: Restore western yellow-billed cuckoo habitat

Increase the acres of western yellow-billed cuckoo habitat in Yolo County, with the land cover types that comprise the species' modeled habitat (in addition to the 60 acres restored by the Yolo HCP/NCCP).

Rationale. Riparian habitat loss and fragmentation is a key factor in the decline of the western yellow-billed cuckoo (78 FR 61622: October 13, 2013). As a result, this species currently breeds in scattered locations where fragmented suitable habitat remains. Protecting and restoring western yellow-billed cuckoo habitat will help ensure the availability of foraging habitat necessary to support migrant western yellow-billed cuckoo using Yolo County. This will also provide nesting habitat to accommodate the potential reestablishment of a breeding population in Yolo County.

F.3.18.2 Climate Change

Western Yellow-Billed Cuckoo Vulnerability to Climate Change

The Climate Vulnerability Assessment gave Western yellow-billed cuckoo a score of 40 and the species is considered a moderate priority with respect to climate vulnerability (Gardali et al 2012). The species is vulnerable to the effects of climate change due to its high degree of habitat specialization, expected change in habitat suitability along all major streams in the RCIS area, and with a potential increase in exposure to extreme weather events because it is a long-distance migrant.

Table F-12. Climate Vulnerability Scoring for Western yellow-billed cuckoo as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10-50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	2 – moderate; taxon is expected to be exposed to some increase in extreme weather events
Sensitivity	
Habitat specialization	3 – high; taxon that use only specific habitat types or elements
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	3 - high; long-distance migrants (migrates at least to the neotropics)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

While there are few records of Western yellow-billed cuckoo in the strategy area, the species presumably historically nested along the west side of the Sacramento River and along smaller tributary drainages, including Putah Creek, Willow Slough, and Cache Creek (Appendix C Covered Species Accounts). Currently little suitable breeding habitat remains in Yolo County for the species due to the lack of contiguous patches of riparian habitat. Already limited breeding habitat in the strategy area could be further stressed under warmer and drier conditions. Climate change may also alter the plant species composition and humidity of riparian forests over time; decrease riparian cover and drier conditions would negatively impact a species in which micro-climate is important in suitable habitat selection for yellow-billed cuckoo. Altered climate conditions may also change food availability for yellow-billed cuckoo if timing of peak insect emergence changes in relation to when the cuckoos arrive on their breeding grounds to utilize this critical food source for successful reproduction.

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distribution affected by climate change predict the probability of yellow-billed cuckoo occurrence in the RCIS area could increase over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Models predict an increased probability of occurrence over a larger area, with a higher probability (60-80%, up from 40-60%) along Cache Creek, Willow Slough, and Putah Creek; models also predict an increase probability for occurrence along the Sacramento River. Overall the models predict increased overall probability of Western yellow-billed cuckoo occurrence along riparian corridors in the Sacramento Valley. There are ample opportunities for the species to expand its nesting range within the strategy area based on these models predictions, particularly if the conservation strategy protects and manages riparian and stream habitat.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

To successfully nest, cuckoos require large patches of riparian corridors. Achieving Goal L1, *Large interconnected landscapes*, reduces habitat fragmentation allowing existing cuckoo populations to expand within the strategy area from current occupied habitat to areas with potentially higher habitat suitability under future conditions. A threat to yellow-billed cuckoo from climate change could be a change in hydrologic conditions; achieving Goal L2, *Ecological Processes and Conditions*, would restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing yellow-billed cuckoo populations from climate change stressors. Achieving Objective L4-2, *Resilience to Climate Change* Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat, all of which will serve to maintain and expand functional riparian habitat for the species in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes. Achieving Goal WYBC1, *Western yellow-billed cuckoo habitat*, will protect and restore occupied riparian habitat, buffering the existing species population from the stressors of climate change. Focusing on the protection of nesting locations and improving suitable habitat within and adjacent to known occurrences will allow the yellow-billed cuckoo to respond to the effects of climate change in the strategy area.

F.3.19 Least Bell's Vireo

F.3.19.1 Rationale for Goals and Objectives

Goal LBV1: Least Bell's Vireo Habitat

Sufficient habitat in Yolo County to support least Bell's vireos that migrate through, and to support potential future reestablishment of a nesting population.

How the landscape and natural community objectives contribute to least Bell's vireo conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objective L1.5, Ecotone Conservation.* Achieving this objective provides for the protection and management of ecotones between riparian vegetation and more upland areas. Least Bell's vireos are among many riparian species that commonly use upland habitat adjacent to riparian nesting sites; these upland areas act as both flood refugia and supplemental foraging areas. Additionally, natural uplands adjacent to restored and protected riparian natural community are important for reducing adverse effects of adjacent land use. Vireos with territories bordering on agricultural land and urban areas are significantly less successful in producing young, compared to vireos in territories bordering undeveloped uplands (Riparian Habitat Joint Venture 2004).

- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will benefit least Bell's vireo by restoring natural fluvial processes to floodplains. Least Bell's vireo will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early- to midsuccessional riparian vegetation, consistent with this objective. Early- to midsuccessional vegetation comprises the dense shrub cover required by least Bell's vireo for nest concealment as well as structurally diverse canopy for foraging (Kus 2002).
- *Objective L3.1, Invasive Species.* Achieving this objective provides for control of invasive plant species that may degrade least Bell's vireo habitat by diminishing riparian structural diversity. This species requires structural diversity in its breeding habitat. Large, monotypic stands of invasive plants can diminish this structural diversity and render habitat unsuitable for least Bell's vireo. The nonnative invasive Himalayan blackberry, for example, often invades riparian restoration sites and does not provide the same habitat structural complexity as other riparian plant species: this invasive species may inhibit establishment of other understory species that form important structural components of least Bell's vireo habitat. Least Bell's vireos nest in small willows and understory shrubs, therefore understory vegetation is critical to their nesting success. This objective also provides for the control of invasive brown-headed cowbirds if they are found to be adversely affecting least Bell's vireos in Yolo County.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect least Bell's vireos from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2*, *Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to least Bell's vireos from climate change.
- *Objectives R1.1, Protect Riparian Areas; R1.2, Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas.* Achieving this objective will benefit least Bell's vireos by conserving, increasing, and maintaining and enhancing habitat for this species, including maintaining and enhancing structural diversity of riparian vegetation.

Objective LBV1.1: Protect and Manage Least Bell's Vireo Habitat

Increase protection of least Bell's vireo habitat, in addition to the habitat protected by the Yolo HCP/NCCP, and manage that habitat for the species.

Objective LBV1.1: Restore least Bell's vireo habitat

Increase the acres of least Bell's vireo habitat in Yolo County, with the land cover types that comprise the species' modeled habitat (in addition to the 600 acres of habitat restored by the Yolo HCP/NCCP).

Rationale. The least Bell's vireo is an obligate riparian breeder that typically inhabits structurally diverse woodland containing dense cover within three to six feet of the ground for nesting, and a dense stratified canopy for foraging. The least Bell's vireo has been extirpated from Yolo County as a nesting species; however, it is expanding its nesting range northward and has recently been observed in Yolo County during the breeding season (although there are no documented breeding records yet). Protecting and restoring least Bell's vireo habitat will help ensure the availability of foraging habitat necessary to support migrant least Bell's vireo using

Yolo County and the availability of nesting habitat to accommodate the potential reestablishment of breeding in Yolo County.

F.3.19.2 Climate Change

Least Bell's Vireo Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), Least Bell's vireo was given a score of 40 and moderate climate priority. The species was considered a priority with respect to climate vulnerability (Table 3-14). Least Bell's vireo is vulnerable to the effects of climate change due a potential increase in exposure to extreme weather events because it is a long-distance migrant and it high habitat specialization on willow-dominated riparian corridors.

Table F-13. Climate Vulnerability Scoring for Least Bell's Vireo as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	3 – high; taxon is expected to be exposed to major increase in extreme weather events
Sensitivity	
Habitat specialization	3 – high; taxa use only specific habitat types or elements
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	3 - high; long-distance migrants (migrates at least to the neotropics)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict the winter and breeding range of Least Bell's vireo occurrence in the strategy area would increase over time (National Audubon Society 2015).

How the RCIS/LCP Conservation Strategy Addresses Climate Change

There are opportunities to implement recommended actions in the RCIS conservation strategy to support predicted increased habitat suitability for Least Bell's vireo in the strategy area by protecting of known breeding locations, providing suitable nesting and foraging habitat, and expanding protections and management of foraging habitat surrounding those nesting locations.

Much of the riparian habitat throughout the range of the Least Bell's vireo has been fragmented (Kus 2002); under drier climate change scenarios, habitat fragmentation may be exacerbated by reduced precipitation and streamflows. Achieving Objectives L1-1, *Landscape Connectivity*, and L1-3, *Environmental Gradients*, will provide for the conservation of large interconnected areas of nesting and foraging habitat that can support Least Bell's vireo. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. The riparian system is adapted to periodic flooding and flooding is currently restricted in the majority of Least Bell's vireo nesting habitat (Kus 2002). Restoring riverine hydrologic and geomorphic processes, achieving Objective L2-1, *Hydrologic and Geomorphic Process*, would increase natural floodplains and increase the availability of suitable nesting and foraging habitat for vireos. Least Bell's vireo will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early- to midsuccessional riparian vegetation. Early- to midsuccessional vegetation comprises the dense shrub cover required by least Bell's vireo for nest concealment as well as structurally diverse canopy for foraging (Kus 2002). Increased reproductive success would lessen the negative effects of climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Similarly, achieving Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat, all of which will serve to maintain and expand functional riparian habitat for the Least Bell's vireo in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes in the strategy area, reducing stressors on riparian communities, making the natural community more resilient to climate change. Additional protection, restoration, and management of riparian nesting habitat will retain, if not increase suitable habitat for Least Bell's vireo in the strategy area. Successful implementation of actions that achieve Goal LBV1, *Least Bell's Vireo Habitat*, would protect, manage, enhance, and increase available vireo nesting habitat for the benefit of the species. It controls vireo nest parasites, thereby facilitating reproductive success and making the nesting population of Least Bell's vireo more resilient to effects of changing climate. Focusing on the protection of known nesting locations and improving suitable habitat within and adjacent to known occurrences will allow Least Bell's vireo to respond to the effects of climate change in the strategy area.

F.3.20 White-Tailed Kite

F.3.20.1 Rationale for Goals and Objectives

Goal WTK1: White-Tailed Kite Habitat

How the landscape and natural community objectives contribute to white-tailed kite conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.

- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect white-tailed kites from adverse effects of noise, light, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to white-tailed kites from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving these objectives provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for white-tailed kites and their prey in Yolo County.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements.* Achieving these objective provides for patches of woodlands and other suitable white-tailed kite habitat within the agricultural matrix and on agricultural fields, for white-tailed kite nesting.
- *Objective CL1.1, Mixed Agricultural Uses with Habitat Values.* Achieving these objectives provides for the maintenance of crop types that provide foraging value for white-tailed kites.
- *Objectives WF1.1, Increase valley Oaks; WF1.2, Protect Valley Oaks; WF2.1, Protect Upland Oaks; WF2.2, Restore Upland Oaks; WF3.1, Protect Riparian Oaks;* and *WF3.2, Restore and Enhance Riparian Oaks.* Achieving these objectives are expected to benefit white-tailed kites by providing nesting habitat.
- *Objectives R1.1, Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving these objectives provide for the protection and restoration of riparian habitat that provides nesting habitat for white-tailed kites.

The landscape and natural community objectives will provide for the conservation of white-tailed kite in Yolo County, and no species-specific conservation goals and objectives are necessary for this species.

F.3.20.2 Climate Change

White-Tailed Kite Vulnerability to Climate Change

The Climate Vulnerability Assessment gave white-tailed kite a score of 16, and the species is not considered a priority with respect to climate vulnerability (Table 3-9); however, the species continues to show local population declines due to extensive habitat loss as grasslands and wetland communities are converted to agriculture or development (California Partners in Flight 2000). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows (PRBO Conservation Science 2011); in the strategy area, a reduction of grassland and fresh emergent wetlands would result in reduced nesting and foraging habitats that white-tailed kite utilize. Additionally, decreased water availability may result in agricultural crop conversion, favoring less water intense crop; crop conversion to types that do not support sufficient prey or restrict accessibility to prey for white-tailed kite, may result in abandonment of traditional nesting territories.

Table F-14. Climate Vulnerability Scoring for White-tailed Kite as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	1 – low; taxon uses a wide variety of habitat types
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	1 - low; year-round resident
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of white-tailed kite occurrence in the strategy area would decrease over time, but the species range may expand into the foothills east of the strategy area and westward toward the Coast Range (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Similarly, the Audubon Climate Report predicts continued potential for winter range expansion and a shift in the breeding range to areas with higher elevation in California (National Audubon Society 2015). Models predict overall lower probability of occurrence throughout the strategy area from 40-60% down to 20-40%. Areas in the strategy area that are predicted to be more resilient to climate change (i.e., have a higher probability of occurrence under future climate change scenarios) and more likely to provide habitat for white-tailed kite than other parts of the strategy area are located generally on the Sacramento River around Discovery Park.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy aims to reduce the stressors of climate change on white-tailed kite by protecting occupied habitat, provide suitable nesting and foraging habitats, and expand protections and management of suitable foraging habitat surrounding known occurrence locations. A non-migratory species, the white-tailed kite relies on local habitat conditions to persist; achieving Objective L1.3, *Environmental Gradients*, will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving RCIS/LCP Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving Objectives CP1.1, *California Prairie Protection*; CP1.3, *Burrowing Rodents*, CP1.4, *Grazing Regimes*; and CP1.2, *Restore and Enhance Native Prairie*, provides for the protection, restoration, and enhancement of the natural community that provides grassland habitat for white-tailed kites and their prey in Yolo County. Additionally, voluntary action achieving Objective CL1.1, *Mixed Agricultural Uses with Habitat Values*, provides for the maintenance of crop types that provide foraging value for white-tailed kites. Achieving Objectives WF1.1 through WF3.2, would increase, protect, and restore oak woodland habitat and increase the availability of nesting habitat for kites. Similarly, achieving Objectives R1.1, *Protect Riparian Areas*, and R1.2, *Increase Riparian Habitat Areas*, provide for the protection and restoration of riparian habitat that provides nesting habitat for white-tailed kites. By restoring degraded areas to desired habitat conditions, maintaining those habitat values under climate change, and incorporating redundancies into protected areas, these actions support future habitat needs and provides opportunities for white-tailed kite to respond to changing climate conditions.

F.3.21 California Black Rail

F.3.21.1 Rationale for Goals and Objectives

Goal BBR1: California Black Rail Habitat

How the landscape and natural community objectives contribute to black rail conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change, including sea level rise.
- *Objective L1.5, Ecotone Conservation.* Achieving this objective provides for the protection and management of ecotones between marshes and adjacent uplands. This is important to California black rails to provide upland refugia during flood events.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect black rails from adverse effects of noise, light, habitat degradation, and other disturbances from nearby developed areas or operations and maintenance activities.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to black rails from climate change.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving these objectives provide for protection and restoration of California black rail habitat.

Objective CBR1.1: Protect California Black Rail Habitat

Increase the protection of California black rail habitat in Yolo County, including patches of marsh greater than 20 acres in size, with land cover types and in locations that comprise the species' modeled habitat, prioritizing protection of occupied habitat or habitat where potential for occupancy is high (species account, Appendix A).

Objective CBR1.2: Restore California Black Rail Habitat

Increase the acres of California black rail habitat in Yolo County, with the land cover types and in locations that comprise the species' modeled habitat (species account, Appendix A).

Objective CBR1-3: Enhance California Black Rail Habitat

Enhance California black rail habitat by increasing its ability to support the species.

Rationale. These objectives address the need to ensure that some of the protected and restored freshwater emergent wetland meets specific habitat requirements for California black rail. High-water and predator refugia are important components of California black rail habitat that have been eliminated or degraded in many areas where black rails occur or previously occurred. This loss subjects rails to increased flood and predation risks. The CVFPP Conservation Strategy calls for protection of California black rail habitat in patch sizes greater than 20 acres (DWR 2016).

F.3.21.2 Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), California black rail was given a score of 49, and was considered a high priority with respect to climate vulnerability (Table 3-10). California black rail is vulnerable to the effects of climate change due to expected loss of wetland habitat in the Bay Area from sea level rise, high habitat specialization of coastal wetlands and freshwater estuaries, and potential increase in exposure to extreme weather events.

Table F-15. Climate Vulnerability Scoring for California Black Rail, as Described in Gardali et al. (2012)[1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	3 – high; habitat suitability is expected to decrease by >50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	3 – high; taxon is expected to be exposed to major increase in extreme weather events
Sensitivity	
Habitat specialization	3 – high; taxa use only specific habitat types or elements
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	1 - low; year-round resident
Dispersal ability	2 – moderate for short-distance migrants (movements primarily restricted to the nearctic zone)

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

The western population of black rail is generally restricted to the tidal marshlands of the northern reaches of the San Francisco Bay estuary, however, several small fragment subpopulations exist in southeastern California (Sierra foothills and Sacramento Valley) where freshwater marshlands occur (Evens et al. 1991; Richmond et al., 2008). Loss of habitat associated with water-management practices for agriculture, salt production in coastal wetlands, and filling for urbanization has significantly reduced black rail populations in western U.S. (Evens et al. 1991). The effects of climate change may further exacerbate the threats to California black rail through loss of upland habitat (used as escape cover during high tides) caused by sea level rise predicted under climate change scenarios; and diversion of freshwater inflow to San Francisco Bay as water demand increases (Eddleman et al. 1994).

How the RCIS/LCP Conservation Strategy Addresses Climate Change

Voluntary actions recommended in the conservation strategy aim to reduce the stressors of climate change on California black rail by protecting occupied habitat, providing suitable nesting and foraging habitat, and expanding protections and management of suitable foraging habitat. A year-round resident, California black rail relies on local habitat conditions to persist. Black rails are sensitive to isolation of wetland patches, and that with increased isolation between wetland patches can lead to local extinction, for a given patch size (as increasing patch size reduces local extinction probability). Thus, it is important to protect a network of large well-connected habitat patches (Risk et al. 2011). The conservation strategy aims to support black rail habitat needs through achieving Objectives L1.1, *Landscape Connectivity*, and L1.3, *Environmental Gradients*, by providing for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change, including sea level rise. Achieving Objective L1-5, *Ecotone Conservation*, provides for the protection and management of ecotones between marshes and adjacent uplands. This is important to California black rails to provide upland refugia during flood events. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions and will further provide for monitoring and adaptive management to address threats to black rails from climate change. Additionally, protection, management, and restoration of fresh emergent wetland (Goal FW1) will retain, if not increase suitable habitat for California black rail in the strategy area, providing opportunities for California black rail to respond to changing habitat conditions under climate change. Achieving Goal CBR1, *California Black Rail Habitat*, will protect, restore, and enhance the availability and quality of emergent wetlands in or near occupied or previously occupied habitat, buffering California black rail populations from the stressors of climate change.

F.3.22 Loggerhead Shrike

F.3.22.1 Rationale for Goals and Objectives

Goal LS1: Loggerhead Shrike Habitat

Sufficient habitat in Yolo County to support the population of loggerhead shrike.

How the landscape and natural community objectives contribute to white-tailed kite conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect loggerhead shrikes from adverse effects of noise, light, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to loggerhead shrikes from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving these objectives provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for foraging loggerhead shrikes and their prey in Yolo County.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements.* Achieving these objectives provides for patches of woodlands and other suitable loggerhead shrike habitat within the agricultural matrix and on agricultural fields, for loggerhead shrike foraging, nesting, and perching.

- *Objective CL1.1, Mixed Agricultural Uses with Habitat Values.* Achieving this objective provides for the maintenance of crop types that provide foraging value for loggerhead shrikes.
- *Objectives WF1.1, Increase Valley Oaks; WF1.2, Protect Valley Oaks; WF2.1, Protect Upland Oaks; WF2.2, Restore Upland Oaks; WF3.1, Protect Riparian Oaks;* and *WF3.2, Restore and Enhance Riparian Oaks.* Achieving these objectives is expected to benefit loggerhead shrikes by providing nesting and perching habitat.
- *Objectives R1.1, Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving these objectives provide for the protection and restoration of riparian habitat that provides nesting and perching habitat for loggerhead shrikes.

The landscape and natural community objectives will provide for the conservation of loggerhead shrike in Yolo County, and no species-specific conservation goals and objectives are necessary for this species.

F.3.22.2 Climate Change

Loggerhead Shrike Vulnerability to Climate Change

The Climate Vulnerability Assessment gave loggerhead shrike a score of 12, and the species is not considered a priority with respect to climate vulnerability (Table 3-11). The loggerhead shrike may be vulnerable to the effects of climate change due to a reduction of preferred nesting habitat – grasslands, pasturelands, and farmlands. Dry conditions due to less precipitation in the Central Valley (PRBO Conservation Science 2011) may result in a reduction in prey base and lower reproductive success. Additionally while loggerhead shrikes are locally abundant in Yolo County, a decline in species distribution has been noted and the species range has contracted (Appendix C Species Account). Climate change may further contribute to species range contraction.

Table F-16. Climate Vulnerability Scoring for Loggerhead Shrike as Described in Gardali et al. (2012) [1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	1 – low; habitat suitability is expected to increase or decrease by 0–10%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	1 – low; taxon uses a wide variety of habitat types
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	1 - low; year-round resident
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of loggerhead shrike occurrence in the strategy area would generally remain the same over time, with some areas showing increased probability of occurrences and other areas showing decreased probability of occurrence (Point Blue Conservation Science and California Department of Fish and Wildlife 2011).

Models predict areas with increased probability (from 20-40% up to 40-60%) include areas surrounding upper Cache Creek (west of Yolo, east of Guinda, and west of Arbuckle) and areas surrounding Woodland. Areas that show decreased probability (from 20-40% down to 0-20%) include West Sacramento, Davis, and Winters. Additionally, the models predict the loggerhead shrike range distribution slightly expands eastward toward the foothills and westward toward the Coast Range (PRBO Conservation Science 2011).

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy aims to reduce potential stressors of climate change by recommending and prioritizing strategies protecting known nesting location and suitable nesting habitat, and expanding protections and management of foraging habitat surrounding suitable nesting habitat. Achieving Objectives L4-22, *Resilience with Climate Change* and Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, will further provide for monitoring and adaptive management to address threats to loggerhead shrikes from climate change. Achieving Goal CP1, *Large contiguous areas of California prairie to support native species*, will provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for foraging loggerhead shrikes and their prey in Yolo County. Likewise, achieving Goal WF1, *Valley oak protection and restoration*; Goal WF4, *Oak woodland management*; and Goal R1, Riparian

Conservation, are expected to benefit loggerhead shrikes by providing nesting and perching habitat, if not expand potential nesting habitat for shrikes. Achieving Objective CL1.1, *Mixed agricultural uses with habitat values*, and Objectives Cl1.2, *Incorporation of habitat features*, are expected to help offset the potential negative effects of agricultural crop conversion under drier climate change conditions, ensuring sufficient prey is available for loggerhead shrike. By restoring degraded areas to desired habitat conditions, maintaining those habitat values under climate change, and incorporating redundancies into protected areas, these actions support future habitat needs and provides opportunities for loggerhead shrike to respond to changing climate conditions.

F.3.23 Yellow-Breasted Chat

F.3.23.1 Rationale for Goals and Objectives

Goal YBC1: Yellow-Breasted Chat Distribution and Abundance

Sustain and increase the distribution and abundance of yellow-breasted chat within its range in Yolo County.

How the landscape and natural community objectives contribute to yellow-breasted chat conservation:

- *L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will benefit yellow-breasted chat by restoring natural fluvial processes to floodplains. Yellow-breasted chats will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early successional riparian vegetation. The species most often forages in riparian vegetation communities early stages of succession, as opposed to young and mature forests (Melhop and Lynch 1986).
- *Objective L3.1, Invasive Species.* Achieving this objective provides for control of invasive plant species that may degrade yellow-breasted chat habitat by diminishing riparian structural diversity. This objective also provides for the control of invasive brown-headed cowbirds if they are found to be adversely affecting yellow-breasted chats in Yolo County.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect yellow-breasted chats from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to yellow-breasted chats from climate change.
- *Objectives R1.1, Protect Riparian Areas; R1.2, Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas.* Achieving these objectiveswill benefit yellow-breasted chats by conserving, increasing, and maintaining and enhancing habitat for this species, including maintaining and enhancing structural diversity of riparian vegetation.

The landscape and natural community objectives will provide for the conservation of yellow-breasted chats in Yolo County, and no species-specific conservation goals and objectives are necessary for this species.

F.3.23.2 Climate Change

Yellow-Breasted Chat Vulnerability to Climate Change

The Climate Vulnerability Assessment gave yellow-breasted chat a score of 35, and the species is considered a priority with respect to climate vulnerability (Table 3-12). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows making the yellow-breasted chat vulnerable to the effects of climate change due from the potential loss and degradation of riparian habitat (PRBO Conservation Science 2011). Additionally, because it is a long-distance migrant that likely sensitive to changes in seasonal phonologies (e.g., changes in streamflow timing that could secondarily affect prey abundance), drier conditions could impact habitat suitability for the species.

Table F-17. Climate Vulnerability Scoring for Yellow-breasted Chat as Described in Gardali et al. (2012[1]

Criteria	Score[2, 3]
Exposure	
Habitat suitability	2 – moderate; habitat suitability is expected to decrease by 10–50%
Food availability	1 - low; food availability for taxon would be unchanged or increase
Extreme weather	1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events
Sensitivity	
Habitat specialization	2 – moderate; taxon that tolerates some variability in habitat type or element
Physiological tolerance	1 – low; minimal or no evidence of physiological sensitivity to climatic conditions
Migratory status	3 - high; long-distance migrants (migrates at least to the neotropics)
Dispersal ability	1 – low; taxa with high dispersal ability

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of yellow-breasted chat occurrence in the Sacramento Valley would decrease over time, but in the strategy area, the species distribution is generally resilient with a stable probability of occurrence of 0-20% (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Some riparian corridors with current probability of occurrence of 20-40%, such as Cache Creek, Upper

Cache Creek, Putah Creek, and Sacramento River, respond favorably to the effects of climate change; these areas show the same probability of occurrence, but the range for species occurrence increases.

How the RCIS/LCP Conservation Strategy Addresses Climate Change

There are ample opportunities for the to implement voluntary actions recommended in the conservation strategy to support the potential positive effects of climate change on yellow-breasted chat habitat that are predicted to occur. As a long distant migrant, landscape and habitat connectivity, would benefit the yellow-breasted chat as it returns from its wintering grounds. Achieving Objective L1-1, *Landscape Connectivity*, and L1.3, *Environmental Gradients*, will provide for larger blocks of contiguous nesting and foraging habitat that can support yellow-breasted chat. Riparian woodland habitat is an important feature for yellow-breasted chat; Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Goal L2, *Ecological Processes and Conditions*, would restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing yellow-breasted chat nesting habitat from climate change stressors. Achieving Objective L3.1, *Invasive Species*, provides for control of invasive plant species that may degrade yellow-breasted chat habitat by diminishing riparian structural diversity. This objective also provides for the control of invasive brown-headed cowbirds that may be adversely affecting yellow-breasted chats in Yolo County; reduced stressors from invasive species, facilitates reproductive success thereby making the breeding population more resilient to climate change. Achieving Objective L4-2, *Resilience to Climate Change* and Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, both will conserve and enhance the landscape to increases its habitat value under changing climate conditions. Similarly, achieving Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat, all of which will serve to maintain and expand functional riparian habitat for the yellow-breasted chat in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes in the strategy area, reducing stressors on riparian communities, making the natural community more resilient to climate change. Additional protection, restoration, and management of riparian nesting habitat will retain, if not increase suitable habitat for the yellow-breasted chat in the strategy area.

F.3.24 Townsend's Big-Eared Bat

F.3.24.1 Rationale for Goals and Objectives

Goal TBEB1: Maintenance of Townsend's Big-Eared Bat Distribution and Abundance

How the landscape and natural community objectives contribute to yellow-breasted chat conservation:

- *L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with*

Climate Change. Achieving these objectives will further provide for monitoring and adaptive management to address threats to Townsend's big-eared bat from climate change.

Objective TBEB1.1: Protect Roost Sites

Rationale. The Townsend's big-eared bat is vulnerable to human disturbance during roosting (especially maternity roosts) and during its daily and seasonal periods of hibernation to conserve energy when inactive. Roosting habitat is limited to caves, mines, tunnels, and other features that mimic caves, such as large tree hollows, abandoned buildings with cave-like attics, water diversion tunnels, and internal spaces in bridges. Until Townsend's big-eared bat colonies are well protected, every maternal roost is important for maintaining the species in the strategy area.

F.3.24.2 Climate Change

Townsend's Big-Eared Bat Vulnerability to Climate Change

Climate influences many aspects of the Townsend's big-eared bat's life history including, their access to food, rate of energy expenditure, reproduction and development, timing of hibernation, and frequency and duration of torpor. Sherwin et al. (2013) suggest that bats specialized in root types, such as the cave dwelling big-eared bat, are at risk from changing vegetation and climate conditions.

The Townsend's big-eared bat life history centers on reproduction and meeting the energetic demands of a small insectivorous mammal (see Appendix C Species Account). As an insectivorous bat that gleans prey from foliage (CDFW 2018), the Townsend's big-eared bat depends on the availability of beetles and moths, whose activity is influenced by climatic condition (Burles et al. 2009). The projected impacts of climate change on the Sacramento Valley ecoregion will be warmer temperatures, reduced precipitation relative to current conditions, and reduced streamflow and water availability (PRBO 2011). Projected impacts of climate change may alter the temporal and spatial availability of prey for the big-eared bat, influencing other aspects of life history. Under drier climate conditions, the big-eared bat may experience dehydration stress from increased rate of evaporative water loss from naked flight membranes (Webb et al. 1995). Traveling further from roosting habitat, which are already scarce in California (Sherwin et al. 2013), to access water and food results in energetic losses and may alter reproductive success and survivability. Changes in climate conditions, such as temperature and humidity, are likely to affect the thermal properties of different roost types, which are used for reproduction, resting, torpor, and seasonal hibernation (Newson et al. 2008), which may alter roost structure selection, timing of reproduction, bouts of topor, and timing of hibernation. Climate change may affect timing of reproduction as reproduction in insectivorous bat is dependent on insect availability, can be delayed by precipitation, and warmer conditions have been shown to cause earlier parturition (Grindal et al. 1992; Burles et al. 2009).

The Townsend's big-eared bat has shown local population declines across California (CDFW 2018). Causes of population declines are most likely due to disturbance and destruction of roost sites (Western Bat Working Group YEAR), where the distribution of the species appears to be constrained primarily by the availability of suitable roosting sites and the degree of human disturbance at roosts (see Appendix C Species Account). Like other species of bat in North America, the Townsend's big-eared bat is threatened by reduction of roosting and foraging habitat that are impacted by loss of riparian habitat, loss of genetic diversity and population connectivity due to reduced population sizes or available roost sites (Western Bat Working Group YEAR). Climate change models additionally predict the frequency and intensity of climatic extreme will increase, exposing bats to more frequent climatic events. Although the pathology and mode of spread of fungal diseases, such as White Nose Syndrome, is not yet fully understood, research has shown that increased arousal in roosts and increased energetic stress is related to enhanced susceptibility to fungal infection (Jones et al. 2009, Boyles & Willis 2010).

How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy is focused on increasing permeability across the landscape to facilitate dispersal to available habitat, should pressures force them out of their current ranges, and reducing habitat fragmentation. Achieving Goal L1, *Large interconnected landscapes*, reduces habitat fragmentation allowing existing Townsend's big-eared bat populations to move within the strategy area from current habitat to areas with potentially higher habitat suitability under future conditions. Townsend's big-eared bat occurs in many habitat types in California, including agriculture, riparian communities, oak woodland, and native prairies. Habitat loss and increased completion for already scarce roosting sites will result in greater pressure on natural communities. Objective L1-4, Natural Community Restoration, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape under conditions resulting from climate change. Similarly, achieving RCIS/LCP Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving Objective L4-1, *Heterogeneity within Agricultural Lands*, would provide roosting habitat (such as snags and structural elements) to provide roosting opportunities within the agricultural landscape. Achieving Objective CL1.3, *Cultivated Land pollinators*, would benefit the big-eared bat by promoting prey availability, thereby reducing the stressors of climate change on forage availability. Achieving Objectives WF1.1 through WF3.2 would increase, protect, and restore oak woodland habitat and increase the availability of potential roosting and foraging habitat for big-eared bat. Similarly, achieving Objectives R1.1, *Protect Riparian Areas*, and R1.2, *Increase Riparian Habitat Areas*, provide for the protection and restoration of riparian habitat that provides roosting habitat for big-eared bat.

In select sites in California and in other areas, depressed populations have recovered with the protection (i.e.. gating) of roosts (Western Bat Working Group YEAR). By increasing the protection of known roosting areas, restoring degraded areas to beneficial conditions, and increasing potential roosting habitat, the conservation strategy maintains, if not increases, the availability of suitable habitat for Townsend's big-eared bat, thereby buffering the species from the stressors of climate change. Because the big-eared bat utilizes a variety of land cover types in the strategy area, even if there is a vegetation shift under climate change, habitat in the strategy area may remain suitable. However, building repetition into the region benefits the species and local population of big-eared bat, so that if current roosting and foraging habitat are no longer viable due to drier and warmer environmental conditions, other potential habitat will now be protected and managed for the species, allowing the big-eared bat to emigrate to areas of suitable climate. This, coupled with the protection and management of more habitat in the strategy area will ensure that Townsend's big-eared bat persists in Yolo County.

Appendix G

DWR Invasive Plant Management Plan

Appendix E. Invasive Plant Management Plan

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

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1.0 Introduction

The California Department of Water Resources (DWR) developed this Invasive Plant Management Plan (or Plan) as part of the Conservation Strategy of the Central Valley Flood Protection Plan (CVFPP). The Conservation Strategy tiers from the Conservation Framework, which was an integral part of the State's preferred SSIA, identified in the 2012 CVFPP. The Conservation Strategy describes how to make progress toward meeting the environmental objectives of the Central Valley Flood Protection Act of 2008 (Act) and related legislation throughout the flood management system in the Systemwide Planning Area (SPA). The SPA comprises five Conservation Planning Areas (CPAs) in California's Central Valley: the Feather River CPA, the Upper and Lower Sacramento River CPAs, and the Upper and Lower San Joaquin River CPAs (Figure 1-1). The SSIA includes developing and implementing multipurpose projects, and this Plan will guide the invasive plant management approaches undertaken as part of these projects.

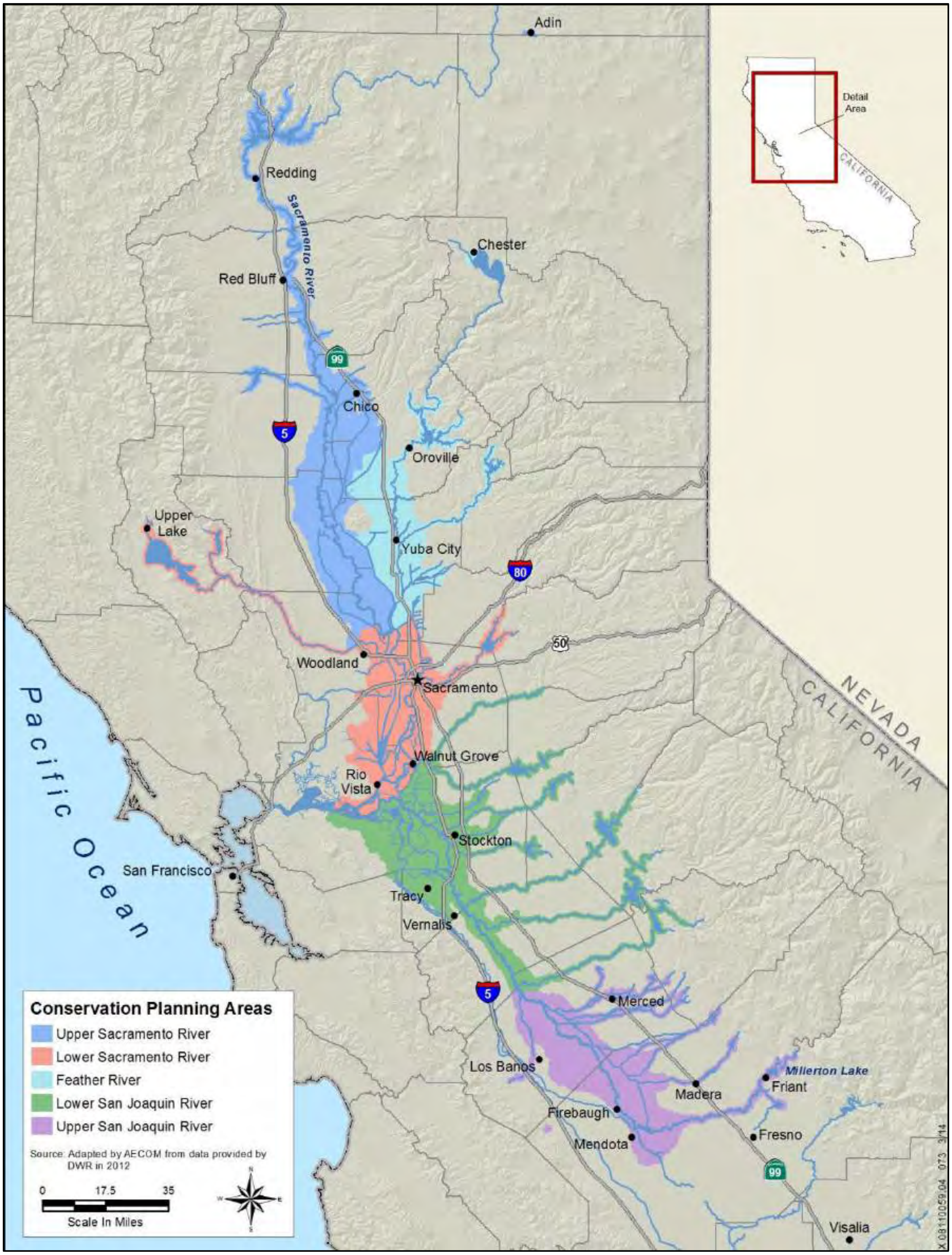
The Conservation Strategy recognizes invasive plants as a primary stressor on the habitats, species, and ecosystem processes that are the focus of conservation planning. As of 2014, at least 68 plant species considered to be invasive by the California Invasive Plant Council (Cal-IPC) potentially occur in upland, riparian, wetland, and open water habitats in the Sacramento and San Joaquin Valleys (Cal-IPC 2013a). Many are widespread and abundant in vegetation managed as part of State Plan of Flood Control (SPFC) operation and maintenance (O&M). These species degrade riverine and floodplain habitats by altering ecosystem processes and displacing native plants. In addition, some of these invasive species, such as tamarisk (or saltcedar) (*Tamarix* spp.), giant reed (*Arundo donax*), and red sesbania (*Sesbania punicea*), are stressors that increase the cost and difficulty of operating and maintaining the SPFC.

These species can alter hydrology and sedimentation rates in riparian and aquatic systems (Cal-IPC 2011a) and can degrade flood system effectiveness. Importantly, recent studies have shown that certain invasive plant species have greater impacts on channel conveyance than native species adapted to the same areas (Stone et al. 2013). Dense stands of certain invasive species can alter channel morphology by retaining sediments and increasing the hydraulic roughness of the channel, which restricts flows and reduces flood conveyance (Bossard et al. 2000). For example, saltcedar traps and stabilizes alluvial sediments, narrowing stream channels and contributing to more frequent flooding (Bossard et al. 2000). Species with shallow root systems, such as giant reed and red sesbania, promote bank undercutting, collapse, and erosion (Bossard et al. 2000; Cal-IPC 2011b). Invasive terrestrial plants can reduce groundwater availability by transpiring large amounts of water, leaving less water available for native riparian vegetation (Bossard et al. 2000).

Invasive plants can also reduce the integrity of native riparian plant communities by outcompeting native plants, reducing habitat quality and food supply for wildlife, and interfering with wildlife management (Bossard et al. 2000; Cal-IPC 2011a). Nationally, invasive species are the second greatest threat to endangered species, after habitat destruction (Cal-IPC 2011a), and approximately 42 percent of the species listed as threatened or endangered by the federal Endangered Species Act (ESA) are at risk primarily because of the adverse effects of invasive species (Pimentel et al. 2005). Aquatic invasive plants can degrade aquatic habitat by reducing areas of open water used by waterfowl for resting, by shading out algae in the water column and thereby diminishing the basis of the aquatic food web, and by displacing native aquatic plants that are used for food or shelter by wildlife (Bossard et al. 2000). In addition, invasive aquatic plants often form dense mats that kill fish by lowering pH, dissolved oxygen, and light levels and by increasing carbon dioxide and turbidity (Bossard et al. 2000).

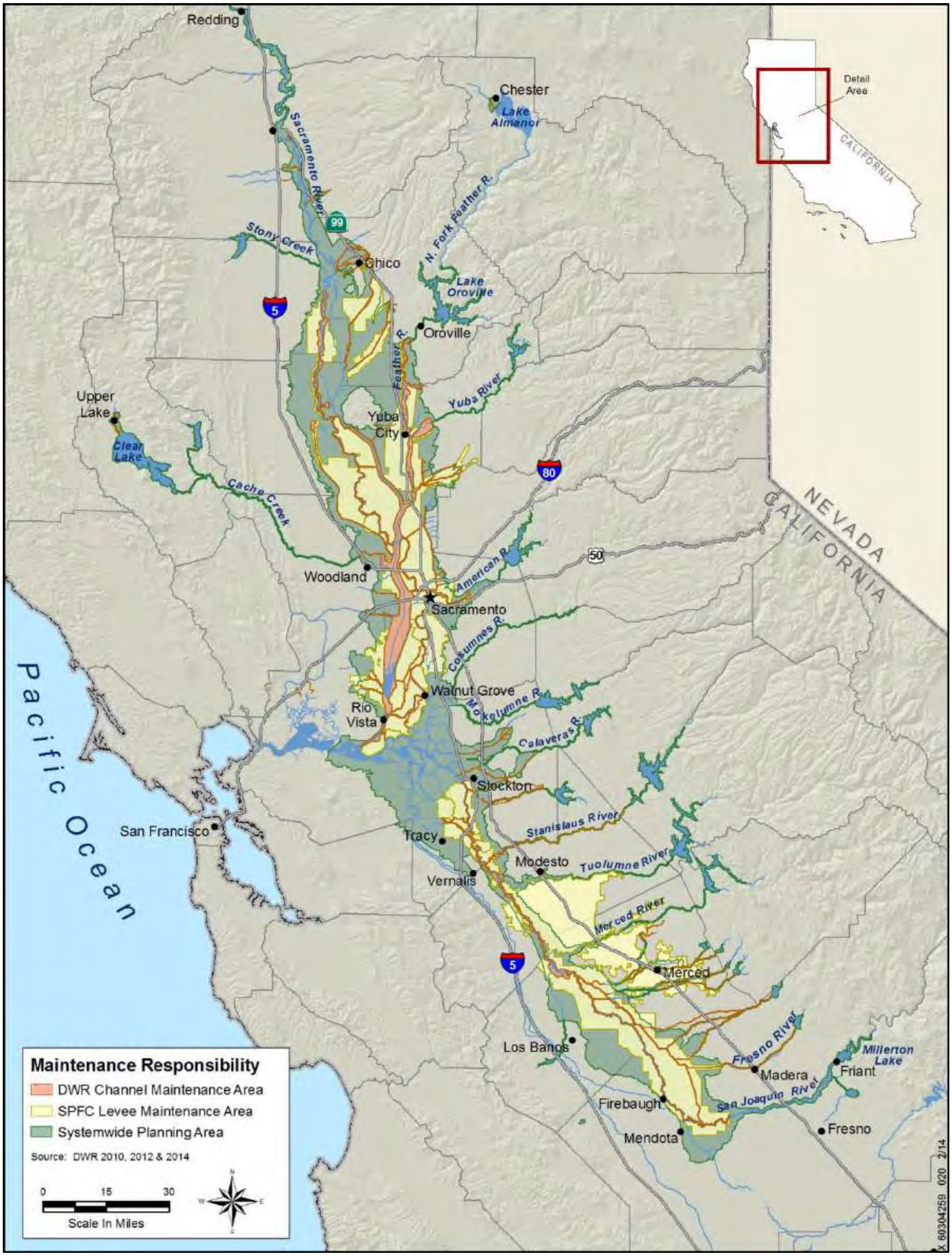
Because of these adverse effects and the threats they pose to achieving the goals of the Conservation Strategy, this Plan is driven by the following vision: *to reduce the impact of invasive plants as a stressor on conservation targets and as an impediment to the operation and maintenance of the State Plan of Flood Control*.

This Plan seeks to increase DWR institutional support for an SPA-wide invasive plant treatment program, and facilitate consistent invasive vegetation treatment actions by levee maintaining agencies and other partners such as the California Department of Fish and Wildlife and the United States Fish and Wildlife Service who are also conducting invasive plant control efforts. SPA-wide implementation of invasive plant treatment faces challenges that include ever-decreasing O&M budgets, regulatory requirements to protect sensitive resources, and the need to meet multiple and sometimes conflicting management objectives. This Plan recognizes those challenges, but it is beyond the scope of a single plan to resolve them all. Instead, the Plan provides first steps toward addressing the challenges through a series of goals, objectives, and implementation actions. The Plan includes measurable objectives for the treatment of four target species (Initial Priority Species) in Channel Maintenance Areas within the SPA (Channel Maintenance Areas; Figure 1-2) and identified in the DWR State Plan of Flood Control Descriptive Document (DWR 2010). It is the intent of this Plan to increase the resources available for invasive plant treatment actions by fashioning an approach that meets multiple needs and, therefore, may take advantage of funding sources not previously available for these actions.



Source: AECOM 2013.

Figure 1-1. CVFPP Systemwide Planning Area and Conservation Planning Areas



Sources: DWR 2010, DWR 2012, and DWR 2014.

Figure 1-2. Channel Maintenance Areas

This Plan identifies actions for DWR, levee maintaining agencies, and its partners, who share O&M duties in Channel Maintenance Areas, to address channel capacity limitations to reduce flood risk and to maintain environmental stewardship of these lands. These actions are guided by new baseline vegetation data, applied for the first time across the entire SPA. These same data guide the implementation actions proposed for partners that are outside of areas where DWR may have the ability to address them. This Plan provides resource and reference materials to facilitate consistent actions in those areas by DWR's partners.

1.1 Purpose for Invasive Plant Management Plan

The lands on which invasive plants occur in the SPA are managed by a variety of entities, including DWR, Local Maintaining Agencies (LMAs) (i.e., levee districts and reclamation districts), the California Department of Fish and Wildlife (CDFW), the U.S. Fish and Wildlife Service (USFWS), and private landowners. The diverse entities involved in invasive plant management in the SPA vary in their authorities and responsibilities making coordination between managing entities a challenge. The ability to implement the most effective SPA-wide invasive plant treatment methods is also hindered by a lack of common baseline information, shared priorities, and decreasing O&M resources. Regional factors such as upstream source populations may not be fully considered or addressed, and information characterizing the distribution of invasive plants within the SPA, which could be used to prioritize specific infestations for treatment, is lacking. A standardized SPA-wide approach to invasive plant management could improve collaboration among all maintenance entities in the SPA, and could include prioritizing the infestations that pose a threat to Conservation Strategy targets, in addition to focusing on SPFC O&M needs. It is not the intent of this Plan to propose new actions or place additional O&M burden on DWR or its partners. On the contrary, it is the intent of this Plan to increase the resources available for invasive plant treatment actions by fashioning an approach that meets multiple needs to take advantage of funding sources not previously available for these actions.

This Plan offers an SPA-wide, coordinated approach to achieving economies of scale and better treatment efficacy of invasive plant management in the SPA by providing the following:

- An inventory of invasive plants in the SPA, using the best information currently available from third parties, supplemented by information collected by DWR, to assist in preparation of the Conservation Strategy
- Identification of target invasive plant species that pose the greatest threat to the ecosystem processes, habitats, and species emphasized by the Conservation Strategy as well as negatively affecting SPFC O&M
- A method for assessing and prioritizing invasive plant populations for treatment
- Guidelines for consistent application of invasive plant treatment techniques (e.g., mechanical treatment, herbicides, grazing, and prescribed burning)

- Guidelines for restoring habitats using native species that can deter invasive plants from recolonizing treatment sites
- A proposed process to update the Plan as better information characterizing the distribution of invasive species in the SPA and potential methods to treat and eradicate these species becomes available
- Identification of other entities managing invasive plants in the SPA and throughout California, to facilitate coordination between DWR and these organizations

1.2 Legislative Direction

Legislative direction for the Conservation Strategy, of which this Plan is a part, is based on the ecological and flood management objectives of the Central Valley Flood Protection Act of 2008. Administrative direction comes from the ecosystem goals of the CVFPP and the FloodSAFE California initiative, as well as the DWR Environmental Stewardship Policy (DWR 2009). The 27 February 2009, *California Central Valley Flood System Improvement Framework* developed by the California Levees Roundtable also provides some interagency direction.

The Central Valley Flood Protection Act (California Water Code, Section 9616[a]) includes three environmental objectives:

- Promote natural dynamic hydrologic and geomorphic processes.
- Increase and improve the quantity, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine aquatic habitats, including the agricultural and ecological values of these lands.
- Promote the recovery and stability of native species populations and overall biotic community diversity.

In support of this legislation, the CVFPP sets forth a strategy to improve public safety, ecosystem functions, and economic sustainability with multi-benefit projects to the extent feasible.

In addition to the directives of the Central Valley Flood Protection Act and related CVFPP goals, a primary driving element in the development of this strategy is the DWR Environmental Stewardship Policy. Environmental stewardship is a concept of and commitment to responsibly manage and protect natural resources (water, air, land, plants, and animals) and ecosystems in a sustainable manner that ensures that they are available for future generations.

The *California Central Valley Flood System Improvement Framework* developed by the California Levees Roundtable (2009) calls for interagency direction for the development of a conservation strategy for the Central Valley flood system with an approach comparable to the

CVFPP Conservation Strategy. The California Levees Roundtable was a partnership of federal, State, and local agencies, and the framework document was developed to address vegetation issues affecting the State/federal levee system in the Central Valley. Among the elements of this framework are recommendations to develop and implement a "Multi-Species and Floodplain Conservation Strategy" and habitat enhancements as part of multi-benefit projects. Habitat enhancements implicitly include the management of invasive plants, which are a recognized stressor on the ecosystem processes, habitats, and species of plants and wildlife that are the foci of the Conservation Strategy.

1.3 Relationship to Conservation Strategy

This Plan supports the Conservation Strategy by describing goals for invasive plant and vegetation management, measurable objectives related to the goals, management actions that could be implemented to meet the goals, and indicators of success that could be monitored to indicate that the goals have been achieved or that changes in management actions are required. Furthermore, this Plan facilitates collaboration within DWR on the assessment, prioritization, and treatment of invasive plants in the SPA, as well as informing restoration actions that minimize the probability of future invasive plant establishment.

Although this Plan focuses on actions that could to be implemented by DWR within its Channel Maintenance Areas to further Conservation Strategy measurable objectives, it can be adopted by LMAs or used as a guidance document by other entities managing invasive plants in the SPA. In addition, the Plan describes the regional context within which DWR manages invasive plants, to identify the potential relationships among DWR's efforts and similar efforts being implemented outside the SPA. Although beyond the geographic scope of the Conservation Strategy, entities outside the SPA can positively contribute to the attainment of Conservation Strategy measurable objectives for invasive plants by reducing upstream source populations of these plants.

1.4 Document Organization

The remainder of this Plan is organized into the following seven sections:

- **Current DWR Practices:** This section describes, by way of introduction, current practices for DWR's SPFC O&M activities, including vegetation management; funding for these activities; and current DWR O&M practices related to invasive plant management.

- **Invasive Plant Management Approach:** This section describes DWR's proposed approach for managing invasive plants within the SPA; it includes a description of overall goals as well as objectives and implementation measures that will contribute to the goals.

- **Target Invasive Plant Species:** This section describes invasive plant species potentially found in the SPA, the processes used to select target species for this Plan, and the known distributions of these target species.

- **Invasive Plant Treatment:** This section describes general methods for prioritizing invasive plant infestations for treatment. It also summarizes relevant invasive plant treatment permitting requirements, describes recommended invasive plant management Best Management Practices (BMPs), and presents a variety of techniques that can be used by DWR to manage invasive plants. Finally, it describes guidelines for revegetating invasive plant treatment sites to minimize the potential for future infestation.

- **Monitoring and Adaptive Management:** This section describes monitoring methods that could be used to detect new infestations of invasive plants and to assess how well prior invasive plant treatment efforts have met defined goals and objectives. This section also describes measures of success and adaptive management techniques that could be implemented when monitoring indicates that goals and objectives have not been met.

- **External Partnerships and Funding Programs:** This section identifies potential collaborators and funding programs that DWR could participate in or provide support to in an effort to maximize the effectiveness of its invasive plant treatment efforts.

- **References:** This section lists the literature cited in the Plan.

2.0 Current DWR Practices

To develop a new SPA-wide approach to invasive plant management, current practices upon which the new approach may build are described first. Invasive plant management by DWR within the SPA is typically conducted as part of DWR's SPFC O&M activities when a particular infestation is in direct conflict with O&M. This section describes DWR's practices in maintaining the SPFC, the manuals and measures that guide how this maintenance is carried out, maintenance funding sources, and current vegetation management practices.

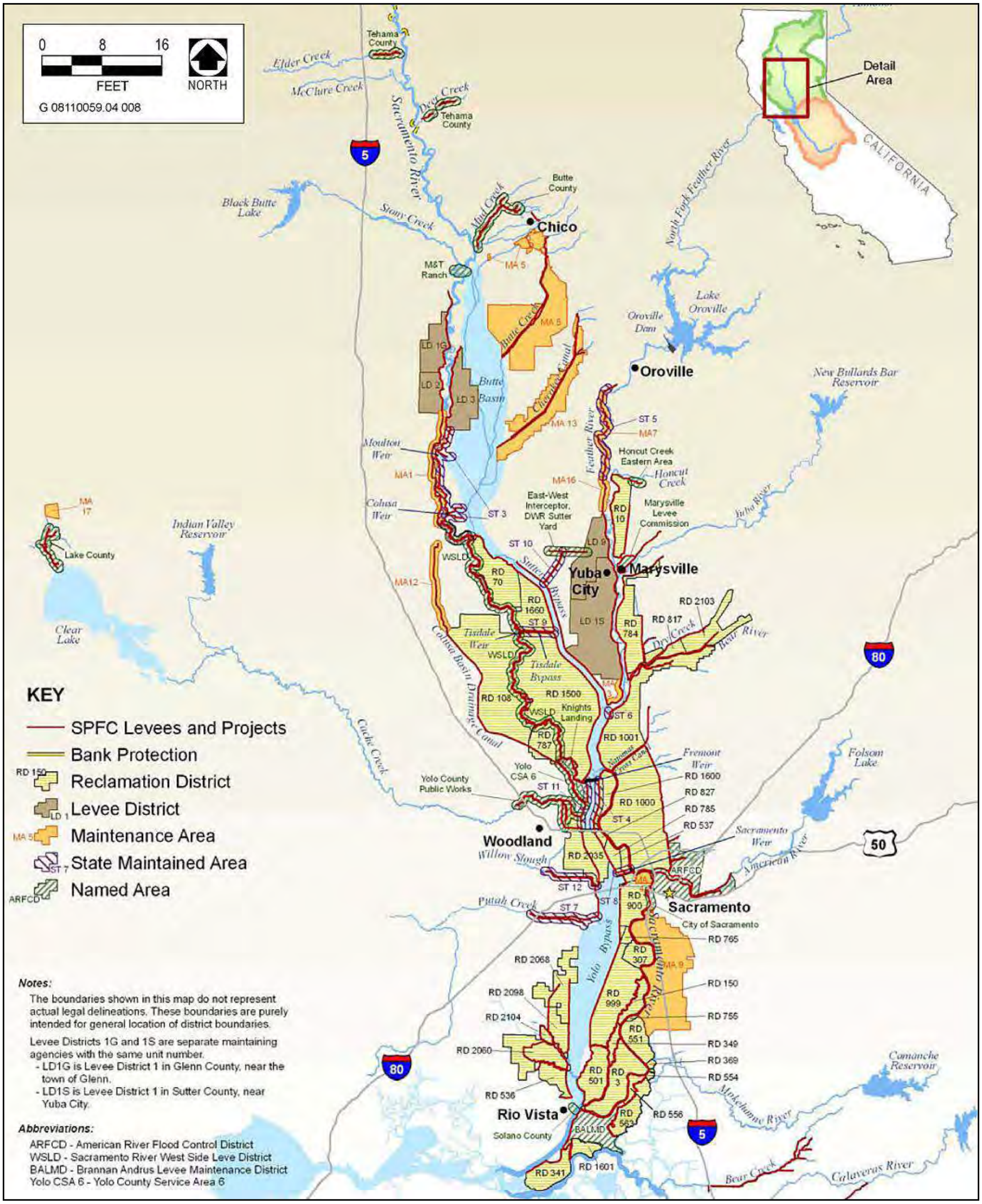
2.1 State Plan of Flood Control Operation and Maintenance

Pursuant to Title 33 of the Code of Federal Regulations, the U.S. Army Corps of Engineers (USACE) established O&M rules, regulations, and standards for flood control. These rules, regulations, and standards apply to SPFC projects, described in more detail in the SPFC Descriptive Document (DWR 2010). Title 23 of the California Code of Regulations (California Water Code) incorporates these rules, regulations, and standards, requiring the Central Valley Flood Protection Board (CVFPB) and DWR to carry them out. DWR performs inspections of the SPFC facilities and reports these findings to the CVFPB. In turn, the CVFPB provides assurances to the federal government that maintenance requirements are being fulfilled.

For maintenance purposes, the SPFC is divided into 118 different units. The management of these units is split between DWR and 81 different LMAs (Figures 2-1 and 2-2). The LMAs are primarily levee districts and reclamation districts, but they also include a variety of cities, counties, and other public agencies and municipalities.

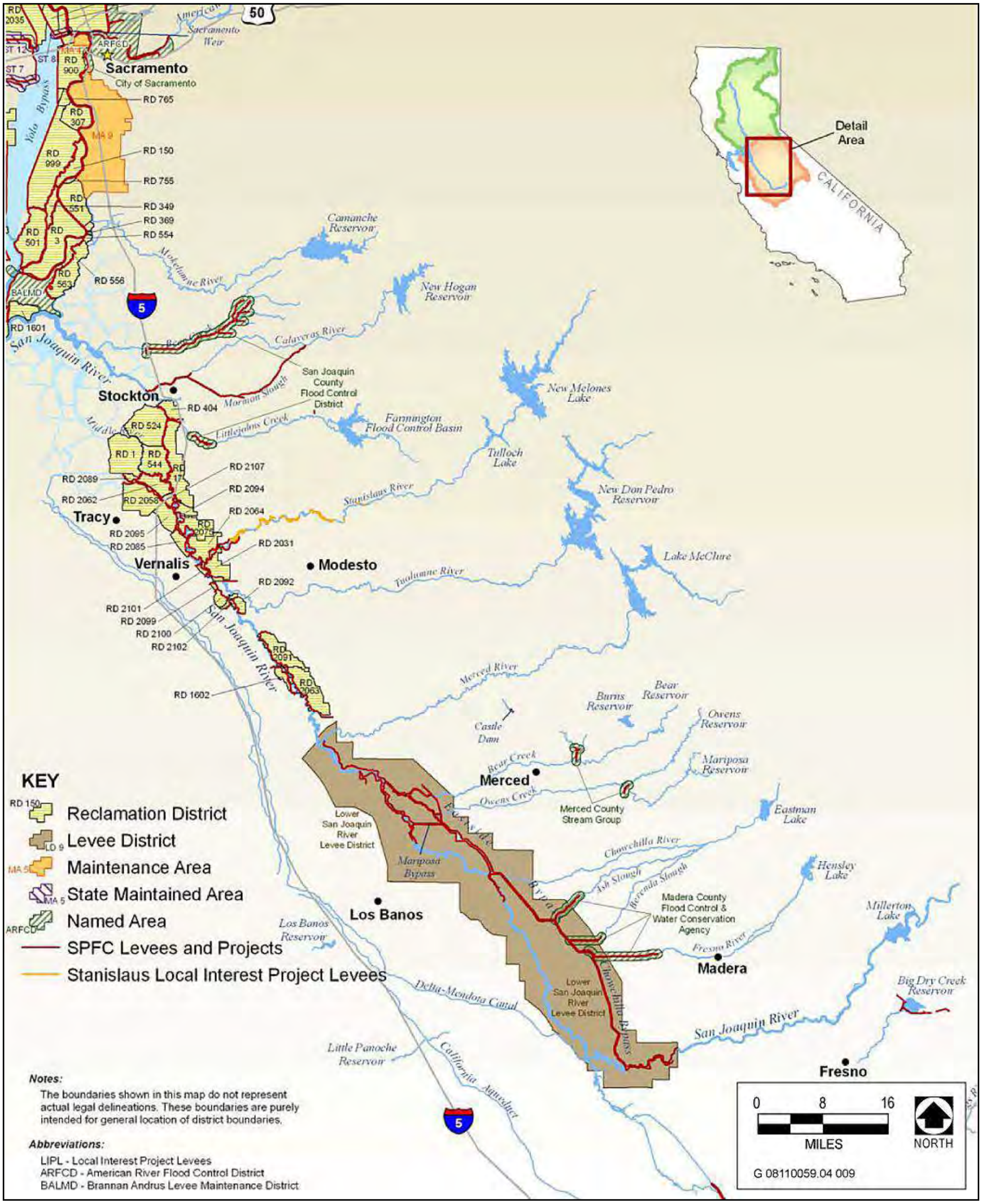
O&M requirements for most SPFC facilities are identified in two standard O&M manuals: the Standard O&M Manual for the Sacramento River Flood Control Project and the Standard O&M Manual for the Lower San Joaquin River Levees, Lower San Joaquin River and Tributaries Project. These manuals are supplemented by 118 individual project (i.e., unit-specific) O&M manuals, which can cover more than one facility. The O&M requirements for floodways (floodplain and channel areas within the bypass system) in much of the Sacramento River Basin are described in the unit-specific O&M manuals that supplement the Standard O&M Manual for the Sacramento River Flood Control Project. These manuals describe the operations and inspection responsibilities of each agency during high-water events, as well as the agencies' responsibilities for keeping the facilities in working order.

This Plan is most focused on invasive plant treatments conducted in channel areas. Because maintenance duties in these channel areas vary between DWR and LMAs within individual O&M units, this Plan refers to invasive plant treatments within the "Channel Maintenance Areas" as mapped for SPFC Descriptive Document (DWR 2010). Further planning is needed to identify and prioritize case-by-case treatments and to determine which entity or entities may implement those specific treatments.



Source: SPFC Descriptive Document, DWR 2010.

Figure 2-1. SPA Maintenance Designations, Sacramento River Region



Source: SPFC Descriptive Document, DWR 2010.

Figure 2-2. SPA Maintenance Designations, San Joaquin River Region

2.1.1 Standard Operation and Maintenance Manuals

The Standard O&M Manual for the Sacramento River Flood Control Project and the Standard O&M Manual for the Lower San Joaquin River Levees, Lower San Joaquin River and Tributaries Project were prepared by USACE in 1955 and 1959, respectively. They provide general rules and information for O&M that apply to all flood control facilities in each project area. The standard manuals conform to Title 33 of the Code of Federal Regulations, Section 208.10, which prescribes regulations that govern the maintenance and operation of flood control facilities. Examples of general rules in the standard manuals include conducting O&M for maximum benefits and in accordance with USACE prescribed regulations, maintaining a reserve supply of materials for flood emergencies, allowing no encroachments that adversely affect O&M, allowing no improvements without USACE approval, submitting a semiannual report, allowing USACE access to facilities at all times, conducting maintenance and repairs as deemed necessary by USACE, and providing coordination during flood periods. The standard manuals provide checklists for inspections; thresholds to trigger maintenance; and guidelines for maintenance efforts, including revetment work, vegetation management (which implicitly includes management of invasive plants), levee repair, burrowing animal control, and maintenance of access roads.

2.1.2 Unit-Specific Operation and Maintenance Manuals

The unit-specific O&M manuals were prepared by USACE when each unit was completed. Each manual provides details on the project authorization, flood protection features in each unit, assurances of cooperation provided by the nonfederal sponsor (usually CVFPB), supplemental O&M methods specific to that unit, and additional inspection and reporting requirements. The unit-specific O&M manuals sometimes also include as-built drawings; information on repairs or upgrades completed after construction of the original facilities; and details of ancillary features that are part of each unit, such as bridges, culverts and other drainage facilities, and other hydrographic features, such as gauges necessary for operation.

2.1.3 Superintendent's Guide

DWR produced a guide for superintendents (Superintendent's Guide) that provides another resource to explain SPFC O&M (DWR 2013). The guide provides detailed recommendations and requirements for safety measures, including pesticide application; inspections and reporting; vegetation management; levee, channel, and structure maintenance; encroachments; and emergency response. The Superintendent's Guide stresses the importance of balancing vegetation management to preserve the environment with protecting the integrity of flood control structures.

Because the Superintendent's Guide is primarily focused on vegetation management to maintain visibility for levee inspections, floodwater conveyance, and overall integrity of the SPFC, it does not specifically discuss invasive plant management as a tool for enhancing ecosystem functions. However, invasive plant management is an implicit component of vegetation management when invasive plants adversely affect levee inspections or floodwater conveyance, or otherwise threaten the integrity of the SPFC; thus, the Superintendent's Guide can be used to understand

DWR practices for invasive plant management within the context of overall levee vegetation management.

2.2 State Plan of Flood Control Operations and Maintenance Designations

Maintenance duties are shared between DWR and LMAs, and these duties vary between the Sacramento River and San Joaquin River Basins. In the San Joaquin River Basin, LMAs conduct both levee and channel/floodplain maintenance. However, in the Sacramento River Basin, levee and channel/floodplain maintenance is split between DWR and the LMAs.

For units in the Sacramento River Basin managed by LMAs, the superintendents, under the direction of the agency board of directors or board of trustees, conduct O&M of levees within their particular flood control unit. In these areas, DWR maintains channel/floodplain areas.

In areas of the Sacramento River Basin not managed by LMAs, DWR conducts maintenance both for the levees and for the channel/floodplain; these management units are called Maintenance Areas (MAs). In addition, CVFPB has the authority to form MAs if LMAs are unable to maintain the levees in their areas to State and federal standards. Maintenance responsibilities for MAs are divided between the two DWR Maintenance Yards.

Maintenance needs are identified through the inspection process. If inspections identify units where maintenance has been inadequate, CVFPB has the authority to designate the unit as an MA (California Water Code, Section 12878) and to assign maintenance responsibilities for the MA to DWR.

2.2.1 DWR Inspections

DWR inspects the SPFC facilities for compliance with federal, State, and local maintenance requirements and reports the findings of these inspections to CVFPB. It conducts two comprehensive levee inspections (spring and fall) and one channel and structure inspection (summer) each year. Representatives of DWR and the LMAs also patrol and inspect all SPFC levees during and after high-water events. Representatives of the LMAs conduct their own levee inspections in winter and summer and report their findings to DWR.

DWR inspections identify features, their types, and their locations, and document their maintenance conditions in the form of ratings. Currently, these inspections do not specifically focus on invasive plants, unless these plants are adversely affecting SPFC O&M. However, DWR does encourage LMAs to remove invasive plants wherever feasible.

DWR reports the results for individual issues by maintaining agency, levee unit, and levee mile. Based on results of these inspections, DWR and LMAs plan their maintenance activities and work toward improving the rating of features before the next inspection.

2.3 Funding for SPFC Operations and Maintenance

A reduction in O&M budget allocation in the recent past necessitates consideration of the potential budgetary implications of any future additional invasive plant treatment efforts. DFM/FMO O&M budgets are determined annually. Approximately 55–65 percent of the O&M budget is supplied by the State general fund, and the remainder is supplied through MA assessments. O&M budgets are approved through the CVFPB and are based on actual costs per task to maintain levees to State and federal standards. Funding is provided for all O&M activities, including invasive plant control, as well as support activities such as planning, environmental permitting and coordination, and design services provided by DWR's Maintenance Support Branch. Vegetation management costs are fairly consistent from year to year and vary mostly with the cost of materials. Labor and material costs associated with invasive plant control generally range from 10 to 15 percent of the total O&M budget. Although budgets are based on actual costs per task, a single budget allotment is provided for all tasks in an MA, and funds may be moved to specific tasks as needed.

2.4 Current DWR Vegetation Management Practices

Vegetation management tasks completed by DWR fall into three broad categories: levee, channel/floodplain, and structural. As stipulated by the O&M manuals, vegetation management is necessary to facilitate regular inspections of SPFC elements for functionality and safety, to enable flood fighting, and to maintain the design flood capacity of the SPFC. The scope of this management is broader than the treatment of invasive plants alone; additional guidance for the management of vegetation on levees is further described by DWR's Vegetation Management Strategy (Appendix D of the Conservation Strategy).

Vegetation management actions completed by DWR's Maintenance Yards are guided, in part, by the requirements of a California Department of Fish and Wildlife Streambed Alteration Agreement (SAA), also referred to as a Routine Maintenance Agreement (RMA), and executed between DWR and CDFW. The RMA establishes standard conditions under which maintenance can occur on specific flood control facilities and what type of maintenance work is anticipated for each covered facility. The RMA satisfies the requirements of California Fish and Game Code Section 1602, and defines where within the stream zone certain types of maintenance work may occur, defines when the work may occur, and establishes a procedure and timeline for approving work locations. The RMA can incorporate timing restrictions and other avoidance measures intended to avoid take or adverse effects on CESA-listed or California Fully Protected Species. The current RMA is due to expire in 2016 and DWR is taking steps towards an updated RMA.

DWR uses chemical and physical tools to manage vegetation consistent with RMA requirements. Physical methods include manual removal using hand tools, mechanical methods (mowing, disking, dragging, grading, mastication), burning, and grazing. Many of these methods are used in concert to reach the ultimate goal of clearing the vegetation. These methods are applied on the levee slopes, on the levee crown, and adjacent to and in the channel. Typically, with the exception of management to control invasive plants, 15-foot-wide vegetated zones extending along both banks of low-flow channels are left intact as is existing vegetation on the lower waterside slope of the levee per DWR's vegetation management strategy.

The frequency of vegetation management for each channel depends primarily on channel capacity considerations. In general, undersized flood channels that have a flow capacity less than or equal to flows expected during a 100-year flood event (i.e., the magnitude of flood flows expected to be equaled or exceeded every 100 years on average) require more frequent maintenance to preserve capacity. Oversized channels that have the capacity to convey flows in excess of those expected during a 100-year event require less frequent channel maintenance to preserve the capacity of the channel.

Specific vegetation management methods and tools routinely used by the Maintenance Yards are summarized below. Although this description is focused on activities completed by DWR within Channel Maintenance Areas, similar methods are routinely used by LMAs for the portions of the SPFC for which they have primary maintenance responsibilities.

2.4.1 Herbicides

Herbicides are applied in fall, winter, and early spring, and are rotated when possible to reduce herbicide resistance. Nonselective herbicides are used to maintain bare ground areas (e.g., levee toe roads, crown roadways, and access points). Broadleaf selective herbicides are used to remove broadleaf weeds from levee slopes. Spot spraying is used for species-specific control and for control of brush and vines that may interfere with access or visibility. All herbicides are applied according to label specifications and by a California Licensed Qualified Applicator. The RMA defers the application of time restrictions for herbicide use along levee slopes, channel slopes, and access roads to the California Department of Pesticide Regulation, and does not restrict the timing.

2.4.2 Manual and Mechanical Control of Vegetation

Vegetation is controlled manually on levee slopes and adjacent to the channel. Manual control typically involves selectively trimming or cutting down woody and brushy vegetation Mechanical vegetation management can include dragging or grading, disking or bulldozing, operating a brush hog or similar device, or mowing. Mowing typically occurs in late spring and early fall on levee slopes that are accessible and not too steep for the mower.

2.4.3 Controlled Burning

Controlled burns typically are conducted only in rural areas during midsummer to early fall (June to October) in coordination with the local air quality management district and CDFW. Burning typically is used along levee slopes to improve visibility.

2.4.4 Livestock Grazing

The Maintenance Yards use goats and sheep for grazing in limited locations. It has applied this management method only at the Fremont Weir in the late summer and early fall.

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3.0 Invasive Plant Management Approach

This section provides further detail on DWR's SPA-wide approach for treating invasive plants, with a focus on Channel Maintenance Areas as designated in the SPFC Descriptive Document (DWR 2010). The FloodSAFE Environmental Stewardship and Statewide Resources Office (FESSRO) and DWR's Division of Flood Management/Flood Maintenance Office (DFM/FMO) staff jointly developed this approach based on the following vision: *to reduce the impact of invasive plants as a stressor on conservation targets and as an impediment to the operation and maintenance of the State Plan of Flood Control*. Consistent with this vision, DWR has formulated three goals related to the management of invasive plants:

1) **Increase DWR institutional support for an SPA-wide invasive plant management in DWR Channel Maintenance Areas.** This goal involves looking internally for system or process improvements that may build institutional support and yield greater effectiveness to future coordinated treatment efforts.

2) **Develop and implement a coordinated systemwide invasive plant treatment approach within DWR Channel Maintenance Areas and effectively track results.** Achievement of this goal requires the use of new SPA-wide data to prioritize a subset of species for initial attention, and to prioritize where best to initiate treatment efforts for the benefit of both conservation targets and O&M considerations. Implementation will also include integrating a new focus on invasive plants into current practices, tracking success, and correcting course over time. DWR's implementation will focus on DWR Channel Maintenance Areas.

3) **Develop partnership opportunities and provide resources to encourage consistency with DWR's invasive plant management approach throughout the SPA.** DWR's approach is intended to facilitate consistent actions by partners (e.g., LMAs) operating outside of DWR Channel Maintenance Areas. Facilitation will be accomplished in a variety of ways, including, for example, by providing reference materials and leveraging existing invasive plant treatment efforts. Incorporating invasive plant treatment actions in funding and project selection criteria may be a way to support these actions as part of multi-benefit projects.

Each goal is supported by numerous objectives and implementation measures, summarized in Table 3-1 and described in more detail below. Explanatory text is included to identify the implementation measures that DWR has already completed (in whole or in part) and to provide further details on how DWR will complete remaining implementation measures. Implementation measures have been developed to leverage existing DFM/FMO expertise and are based on current DWR procedures and programs wherever possible.

Table 3-1. Invasive Plant Management Strategy Implementation Summary

Implementation Measure and Collaborators	Deliverable	Status
Implementation Measure 1.1.1: Organize an invasive plant management steering committee (IPMSC) to guide development of this Plan and inform DWR's invasive plant management approach *FESSRO, DFM/FMO*	n/a	Steering committee created and guiding development of this Plan
Implementation Measure 1.1.2: Considering both the potential for adverse ecological effects and adverse effects on SPFC O&M, the IPMSC will develop a prioritized list of target invasive plants to guide implementation of DWR's invasive plant management approach and to assist in development of numerical treatment acreage objectives *IPMSC*	Initial Priority Species designated with this Plan	Completion concurrent with finalization of Plan
Implementation Measure 1.1.3: Update this Plan concurrently with CVFPP updates to reflect the best available scientific information on invasive plant management, the distribution of invasive plants within the SPA, DWR practice and guidelines, and other relevant factors as determined by the IPMSC *DWR*	Updated Plan	CVFPP update scheduled for 2017
Implementation Measure 1.2.1: Prior to the end of 2018, meet with appropriate DWR staff, including members of the IPMSC, DWR management, and key partners to discuss currently identified institutional constraints, identify other potential constraints, and develop an action plan to implement potential solutions *IPMSC, DWR, External Partners*	Action plan	January 2018
Implementation Measure 2.1.1: Combine new DWR fine-scale vegetation mapping with other relevant data, to develop a comprehensive baseline map of target invasive plants within Channel Maintenance Areas and the SPA *DWR*	New map of invasive plant distributions within the SPA in Plan	Completion concurrent with finalization of Plan
Implementation Measure 2.2.1: Collaborate with DFM/FMO leadership and/or their designees to prioritize infestations of Initial Priority Species through the application of a decision support model called WHIPPET *FESSRO, DFM/FMO*	WHIPPET analysis results vetted, and treatment areas determined	2018
Implementation Measure 2.3.1: In collaboration with DFM/FMO, identify 5-year acreage treatment targets for each Initial Priority Species *FESSRO, DFM/FMO*	213 acres of invasive species infestation treated and recorded in appropriate tracking system	2018
Implementation Measure 2.4.1: Develop a comprehensive list of potential invasive plant treatment techniques, incorporating the expertise of Maintenance Yard staff, that would be effective on target invasive plants species *FESSRO, DFM/FMO*	Treatment recommendations included in this Plan	Completion concurrent with finalization of Plan
Implementation Measure 2.5.1: In consultation with DFM/FMO staff, develop appropriate avoidance and minimization measures (to minimize the unintentional introduction and spread of invasive plants) that will be applied during all invasive plant treatments *FESSRO, DFM/FMO*	Avoidance recommendations included in this Plan	Completion concurrent with finalization of Plan

Table 3-1. Invasive Plant Management Strategy Implementation Summary

Implementation Measure and Collaborators	Deliverable	Status
Implementation Measure 2.6.1: Collaborate with DFM/FMO to track progress toward defined invasive plant treatment acreage targets by adapting existing tracking and inspection systems for vegetation management. *FESSRO, DFM/FMO*	Project tracking information captured in appropriate tracking system	2018
Implementation Measure 2.7.1: Where feasible, revegetate invasive plant treatment sites with appropriate native species to reduce the probability of reinfestation by invasive plants *DWR*	n/a	As needed
Implementation Measure 3.1.1: Document all entities with SPFC maintenance responsibilities and describe their roles for invasive plant management relative to those of DWR *DWR*	Reference material included in this Plan	Completion concurrent with finalization of Plan
Implementation Measure 3.1.2: In consultation with the IPMSC, identify entities or existing collaborative efforts with the greatest potential to optimize DWR's invasive plant management approach, and develop a resource estimate for DWR participation *FESSRO, DFM/FMO, External Partners*	Analysis of existing efforts	Completion concurrent with finalization of Plan
Implementation Measure 3.2.1: Distribute this Plan, supporting information (e.g., vegetation maps or maps of invasive species), and results of follow-up actions, to LMAs and other entities managing invasive plants within the SPA, upon request *DWR*	To be determined	Completion concurrent with finalization of Plan
Implementation Measure 3.2.2: Prioritize funding proposals that include actions to map and treat target invasive plants along with other conservation and flood risk reduction actions funded through DWR to support implementation of the CVFPP *DWR*	Funding Guidelines	As needed

Key: CVFPP = Central Valley Flood Protection Plan; DFM/FMO = DWR's Division of Flood Management/Flood Maintenance Office; DWR = California Department of Water Resources; FESSRO = FloodSAFE Environmental Stewardship and Statewide Resources Office; PLAN = Invasive Plant Management Plan; IPMSC = invasive plant management steering committee; O&M = operation and maintenance; SPA = Systemwide Planning Area; SPFC = State Plan of Flood Control.

Goal 1: Increase DWR Institutional Support for an SPA-wide Invasive Plant Management in Channel Maintenance Areas

Objective 1.1: Collaborate with DFM/FMO, and other DWR Staff as Appropriate, to Develop and Maintain an Invasive Plant Management Program that Positively Contributes to the Conservation Strategy and Meets SPFC O&M Requirements

Implementation Measure 1.1.1: Convene an internal invasive plant management steering committee (IPMSC) to guide development of this Plan and inform DWR's invasive plant management approach.

DWR convened the IPMSC to support initial scoping and development of this draft Plan. The IPMSC comprises staff from FESSRO, DFM/FMO, and the Maintenance Yards, and includes ad hoc participation by additional DWR staff as appropriate (e.g., from the Division of Environmental Services [DES]). The IPMSC will continue to meet as needed to review DWR's draft invasive plant management approach, support implementation of this Plan, and foster ongoing collaboration within DWR.

Implementation Measure 1.1.2: Considering both the potential for adverse ecological effects and adverse effects on SPFC O&M, the IPMSC will develop a prioritized list of target invasive plants to guide implementation of DWR's invasive plant management approach and to assist in development of numerical treatment acreage objectives (see Objective 2.3 below).

The IPMSC developed a list of 32 target invasive plants during preparation of this Plan (see Section 4.0). Based on the best information available, these species are known to occur or could occur within the SPA, and they have documented, adverse effects on ecosystem processes and, in some cases, on SPFC O&M. The process and rationale for selecting these species are described fully in Section 4.0.

Because effectively addressing all 32 target species would be an extensive undertaking, it is beyond the scope of DWR's existing resources to effectively target each species. Therefore, the IPMSC selected four Initial Priority Species from this list: giant reed, red sesbania, saltcedar, and Himalayan blackberry (*Rubus armeniacus*). As described in Section 4.0, these species all have documented, and significant, adverse effects on both ecosystem processes and SPFC O&M. The following additional factors were considered in selecting these four Initial Priority Species:

- Availability of distribution maps: Mapping of these species across the entire SPA is currently available, and periodic updates using aerial photography are feasible, so initial baseline acreages can be cost-effectively estimated and periodically updated using DWR's available resources. Other target species may have adverse effects similar to those of the Initial Priority Species, but their distributions cannot be cost-effectively mapped and tracked at a scale that would be appropriate for development and implementation of an SPA-wide invasive plant management approach.

- Potential for adverse hydraulic effects: Recent studies have indicated that at least some invasive species have greater relative impacts on hydraulics, and, therefore, channel capacity, compared to the native species adapted to these same habitats. For example, Stone et. al. (2013) found decreased elasticity of *Tamarix* stems to have greater impact on hydraulics than native cottonwood and willow species. Similarly, Chen et al. (2009 unpublished) conducted flume studies to determine roughness characteristics of different species. They found higher Manning's "n" values associated with blackberry than for other native species. Importantly, Chen et al. also found that all vegetation roughness values significantly decreased with increasing depth, as did Aberle and Jarvela (2013) and Anderson et al. (2006). These findings suggest that standard methods employing a single roughness value to represent vegetation, regardless of water depth, may overestimate vegetation effects on decreasing channel capacity during high water events. Fortunately, new tools are in development to reduce this uncertainty and improve modeling results.

- Potential for adverse effects on SPFC O&M needs: Despite the limitations of the current planning approaches described above, the initial priority species commonly occur in dense thickets of woody, or wood-like, vegetation. Therefore, the effects of these species on SPFC O&M (e.g., effects on hydraulics and channel capacity) can be better assessed in the hydraulic models used to inform large-scale flood management planning than the adverse effects of herbaceous species, or other woody species that do not commonly occur in large, dense patches.

Implementation Measure 1.1.3: Update this Plan concurrently with CVFPP updates to reflect the best available scientific information on invasive plant management, the distribution of invasive plants within the SPA, DWR practice and guidelines, and other relevant factors, as determined by the IPMSC.

DWR anticipates updating this Plan every 5 years, concurrent with updates to the CVFPP and based on resource availability. Following finalization of the 2017 CVFPP (of which this Plan is a part), the CVFPP is next scheduled for update in 2022.

Objective 1.2: Identify and Address Potential DWR Institutional Constraints (e.g., Staff Capacity, Contracting Limitations, Funding) to Ongoing Support for Large-Scale Invasive Plant Treatment Efforts within DWR.

Implementation Measure 1.2.1: Prior to the end of 2014, meet with appropriate DWR staff, including members of the IPMSC, DWR management, and key partners to discuss currently identified institutional constraints, identify other potential constraints, and develop an action plan to implement potential solutions.

During development of this Plan, examples of past constraints on regional invasive plant management were identified by the IPMSC. These constraints affected actions that could have been implemented by DWR and/or LMAs in their Channel Maintenance Areas, as well as actions that could have been implemented by LMAs and other partners throughout the SPA. Examples of constraints included contractual constraints between DWR and an LMA wishing to conduct a project targeting one of the four Initial Priority Species, access limitations for external partners willing to treat target invasive species on adjacent DWR Channel Maintenance Areas, and DWR resource limitations that prevented the Maintenance Yards from assuming O&M responsibilities explicitly focused on invasive plants. Funding for new actions is a widely recognized limitation, and it is the intent of this Plan to increase funding for these actions as opposed to creating an additional burden on O&M budgets. The approach is fashioned to meet multiple objectives in order to benefit from new funding sources not previously available.

IPMSC discussions also addressed the interest, expressed in other branches of DWR, in coordinating efforts to manage invasive species on a broad scale, including treatment of other invasive taxa (e.g., aquatic invertebrates). Forming an internal DWR coordination group that includes appropriate external partners could facilitate future invasive species management approaches, reduce duplication of effort, and identify points of contact among external partners.

Goal 2: Develop and Implement a coordinated systemwide invasive plant treatment approach within Channel Maintenance Areas and effectively track results.

Objective 2.1: Develop a New Comprehensive Baseline for the Extent of Target Invasive Plants within the SPA to Guide Management Approach within Channel Maintenance Areas and the Actions of Others throughout the SPA

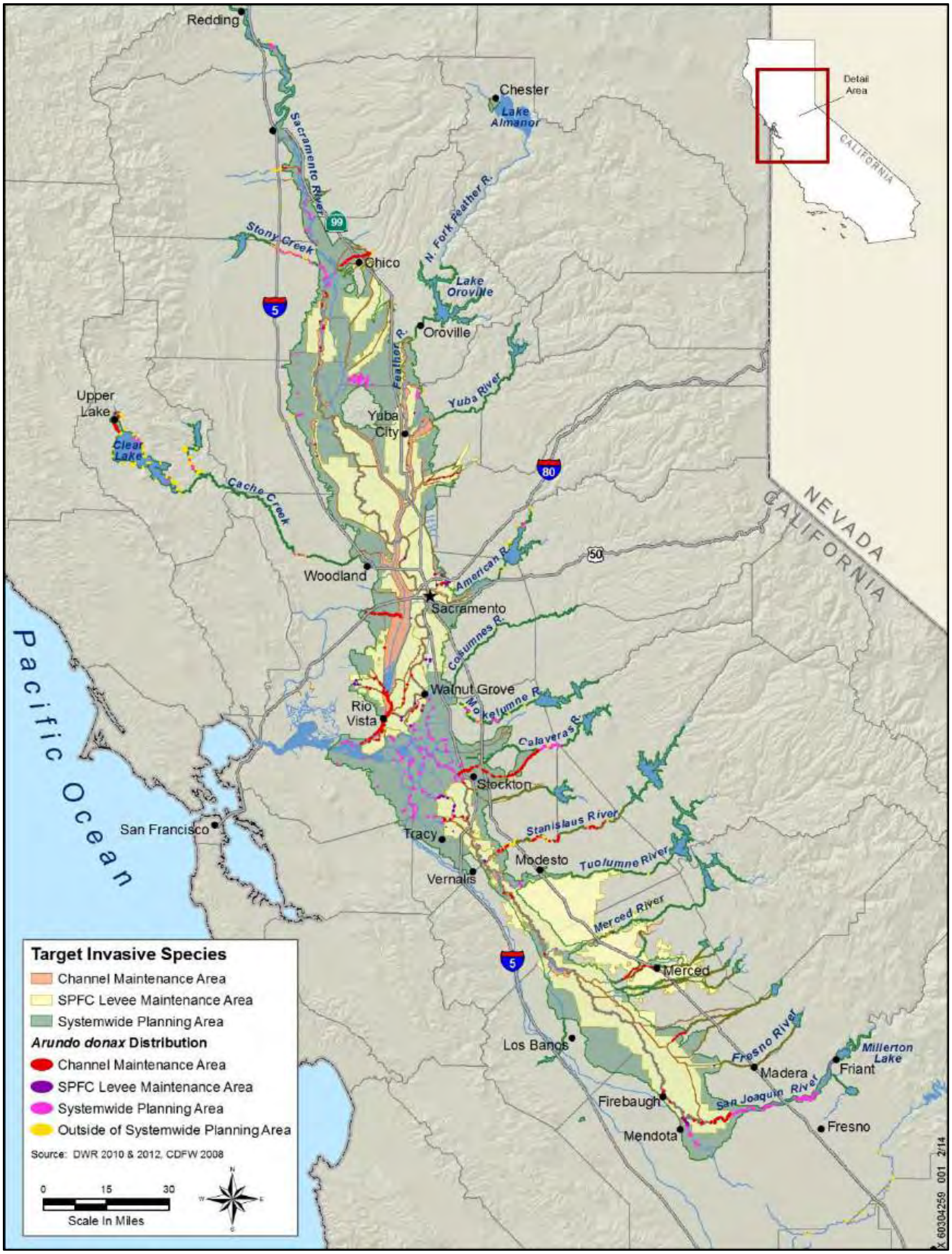
Implementation Measure 2.1.1: DWR would combine newly available, fine-scale vegetation mapping data with other relevant data to develop a baseline map of target invasive plants within Channel Maintenance Areas and the SPA.

During preparation of this Plan, recently available, fine-scale vegetation mapping covering the SPA (CDFW 2013) was combined with other geographic information system (GIS) data (CDFG 2008 and Cal-IPC 2013a) to develop a baseline map showing the acreage and spatial distribution of all four Initial Priority Species (Figures 3-1 to 3-4). Although there are acknowledged accuracy limitations with these data, they represent the best information available for estimating the distribution of the Initial Priority Species within the SPA, and the data are of sufficient accuracy to support development of DWR's approach to the management of these four species.

As described above, this Plan's initial focus on the four Initial Priority Species does not indicate that the remaining target species (identified in Section 4.0 of this Plan) are unimportant. However, DWR's approach to managing these 27 species is undetermined at this time, in part because of acknowledged resource limitations (see Implementation Measure 1.1.2) and in part because of a lack of information on the distribution and acreage of these species in the SPA. In these cases, data provided by Cal-IPC (2013b) were used to provide a coarse-scale approximation of these species' distributions within the SPA, to guide future efforts by DWR and external partners. Figures 3-5 and 3-6 show the approximate frequency of occurrence for these remaining 27 invasive species within the Sacramento River and San Joaquin River Regions, to be used as an approximate current baseline against which future conditions can be compared.

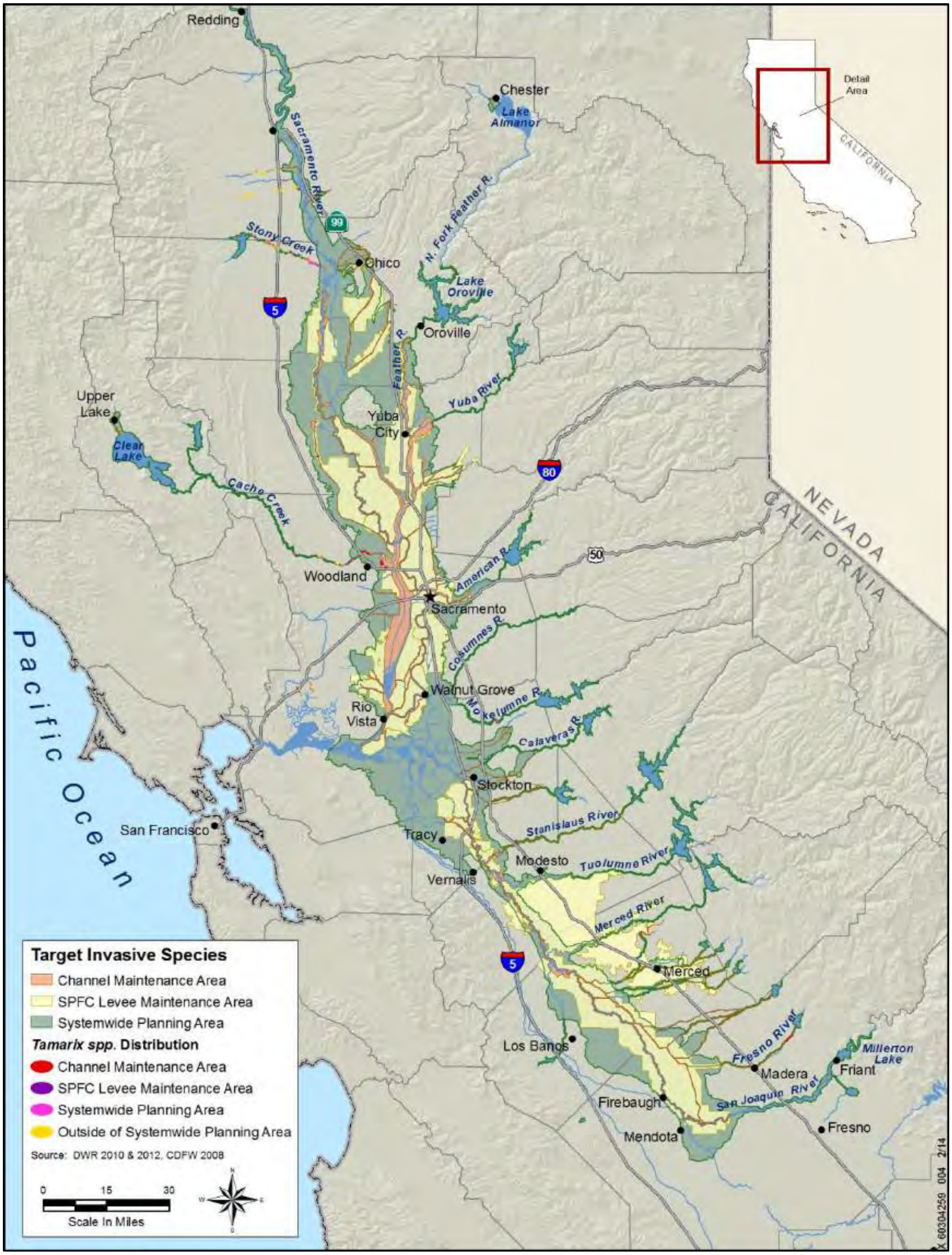
Objective 2.2: Prioritize Populations of Initial Target Species for Treatment to Create Multiple Benefits for Conservation Strategy measurable objectives and SPFC O&M

Implementation Measure 2.2.1: Collaborate with DFM/FMO to prioritize infestations of Initial Priority Species plants through the application of a decision support model called WHIPPET.



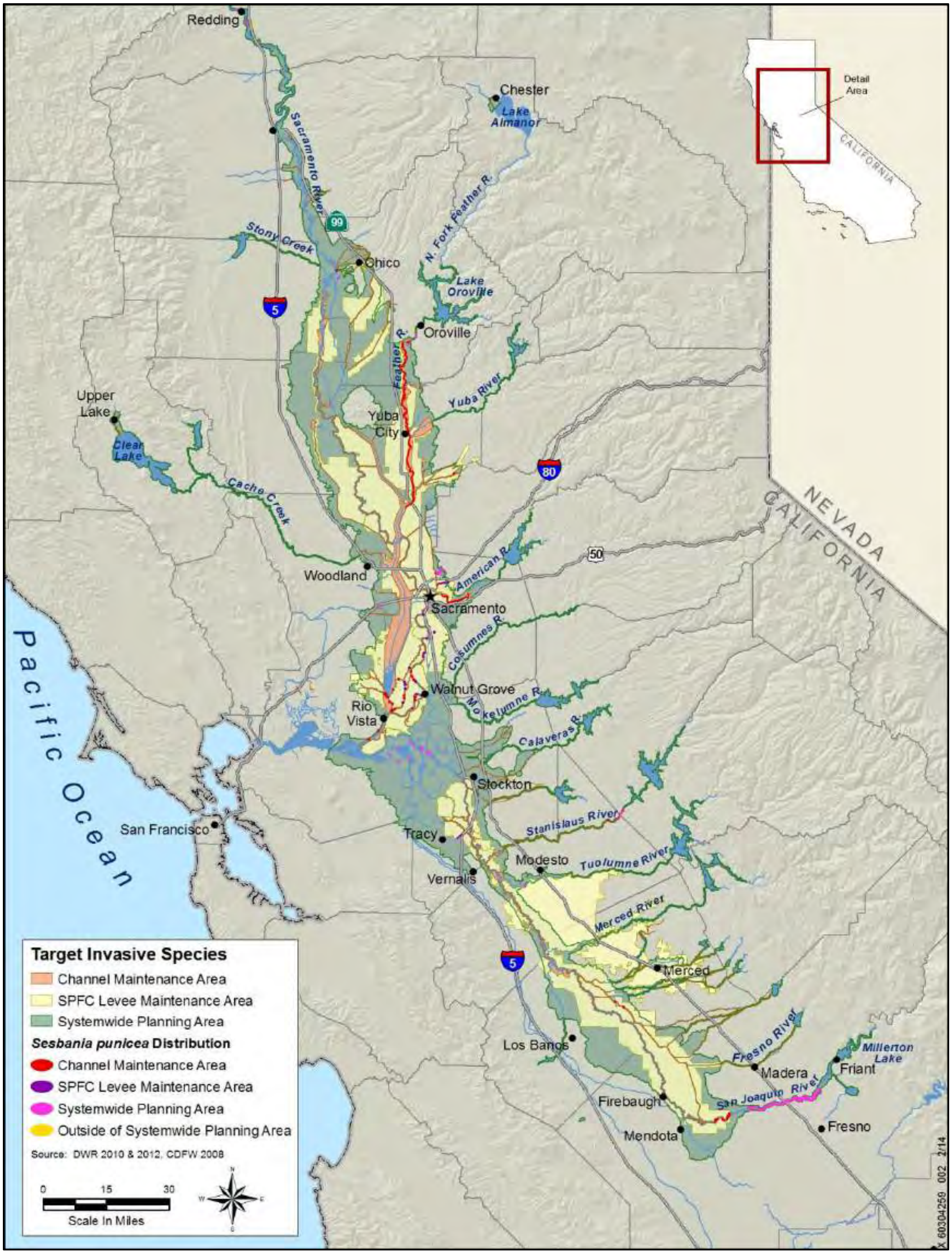
Sources: Cal-IPC 2013b, CDFG 2008, DWR 2010, and DWR 2012.

Figure 3-1. Distribution of Giant Reed within the SPA



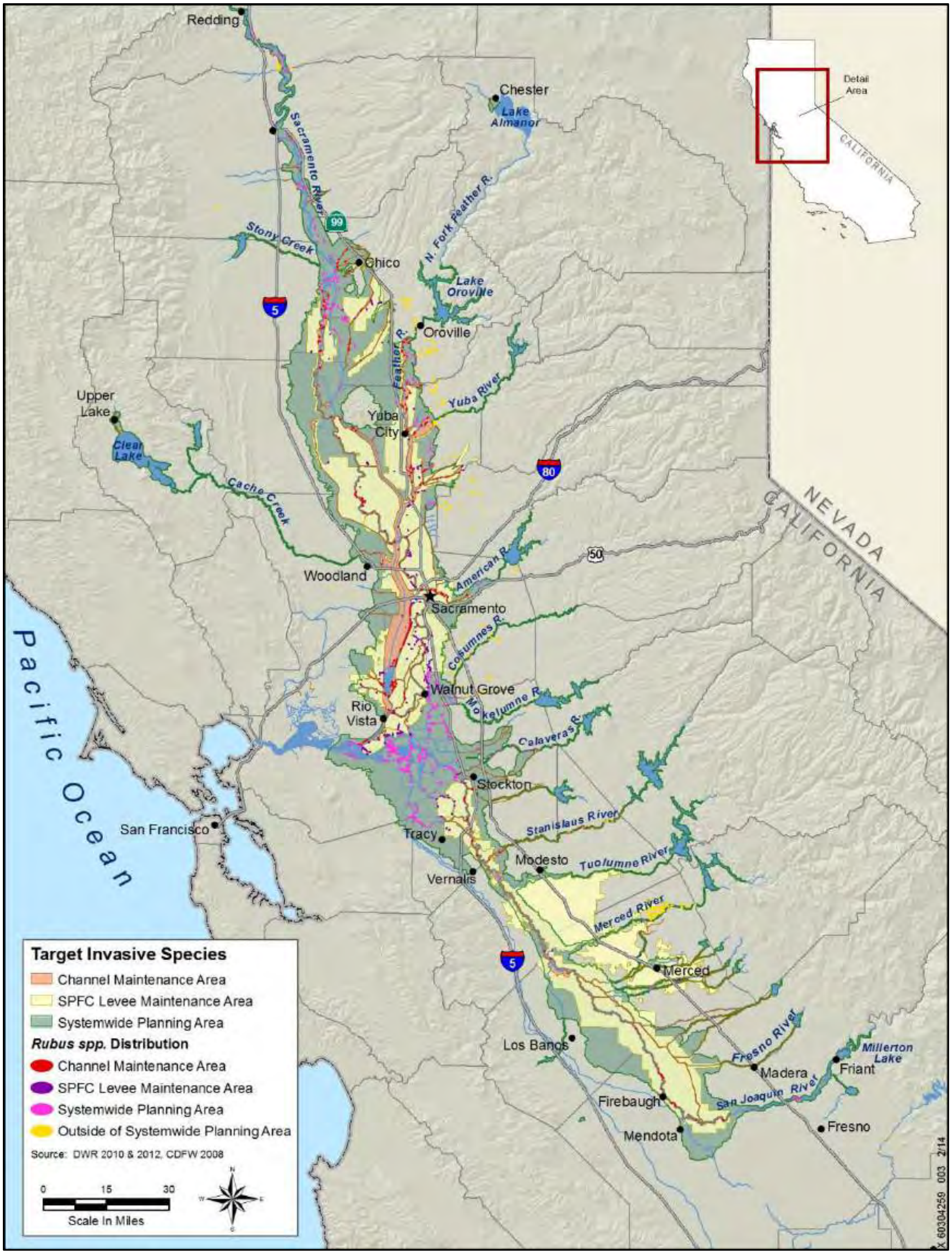
Sources: Cal-IPC 2013b, CDFG 2008, DWR 2010, and DWR 2012.

Figure 3-2. Distribution of Saltcedar within the SPA



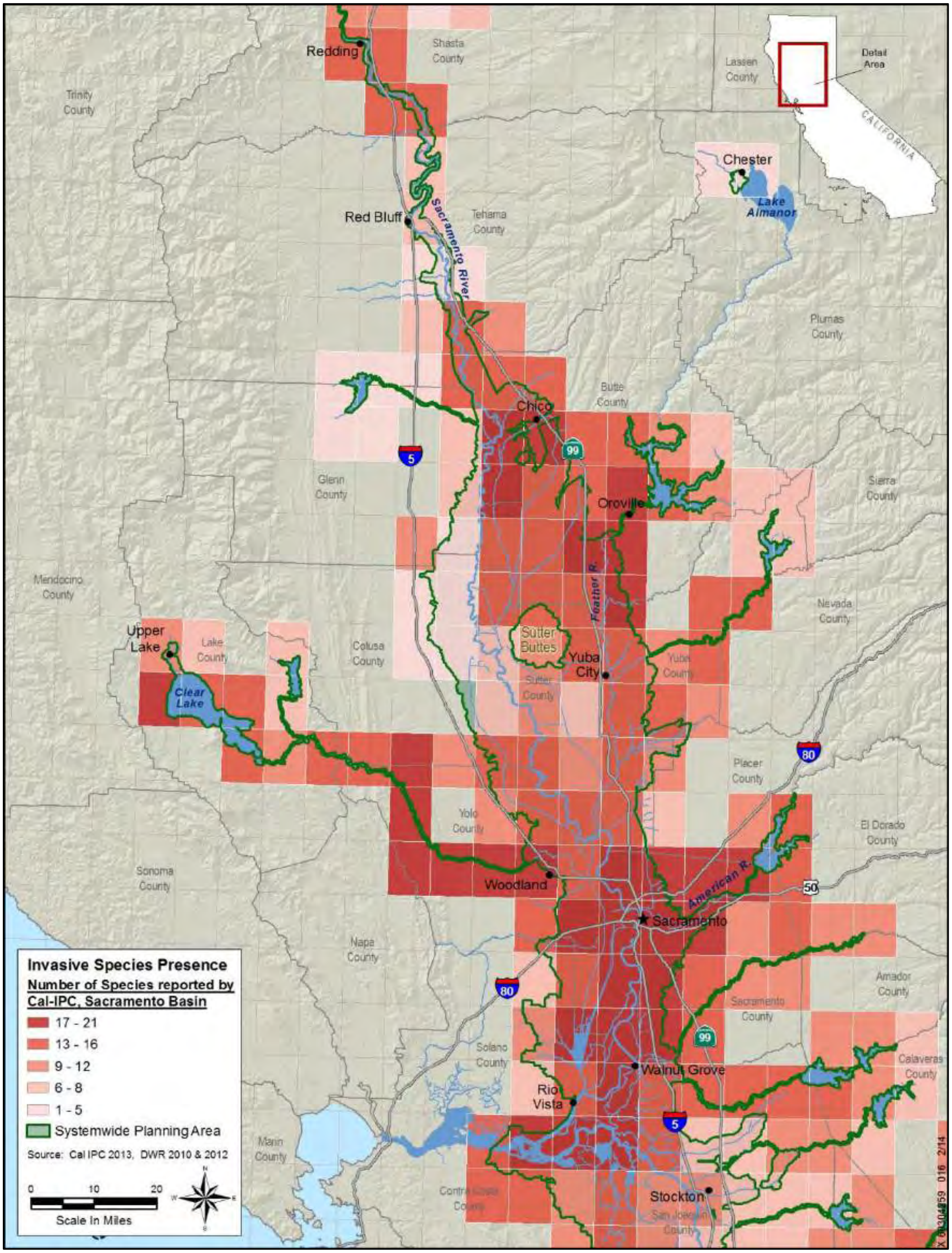
Sources: Cal-IPC 2013b, CDFG 2008, DWR 2010, and DWR 2012.

Figure 3-3. Distribution of Red Sesbania within the SPA



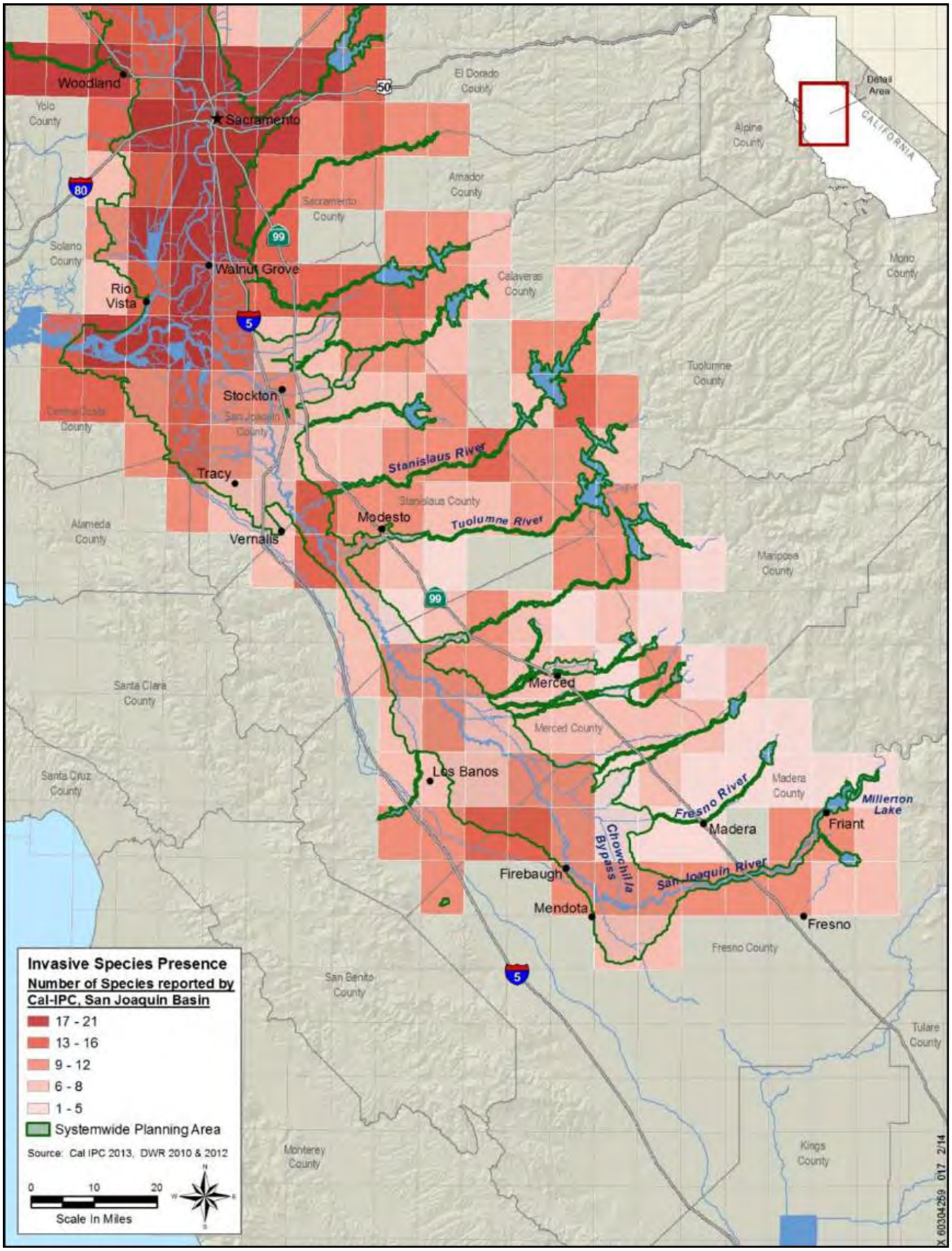
Sources: Cal-IPC 2013b, CDFG 2008, DWR 2010, and DWR 2012.

Figure 3-4. Distribution of Himalayan Blackberry within the SPA



Sources: Cal-IPC 2013b, DWR 2010, and DWR 2012.

Figure 3-5. Number of Target Invasive Plants per 7.5-Minute USGS Quadrangle, Sacramento River Region



Sources: Cal-IPC 2013b, DWR 2010, and DWR 2012.

Figure 3-6. Number of Target Invasive Plants per 7.5-Minute USGS Quadrangle, San Joaquin River Region

Initial coordination between the IPMSC and staff from DES identified an existing decision support model called the Weed Heuristics Invasive Populations Prioritization for Eradication Tool (WHIPPET) (www.cdfa.ca.gov/weedhome). WHIPPET is capable of prioritizing treatment areas in a regional setting with multiple infestations of multiple species. DWR could consider the use of WHIPPET to as a first step in prioritizing specific treatments of Initial Priority Species.

Acknowledging limited resources in DWR, application of WHIPPET would cost-effectively inform initial planning targets, guide SPA-wide treatment efforts, and better formulate treatment targets over time. In its use of WHIPPET, DWR would rely on the best available information characterizing the distribution, abundance, and effects of target invasive species, as shown in Figures 3-1 through 3-4 and as summarized in Section 4.0. Results from WHIPPET would be vetted by Maintenance Yard staff to confirm model results with field knowledge of priority infestations that are likely to adversely affect both SPFC O&M and Conservation Strategy measurable objectives.

Objective 2.3: Reduce Initial Priority Species by a Defined Acreage, Beginning with a 5-Year Target

Implementation Measure 2.3.1: In collaboration with FMO, and in consultation with the IPMSC, implement treatment of draft 5-year acreage targets of Initial Priority Species.

Consistent with the development of numerical objectives (e.g., acreage or linear foot/mileage targets) for other conservation targets or stressors in the Conservation Strategy, the IPMSC developed near- and long-term treatment targets for management of the four Initial Priority Species. Table 3-2 shows that the total acreage of these four species in the SPA is on the order of 3,776 acres, with approximately 1,065 acres occurring in Channel Maintenance Areas managed by either DWR or LMAs. The near-term, or 5-year treatment target, developed for this Plan is 213 acres of Initial Priority Species treated upon the anticipated adoption of this plan as part of the 2017 CVFPP update. This numerical objective was derived by dividing the total acreage of Initial Priority Species in Channel Maintenance Areas by the number of CVFPP updates that are planned to occur for the duration of CVFPP implementation (i.e., 25 years, with five updates). These 5-year treatment acreage targets may be updated during future updates to the CVFPP if improved information on the distribution and extent of invasive plants in the SPA becomes available. Furthermore, the designation of 5-year acreage targets does not imply that the total amount of invasive plants occurring in the SPA will be reduced by this acreage over 5 years (i.e., it does not imply that all treatments will result in complete eradication of targeted infestations).

Near-term targets have not been defined at this time for areas outside of Channel Maintenance Areas because treatments will be prioritized to meet the multiple goals of reducing stress on Conservation Strategy targets and SPFC O&M. Meeting O&M needs for channel capacity dictates prioritization of treatments within Channel Maintenance Areas first. As described in Implementation Measure 2.2.1, collaboration with DFM/FMO will prioritize treatment of Initial Priority Species following adoption of this Plan; therefore, this target is a placeholder until this analysis occurs. Additionally, because maintenance of channel areas is shared between DWR and LMAs within the SPA, designation of who may have the ability to implement treatment actions will also occur in later analysis. Long-term targets are full treatment of all currently mapped infestations for the Initial Priority Species. Fortunately, developing planning targets for a long timeframe provides opportunities to address institutional constraints on large-scale treatment efforts by DWR and external partners.

Table 3-2. Acreages of Initial Priority Species Occurring within the SPA

Management Area	Initial Priority Species				Total (acres)	Near-Term Target (acres treated)	Long-Term Target (acres treated)
	Giant Reed (acres)	Red Sesbania (acres)	Saltcedar (acres)	Himalayan Blackberry (acres)			
Channel Maintenance Areas	252	15	76	722	1,065	213	1,065
LMA Areas in SPFC	17		4	357	378	TBD	TBD
Remainder of SPA	382	469	51	1,432	2,333	TBD	TBD
Total	**651**	**484**	**131**	**2,511**	**3,776**		

Key: SPA = Systemwide Planning Area; TBD = to be determined.
Note: Columns may not total accurately due to rounding.

To support development of numerical objectives for the Conservation Strategy, numerical objectives have also been developed for individual CPAs. These targets are provided, by CPA, for Channel Maintenance Areas (Table 3-3), for other LMA areas within the SPFC (Table 3-4), and for the remainder of the SPA (Table 3-5). These targets are intended to inform development of multi-benefit projects implemented through Regional Flood Management Plans, Corridor Management Plans, Basin-Wide Feasibility Studies, and other related planning efforts in the SPA.

Objective 2.4: Develop Treatment Methods Using the Local Knowledge and Experience of Maintenance Yard Staff, Supplemented by the Best Available Information from Recognized Leaders Engaged in Invasive Plant Research and Control

Implementation Measure 2.4.1: In consultation with the IPMSC, develop a comprehensive list of invasive plant treatment techniques, incorporating the expertise of Maintenance Yard staff, that would be effective on target invasive plant species.

Section 5.0 summarizes the best available information regarding treatment techniques for the 32 target invasive plants described in this Plan, including detailed treatment recommendations for the four Initial Priority Species.

Implementation Measure 2.5.1: In consultation with DFM/FMO staff, develop appropriate avoidance and minimization measures (to minimize the unintentional introduction and spread of invasive plants) that can be applied during all invasive plant treatments.

Table 3-3. Initial Planning Targets for Channel Maintenance Areas

Conservation Planning Area	Initial Priority Species				Total (acres)	Near-Term Target (acres treated)	Long-Term Target (acres treated)
	Giant Reed (acres)	Red Sesbania (acres)	Saltcedar (acres)	Himalayan Blackberry (acres)			
Upper Sacramento River	90	0	0	178	268	54	268
Feather River	48	0	0	209	257	51	257
Lower Sacramento River	18	0	70	276	363	73	363
Lower San Joaquin River	5	0	0	29	34	7	34
Upper San Joaquin River	92	15	6	30	143	29	143
Total	**252**	**15**	**76**	**722**	**1,065**	**213**	**1,065**

Note: Columns may not total accurately due to rounding.

Table 3-4. Initial Planning Targets for LMA Areas in the SPFC (outside of channel maintenance areas)

Conservation Planning Area	Initial Priority Species				Total (acres)	Near-Term Target (acres treated)	Long-Term Target (acres treated)
	Giant Reed (acres)	Red Sesbania (acres)	Saltcedar (acres)	Himalayan Blackberry (acres)			
Upper Sacramento River	3	0	4	44	51	10	51
Feather River	3	0	0	49	52	10	52
Lower Sacramento River	1	0	0	229	230	46	230
Lower San Joaquin River	2	0	0	25	26	5	26
Upper San Joaquin River	8	0	0	11	19	4	19
Total	**17**	**0**	**4**	**357**	**378**	**76**	**378**

Key: LMA = Local Maintaining Agency; SPFC = State Plan of Flood Control.
Note: Columns may not total accurately due to rounding.

Table 3-5. Initial Planning Targets for the Remainder of the SPA

Conservation Planning Area	Initial Priority Species				Total (acres)	Near-Term Target (acres treated)	Long-Term Target (acres treated)
	Giant Reed (acres)	Red Sesbania (acres)	Saltcedar (acres)	Himalayan Blackberry (acres)			
Upper Sacramento River	284	0	46	511	840	168	840
Feather River	30	0	0	115	145	29	145
Lower Sacramento River	4	0	5	80	89	18	89
Lower San Joaquin River	38	0	1	706	745	149	745
Upper San Joaquin River	26	469	0	20	515	103	515
Total	**382**	**469**	**51**	**1432**	**2,333**	**467**	**2,333**

Key: SPA = Systemwide Planning Area.
Note: Columns may not total accurately due to rounding.

Objective 2.5: Avoid and Minimize Adverse Effects on Nontarget Species and Unintentional Introduction of Invasive Plants during Invasive Plant Treatment into Channel Maintenance Areas.

Section 5.0 of this Plan summarizes avoidance and minimization BMPs recommended for implementation during invasive plant treatments. This list of BMPs was created by supplementing current practices used by DFM/FMO and the Maintenance Yards with information from other sources on best practices for invasive plant treatment. Implementation of these BMPs by both DWR, and other parties, such as levee maintaining agencies to the extent they are able and are involved in invasive plant treatment efforts, will contribute to standardizing a systemwide approach to invasive plant management.

Objective 2.6: Track the Success of DWR's Invasive Plant Management Approach

Implementation Measure 2.6.1: Collaborate with DFM/FMO to track progress toward defined invasive plant treatment acreage targets by adapting existing tracking and inspection systems for vegetation management. Tracking systems will also monitor incipient infestations and prioritize them for treatment to prevent further spread.

The first step in implementing this measure will be to determine, in collaboration with DFM/FMO, whether the current levee inspection process can be adapted to better guide invasive plant management. For example, LMAs are encouraged to remove invasive species from the Vegetation Management Zone of levees if such plants are detected during inspections. By tracking these detections and maintaining data on the applied treatments, DWR will begin to build a systemwide foundation of information to guide future efforts. Additionally, DWR and

LMA inspection staff and Maintenance Yard staff could adapt current inspection processes to incorporate efforts aimed at early detection of new invasive plant infestations. Early detection of new infestations will facilitate cost-effective treatment of these infestations (i.e., they will be treated before they become established and therefore more difficult and costly to treat).

A second aspect of improved tracking will involve the tracking systems used by external partners. The IPMSC reviewed several tracking systems related to invasive species, such as the Cal-IPC CalWeed Mapper, the Bay Area Early Detection Network, and early tracking efforts of the Weed Management Area (WMA) program at the California Department of Food and Agriculture (CDFA). In addition, an online database called the Natural Resources Project Inventory (NRPI) was established as a collaborative effort between the Information Center for the Environment (ICE) at the University of California, Davis, and the California Biodiversity Council (CBC). The database identifies more than 8,000 natural resource projects and is the most comprehensive statewide database of natural resource projects, including projects focused on invasive plant treatment. Using the NRPI, and encouraging its use by others, will optimize the efficacy of existing forums, improve regional collaboration and information sharing, and increase DWR’s contribution to systemwide efforts.

Objective 2.7: Minimize Long-Term Invasive Plant Treatment Costs through Post-Treatment Management Actions

Implementation Measure 2.7.1: Where feasible, revegetate invasive plant treatment sites with appropriate native species to reduce the probability of reinfestation by invasive plants.

Funding and staffing resources to revegetate all treatment areas likely will not be available; however, some form of vegetation will recolonize treatment areas naturally. Therefore, in some cases, revegetation with native species will be warranted to avoid recolonization by invasive species that have more significant channel capacity impacts than natives. In Section 5.0, this Plan provides guidance for revegetation efforts within Channel Maintenance Areas as a means of facilitating a systemwide approach that is applied by LMAs and others within other parts of the SPA.

Goal 3: Develop Partnership Opportunities and Provide Resources to Encourage Consistency with DWR’s Invasive Plant Management Approach throughout the SPA

Objective 3.1: Inventory Invasive Plant Treatment Programs Being Implemented by Potential Collaborators within the SPA and Identify Existing Efforts with the Greatest Potential to Benefit from DWR Participation and Positively Contribute to the Conservation Strategy

Implementation Measure 3.1.1: Document all entities with SPFC maintenance responsibilities and describe their roles for invasive plant management relative to those of DWR.

This information is provided in Section 7.0.

Implementation Measure 3.1.2: In consultation with the IPMSC, identify entities or existing collaborative efforts with the greatest potential to optimize DWR's invasive plant management approach, and develop a resource estimate for DWR participation.

Section 7.0 provides an overview of existing efforts through which DWR may optimize the results of its invasive plant management approach. For example, DWR was one of 14 agencies listed as participants in the California Interagency Noxious and Invasive Plant Committee (CINIPC), originally formed in 1995. The Memorandum of Understanding (MOU) that created the group has expired, but the group continues to meet two to three times per year. DWR may consider assisting in accomplishing the activities outlined in the group's blueprint for landscape-level management. Additionally, DWR may consider participating in the Invasive Weeds Awareness Day at the Capitol, which includes educational visits to legislators and agency leaders. Lastly, DWR could consider providing additional support for CDFW's State Wildlife Action Plan, which addresses invasive weeds for the first time in its 2015 update (http://www.dfg.ca.gov/swap/).

Objective 3.2: Facilitate Consistency with the Plan Approach among LMAs and Other Entities Managing Invasive Plants within the SPA

Implementation Measure 3.2.1: Distribute this Plan, and results of follow-up actions, to LMAs and other entities managing invasive plants within the SPA, upon request.

A first step to implement this measure would be making information available. This Plan could be posted online, along with other Conservation Strategy materials, and LMAs will be directed to this source.

Implementation Measure 3.2.2: Prioritize funding proposals that include actions to map and treat target invasive plants along with other conservation and flood-risk reduction actions funded through DWR to support implementation of the CVFPP.

Funding guidelines and selection criteria could include information about which project types and aspects are desirable. The Central Valley Flood Protection Act of 2008 and the resultant CVFPP and SSIA encourage the development of multipurpose projects. Including invasive plant treatment actions among other conservation actions, and within cost-share funding guidelines, would further the intent of the legislation and its supporting planning documents. Additional "credit" could be assigned to multi-benefit projects that include these actions, in contrast to those without multi-benefit characteristics. One example of such a system is the CDFA Weed Management Area program, which sets forth criteria for funding invasive species treatments. Facilitating invasive plant treatments as part of future projects would also serve the goal of collecting data on infestations and treatments: projects funded through DWR could be required to contribute treatment data to the appropriate tracking system.

4.0 Target Invasive Plant Species

4.1 Definition of Terminology

Within the context of this Plan, invasive plants include plants that have the potential to adversely affect Conservation Strategy measurable objectives or public safety through compromised operation and maintenance of the SPFC. In many cases, these species also meet the definition of a “noxious weed” as defined by California or federal officials (i.e., CDFA or the Secretary of Agriculture) or they may be designated by Cal-IPC’s Invasive Plant Inventory (Cal-IPC 2013a) as nonnative, invasive plants that threaten California’s wildlands.

However, not all species occurring in the Sacramento and San Joaquin Valleys and considered by these organizations to be noxious or invasive are addressed in this Plan. For example, Cal-IPC considers many widely naturalized species (e.g., nonnative, annual grasses) to be invasive, but treatment of these species is generally infeasible and may not be warranted in many circumstances because the plants are widely distributed, naturalized, and form major herbaceous components of plant communities that provide important wildlife habitat. Also, this Plan discusses some species that are not currently considered to be noxious or invasive by any organization because these plants have the potential to adversely affect the goals and objectives of the Conservation Strategy.

Specifically, this Plan focuses on weeds that are capable of the following:

- Degrading riverine, marsh, or riparian habitats
- Adversely affecting SPFC O&M
- Altering hydrology and sedimentation rates
- Altering riverine geomorphic processes
- Reducing water quality
- Reducing the integrity of native plant communities by displacing native species and reducing groundwater availability
- Reducing habitat quality and food supply for Conservation Strategy target wildlife species

The process used for selecting the target invasive plant species addressed by this Plan is described in detail below.

4.2 Identification of Target Invasive Plant Species

The selection of target invasive species for consideration by this Plan primarily relied on information contained in Cal-IPC's Inventory (Cal-IPC 2013a) as a starting point. The Inventory is the most comprehensive, objective, and science-based evaluation of invasive plants occurring in California. It is compiled by invasive species experts using the best available information on 13 different aspects of each species, including the plant's potential to adversely affect ecosystem processes and native habitats, the species' distribution and rate of spread, and similar factors. Based on these data, each plant is assigned one of three ranks: High, Moderate, or Limited, defined as follows:

- **High:** These species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology is conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.

- **Moderate:** These species have substantial and apparent—but generally not severe—ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, although establishment generally depends on ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.

- **Limited:** These species are invasive, but their ecological impacts are minor on a statewide level, or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic.

For this Plan, a master list of target species was compiled to include all species listed in the Inventory as potentially occurring in the Sacramento and San Joaquin Valleys (Table 4-1). The master list also included species not formally identified in the Inventory but considered to have the potential to adversely affect SPFC O&M based on the professional opinion of DWR Maintenance Yard staff (Romero pers. comm.). The following information was tabulated for each of these species, primarily by consulting the Inventory (2013a), unless otherwise noted (Table 4-1):

- The species' growth form (i.e., whether it is a tree, shrub, floating aquatic plant, perennial herb, perennial grass, annual herb, or annual grass)

- The species' Cal-IPC ranking (i.e., High, Moderate, or Limited)

- The species' Cal-IPC Alert status (species with an Alert status are believed to have the potential to spread into other ecosystems throughout California)

- The impacts of each species on SPFC O&M activities, as determined by Maintenance Yard staff (Romero pers. comm.)

Table 4-1. Invasive Plant Species Potentially Occurring within the SPA

Common Name	Scientific Name	Growth Form	Cal-IPC Ranking[1]	Cal-IPC Alert[1]	CDFA Rating[2]	SPFC O&M Impact[3]	Habitat Invaded[1, 4]		
							Rivers, Streams, Canals	Marsh	Riparian
Russian knapweed	*Acroptilon repens*	Perennial herb	Moderate	No Alert	B	Low			D
Barbed goat grass	*Aegilops triuncialis*	Annual grass	High	No Alert	B	None			D
Tree of heaven	*Ailanthus altissima*	Tree	Moderate	No Alert	C	Moderate		C	C
Alligator weed	*Alternanthera philoxeroides*	Floating aquatic	High	Alert	A	Moderate	D	D	
Giant reed	*Arundo donax*	Perennial grass	High	No Alert	B	High	B		D
Black mustard	*Brassica nigra*	Annual herb	Moderate	No Alert	n/a	Moderate			D
Italian thistle	*Carduus pycnocephalus* ssp. *pycnocephalus*	Annual herb	Moderate	No Alert	C	Moderate			D
Southern catalpa	*Catalpa bignonioides*	Tree	n/a	n/a	n/a	Low			D
Yellow star-thistle	*Centaurea solstitialis*	Annual herb	High	No Alert	C	High			B
Skeleton weed	*Chondrilla juncea*	Perennial herb	Moderate	No Alert	A	Low			
Bull thistle	*Cirsium vulgare*	Annual herb	Moderate	No Alert	C	Moderate		C	D
Poison hemlock	*Conium maculatum*	Perennial herb	Moderate	No Alert	n/a	Low		D	C
Pampas grass	*Cortaderia selloana*	Perennial grass	High	No Alert	n/a	Moderate			D
Scotch broom	*Cytisus scoparius*	Shrub	High	No Alert	C	Moderate			D
Stinkwort	*Dittrichia graveolens*	Annual herb	Moderate	Alert	n/a	Moderate			D
Brazilian waterweed	*Egeria densa*	Submerged aquatic	High	No Alert	C	High	C		
Water hyacinth	*Eichhornia crassipes*	Floating aquatic	High	Alert	Q	High	D		
Medusa head	*Elymus caput-medusae*	Annual grass	High	No Alert	C	Low			D
Blue gum	*Eucalyptus globulus*	Tree	Moderate	No Alert	n/a	Low		C	D
Edible fig	*Ficus carica*	Tree	Moderate	No Alert	n/a	Moderate		C	C
Fennel	*Foeniculum vulgare*	Perennial herb	High	No Alert	n/a	High			D
French broom	*Genista monspessulana*	Shrub	High	No Alert	C	Low			D
Shortpod mustard	*Hirschfeldia incana*	Annual herb	Moderate	No Alert	n/a	High			D
Hydrilla	*Hydrilla verticillata*	Submerged aquatic	High	Alert	A	Moderate	D		
Klamathweed	*Hypericum perforatum* ssp. *perforatum*	Annual herb	Moderate	No Alert	n/a	Low			
Perennial pepperweed	*Lepidium latifolium*	Perennial herb	High	No Alert	B	High		C	C
Privet	*Ligustrum* sp.	Tree	n/a	n/a	n/a	Low			D
American frogbit	*Limnobium spongia*	Floating aquatic	High	Alert	A	Low	D		
Dalmatian toadflax	*Linaria dalmatica* ssp. *Dalmatica*	Perennial herb	Moderate	No Alert	A	Low			
Water primrose	*Ludwigia* sp.	Floating aquatic	High	No Alert	Q	High	B	U	U
Purple loosestrife	*Lythrum salicaria*	Floating aquatic	High	No Alert	B	High	D	D	D
Pennyroyal	*Mentha pulegium*	Annual herb	Moderate	No Alert	n/a	Low	D	C	C

Table 4-1. Invasive Plant Species Potentially Occurring within the SPA

Common Name	Scientific Name	Growth Form	Cal-IPC Ranking[1]	Cal-IPC Alert[1]	CDFA Rating[2]	SPFC O&M Impact[3]	Habitat Invaded[1, 4]		
							Rivers, Streams, Canals	Marsh	Riparian
Parrot's feather	*Myriophyllum aquaticum*	Floating aquatic	High	Alert	n/a	Low	D		
Tree tobacco	*Nicotiana glauca*	Shrub	Moderate	No Alert	n/a	Moderate			D
Scotch thistle	*Onopordum acanthium* ssp. *acanthium*	Shrub	High	No Alert	A	Moderate			
Harding grass	*Phalaris aquatica*	Perennial grass	Moderate	No Alert	n/a	Low			D
Crisp-leaved pondweed	*Potamogeton crispus*	Floating aquatic	Moderate	No Alert	n/a	High	C	D	
Black locust	*Robinia pseudoacacia*	Tree	Limited	No Alert	n/a	Moderate			D
Himalayan blackberry	*Rubus armeniacus*	Shrub	High	No Alert	n/a	High		B	A
Ravenna grass	*Saccharum ravennae*	Perennial grass	Moderate	Alert	n/a	Low		D	D
Russian thistle	*Salsola tragus*	Annual herb	Limited	No Alert	C	High			
Red sesbania	*Sesbania punicea*	Tree	High	Alert	B	High		D	D
Milk thistle	*Silybum marianum*	Annual herb	Limited	No Alert	n/a	High			
Saltcedar	*Tamarix* sp.	Shrub	High	No Alert	B	High	B	B	B
Tall sock-destroyer	*Torilis arvensis*	Annual herb	Moderate	No Alert	n/a	Low			B
Chinese tallowtree	*Triadica sebifera*	Tree	Moderate	Alert	n/a	Moderate			D
Greater periwinkle	*Vinca major*	Perennial herb	Moderate	No Alert	n/a	Low		D	D

Key: Cal-IPC = California Invasive Plants Council; CDFA = California Department of Food and Agriculture; SPFC = State Plan of Flood Control; O&M = operation and maintenance.
Notes:
1 *Source: Cal-IPC 2013a.*
2 CDFA Ratings:
A = A pest of known economic or environmental detriment, and is either not known to be established in California or is present in a limited distribution that allows for the possibility of eradication or successful containment.
B = A pest of known economic or environmental detriment and, if present in California, is of limited distribution.
C = A pest of known economic or environmental detriment and, if present in California, is usually widespread.
Q = An organism or disorder suspected to be of economic or environmental detriment, but whose status is uncertain because of incomplete identification or inadequate information.
D = An organism known to be of little or no economic or environmental detriment, to have an extremely low likelihood of weediness, or to be a parasite or predator.
3 Source: Romero pers. comm.
4 Habitat Invaded Codes:
A = > 50% of habitat invaded.
B = > 20% to 50% of habitat invaded.
C = > 5% to 20% of habitat invaded.
D = Weed is present, but ≤ 5% of habitat invaded.
U = Unknown (likely present but unable to estimate percentage of occurrences invaded).

- The percentages of specific habitat types within the SPA that are thought, by Cal-IPC, to have been invaded by the species

As stated, the target species listed in Table 4-1 were categorized based on their distribution; their relationship to Conservation Strategy target ecosystem processes, habitats, and species; and their potential to adversely affect SPFC O&M activities. As a result of the categorization shown in Table 4-1, certain species were selected from this master list and designated as either Primary or Secondary species; these are the species that form the foci of this Plan (Table 4-2). The distribution of these species within the SPA, identified using data provided by Cal-IPC (2013b), is shown in Figures 4-1 and 4-2. The criteria used to select species from Table 4-1 and assign these species Primary or Secondary status are summarized below.

Primary species are those that meet the following two criteria:

1) they are likely to occur throughout the SPA (as opposed to being localized within certain regions), and

2) they have a high probability of negatively affecting Conservation Strategy target processes, habitats, or species (i.e., they have a Cal-IPC rating of High [all species] or Moderate [woody species only]), or they have a high probability of negatively affecting SPFC O&M.

Plants that have a negative effect on SPFC O&M were included as Primary species, regardless of their effect on Conservation Strategy measurable objectives, because the elimination or reduction of these species would reduce ongoing SPFC maintenance needs, assist in alleviating channel capacity limitations, and thereby positively contribute to the objectives of the Conservation Strategy. For plants that would negatively affect Conservation Strategy measurable objectives, a less strict criterion was used for assigning Primary status to woody species (trees and shrubs) because, compared to herbaceous and floating aquatic species, woody species are generally more likely to have greater negative effects on riverine geomorphic processes and riparian ecosystem processes that are related to or sustained by geomorphic processes.

Secondary species include plants with a more limited distribution in the SPA, relative to Primary species; or, species that are less likely to negatively affect SPFC O&M or Conservation Strategy target processes, habitats, and species. Although, under certain circumstances, some Secondary species may have similar, or greater, adverse ecological or O&M effects, as compared to Primary species, their distribution is more limited within the SPA and therefore, their effects are also more limited. Additionally, because of their growth habit, size, or other characteristics, some Secondary species (e.g., some annual, herbaceous species) may pose a minimal threat to Conservation Strategy measurable objectives or SPFC O&M. However, outside the SPA, these species do have significant negative effects on ecosystems. Therefore, while not a high priority for this Plan, these species are included in the Plan because they are regarded as problem species in general, and treatment of these species within the SPA would positively contribute to their eradication region-wide or California-wide.

Table 4-2. Primary and Secondary Invasive Plant Species

Status	Criteria	Species
Primary	Species invading at least 5% of any habitat type occurring in the SPA (i.e., "Habitat Invaded" code of A, B, or C for any habitat type shown in Table 4-1), and which is any of the following: • Tree or shrub with Cal-IPC rating of Moderate or High • Any other species with Cal-IPC rating of High • Any species ranked as having a High effect on SPFC O&M activities	• Tree of heaven, *Ailanthus altissima* • Giant reed, *Arundo donax*[1] • Yellow star-thistle, *Centaurea solstitialis* • Brazilian waterweed, *Egeria densa* • Blue gum, *Eucalyptus globulus* • Edible fig, *Ficus carica* • Perennial pepperweed, *Lepidium latifolium*[1] • Water primrose, *Ludwigia* sp. • Purple loosestrife, *Lythrum salicaria* • Crisp-leaved pondweed, *Potamogeton crispus* • Himalayan blackberry, *Rubus armeniacus*[1] • Milk thistle, *Silybum marianum* • Saltcedar, *Tamarix* sp. [1]
Secondary	Species not invading more than 5% of any habitat type in the SPA (i.e., Cal-IPC distribution code of D, U, or blank for all habitat types shown above in Table 4-1), but which is any of the following: • Tree or shrub with Cal-IPC rating of Moderate or High • Any other species with Cal-IPC rating of High • Any species ranked as having a High effect on SPFC O&M activities -OR- • Any Cal-IPC Alert species	• Barbed goat grass, *Aegilops triuncialis* • Alligator weed, *Alternanthera philoxeroides* • Pampas grass, *Cortaderia selloana* • Scotch broom, *Cytisus scoparius* • Stinkwort, *Dittrichia graveolens* • Water hyacinth, *Eichhornia crassipes* • Medusa head, *Elymus caput-medusae* • Fennel, *Foeniculum vulgare* • French broom, *Genista monspessulana* • Shortpod mustard, *Hirschfeldia incana* • Hydrilla, *Hydrilla verticillata* • American frogbit, *Limnobium spongia* • Parrot's feather, *Myriophyllum aquaticum* • Tree tobacco, *Nicotiana glauca* • Scotch thistle, *Onopordum acanthium* ssp. *acanthium* • Ravenna grass, *Saccharum ravennae* • Russian thistle, *Salsola tragus* • Red sesbania, *Sesbania punicea*[1] • Chinese tallowtree, *Triadica sebifera*

Key: Cal-IPC = California Invasive Plant Council; SPA = Systemwide Planning Area; SPFC = State Plan of Flood Control; O&M = operation and maintenance.

Note:

[1] Species distribution previously mapped within SPA.

The list of Primary and Secondary species presented in Table 4-2 should be considered tentative. It is based on the best readily available information on the distribution of these species in the SPA, the relationships of these species to Conservation Strategy measurable objectives, and the potential of these species to negatively affect SPFC O&M. It is expected that Primary and Secondary species will change over time as more data characterizing the distribution of these plants within the SPA are collected and as relationships between particular species and Conservation Strategy measurable objectives are better understood.

The following section describes each of the 32 Primary and Secondary weed species identified in Table 4-2. Appropriate treatment techniques for these species are discussed in detail in Section 5.0 of this Plan.

4.3 Description of Target Invasive Plant Species

The following target invasive plant species descriptions were adapted from *Aquatic and Riparian Weeds of the West* (DiTomaso and Healy 2003) and *Weeds of California and Other Western States* (DiTomaso and Healy 2007); other sources were consulted and cited accordingly. The Cal-IPC Inventory and CDFA ratings for each species are listed in Table 4-1.

4.3.1 Primary Species

Tree of Heaven

Tree of heaven (*Ailanthus altissima*) is a deciduous tree in the Simaroubaceae family. It is native to China and was introduced to the United States as a landscape ornamental, a food source for silkworm (*Bombyx mori*), and a medicinal plant for Chinese immigrants during the Gold Rush. Tree of heaven produces large numbers of winged seeds that disperse by wind and water. Seeds remain viable for only 1 year or less, so tree of heaven does not develop a persistent seedbank. This species is fast growing, reaching heights up to 70 feet. The tree produces long, lateral roots that grow suckers up to 50 feet from the adult tree. A single individual can produce dense clonal stands as large as approximately 1 acre. These large, dense stands degrade wildlife habitat and can adversely affect floodwater conveyance and SPFC maintenance. Persistent manual removal of shoots and roots, followed by an application of herbicide, may be required, because this species readily resprouts from cut stems and roots that are left in contact with moist soil, and cutting or girdling trunks stimulates rapid growth of numerous suckers.

Giant Reed

Giant reed is a perennial, reed-like grass in the Poaceae family. This grass can grow extremely quickly (up to 2 inches a day) and can reach a height of 30 feet (Hoshovsky 1987). The species is considered indigenous to the Mediterranean Basin (Hickman 1993) and was intentionally introduced to southern California in the 1820s for use as erosion control in drainage canals and thatching for roofs (Bell 2002). Giant reed can tolerate a wide range of conditions. It grows best in well-drained soils with an abundance of available moisture. Overall, giant reed is well adapted to the disturbance dynamics of riparian systems. For example, when flood events break up clumps of giant reed and spread the pieces downstream, fragmented stem nodes and rhizomes can take root and establish as new plant clones. The rapid growth rate and strong competitive ability enables giant reed to invade recently disturbed areas quickly and out-compete native vegetation (Hoshovsky 1987); their large, continuous, clonal root masses can cover several acres. Giant reed typically develops dense monocultures, displacing native vegetation, diminishing wildlife habitat, and increasing flooding and siltation. Root masses can become more than three feet thick and are capable of stabilizing streambanks and terraces, ultimately altering flow regimes. Giant reed occurs throughout the Sacramento and San Joaquin Valleys. It is found in riparian areas and floodplains of medium-sized to large streams, from wet sites to dry riverbanks far from permanent water. It tends to favor low-gradient (less than 2 percent) riparian areas over steeper and smaller channels, but scattered colonies are found in moist sites or springs on steeper slopes.

Giant reed affects hydrologic processes, habitats, and species throughout the SPA. Giant reed displaces native plants and associated wildlife species because of the massive stands it forms (Gaffney and Cushman 1998; Bell 2002). As giant reed replaces riparian vegetation, it reduces habitat and food supply, particularly insect populations, for several special-status species such as least Bell's vireo, southwestern willow flycatcher, and yellow-billed cuckoo (Frandsen and Jackson 1994; Dudley and Collins 1995). Giant reed provides little shading to the instream and bank-edge river habitats, leading to increased water temperatures and reduced habitat quality for aquatic wildlife (Chadwick and Associates 1992). Large stands of giant reed can significantly increase water loss from underground aquifers due to its high evapotranspiration rate, which is estimated at roughly three times greater than that of native riparian vegetation. Giant reed is highly flammable, even when green, and can carry fire into a creek corridor. The dense growth habit of giant reed can more than double the available fuel for wildfires compared to native vegetation (Dudley 2006). Giant reed also alters hydrological regimes and channel morphology by retaining sediments, constricting flows, and limiting lateral migration (Gran and Paola 2001). Spencer (2010) investigated the hydraulic effects of giant reed on flow velocity and direction on Cache Creek and Stony Creek and found that channel roughness was higher when giant reed was present, resulting in higher water surface elevations during flood events.

Yellow Star-Thistle

Yellow star-thistle (*Centaurea solstitialis*) is an erect winter annual (sometimes biennial) in the Asteraceae family. This species is considered one of the most serious rangeland weeds in the western United States and has spread rapidly since its introduction into California around 1850.

Yellow star-thistle grows in open, disturbed sites, grasslands, rangelands, open woodlands, fields, pastures, and roadsides throughout most of California. It has spiny yellow-flowered heads that can grow over 3 feet tall. Taproots grow vigorously early in the season to depths of more than 3 feet, giving plants access to deep soil moisture during the dry summer and early fall months. Flower heads consist of numerous, yellow, disk flowers that produce abundant quantities of seeds capable of remaining viable for up to 10 years under field conditions. Seed germination is closely correlated with rainfall events. Large flushes of seed germinate after the first fall rains, but smaller germination flushes can occur nearly year-round. This species is highly competitive and can develop dense stands that displace native plants. Its long taproot effectively competes with native plants, particularly native perennials, for deep soil moisture during the dry summer months. Infestations reduce wildlife habitat quality and livestock forage value, displace native plants, and decrease native plant and animal diversity. A variety of management techniques (grazing, mowing, burning, etc.) can prevent seed production and control infestations when they are employed for 2–3 consecutive years, but vigilant monitoring and spot eradication may also be required.

Brazilian Waterweed

Brazilian waterweed (*Egeria densa*) is a common aquatic herb in the waterweed (Hydrochartiaceae) family that occurs in lakes, reservoirs, springs, ponds, and slow-flowing streams and sloughs. It is native to Argentina, Brazil, and Uruguay, and has been distributed elsewhere via the aquarium trade. In California, this species occurs below 7,000 feet in elevation in the Sierra Nevada, Central Valley, Central Coast, San Francisco Bay region, and San Jacinto Mountains.

Brazilian waterweed has stems up to 15 feet long that are frequently branched. It is usually rooted in bottom mud, but may be found as free-floating mats or in fragments. It reproduces by rhizomes and plant fragments, and can spread easily along existing watercourses into new habitats when stem fragments break off and float away from the parent plant during active growth in spring. This species' dense underwater growth reduces water flow, which can adversely affect irrigation projects, hydroelectric utilities, and urban water supplies. Beds of this weed also accumulate sediment and reduce the abundance and diversity of native plant seeds in lake bottoms (De Winton and Clayton 1996). Because this species readily spreads via plant fragments, care must be taken during mechanical control efforts to prevent new plants from developing; some herbicides have been moderately effective.

Blue Gum

Blue gum (*Eucalyptus globulus*), of the family Myrtaceae, is native to Australia. This species is the most common Eucalyptus in California, found below 1,000 feet in elevation on the North, Central, and South Coasts, as well as inland throughout the Central Valley. It grows quickly to 150–180 feet tall and displaces native plant communities by creating shade, causing dense leaf litter accumulation, and altering soil chemistry through the addition of chemicals from its leaves. It is long-lived and thrives in a variety of soils, but grows best on deep alluvial soils with ample moisture (Skolmen and Ledig 1990). It typically inhabits disturbed, especially riparian, areas. Blue gum reproduces by seeds released from capsules that remain attached to the tree. Seeds typically fall within 300 feet of the parent plant, although they may disperse to greater distances (assisted by water or animals). Because of its flammable plant compounds, dense growth habit, and copious leaf litter, groves of this species are highly combustible and increase the risk of fire. When trees are cut, the stumps or roots readily develop new shoots; however, continually cutting back regrowth for 4 years or more can eventually kill the tree. Also, applying an herbicide to freshly cut stumps can reduce resprouting.

Edible Fig

Edible fig (*Ficus carica*) is a deciduous tree in the Moraceae family. This species, which grows up to 30 feet tall, is native to southern Arabia and was introduced to California by Spanish missionaries in the mid- to late 1700s. In California, it invades and dominates riparian forests, streamside habitats, levees, and canal banks in and around the Central Valley, surrounding foothills, the South Coast, and the Channel Islands. Edible fig reproduces by seed and by vegetative growth (root and stem fragments). It prefers soils that stay moist throughout summer. This species can form dense thickets that outcompete native trees and understory vegetation. Such thickets are difficult to control because cutting or injuring the tree typically stimulates the development of numerous root sprouts.

Perennial Pepperweed

Perennial pepperweed (*Lepidium latifolium)* is an herbaceous perennial plant in the Brassicaceae (Mustard) family, native to southeast Europe. This plant can invade a wide variety of habitat types, including riparian, marsh, and floodplain habitats. It is found throughout California and can form large stands that exclude native plant species, thereby decreasing plant diversity and structural complexity (Cal-IPC 2013a). Perennial pepperweed seeds spread via wind, water, and waterfowl; the plant also reproduces vegetatively from underground stems and root fragments. Its root system is extensive, reaching up to 9 feet deep, giving it a competitive advantage over native plants for access to water and nutrients. However, its deep roots do not hold soil together well and may contribute to erosion and water quality issues (DiTomaso et al. 2013). Perennial pepperweed may also transport salts from lower soil horizons, drawing the salts through its roots to its leaves, then exuding and depositing them on the soil surface. This characteristic effect of pepperweed can shift plant composition to favor halophytes (salt-loving plants) (Renz 2000). Dense infestations are difficult to control; seasonal flooding during the growing season, mowing at bud set, and follow-up herbicide treatments of regrowth can reduce populations.

Water Primrose

Water primrose (*Ludwigia* sp.), of the Onagraceae family, is a widespread genus, with several species occurring throughout California, including in the Central Valley, Sierra Nevada foothills, and the San Francisco Bay region. One species is native to California (*L. peploides*), and several others have been introduced from the central and eastern United States and South America. All species, even the native species, have similar ecological effects, and all are considered invasive. Also, *Ludwigia* species readily hybridize, so that species thought to be native to California may, in fact, be hybrids with nonnative species.

Water primrose is an aquatic weed that forms dense mats above and below the water surface in shallow, stagnant, nutrient-rich pools and in areas with hydrological disturbance, such as flood control channels, irrigation ditches, and irrigation ponds (Verdone 2004). These plants can also persist in drier transition zones. They reproduce both by seed and vegetatively. Creeping stems and stem fragments that can establish new plants are dispersed by water and soil movement, and by animals. Once established, water primrose can spread very rapidly. The plant escaped from ornamental/domestic use and continues to spread via animals, boats, flooding, and flowing water (Verdone 2004). Heavy infestations of water primrose can alter water flow, cause sediments to accumulate, and diminish water quality (Verdone 2004). This weed can also outcompete native aquatic and wetland plant species, reducing species diversity and degrading waterfowl habitat (Verdone 2004). Areas that were once open water habitat become closed mats of water primrose (Verdone 2004). Because of its propensity to propagate by stem fragments, it is difficult to control; herbicide application followed by mechanical removal has been effective in some areas.

Purple Loosestrife

Purple loosestrife (*Lythrum salicaria*) is a perennial wetland herb in the Lythraceae family. It is typically less than 5 feet tall, with showy spikes of reddish-purple flowers. This species is native to Eurasia and was introduced into the northeastern United States in the early 1800s. It is found in scattered freshwater wetlands in northern and central California. Infestations occur in

Humboldt, Mendocino, Modoc, Shasta, and Siskiyou Counties, as well as in counties in the Sacramento Valley and San Francisco Bay regions.

Purple loosestrife is common in disturbed wetland habitats, including along streambanks, riverbanks, and other areas within channels (e.g., cobble bars); the edges of ponds, lakes, and reservoirs; flooded areas; ditches; and roadsides. This weed produces copious seeds that contribute to an immense seedbank. Once established, the plant forms extensive monospecific stands; plants enlarge at their base each year with more stems, sometimes becoming a rounded, bush-like clump of 30 to 50 stems arising from a single root stock. This species can rapidly degrade wetlands, displace native vegetation, and adversely affect wildlife species that rely on wetlands for habitat and food. Purple loosestrife also clogs waterways and can alter the hydrologic and soil conditions of wetland pastures, meadows, and irrigation systems. Cut stems can reroot under certain conditions, and flooding can encourage the species to spread. Mechanical removal of the plant before seed maturation occurs helps to reduce the spread of the plant.

Crisp-Leaved Pondweed

Crisp-leaved pondweed (*Potamogeton crispus*) is a fast-growing, aquatic perennial in the Potamogetonaceae family. This species is native to Eurasia and was introduced to California sometime before 1900. It is now widespread in California, occurring in rivers, canals, ponds, lakes, and marshy areas in the Central Valley. It is tolerant of slightly brackish waters, and is restricted to alkaline, calcareous waters. Crisp-leaved pondweed primarily reproduces vegetatively, forming vegetative propagules (turions) that lay dormant during summer and germinate when most native vegetation has died back. The species also produces viable seeds that are dispersed by water currents and waterfowl. It grows in dense mats that cover large areas and impede water flow, clog irrigation canals, and can deplete nutrients that are important for wildlife. Long-term management requires reducing or eliminating turions (by cutting pondweed at the sediment surface) to interrupt the plant’s life cycle (McComas and Stuckert 1996). Mechanical treatments and application of herbicide can also be effective in managing this species.

Himalayan Blackberry

Himalayan blackberry is a sprawling, robust shrub in the Rosaceae family, native to western Europe. In California, it occurs in riparian areas and, occasionally, in upland areas with persistent soil moisture, throughout the Coast Ranges, Central Valley, and Sierra Nevada. Flowers are characteristic of the rose family and are white to pinkish in color. This plant produces fruit from July to September and can produce 7,000 to 13,000 seeds per square yard. Mature fruits are edible and compose a small part of the diet of both native and nonnative wildlife. This method of seed dispersal helps this invasive blackberry spread rapidly and dominate native species of blackberry, such as California blackberry (*Rubus ursinus*). Himalayan blackberry can be distinguished from California blackberry by its taller, more robust stature and larger thorns and berries. The flower petals of California blackberry are narrower at the base and do not have the crinkled appearance of the Himalayan blackberry flower (DiTomaso and Healy 2007).

Himalayan blackberry is common in riparian areas and tolerates periods of inundation by fresh or brackish water. Such periodic flooding can produce long-lived, early seral plant communities that are conducive to the growth and spread of blackberries. This species is a strong competitor and rapidly displaces native plants by forming dense, impenetrable thickets that limit the growth of understory plants. Small populations may be controlled by manual removal; however, removing only the aboveground portion of the plants usually stimulates the growth of root sprouts. To control Himalayan blackberry, all aboveground biomass should be first cut to the ground surface early in the growing season (April–May) and removed from the site. The cut vegetation should then be allowed to resprout and the new growth treated with a foliar application of herbicide in early spring and/or late summer. Regrowth has also been controlled by grazing sheep and goats in areas where mature plants have been removed (Bossard et al. 2000).

Milk Thistle

Milk thistle (*Silybum marianum*) is an erect winter or summer annual or biennial in the Asteraceae family. This species is native to the Mediterranean region and has been used medicinally for at least 2,000 years. In California, milk thistle occurs on the North and South Coasts and in the North and South Coast Ranges, Central Valley, San Francisco Bay region, and Channel Islands, to an elevation of 1,600 feet.

This plant generally grows up to 6 feet tall and blooms from April through July. It reproduces from seeds that are dispersed by wind, water, soil movement, and animals, and which are also found in crop seed. Most seeds germinate after the first fall rain, but ungerminated seeds can remain viable for several years. Disturbances that expose bare soil (e.g., heavy grazing and fire) generally improve milk thistle germination. Milk thistle often grows in dense, competitive stands, mainly on disturbed sites in pastures and fields, as well as along levees, roadsides, and similar disturbed areas. It is uncommon in undisturbed habitats. After it reproduces and dies, milk thistle skeletons can remain standing for months and preclude the regeneration of native plants. Burning can encourage seed germination and establishment of this plant. Seedlings can be discouraged through disking, and the development of milk thistle stands can be controlled by removing mature plants before flowers open.

Saltcedar

Saltcedar is a tree in the Tamaricaceae family that was introduced to the United States from eastern Asia approximately 200 years ago. Since its introduction, saltcedar has become established in several communities throughout the country, particularly in the Southwest, where it has displaced native riparian vegetation in slow-moving riverine and aquatic habitats. This tree grows in marshes, on riverbanks, in springs, and on floodplains, in mesic habitats with a high water table. Within the SPA, it occurs in the southern San Joaquin Valley and in scattered locations in the northern Sacramento Valley (e.g., Colusa and Glenn Counties).

Saltcedar has numerous, large basal branches that can grow to approximately 20 feet tall (Carpenter 1998). Its flowers produce many tiny, tufted seeds that disperse by wind and water (DiTomaso 1998). It can propagate from seed, buried or submerged stems, and adventitious roots, even after the aboveground portion of the plant has been removed (Zouhar 2003) Saltcedar is tolerant of highly saline habitats, and it concentrates assimilated salt in its leaves. Over time, as leaf litter accumulates under the plants, the surface soil can become highly saline and impede future colonization by native plant species (Carpenter 1998). Saltcedar's roots can also drastically reduce available surface and groundwater. The combined effects of this plant cause a decrease in available water and an increase in salinity in the upper soil profile, both of which can inhibit the growth of native vegetation (DiTomaso and Healy 2007). In addition, saltcedar traps and stabilizes alluvial sediments, narrowing stream channels and causing more frequent flooding (Bossard et al. 2000). Efforts to cut or burn saltcedar to the ground have proven ineffective, because the plants will typically regenerate from the roots. Removing and/or chemically treating the root system has proven to be effective at managing invasive populations; follow-up treatments may be required. Saltcedar seedlings are easily pulled by hand and should be removed during the first year to prevent reinfestation. Young seedlings are not competitive in the presence of dense native vegetative cover, so establishing native cover after removing saltcedar discourages reinfestation (DiTomaso and Healy 2007).

4.3.2 Secondary Species

Barbed Goat Grass

Barbed goat grass (*Aegilops triuncialis*) is an annual grass in the Poaceae family that invades grassland, rangeland, and oak woodland habitats. This species is distributed throughout grassland and oak savanna/oak woodland habitats in the Coast Ranges, the San Francisco Bay region, the northern Sierra Nevada and Cascade Range foothills, the Sacramento Valley, and the northern San Joaquin Valley, generally below 3,000 feet in elevation. Evidence suggests that this species is actively expanding its range throughout California. Barbed goat grass successfully competes with native forbs and desirable annuals; its seeds are adept at germinating and can send roots down through thatch or bunch grasses. Once it is mature, the plant is essentially unpalatable to livestock, and may cause them severe injury: the disarticulated joints of the plant are sharp and can pierce the stomach linings of livestock when ingested. Early detection of barbed goat grass is critical to controlling infestations. Controlled burns during late spring, when seed heads are still attached to stems, is effective if conducted for 2 consecutive years. Herbicide treatment of small patches is effective, but is not a viable way to control large infestations. Mowing and grazing are not effective; these methods appear to increase weed density because they also eliminate other plants that compete for the same resources (Davy et al. 2008).

Alligator Weed

Alligator weed (*Alternanthera philoxeroides*) is an herbaceous perennial in the Amaranthaceae family. It is native to South America and was introduced to the United States via the aquarium trade. In California, it is found in the San Joaquin Valley (Tulare and Kings Counties) and in Los Angeles County. This species can invade lakes, streams, canals, ponds, marshes, irrigation ditches, and other slow-moving watercourses. Although typically found in aquatic habitats, alligator weed can also occur in terrestrial habitats. The aquatic form has hollow, floating, emergent and submerged stems, whereas the terrestrial form has solid stems. The plant becomes rooted in soils under shallow water and can form dense, interwoven, floating mats that extend over the surface of deeper water. This species reproduces vegetatively: the dense mats can break apart, enabling the plant to colonize new sites. Floating mats disrupt the natural ecology of infested sites by reducing light penetration and crowding out native species. Mechanical removal is effective only if all plant parts are carefully removed; buried stems can regenerate from depths of up to 1 foot, so incomplete removal can facilitate the spread of the weed.

Pampas Grass

Pampas grass (*Cortaderia selloana*) is a large, long-lived (15–20 years) perennial grass of the Poaceae family. It was introduced from South America as an ornamental plant and for erosion control. It has escaped cultivation and has spread along sandy, moist ditch banks throughout coastal regions of California, as well as inland, in regions such as the Central Valley (especially Butte, Yolo, Sacramento, and Stanislaus Counties). Pampas grass has long basal leaves and tall, showy, plume-like inflorescences. It has dense, fibrous roots that penetrate more than 10 feet deep, and lateral rhizomes that can spread to a diameter of more than 18 feet. Each seed-bearing plume can produce up to 100,000 seeds, which can be dispersed long distances by wind and human activities. Sites with bare, moist, sandy soil are the most favorable for seed establishment. Pampas grass competes with native vegetation and, when it establishes in forests, with the seedlings of trees, ultimately slowing their establishment and growth. This species is also considered a fire hazard because it accumulates large quantities of dry leaves, leaf bases, and flowering stalks. Manually cutting or chopping out mature plants below the crown can kill the plant.

Scotch Broom

Scotch broom (*Cytisus scoparius*) is a long-lived perennial shrub in the pea (Fabaceae) family. It is native to Europe and North Africa and was introduced to California in the 1850s as an ornamental shrub. Later, it was used to stabilize dunes to prevent erosion. It is found along the California coast from Monterey north to the Oregon border. It is also prevalent in El Dorado, Nevada, and Placer Counties in the Sierra Nevada foothills. This plant grows 6–10 feet tall, has sharply angled branches, and reproduces by seed when it reaches 2–3 feet tall (2–3 years old). Scotch broom grows in sunny sites with dry, sandy soil, spreading quickly through disturbed areas such as pastures, forest edges, riverbanks, and roadsides. It is a strong competitor and displaces native plant and forage species by forming dense, monospecific stands. Seedlings are also shade-tolerant and can therefore outcompete trees, making reforestation difficult. Established populations are difficult to eliminate because of the longevity of the species' seedbanks. Cutting plants to ground level and grazing (by goats) can help reduce resprouting. Prescribed burns do not prevent resprouting and may stimulate seed germination.

Stinkwort

Stinkwort (*Dittrichia graveolens*) is an erect, fall-flowering, aromatic annual in the Asteraceae family that is native to the Mediterranean region. It was first reported in 1984 in Santa Clara County, and by 2012 had spread to 36 of the 58 counties in California. This weed is quickly spreading throughout California and the Central Valley (Brownsey et al. 2012). It grows in disturbed places, roadsides, pastures, fields, riparian woodlands, levees, washes, and the margins of wetlands and tidal marshes. It prefers well-drained, gravelly soils and thrives in arid conditions, but can also do well at the margins of wetlands. This plant grows to about 2.5 feet tall, with sticky, glandular-haired foliage and flower heads that consist of short, yellow, ray flowers and reddish disk flowers. Unlike most summer and late-season annuals, it flowers and produces seeds from September to December; one plant can produce up to 30,000 seeds, up to

90% of which may be viable (Santa Clara County Weed Abatement Program 2009). Stinkwort seeds may remain viable in the soil for 2 to 3 years, and they are capable of germinating year-round, so the weed can quickly eliminate open spaces and pastureland. Seeds are likely spread by wind, mammals, birds, and human activity (Brownsey et al. 2012).

Although only limited information about stinkwort is available, this weed likely represents a habitat-transforming threat to native species diversity and abundance. Because its root system is shallow, hand removal is the most effective control method. Mowing very close to the ground and applying certain herbicides may also be effective. Employing management actions before seed production could minimize the unintentional spread of this weed. In areas where infestations have established, 2 to 3 years of treatment may be necessary to deplete the seedbank.

Water Hyacinth

Water hyacinth (*Eichhornia crassipes*) is an aquatic herb in the pickerel-weed (Pontederiaceae) family that occurs in both natural and human-made freshwater ponds, sloughs, and waterways. It is native to South America's Amazon River basin and has spread throughout all tropical and subtropical countries. In California, this species occurs below 660 feet in elevation in the Central Valley, in the San Francisco Bay Area, along the south coast of California, and in the Peninsular Ranges.

Water hyacinth produces stout, erect stems that may be greater than 12 inches long. The stems are swollen and filled with a spongy tissue that helps the plant float on water. Its leaf blades are generally oval to round and less than 4 inches wide, and its funnel-shaped flowers range in color from pale to deep lavender to blue or white. Water hyacinth reproduces by fragmentation of rhizomes and stems and by seed. This species' rapid growth allows it to quickly dominate aquatic systems, displacing native aquatic plants, degrading habitat for waterfowl, and creating ideal breeding habitat for mosquitoes. Water hyacinth's high evapotranspiration rates increase water loss from aquatic systems. Because this species readily spreads via plant fragments, care must be taken during mechanical control efforts to prevent new plants from developing; glyphosate foliar spray can help control water hyacinth.

Medusa Head

Medusa head (*Elymus caput-medusae*) is a slender annual grass in the Poaceae family. In 1950, Medusa head was reported from only six counties in northwestern California. It now occurs in the North Coast Ranges, Cascade Range, Klamath Ranges, Sierra Nevada, Central Valley, South Coast Ranges, northern South Coast (Santa Barbara County), and Channel Islands, up to 7,000 feet, and is expanding in range.

Medusa head grows up to 2 feet tall. It matures 2–4 weeks later than most other annual grasses, displaying distinctive patches of green in otherwise brown grassland. Fibrous roots grow rapidly throughout the cool season, depleting upper soil moisture early in the growing season and accessing deep soil moisture late in the season. Medusa head is predominantly self-pollinating and reproduces by seed. Seed production is prolific. Seeds disperse locally by wind and water, and to greater distances by soil movement and human activities, and by clinging to the feet and fur of animals. Most seeds germinate in fall after the first rain, but some seeds remain dormant or germinate in winter or spring. Seeds can germinate in dense litter under low-moisture conditions and without directly contacting a moist substrate.

Medusa head invades grasslands, oak savannahs, oak woodlands, and chaparral communities, growing best on clay soils or where deep soil moisture is available late in the growing season. Medusa head frequently outcompetes desirable nonnative annual grasses and native grasses and forbs. Once established, it can reach densities of nearly 200 plants per square foot. After seed set, the silica-rich dead plants persist as a dense litter layer for three or more growing seasons, encouraging further Medusa head dominance by preventing germination and survival of native species. The high silica content of this weed makes it unpalatable to livestock and wildlife, except in early spring. However, dense infestations tend to be completely avoided by livestock, even when the young plants are otherwise palatable, because of the dense litter layers. In infested areas with favorable growing conditions (i.e., soils with high clay content), Medusa head can approach 100% cover if left unmanaged. When surrounding vegetation has dried and Medusa head seeds have not matured, controlled burns that are slow and hot can significantly reduce populations. Disking or plowing before seed set also can greatly reduce stands.

Fennel

Fennel (*Foeniculum vulgare*) is an erect perennial herb in the Apiaceae family. This plant grows 4–10 feet tall and has finely dissected leaves. It is a culinary spice native to southern Europe and the Mediterranean region. It likely spread in the United States by escaping cultivation, and has occurred in California for more than 100 years. In this state, it is found in mesic locations below 2,000 feet in elevation. It colonizes disturbed areas, especially weedy sites adjacent to fresh or brackish water, riparian areas, pastures, abandoned lots, and roadsides.

Fennel reproduces from both root crowns and seeds. Seed production is prolific, peaking in August and September. Seeds are dispersed by water and animals, and by humans when seeds cling to clothing or mud on vehicles. Fennel is a competitive invader that can preclude the establishment of native plant species. It drastically alters the composition and structure of many plant communities by outcompeting native species for light, nutrients, and water, and can further outcompete other plants by forming dense, uniform stands. Manual removal of individual roots and plants can control infestations with limited numbers of plants. Two consecutive years of fall burning, followed by application of herbicide to new foliage, can control large stands.

French Broom

French broom (*Genista monspessulana*) is a tall (up to 10 feet) evergreen shrub in the pea (Fabaceae) family. It is native to the Mediterranean region, and was introduced to California in the mid-1800s as a landscape ornamental. Its current distribution in California includes the Coast Ranges, Sierra Nevada foothills, Transverse Ranges, Channel Islands, and San Francisco Bay region. French broom frequently occurs in disturbed places such as riverbanks and road cuts, but it can also invade grasslands and open-canopy forests. It prefers siliceous soils, but can grow in various soil moisture conditions. This species is an aggressive invader that produces abundant seeds and will resprout from the root crown if it is cut, grazed, or burned. Seeds are dispersed by ants, birds, mammals, human activity, and water movement. French broom displaces native plant and forage species and can dominate plant communities by forming dense, monospecific stands.

Eradication is made difficult by the longevity of the species' seedbank and the toxicity of its foliage to livestock. An integrated removal method that combines mechanical removal and herbicide application, with many follow-up treatments, may be the most effective way to control this species.

Shortpod Mustard

Shortpod mustard (*Hirschfeldia incana*) is a biennial, short-lived perennial forb in the Brassicaceae family, native to Europe. In California, it occurs in coastal scrub, grasslands, and disturbed areas, such as fields, pastures, ditch banks, and dry washes. It has also invaded shrublands and riparian areas. Shortpod mustard forms a flat basal rosette, and its stem bases and leaves are moderately covered with stiff hairs. It reproduces by seeds that fall near the parent plant, but seeds can also be dispersed by water, agricultural activities, and animals. This weed reduces the biomass and fecundity of coexisting species and competes with native annual plants for water. Manual removal or disking before seeds develop can control populations of shortpod mustard. Control methods implemented over a period of several years may eventually exhaust the seedbank.

Hydrilla

Hydrilla (*Hydrilla verticillata*) is a perennial, submersed aquatic plant in the Hydrocharitaceae family. It was introduced to the United States from Eurasia via the aquarium trade. In California, it occurs in the Mojave and Colorado Deserts, on the South and Central Coasts, and in the San Francisco Bay region and Central Valley. Hydrilla plants consist of a series of individual green stems that bear tightly packed whorls of two to eight triangular leaves at each node. This species has distinctive subterranean vegetative propagules (tubers) and swollen shoots (turions) in its leaf axils. Hydrilla is capable of infesting any freshwater aquatic system; it is easily spread by people and wildlife. The plant reproduces vegetatively from stem fragments, rhizomes, and root crowns, and through the production of tubers and turions. Growth is enhanced in water with agricultural runoff containing elevated nutrient levels. Hydrilla forms large mats that fill the water column and can block or severely restrict water flow (for example, in canals). It also crowds out native plants, decreases habitat for fish and wildlife, and degrades water quality. Hydrilla can be removed by raking or seining it from watercourses, but it will reestablish from any remaining fragments, roots, tubers, or other vegetative structures.

American Frogbit

American frogbit (*Limnobium spongia*) is a perennial plant of the Hydrocharitaceae family. It can be rooted or free-floating, occurring in rivers, streams, and other water bodies. In 2003, this South American native was documented in two infestations in California, in Arcata and Redding, where it was presumably introduced through the aquarium trade (Anderson 2011). By 2007, it had spread to the San Joaquin River in Fresno, and the species was found in the Sacramento–San Joaquin River Delta (Delta) in 2008 (Anderson 2011). It is currently found in the San Joaquin River and in the Delta. American frogbit forms thick mats that choke waterways and cause negative impacts on pumping and irrigation systems. The mats also reduce dissolved oxygen in the water and block light throughout the water column, adversely affecting fish and other organisms. In infested areas, open water becomes inaccessible to wildlife. American frogbit can spread rapidly by quickly producing seeds and vegetative growth. The small, floating seeds easily disperse along watercourses by wind, currents, tidal action, and waterfowl. Mechanically removing all parts of the plant (i.e., shoots and stolons) can be effective if the plants have not yet produced many seeds, but physical control of a large infestation may require several years of repeated treatment.

Parrot's Feather

Parrot's feather (*Myriophyllum aquaticum*) is a stout, aquatic perennial of the family Haloragaceae. It was introduced from South America via the aquarium trade. It forms dense mats of intertwined brownish stems (rhizomes) in freshwater lakes, ponds, canals, and slow-moving waters of northern and central California. Parrot's feather reproduces vegetatively from its brittle and easily fragmented stems, which settle in sediment and produce new plants. These fragments can also disperse by waterfowl, other wildlife, and water. This species outcompetes native aquatic plants, often eliminating or significantly reducing their numbers in infested sites. The weed also forms dense mats that clog waterways, block irrigation pumps and water intakes, and cause similar adverse effects on agricultural and water management activities. This species may also significantly alter the physical and chemical characteristics of lakes and streams. Repeated mechanical harvesting can help reduce stem densities, but stem fragments easily develop into new plants.

Tree Tobacco

Tree tobacco (*Nicotiana glauca*), of the Solanaceae family, can be a tree or a shrub that stands 10–20 feet tall. This native of South America was introduced to California about 100 years ago. It is now found throughout California, including in the Central Valley, at elevations up to 5,000 feet. Tree tobacco grows on disturbed soils, vacant lots, and roadsides, and along streams and other riparian areas, such as washes and disturbed flats. It reproduces prolifically from seeds that are dispersed by water, soil movement, and human activities. All plant parts contain alkaloids that are highly toxic to humans and livestock when ingested. Tree tobacco competes with native plants, but its ability to outcompete native plants is not well documented. Mechanical removal is effective, but roots must be removed to prevent resprouting. Certain herbicides have also been shown to be effective (Oneto et al. 2004).

Scotch Thistle

Scotch thistle (*Onopordum acanthium* ssp. *acanthium*) is a biennial of the Asteraceae family, introduced to California from Eurasia. This plant grows 4–9 feet tall, has a thick, long taproot and broad stems, and is covered with wooly, pale-gray hairs. Scotch thistle inhabits disturbed sites, roadsides, fields, annual grasslands, pastures, rangelands, canals, ditch banks, and riparian areas throughout California. It reproduces from seeds that are dispersed short distances by wind and animals and greater distances by water, livestock, and humans. Most seeds germinate after the first fall rain, but seeds can germinate year-round. Large infestations of Scotch thistle can form tall, dense, impenetrable stands that outcompete native plants for resources. The long taproot (1 foot long or more) may affect soil moisture levels and allow Scotch thistle to outcompete native grasses that rely on water close to the surface. Minimizing open gaps and bare ground can discourage invasion by this species. Manually removing Scotch thistle before seeds mature can control small populations. Establishing or encouraging perennial grasses can discourage growth of Scotch thistle seedlings by creating strong competition for moisture.

Ravenna Grass

Ravenna grass (*Saccharum ravennae*) is a large perennial grass in the Poaceae family. It is an escaped horticultural plant from Eurasia that is rapidly spreading along Cache Creek in the Sacramento Valley. It establishes in disturbed areas and prefers moist places, such as marshes and riparian habitats. Because its growth habit is similar to that of giant reed and pampas grass, it has similar ecological impacts where it occurs. Little is known about its invasiveness and distribution, but it is considered to be an imminent problem. Its seeds are dispersed by wind and water. It alters fire dynamics, light availability, soil moisture, and the nutrient content of soils, as well as accumulating sediment. Ravenna grass may also alter streambank erosion patterns and encourage flooding. It can grow on more exposed soils than many other riparian species, so it may add significant biomass to swift streams. In some areas, it has formed monospecific stands that may outcompete native vegetation. Little is known about effective control mechanisms, but repeated mechanical and herbicide treatments may be necessary to prevent resprouting.

Russian Thistle

Russian thistle (*Salsola tragus*) is a tumbleweed-forming, spiny, summer annual in the goosefoot family (Chenopodiaceae), native to Eurasia. Russian thistle occurs throughout California, colonizing disturbed or moist areas where it can create large, monospecific stands. In general, it competes poorly with other vegetation, so it typically does not occur outside areas of bare soil or recent disturbance.

Russian thistle reproduces by seeds that are dispersed when the plant dries and breaks off at the base to form tumbleweeds. Tumbleweeds can build up in large drifts, clog drainages and roadways, and contribute to increased fire frequency or intensity. Seeds germinate throughout spring and early summer months, even in years with little to no precipitation. This species can therefore be especially problematic during periods of drought when other annual vegetation does not germinate. Although the very young seedlings are soft, nutritious, and edible for livestock, later stages of growth produce tough, spiny foliage that is often not eaten by grazing or browsing animals unless other forage species are unavailable. Also, the mature foliage contains high concentrations of oxalates, which can be toxic to livestock (DiTomaso and Healy 2007). Although Russian thistle seeds are numerous, they are generally short-lived (approximately 2 years), so control measures can be successful at eradicating infestations if repeated long enough to fully exhaust the seedbank (DiTomaso and Healy 2007). Properly timed disking of seedlings can prevent seed production and control infestations, but it may take up to 2 years to deplete the seedbank.

Red Sesbania

Red sesbania is a deciduous shrub or small tree in the pea family (Fabaceae) that generally flowers from June to August in California. The long-lasting flowers are orange to reddish in color and are characteristic of the legume family. This native of South Africa was introduced to the United States as an ornamental, then escaped cultivation to become a wildland invader. It grows up to 13 feet tall and forms thick, impenetrable clusters in riparian areas (DiTomaso and Healy 2007). This species predominantly inhabits streambanks, but also dominates the edges of ponds, marshes, canals, gravel bars, and instream islands. Currently, it is found in the southern Sacramento Valley (American River Parkway), the San Joaquin Valley (Suisun Marsh and San

Joaquin River Parkway), and the southern North Coast Ranges; it may also occur elsewhere below 150 feet in elevation. New colonies tend to establish along the banks of rivers and creeks. New colonies establish in riparian areas and spread through production of seeds and seed pods that float downstream and germinate in saturated soils. Red sesbania typically reproduces within 2 years, and is capable of producing thousands of viable seeds within a few months, leading to rapid spread of the species (DiTomaso and Healy 2007). Also, red sesbania is moderately shade-tolerant and can establish itself in the shade of other native riparian vegetation, allowing it to easily attain community dominance.

This species displaces native plants, contributes to bank erosion and flooding, and diminishes wildlife habitat. Mechanical, biological, and chemical controls have all proven effective at controlling the spread of red sesbania. The root system of red sesbania is relatively shallow and easy to remove, especially in saturated soil, making mechanical removal of young plants a feasible means of control. Mechanical removal and maintenance of red sesbania may require up to 5 successive years to effectively eradicate an infestation. Targeting small, upstream populations of red sesbania has proven most effective at slowing the spread of the invasive plant along riparian corridors. Plants in standing water can also be cut below the water line to help discourage regrowth (DiTomaso and Healy 2007).

Chinese Tallowtree

Chinese tallowtree (*Triadica sebifera*) is a fast-growing deciduous tree in the Euphorbiaceae family. This native of eastern Asia is found in riparian and wetland areas of California. It grows to 50 feet tall and has milky sap and pendent leaves. It can aggressively invade both disturbed and undisturbed terrestrial, wetland, and riparian plant communities. It reproduces by seeds that are dispersed by animals (especially birds), water, and human activities. Large stands displace native vegetation and can significantly alter soil nutrients: when its leaf litter decomposes, levels of nitrogen, phosphorous, and other mineral nutrients increase while magnesium and sodium levels decrease. Chinese tallowtree tolerates shade, drought, salinity, and flooded conditions. Manually removing trees and seedlings can control infestations, but application of herbicides may be necessary to prevent the stumps and roots from resprouting.

5.0 Invasive Plant Treatment

This section describes general permitting considerations for invasive plant treatments, recommended BMPs for invasive plant treatment, and a variety of techniques that can be effectively used to treat invasive plants, including specific recommendations for the four Initial Priority Species. This information is based on current DWR practices employed by DFM/FMO and the Maintenance Yards, supplemented by information from other sources such as Cal-IPC (Cal-IPC 2012) on best practices for invasive plant treatment.

5.1 Regulatory Permitting Requirements

Agencies that may have regulatory authority over invasive plant control activities within the SPA include USACE, USFWS, the National Marine Fisheries Service (NMFS), CDFW, the Central Valley Regional Water Quality Control Board (RWQCB), the State Historic Preservation Officer (SHPO), the California State Lands Commission, and CVFPB. A comprehensive discussion of the above agencies' permitting requirements for SPFC O&M activities, including vegetation and invasive plant management, is found elsewhere (AECOM 2011); however, the permitting requirements of the agencies most likely to review and issue permits for DWR's invasive plant management efforts are summarized below.

5.1.1 U.S. Army Corps of Engineers

Control efforts that involve soil excavation, stockpiling, or other activities, such as mechanized clearing, that could affect the substrate of a river, lake, or wetland could require permits from USACE under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. Many of DWR's SPFC O&M activities would likely qualify for authorization under USACE's Nationwide Permit (NWP) 3, which covers routine maintenance activities. Before an NWP is issued, USACE requires project compliance with additional regulations, such as the Magnuson-Stevens Fishery Conservation and Management Act for Essential Fish Habitat (regulated by NMFS), and the Migratory Bird Treaty Act (regulated by USFWS). As the lead agency for permit issuance, USACE would ensure project compliance with ESA (regulated by USFWS and NMFS) and the National Historic Preservation Act (regulated by the SHPO). Whenever a Section 404 permit is required by USACE, Section 401 certification is required by the RWQCB.

For larger projects (more than 10 acres) or those that do not qualify as routine maintenance under NWP 3 because of their location or potential species impacts, it may be possible to obtain a regional or programmatic general permit. Regional General Permits and programmatic general permits are long-term permits developed to streamline the USACE regulatory process for ongoing activities that cause minimal individual or cumulative environmental impacts. These permits are issued for a category or categories of activities and are contingent on compliance with specific environmental protective measures to ensure that environmental impacts are minimized.

5.1.2 Regional Water Quality Control Board

Any invasive plant management activities that require a Section 404 permit from USACE also require Section 401 certification or a waiver from the RWQCB before they can be initiated. In addition, the RWQCB has permitting, administrative, and enforcement authority for the National Pollutant Discharge Elimination System (NPDES) program under Section 402 of the Clean Water Act.

Under California's NPDES program, projects that disturb 1 acre or more of soil or projects that disturb less than 1 acre but are part of a larger common plan of development that, in total, disturbs 1 acre or more, are required to obtain coverage under the State's general permit for discharges of stormwater associated with construction activity. Construction activities subject to this general permit include clearing, grading, and disturbances to the ground such as stockpiling or excavation. The construction general permit requires the development and implementation of a Stormwater Pollution Prevention Plan. If construction site compliance is not covered under a Section 401 water quality certification, an NPDES/402 permit may be required.

5.1.3 U.S. Fish and Wildlife Service and National Marine Fisheries Service

If activities that require a federal permit, such as a USACE Section 404 permit or Section 10 permit, have the potential to result in the "take" of a federally listed species, compliance with ESA is accomplished by the lead federal agency (typically USACE) through consultation with USFWS or NMFS under ESA Section 7. "Take" is defined under ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." USFWS consultation is required for terrestrial species. Consultation with NMFS is required for marine and anadromous aquatic species (e.g., salmonids), whereas USFWS consultation is required for other aquatic species.

For activities that do not require a USACE permit or other federal action, but that could still result in "take" of a federally listed species, incidental take authorization must be obtained from USFWS and/or NMFS under ESA Section 10. Applications for incidental take authorization are initiated by submitting a Habitat Conservation Plan that is designed to offset and mitigate the harmful effects that a proposed activity might have on a listed species.

5.1.4 California Department of Fish and Wildlife

Section 1600 et seq. of the California Fish and Game Code provides CDFW with jurisdiction over activities that would alter the bed or bank of a river, lake, or stream. In many cases, the protections afforded by Section 1600 overlap with similar provisions of Clean Water Act Section 404 and Section 401; however, CDFW's jurisdiction under Section 1600 also includes adjacent floodplain and riparian vegetation, which may not be otherwise regulated under the Clean Water Act. Activities that would alter the bed or bank of a river, lake, or stream or remove adjacent floodplain or riparian vegetation require a Lake and Streambed Alteration Agreement from CDFW.

As described in Section 2 of this Plan, CDFW and DWR have executed an RMA that streamlines compliance with Section 1600 because much of the work performed by the Maintenance Yards occurs in the stream zone. The RMA outlines a process that allows CDFW to annually review DWR's maintenance work on flood control projects to ensure that the work does not adversely affect fish and wildlife resources. For maintenance work that is not expressly covered under the RMA, DWR must obtain an individual Lake and Streambed Alteration Agreement before the work may commence. Additionally, if any vegetation management activities could result in take of a species listed under CESA, those activities would not qualify for authorization under the RMA, and an Incidental Take Permit for the project would be required, under California Fish and Game Code Section 2080. The California Fish and Game Code defines "take" as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

5.2 Best Management Practices for Invasive Plant Treatment

Vegetation management projects that involve invasive plant control may, as described above, require permits from one or more resource agency. In these cases, permit authorizations will typically contain a series of conditions that dictate how the work will be executed to avoid or minimize adverse effects on regulated species or habitats. SAA's with CDFW can contain standard avoidance and minimization measures that DWR must implement for all SPFC maintenance activities, including invasive plant control

Aside from measures specified by the SAA, which focus on actions to be implemented during vegetation management activities to avoid and minimize adverse effects on sensitive biological resources, additional BMPs may be implemented by DWR to minimize the probability of invasive plant introduction and spread. Proactive prevention of invasive plant spread and infestation is the most cost-effective strategy for managing invasive plants. It reduces future maintenance needs and costs; reduces fire hazards and herbicide use; enhances access and safety; limits landowner liability and maintains good public relations; and protects existing wildlife habitat, endangered species, native plant populations, and beneficial insects (Cal-IPC 2012).

To proactively limit the unintentional spread or introduction of invasive plants, DWR may implement the following specific BMPs, as feasible, during invasive plant treatments and other SPFC O&M activities:

- **Develop and implement a Hazard Analysis and Critical Control Point (HACCP) plan for Maintenance Yard O&M activities.** HACCP plans focus on identifying critical control points where invasive species can be removed while documenting the BMPs used to prevent and remove these species. HACCP planning builds a framework of information with which to weigh the risk of species spread against management benefits. An HACCP planning manual, supporting documents, forms, and a database of completed HACCP plans (with BMPs) are available on the HACCP Planning for Natural Resources Management website (http://www.haccp-nrm.org/), supported by USFWS. Additional information on invasive plant BMPs is found in Cal-IPC's Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers (Cal-IPC 2012) and in the U.S. Forest Service's (USFS's) Guide to Noxious Weed Prevention Practices (USFS 2001). Additionally, Cal-IPC has developed video training materials describing BMPs for invasive plant management (http://www.cal-ipc.org/resources/booksandcds/preventionvideo.php), which could be adapted for use by DWR to train Maintenance Yard and other staff on appropriate BMPs.

- **Manage O&M activities to limit introduction and spread of invasive plants.** Modifications of activities would include limiting soil disturbance and areas of bare soil; revegetating or covering disturbed soil with locally adapted native plants, sterile nonnative plants, or certified weed-free mulches; cleaning and washing tools and equipment within designated areas before entering and leaving work sites; regularly monitoring and promptly treating invasive plants in or next to soil stockpiles, equipment staging areas, and similar areas of concentrated disturbed or bare soil; minimizing access roads and equipment staging areas; implementing measures to limit erosion and transport of weed seeds from work areas (e.g., using straw wattles or silt fencing); and avoiding work and use of heavy equipment during or after rainfall, or whenever soil disturbance is more likely (when soils are saturated).

- **Train staff, including contractors, on weed identification and methods to avoid the unintentional spread of invasive plants.** This training could occur concurrently with preactivity training focused on identifying and avoiding sensitive biological resources (where appropriate). Educational materials provided to personnel could include weed identification tools and written copies of required practices for designated locations within the work site.

- **Manage vegetation using methods that reduce the spread of invasive species and encourage desirable vegetation.** This practice includes (to the extent feasible) scheduling mowing and similar vegetation management activities for times when desirable native plants are less susceptible to defoliation (e.g., early in the growing season, during dormancy, or after production of viable seed); scheduling management of invasive plants for times when plants are most susceptible to planned treatment actions (e.g., during early vegetative growth [if using herbicides] or during flowering [if mowing]); and collecting and disposing of cut weed materials so that vegetative parts and weed seeds are not unintentionally spread after cutting.

5.3 Invasive Plant Treatment Techniques

As described previously in Section 2.0, the Maintenance Yards currently use a variety of methods to manage vegetation, including invasive species, in areas maintained by DWR inside the SPA. These methods include manual removal using hand tools, mechanical treatment (mowing, disking, dragging, grading), herbicide use, controlled burning, and livestock grazing and the BMP’s described above can complement existing methods and reduce additional introduction of new invasive plant infestation. Successful control of invasive plants frequently requires a combination of these methods within an Integrated Pest Management (IPM) framework. IPM is an ecosystem-based strategy that focuses on long-term prevention and elimination of pests, or invasive plants, through a combination of techniques. These techniques include identifying and monitoring problem plant infestations, employing thresholds to determine when action is needed, preventing weed spread, and using control tactics on existing infestations. When used simultaneously, these techniques can effectively control invasive plant populations. The overall IPM approach is not to eliminate all invasive plants, but rather to keep their populations at tolerable levels.

Potential treatment techniques, including those currently used by DWR, that could be applied either singly or in combination with other techniques to the target species identified in Section 4.0 are summarized in Table 5-1. Because the Initial Priority Species are emphasized in this Plan and in the Conservation Strategy, more detailed treatment recommendations for these four species are provided in Section 5.3.1. Additionally, each treatment technique listed in Table 5-1 is described in Section 5.3.2, based on information contained in Bossard et al. (2000), Tu et al. (2001), and DiTomaso et al. (2013), unless noted otherwise.

5.3.1 Treatment Recommendations, Initial Priority Species

Giant Reed

Description

As described previously, giant reed is a perennial, reed-like grass capable of rapid growth. The stalks of giant reed, called “culms,” resemble those of bamboo and can reach diameters of 1.5 inches (Hoshovsky 1987). Giant reed has fleshy rhizomes from which tough, fibrous roots grow and penetrate deeply into the soil. Giant reed can sometimes be mistaken for the native perennial common reed (*Phragmites australis*) but can generally be distinguished by its growth habit and habitat type. Whereas common reed typically occurs only along streambanks and marshes, giant reed can also be found in upland and inland habitats. Giant reed also can be distinguished by its wider stems, with blade bases that are round-lobed, truncate, or clasping the stem instead of gradually narrowing. Additionally, unlike common reed, giant reed is generally more tolerant of high and low water tables.

Treatment and Control Considerations

Giant reed is shade-tolerant and can grow beneath riparian vegetation. The growth of giant reed can be impeded by lack of moisture during the first year, but plants 2–3 years old can survive drought conditions. Rhizomes must be removed or killed to eradicate infestations; otherwise, remnant rhizome or shoot fragments may develop into new plants. Mowing and cutting of mature plants, coupled with appropriately timed herbicide treatments from March through October may also be effective (DiTomaso and Healy 2007). Prescribed burning may exacerbate infestations of giant reed, because fire removes the stalks but does not affect the rhizomes. After fire disturbance, giant reed grows back rapidly from its roots without competition from other plants, often thicker than before the fire (California State University Sacramento and Sonoma Ecology Center 2005).

Table 5-1. General Treatment Techniques for Target Invasive Plants

Common Name	Mechanical					Cultural					Biological	Chemical
	Manual Removal	Mowing or Cutting	Girdling	Mulching	Tillage	Competition	Grazing	Prescribed Burning/Flaming	Solarization	Water Management	Insects/Fungi/Fish	Herbicide
Alligator weed	D										C	B
American frogbit	C	D										B
Barbed goatgrass	B	B			C			C				B
Blue gum	B	B						D				B
Brazilian waterweed	D	D								C	C	B
Chinese tallowtree	C	B	B									B
Crisp-leaved pondweed	C									C		B
Edible fig	B	B										B
Fennel	B	C										A
French broom	B	B		B			C	B				A
Giant reed	B	B					C	D			B/C	B
Himalayan blackberry	B	B			C		B	C				B
Hydrilla	C									C		B
Medusa head		B			B		B	B				B
Milk thistle	A	B			B							A
Pampas grass	A	B					C					B
Parrot's feather	C									B		C

Table 5-1. General Treatment Techniques for Target Invasive Plants

Common Name	Mechanical					Cultural					Biological	Chemical
	Manual Removal	Mowing or Cutting	Girdling	Mulching	Tillage	Competition	Grazing	Prescribed Burning/Flaming	Solarization	Water Management	Insects/Fungi/Fish	Herbicide
Perennial pepperweed	C	B			D		C			B		B
Purple loosestrife	B	C								B		B
Ravenna grass	A	B										A
Russian thistle	A	B			C	C	C					A
Saltcedar	B	C					C	C		B	B	B
Red sesbania	B	B						B				B
Scotch broom	B	B		B			B	C				B
Scotch thistle	A	B			C	B	C					A
Shortpod mustard	A	B							B			C
Stinkwort	A	B				C		D				A
Tree of heaven	B	B	B				C					B
Tree tobacco	A	B										A
Water hyacinth	D	D								C		B
Water primrose	B	B								B		B
Yellow star-thistle	B	B			C	C	B	B	B		C	B

Sources: Bossard et al. 2000; Tu et al. 2001; DiTomaso et al. 2013.

Notes:
A = Highly effective.
B = Effective in certain circumstances or in combination with other treatment techniques.
C = Moderately effective in certain circumstances or in combination with other treatment techniques.
D = May exacerbate the problem.

Recommended Control Methods

Generally, herbicides are the primary means used to treat giant reed. This species' ability to resprout from plant fragments and vigorously regrow following defoliation reduces the effectiveness of other control methods; however, other control methods (e.g., mowing or cutting) may be combined with herbicide use to increase effectiveness. Control can be achieved by spraying the foliage or removing aboveground biomass, followed by spraying the resultant cut culms. Recommended foliar spray applications include either glyphosate or imazapyr at 2 percent concentration or a mix of these two chemicals (1 percent glyphosate plus 1 percent imazapyr). Application to cut culms can be made with either 100 percent concentration glyphosate or imazapyr at 25 percent minimum concentration. The advantages and disadvantages of glyphosate and imazapyr for control of giant reed are summarized in Table 5-2. A California-licensed Pest Control Advisor (PCA) must prepare a written herbicide application recommendation before herbicides are used.

Table 5-2. Advantages and Disadvantages of Imazapyr and Glyphosate for Control of Giant Reed

Herbicide	Advantages	Disadvantages
Glyphosate	1. No soil residual. 2. No translocation of herbicide to nontarget species through root exudates. 3. Few restrictions on aquatic application.	1. Requires full foliar coverage on dense, uncut biomass for full systemic effect. 2. A large volume of water is required, under high pressure, to penetrate dense, uncut foliage. 3. Poor control of spring and summer resprouts.
Imazapyr	1. Needs less foliar coverage for full systemic effect. 2. Requires less water, applied with less pressure. 3. Good control of spring and summer resprouts.	1. Potential soil residual persists for up to 2 years, depending on application rate (dosage). 2. Potential for interspecific root exudates transfer. 3. Even with aquatic labels, buffer zone requirements or restrictions may apply near water. 4. Slow mode of action, with full efficacy often not apparent for 1–2 years.

For aquatic, riparian, and wetland applications where seasonal or perennial water is nearby (including shallow groundwater), use Habitat (or similar aquatic-labeled product; e.g., Polaris) for imazapyr, and Rodeo (or similar aquatic-labeled product; e.g., Aquamaster) for glyphosate. Spraying should occur during the plants' active, healthy (nonstressed) growth period (generally June through September), preferably before flower formation and well before initiation of leaf senescence. Herbicide should be applied to cut culms immediately after cutting.

Additionally, biological control agents have been developed for giant reed control. Although the effectiveness of these agents, tip-galling wasp (*Tetramesa romana*) and Arundo scale (*Rhizaspidiotus donacis*), has not been widely tested in California, both agents are approved for use in California, and they have been released, or are planned for release, throughout the SPA (Moran pers. comm.). These agents may provide effective control of giant reed as a complement to, or alternative to, herbicides.

Saltcedar

Description

As noted previously, saltcedar has rapidly invaded native riparian areas. Saltcedar is a deciduous tree that inhabits streambanks, lake shores, gravel bars and sandbars, and washes throughout California. Saltcedar can be identified by its dense canopy of slender, often arched or drooping branches, awl-like leaves, and dense spikes of white to pink flowers. Trees typically develop a deep, extensive root system and have a high evapotranspiration rate in arid climates. Saltcedars generally reproduce by seed but can also reproduce vegetatively from root sprouts and stem fragments. Despite the prolific and rapid germination of seeds, seedlings cannot tolerate even 1 day without adequate water, so most germinated seeds do not survive to establish along streambanks. Saltcedar stem fragments may take root when buried in saturated soils, such as occurs with flooding (DiTomaso and Healy 2007).

Treatment and Control Considerations

Efforts to cut or burn saltcedar to the ground have proven ineffective, because the plants will typically regenerate from the roots. However, removing and/or chemically treating the root system has proven to be effective at managing invasive populations; follow-up treatments may be required. Saltcedar seedlings are easily pulled by hand and should be removed early to prevent reinfestation. Young seedlings are not competitive in the presence of dense native vegetative cover, so establishing native cover after saltcedar is removed discourages reinfestation (DiTomaso and Healy 2007).

Recommended Control Methods

Generally, herbicide application is the primary method used to treat saltcedar. Control can be achieved by removing and/or chemically treating the root system and spraying the foliage. For saltcedar control, it is recommended that all aboveground, exposed target biomass is treated—in other words, all foliage (with full canopy coverage) is treated with foliar spray, and every cut stem is treated with herbicide after cutting. Herbicide application should occur during the active, healthy (nonstressed) growth period (generally June through September); preferably after flowering, but before initiation of leaf senescence (i.e., leaf coloration in fall). A California-licensed Pest Control Advisor (PCA) must prepare a written herbicide application recommendation before herbicides are used.

Several treatments and herbicide concentrations are recommended; the selection of herbicide depends on the method chosen. Using imazapyr at 2 percent concentration is recommended for foliar application and treatments of resprouts. Cut-stump spraying requires imazapyr or triclopyr at a minimum of 25 percent concentration. For basal bark spraying, triclopyr with an appropriate adjuvant (e.g., JLB Improved Oil Plus) at a minimum 35 percent concentration is recommended.

Stalker is recommended for nonaquatic/ nonriparian (i.e., upland) applications. Habitat (or similar aquatic-labeled product; e.g., Polaris) is recommended for aquatic, riparian, and wetland applications where seasonal or perennial water is nearby (including shallow groundwater). Garlon 4 (or similar ester formulation; e.g., Remedy Ultra or Tahoe 4) should be used before foliage regrowth (i.e., in the late fall after leaf senescence, through early winter for basal bark spraying) in nonaquatic/ nonriparian (upland) applications. Other alternatives include glyphosate (e.g., Roundup Pro, Touchdown Pro) used at 100 percent concentration for nonaquatic/ nonriparian (upland) applications, and Rodeo (or similar, such as Aquamaster), used at 100 percent concentration for aquatic, riparian, and wetland applications where seasonal or perennial water is nearby (including shallow groundwater).

Red Sesbania

Description

As noted previously, red sesbania is a deciduous shrub or small tree that grows up to 13 feet tall and forms thick, impenetrable thickets in riparian areas (DiTomaso and Healy 2007). The long-lasting flowers are orange to reddish in color and are characteristic of the legume family. Red sesbania is currently found in the southern Sacramento Valley (American River Parkway), along the Sacramento River and Feather River in the northern Sacramento Valley, San Joaquin Valley (Suisun Marsh, San Joaquin River Parkway), and southern North Coast Ranges. It predominantly inhabits streambanks but also dominates the edges of ponds, marshes, canals, gravel bars, and instream islands. New colonies establish in riparian areas and spread through production of seeds and seed pods that float downstream and germinate in saturated soils. Red sesbania typically reproduces within 2 years and is capable of producing thousands of viable seeds within a few months, leading to rapid spread of the species (DiTomaso and Healy 2007). Red sesbania is also moderately shade-tolerant and can establish itself in the shade of other native riparian vegetation, allowing it to easily attain community dominance.

Treatment and Control Considerations

Red sesbania rapidly establishes thick stands along riparian corridors. These dense stands displace native plants and diminish food resources and habitat for native wildlife. Tall stands of red sesbania can increase the hydraulic roughness of stream channels and increase the risk of flooding by altering flood conveyance (Cal-IPC 2013a). Additionally, the foliage, flowers, and immature seeds of red sesbania contain a compound that is moderately toxic to humans and livestock.

Recommended Control Methods

Mechanical, biological, and chemical methods have all proven effective at controlling the spread of red sesbania. The root system of red sesbania is relatively shallow and easy to remove, especially in saturated soil, making mechanical removal of young plants a feasible means of control. Mechanical removal and maintenance of red sesbania may require up to 5 successive years to effectively eradicate an infestation. Targeting small, upstream populations of red sesbania has proven most effective at slowing the spread of the invasive plant along riparian corridors. Plants in standing water can also be cut below the water line to help discourage regrowth (DiTomaso and Healy 2007).

If herbicides are used, spraying the foliage during the active, healthy (nonstressed) growth period (generally June through September), preferably after flowering, but before initiation of leaf senescence (i.e., leaf coloration in fall), is recommended. Using a 2 percent glyphosate concentration for foliar and resprout spraying is recommended, and a 100 percent concentration of glyphosate is recommended for cut-stump spraying. For aquatic, riparian, and wetland applications where seasonal or perennial water is nearby (including shallow groundwater), using a 2,4-D amine formulation at 0.75 pounds active ingredient (AI)/acre equivalent, or Rodeo (or similar aquatic-labeled product, such as Aquamaster) for glyphosate, or DMA (or similar aquatic-labeled 2,4-D product) is recommended. Other alternatives include using oxyflurofen (e.g., Goal 2XL) for nonaquatic/nonriparian (i.e., upland) applications.

Where feasible, late-season disking followed by flooding can prevent reestablishment of red sesbania from seed. Additionally, rope-wick treatment may be used, if the area is accessible to wick application equipment.

Himalayan Blackberry

Description

As noted, Himalayan blackberry is a sprawling, robust, invasive shrub that spreads rapidly and dominates native species of blackberry, such as California blackberry. Himalayan blackberry can be distinguished from California blackberry by its taller, more robust stature and larger thorns and berries. The flower petals of California blackberry are narrower at the base and do not have the crinkled appearance of the Himalayan blackberry flower (DiTomaso and Healy 2007). Flowers are characteristic of the rose family and are white to pinkish in color. This species flowers from July to September and can produce 650 to 1,200 seeds per square foot. These seeds are dispersed by gravity and wind, as well as by many species of birds and mammals.

Treatment and Control Considerations

Himalayan blackberry is common in riparian areas and tolerates periods of inundation by fresh or brackish water. This periodic flooding can produce long-lived early seral communities that are conducive to the growth and spread of blackberries (DiTomaso and Healy 2007). Himalayan blackberry occurs just as commonly in upland communities as well; although, they tend to proliferate in areas with consistent soil moisture. Its ability to withstand a range of soil pH and textures allows Himalayan blackberry to outcompete native plants in both riparian and upland communities.

Recommended Control Methods

Himalayan blackberry control is most effective when a combination of mechanical and chemical methods is employed; repeated treatments are needed to effectively eradicate this species in the long term. To control Himalayan blackberry, all aboveground biomass should be cut to the ground early in the growing season (April–May) and removed from the site. Care should be taken to ensure that all live biomass has been removed, to reduce the potential reestablishment of remaining plant fragments. The cut vegetation should then be allowed to resprout, and the new growth should be treated with a foliar application of herbicide in early spring and/or late summer. Because long-term control of this species is difficult, one or two rounds of follow-up herbicide treatments should be completed (DiTomaso 2012) between May and November during the first year of control. For optimal chemical transport to the plants' root systems, one round of herbicide application should occur during the late summer (DiTomaso 2012) or early fall. Follow-up herbicide treatments should occur two or three times during the following two growing seasons to ensure adequate control of this species. The number of follow-up herbicide treatments needed is flexible, so the treatment schedule can be adjusted if it is determined that more or fewer treatments are required for adequate control. Care should be taken to avoid damaging nontarget species.

Most of the recent literature suggests that triclopyr is the most effective herbicide for controlling Himalayan blackberry (DiTomaso 2012; Oregon State University 2008). For example, an aquatic label of triclopyr (Renovate) with the surfactant Agri-dex is preferred for controlling Himalayan blackberry on the Guadalupe River to minimize potential impacts on steelhead (Oncorhynchus mykiss) (Spahr pers. comm.). In general, using Renovate at a 1 percent solution with the surfactant Agri-dex is recommended for control of Himalayan blackberry.

5.3.2 General Treatment Recommendations

Manual Removal

General overview: Manual removal techniques involve physically removing entire plants either by hand or with tools (e.g., hoes, Pulaski, Root Talon, or Weed Wrench). These techniques generally have limited ecological impacts, cause minimal damage to neighboring plants, have low equipment and supply costs, and are good alternatives where herbicides or other methods cannot be used.

Applicable Uses: Small infestations of herbaceous plants that will not resprout from root fragments; sapling size or smaller woody species.

Benefits: Generally limited potential for adverse environmental effects compared to other treatment techniques.

Drawbacks: Only effective on small infestations of certain species; repeated treatment is often required for perennial species; can be time- and labor-intensive relative to the size of infestation treated.

Mowing or Cutting

General Overview: Mowing or cutting involves using tools (e.g., mowers, weed whackers, pruners, loppers, and saws) to defoliate plants in order to reduce plant vigor, deplete carbohydrate reserves, and remove flowers to prevent seed production.

Applicable Uses: Effective control for small or large infestations of herbaceous annual plants; most effective when plants are in flower and soils become and remain dry (Sheley and Petroff 1999). Cutting can effectively control perennial or woody species, especially when combined with herbicide application.

Benefits: Mowing and cutting reduce vegetation heights and can remove thatch, litter, and fire fuel buildup; increase the competitiveness of desirable species; reduce or prevent seed deposition into soil seedbanks; and increase the efficacy of subsequent treatments, such as manual removal, flaming, or herbicide application.

Drawbacks: Can stimulate production of new stems in some plant species; transport and spread propagules by tools, equipment, and clothing; and cause undesirable shifts in species composition (Maron and Jefferies 2001; Hayes and Holl 2003a). Fuel exhaust from mowers can decrease air quality, and a significant fire hazard is posed by metal blades striking rocks and creating sparks. Each site may respond differently to the same mowing treatment, so site-specific management plans are needed to maximize the benefits of mowing (Hayes and Holl 2003b).

Girdling

General Overview: Girdling trees involves cutting the narrow band of living tissue (cambium) encircling the tree just beneath the bark so that the tree is unable to transport water and nutrients between the roots and the canopy.

Applicable Uses: Trees or shrubs that have a single trunk; most effective on woody species that do not resprout from the base.

Benefits: Typically requires less labor than cutting and removal, is inexpensive, kills only the target plant, leaves no residue except the standing trunk (which can provide valuable wildlife habitat), and, if left to decay, allows the nutrients of the tree to be returned to the ecosystem rather than being removed and deposited elsewhere.

Drawbacks: Some species (e.g., black locust and tree of heaven) heal damaged cambium quickly or resprout below the girdle, rendering the treatment ineffective. Standing snags might present a potential hazard to people or structures, or be undesirable aesthetically. Propagules can be transported and spread by tools, equipment, and clothing.

Mulching

General Overview: Mulching involves applying a layer or layers of material over an infestation or area of soil to reduce the amount of sunlight plants receive and cut off the energy supply they need to grow and reproduce. Commonly used mulch types include hay, manure, grass clippings, straw, rice hulls, leaf litter, sawdust, wood chips, black paper, and black plastic sheets.

Applicable Uses: Annual plants, primarily in small areas, although mulching has proven successful on some herbaceous perennial species.

Benefits: Conserves soil moisture and can improve soil productivity by introducing organic materials and attracting soil fauna.

Drawbacks: Ineffective against perennial weeds with extensive carbohydrate reserves (i.e., roots) that allow them to grow up through the mulch. Materials and application can be expensive. Mulching may not be effective in the long term; also, it may prevent germination of native plants or introduce propagules of other weeds.

Tillage

General Overview: Deep tillage controls invasive plants by burying plant propagules deep into the soil profile. Shallow tillage, using knives, sweeps, harrows, shallow disking, or other tools, detaches roots from shoots and causes plants to desiccate. The ideal time to till is when surface soil is dry and before seed production.

Applicable Uses: Large infestations of annuals in highly degraded systems, on croplands and in level areas, and at restoration sites prior to plant installation.

Benefits: Loosens and aerates topsoil; helps mix organic matter into soil.

Drawbacks: Less effective for controlling perennials. Can spread perennial invasive plants that reproduce vegetatively by rhizomes or roots when cut; also facilitates invasion by other invasive species as a result of soil disturbance. Increases atmospheric dust levels and soil erosion. Generally not practiced on rangelands or wildlands.

Competition

General Overview: Native and nonnative plants compete with one another for light, nutrients, water, and space. Competitive native species can suppress or exclude invasive plants by altering the abiotic and biotic conditions that favor invasive plant establishment and persistence. For example, native trees can be planted to exclude shade-intolerant invasive species. Invasive plant control through competition is often most successful when used as part of an IPM program. Revegetation of sites after treatment can be an effective means of long-term control.

Applicable Uses: Small or large areas that contain a suite of competitive native plants that, through manipulation of abiotic and biotic factors, gain a competitive edge over nonnative plants; also, areas dominated by nonnative plants where native plants can be introduced and managed to promote their establishment.

Benefits: Successful revegetation efforts limit the potential for nonnative species to invade and persist, reducing the need for repeated treatments. This method restores native plant communities that resist invasion by nonnative species while enhancing habitat functions and values.

Drawbacks: Managing and restoring native plants can be expensive, and may be effective only under certain conditions. Uncertainties in invasive species' response to competition limit predictability of management success.

Livestock Grazing

General Overview: Livestock grazing affects plants by damaging the plant tissues responsible for growth and reproduction. Things to consider when developing a grazing plan include livestock class, stocking rates, grazing intensity and frequency, fencing, and herding. Certain livestock kinds (e.g., sheep, cattle, and goats) and classes (e.g., calves, cows, steers, and heifers) target specific invasive plants and avoid others. Stocking rates must be optimized to maximize weed management, avoid overgrazing, and minimize soil compaction. Grazing is implemented before plants produce viable seed and when the target plant or suite of plants is most palatable to the selected kind and class of livestock. The type of fencing used, if needed, depends on livestock kind and class and grazing duration. Temporary electric fencing can be used for smaller animals in small rotating plots, whereas permanent electric or barbed-wire fencing is needed to contain large animals during long grazing periods. Livestock grazing usually requires repeated treatments to deplete the seedbanks and energy reserves of target invasive species.

Applicable Uses: Areas too large for herbicide applications, or where herbicide use would be too costly or constrained by label restrictions or policies. Some livestock (e.g., sheep and goats) are well adapted for grazing in steep or rocky terrain that is otherwise difficult to access. Severe infestations can be reduced, and small infestations may be eliminated, when grazing treatments are combined with other control techniques, such as prescribed fire and herbicides.

Benefits: Can induce shifts in plant community composition toward more desirable species, break up compact soils, reduce thatch and litter layers, lower fire hazards by reducing fuel loads, and introduce nutrients into the soil.

Drawbacks: Some invasive plants are unpalatable to livestock and require a different form of treatment; alternatively, the livestock can be allowed a period in which to adapt to consuming an unpalatable or new forage type. Trampling and removing overstory vegetation can disturb soil and enhance germination of invasive species by moving seed to the soil surface. Livestock grazing can increase light penetration to invasive plants. High grazing intensity can lead to increased soil compaction, which can reduce the vigor of desirable plant species and lead to rapid invasive plant establishment. Seeds of some invasive species can pass, intact and viable, through the digestive systems of animals and result in dispersal of seeds to uncontaminated sites.

Prescribed Burning

General Overview: Prescribed burns destroy plant tissues using fire and heat. They require good logistical planning, coordination, careful timing with respect to weather (winds, moisture conditions), coordination with air quality agencies, and attention to other details required to carry out an effective and safe burn.

Applicable Uses: Effectively treats annual grasses and shrubs. Less effective at treating perennial species with deep roots that remain unharmed by low-intensity fire. Annual grasses must be burned before they set seed, and invasive forbs should be burned before seeds become viable.

Benefits: Can stimulate germination of desirable native species, particularly perennial grasses and legumes; remove layers of thatch and recycle nutrients; and induce germination of fire-adapted invasive species so the seedbank can be flushed and the resultant seedlings can then be killed with another fire or some other method.

Drawbacks: Fire can stimulate germination of some invasive species (e.g., milk thistle). Equipment and vehicles used for large fires and staged nearby may transport propagules and start new infestations elsewhere. Hot fires can sterilize soil, volatilizing nutrients and killing microorganisms on which native plants rely. Removal of vegetation by fire can increase soil erosion and stream sedimentation. Construction firebreaks and associated soil disturbance can increase erosion and provide a seedbed for invasive species. Fire can also kill desirable plant species and seedbanks. Other risks associated with prescribed burns include air quality issues, potential for fire escapes and liability for damage to personal property or injury to third parties, and impacts on small mammals and insects.

Flaming

General Overview: Flaming involves using torches or flamethrowers to quickly heat and destroy cell integrity, causing cellular leakage and death of the tissues of a target plant. Optimal timing for flaming treatments is in winter or early spring, after target plants germinate and while conditions are moist and fire risks are low.

Applicable Uses: Groups of small annual forbs, and the seedlings of perennials forbs and woody plants in small areas.

Benefits: Generally less expensive than herbicide treatments. Is suitable for use during wet weather. Requires relatively low level of effort, is very precise, and kills weeds before propagules have set, and therefore does not require the collection and disposal of weed material. Does not involve the use of chemical contaminants that could affect surrounding vegetation.

Drawbacks: Typically requires more time compared to herbicide treatments, and has a potential for causing injury to the applicator. Repeated treatments (about every 2–3 weeks) may be required to exhaust the energy reserves of perennial species.

Soil Solarization

General Overview: Soil solarization involves first removing aboveground vegetation so that only very short vegetation or bare soil remains. Clear polyethylene plastic is then placed on the area when high amounts of solar radiation and high temperatures are expected (typically July and August). The plastic is placed so that it covers the entire infestation and about 2 feet beyond the edges of the infested area, and the sheet is pulled tight over the ground. The plastic must then be left in place for at least 4–6 weeks.

Applicable Uses: Most often used in agricultural settings; generally effective in treating cool-season annual species that use fall precipitation to germinate and establish before growing quickly in spring.

Benefits: Can reduce the amount of retreatment needed by killing much of the latent invasive plant seedbank. Can release soluble nutrients that are tied up in the organic component of the soil.

Drawbacks: Perennials, warm-season annuals, and species adapted to high temperatures are less likely to be controlled using soil solarization. Solarization is effective only with plentiful sunlight and warm conditions, in late spring or summer, and when soils are moist. Solarization can have multiyear impacts on the biological, physical, and chemical properties of the soil, which can prevent the establishment and growth of native species and beneficial soil organisms. In addition, this technique leaves an open substrate that can be readily invaded by invasive plants once the plastic is removed.

Water Management

General Overview: Water management involves manipulating water levels to control target invasive plants. Lowering water levels, followed by manual/mechanical removal, exposure to freezing temperatures, prescribed burning, or deep flooding in spring, can control several aquatic invasive species in irrigation canals, ponds, reservoirs, and lakes. Drawdown or dewatering involves lowering water levels to expose sediments. The degree of plant control achieved through drawdown depends on plant species and temperature. A drawdown followed by freezing temperatures provides the greatest aquatic plant control. Raising the water level can also provide some level of control for a few emergent aquatic species. For example, flooding of purple loosestrife or perennial pepperweed is effective if plants can be inundated throughout the growing season.

Applicable Uses: Aquatic invasive plants susceptible to changes in depth and duration of water inundation.

Benefits: May promote the growth and competitive ability of certain native species in some situations.

Drawbacks: Only feasible where water levels can be manipulated. Can create conditions that favor the establishment of other, nontarget invasive plants; for example, lowering water levels can produce new substrate and facilitate establishment of invasive plants. Flooding may disperse invasive plants and invasive fish into previously uncontaminated areas.

Biological Control

General Overview: Biological control is the use of animals, insects, fungi, or microbes to feed upon, parasitize, or otherwise interfere with a targeted pest species; organisms used for the purpose of biological control are called "agents." Insects are often used as biological control agents for invasive plants because they effectively exert stress on the target plant to reduce its competitive ability and dominance by boring into roots, shoots, and stems; feeding on seeds and leaves; and extracting plant fluids. There are several methods of biological control, but the most common method used for plants involves targeting a nonnative invasive plant with one or more species of biological control agents from the pest's native range; this is referred to as "classical" biological control. "Conservation" biological control is usually defined as actions that preserve, protect, or promote the abundance of organisms that may keep the abundance of pest organisms in check. Usually this method entails modifying the environment in ways that promote the abundance or impact of native or already established nonnative organisms. In general, the synchrony in the life cycles of host plant and agent, the potential for the agent to adapt to a new climate and habitat, the ability of the agent to find the host, the capacity of the agent to reproduce rapidly, and the nature, extent, and timing of the damage caused by the agent are among the factors that determine the effectiveness of the biological control. Biological control techniques should not be used unless controlled scientific experiments have shown that it is feasible for a particular agent and host, and that risks are very minimal, if not absent. In California, the use of biological control agents is regulated by CDFA.

Applicable Uses: Most often used in rangelands and aquatic systems.

Benefits: Reduces the need for chemical, mechanical, or cultural control methods; can be cost-efficient over the long term because there may be little or no cost after the initial research is complete and the agents are released, assuming the invasive plant was effectively controlled.

Drawbacks: Biological control programs often fail, primarily because the biological agent either never establishes in the field or does not cause sufficient damage to the target pest population. Often, the agent must be reared and released again each time the pest population erupts. Also, agents may affect nontarget native species, alter ecosystem functions, and become invasive themselves (Simberloff and Stiling 1996). Agents may be difficult to contain, feed on desirable species, and carry additional nonnative parasites. Some biological control programs have resulted in significant, irreversible harm to untargeted organisms and to ecological processes.

Chemical Control

General Overview: Herbicides kill plants by altering metabolic processes or damaging cells and tissues. Terrestrial and riparian herbicides are the most frequently used control tool in wildlands, natural areas, and rangelands. Because invasive plants in such areas frequently grow in association with desirable species, herbicide application must be selective. Consideration should be given to the herbicide's potential effect on the surrounding vegetation, habitats, and wildlife. Selective herbicides (e.g., herbicides effective only on certain types of broadleaf plants) should be considered wherever feasible. In some cases, preemergent herbicides may be used to more cost-effectively treat target invasive plants. Unless specifically registered for aquatic use, herbicides should never be used where they may contaminate water bodies or wetlands. Herbicides must always be used according to local and State regulations, must be recommended by a PCA, and must be applied by a Licensed Qualified Applicator (LQA), unless specific exemptions pertain, as defined by California law.

Applicable Uses: Used for management of dense or large invasive plant infestations. Herbicides can often successfully control infestations that cannot be effectively or reasonably controlled through other management actions. Spot treatments can be effective in early control of invasions or can prevent the spread of small infestations. Woody plants are difficult to treat with broadcast applications, but can be treated with foliar or wick-applied herbicides.

Benefits: Relatively easy and inexpensive, and effective in controlling and eradicating invasive plants; selective herbicides can be used to target invasive species while leaving other desirable plants unharmed.

Drawbacks: Improper use of herbicides can lead to spray or vapor drift, contaminate water, poison animals or humans, cause selection for herbicide resistance in invasive plants, and reduce plant diversity. Certain types of herbicides (e.g., preemergent herbicides) can remain active in the soil for long periods, increasing the potential for offsite drift and adverse effects on nontarget organisms. Studies of herbicide toxicity to many species of wildlife are based on studies of proxy organisms in laboratory settings; the potential for adverse effects on wildlife in wildland settings is inferred from these studies, but other, undocumented adverse effects may occur.

5.4 Post-Treatment Revegetation

Invasive plant abatement efforts are usually more successful when coupled with follow-up plantings of native vegetation. Although not all treated areas will require revegetation, without supplemental seeding, planting, and most likely temporary irrigation of native plants, treatment areas may revert back to dominance by invasive plants, requiring costly additional treatment and management. Although DWR recognizes that resources to revegetate all treatment areas will not be available, post-treatment revegetation should be considered whenever feasible. Plans for such treatment would incorporate the following components:

- A clear rationale for selection of the revegetation site
- A detailed site assessment that identifies the existing conditions, functions, and values of the planned revegetation site
- Site-specific objectives for revegetation, and a description of ecosystem functions and values to be created or enhanced through revegetation
- A detailed revegetation design that will achieve established goals and objectives
- Identification of native plant species appropriate for revegetation, as well as a description of propagation methods, propagule types (e.g., seed, cutting, plug, or container planting), and seeding rates and/or plant spacing
- A description of implementation techniques, follow-up maintenance actions, and short-term monitoring that will result in successful establishment of the revegetation site
- Required permits to receive project approval and authorization by regulatory agencies

Figure 5-1 shows lists of plants recommended for use on post-treatment revegetation sites. This is not intended to be a comprehensive list of all possible species; rather, it represents a list of species that are commonly available in native plant nurseries and that would be appropriate (from an ecological and hydraulic perspective) at specific hydrogeomorphic positions in the major river systems of the Central Valley. The particular species to be used will be identified by qualified DWR personnel as part of the site-specific revegetation plan.

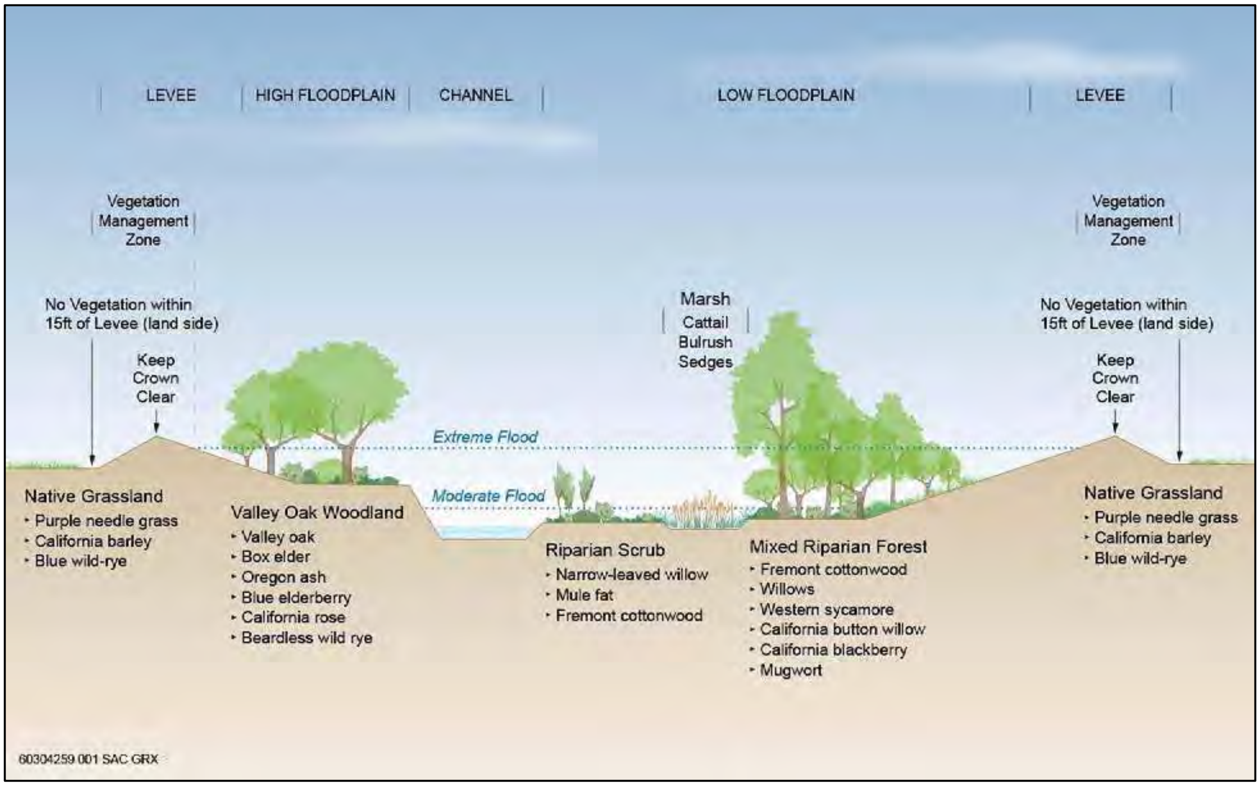


Figure 5-1. Appropriate Native Species for Revegetation in the Central Valley Flood System

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6.0 Monitoring and Adaptive Management

The Conservation Strategy defines invasive plant objectives as the number of acres of DWR-managed land where infestations of Initial Priority Species have been surveyed, treated, and maintained. Monitoring invasive plants will be essential to track areas of infestation, quickly detect new infestations, evaluate treatment effectiveness, inform management decisions, and guide adaptive management evaluations to meet the Conservation Strategy measurable objectives in the SPA. Monitoring methods could include periodic surveys before and after treatments to determine changes in the distribution, status, and demographics of target invasive plant species; reviews of GIS datasets and reports in the Cal-IPC Inventory; and communications with other landowners and managers in the SPA. To the extent feasible, monitoring will follow accepted protocols developed by the Cal-IPC (Cal-IPC 2012).

6.1 Overall Monitoring Program

To the extent feasible, DWR will monitor invasive plants within the SPA by adapting existing monitoring systems where possible, with a focus on DWR Channel Maintenance Areas. Additionally, DWR will support, where possible, the monitoring programs of others in portions of the SPA outside DWR Channel Maintenance Areas. The following monitoring could occur or be supported by DWR:

- **Compilation of invasive plant baseline.** Prior to 2017, an invasive plant baseline map will be completed using existing data sources (summarized in Section 4.0), data provided by Cal-IPC and other partners, and additional data collected by DWR. The baseline map will document existing conditions as of a specified date and provide a standard against which future conditions could- be measured to determine DWR's progress toward defined goals and objectives for invasive plant management (see Section 3.0).

- **Early detection and rapid response.** Early detection and eradication of small or incipient populations of invasive plants helps prevent their spread and significantly reduces management costs. Regular monitoring increases the chances of success. Through its Maintenance Yards and Inspections Unit, DWR regularly monitors areas of the SPFC for which it has maintenance responsibility. Further collaboration with O&M staff could target whether these tracking efforts could incorporate tracking that identifies new, incipient infestations of invasive plants. If so, these infestations will be prioritized for treatment, and treated, where feasible, as described in Section 5.0.

- **Treatment effectiveness.** DWR could monitor and maintain areas of invasive plant treatment and subsequent revegetation to ensure long-term establishment of desired plant species. These areas could be monitored over multiple growing seasons, especially at times of germination and flowering, for at least 3 years after project completion to ensure that any invasive plants are promptly detected and controlled. If 3 years is insufficient to control invasive plants, DWR would continue monitoring and treatment until the invasion has been controlled.

- **Invasive plant tracking.** DWR would first use existing tracking systems to document the baseline acreage and distribution of invasive plants, as described above. New infestations will be recorded (e.g., during annual inspections), and acreages of invasive plants successfully treated at treatment sites would be noted. The tracking system would be used to assess progress toward defined treatment acreage targets, identified in this Plan and the Conservation Strategy (Sections 3.0 and 6.2).

- **Monitoring by partner agencies and organizations.** As described in Section 7.0 of this Plan, numerous agencies and organizations are involved in invasive plant assessment and treatment within the SPA. Some of these organizations, such as Cal-IPC, have developed invasive plant monitoring programs and tracking systems that could be supported by DWR to provide additional information on the distribution and abundance of invasive plants in areas of the SPA not maintained by DWR. In addition to supporting these programs, DWR would require recipients of multi-benefit project funding to enter invasive plant treatment information into existing tracking systems, most likely the NRPI or Calflora (www.calflora.org), a database developed by Cal-IPC.

6.2 Indicators of Success

As described in Section 3.0 of this Plan, DWR has established an initial target of 213 acres of Initial Priority Species to be treated between 2017 and 2022. Progress toward this target could be assessed using a tracking system, to be developed by DWR or adapted from systems such as Calflora or NRPI, which are already in use by potential partner organizations. Initially, nonattainment of this target will serve as the threshold for determining whether adaptive management actions are necessary. These actions may include additional conservation actions, changes to DWR’s invasive plant management approach, or revision of this Invasive Plant Management Plan.

6.3 Adaptive Management

DWR plans to use an adaptive management approach to implement this Plan. Adaptive management is a systematic and iterative process that provides feedback between monitoring and management actions. This process includes reviewing invasive plant management goals and objectives, reviewing baseline data, applying treatment techniques for target invasive plants, subsequently conducting monitoring and analysis to measure achievement of goals and objectives, and refining management techniques as needed to achieve invasive plant management goals and objectives.

In general, adaptive management entails identifying triggers (or thresholds) that would initiate a management response and potential adaptive management actions. Management triggers define the specific point, or a range of values, where monitoring data indicate that outcomes may be developing along an unexpected or unfavorable trajectory, and where taking remedial actions may be necessary to meet goals and objectives. The planning targets for acres of invasive plant treatment summarized in Section 3 will serve as interim management triggers until additional analysis and further internal coordination within DWR better informs long-term goals. The following responses could be initiated if monitoring determines that a management trigger has been activated:

- Review invasive plant management goals and objectives (i.e., acreage targets in Section 3.0)
- Review invasive plant baseline data
- Review invasive plant monitoring results and treatment techniques
- Review other relevant information as needed to assess the effects of underlying causative factors that could be contributing to the observed changes (e.g., modes of invasive plant introduction and establishment, critical control points, distribution within and adjacent to the SPA, climate)
- With the assistance of invasive species experts (if required), identify potential causes of the observed changes
- Develop adaptive management and monitoring measures intended to positively affect (i.e., reverse) observed changes
- Implement identified adaptive management and monitoring measures
- Continue to implement measures until monitoring indicates that the invasive plant management goals and objectives (i.e., acreage targets in Section 3.0) are achieved

This adaptive management process is shown in Figure 6-1.

Although adaptive management measures are generally intended to be temporary, as needed to reverse observed changes in the distribution or abundance of invasive plants, if ongoing monitoring of adaptive management measures indicates that a permanent change is required, this Plan will be amended to incorporate such changes.

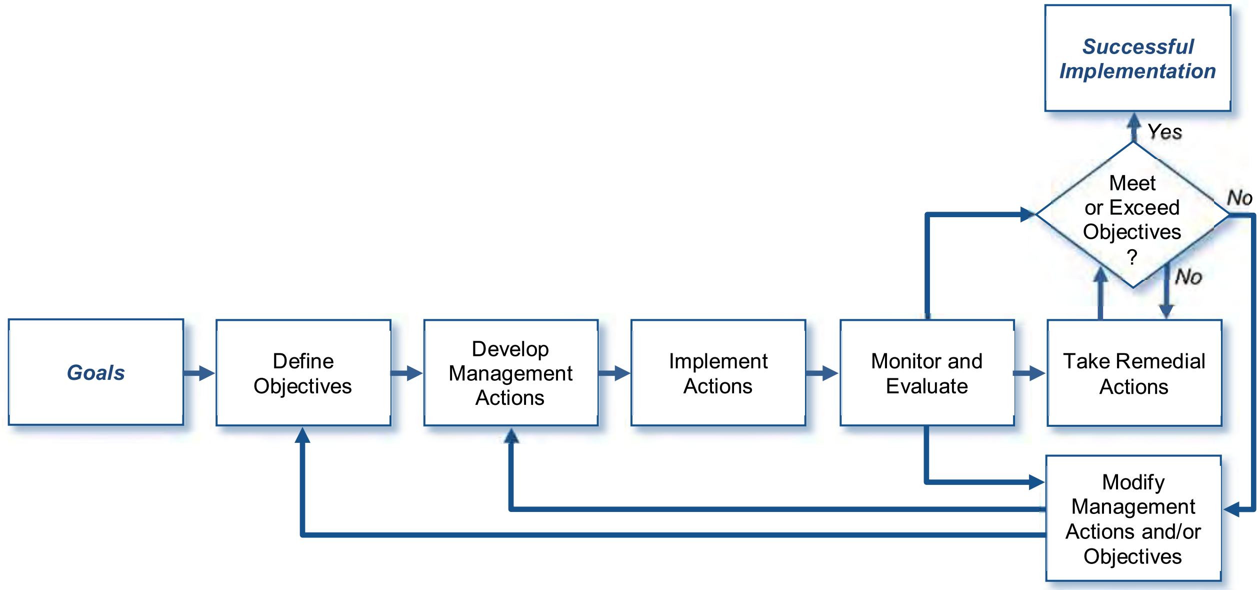


Figure 6-1. Flow Chart for Adaptive Management of Target, Invasive Plant Species in the SPA

7.0 External Partnerships

As discussed previously, numerous organizations, aside from DWR and the LMAs, share maintenance responsibilities or own and manage lands in the SPA. These organizations have enacted a variety of programs that provide additional direction or resources for collaborative planning and management and treatment of invasive plants. Additionally, numerous programs administered by the State of California, the federal government, and nonprofit organizations provide grants and other funding for invasive plant treatment. These programs and organizations represent opportunities for DWR to leverage its management efforts to better eradicate invasive plant infestations in the SPA. Evaluating these programs to gauge the opportunities and potential benefits of DWR's participation and support is an important aspect of DWR's overall strategy for managing invasive plants in the SPA. This section describes these programs and existing collaborative planning efforts.

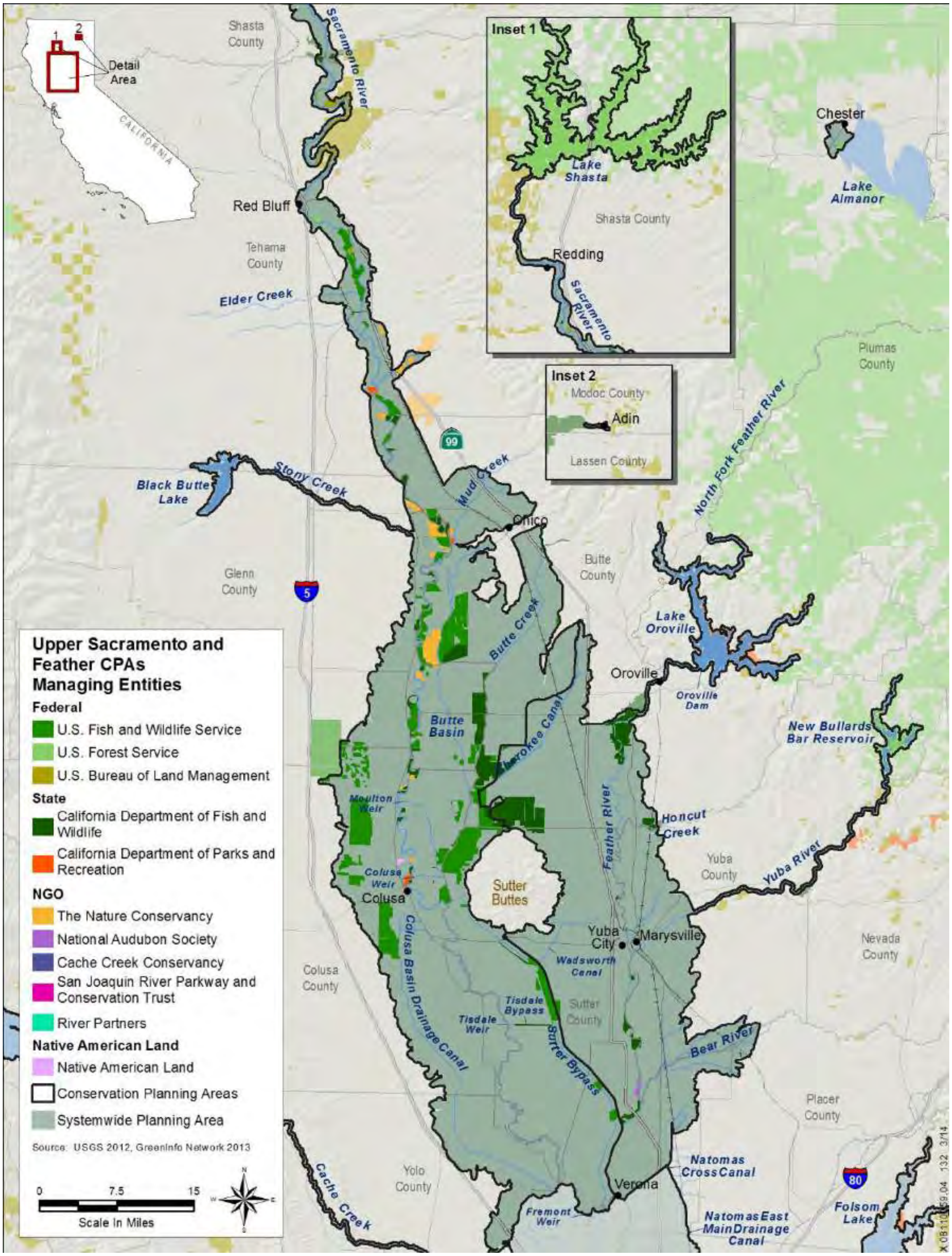
7.1 Invasive Species Management Organizations and Collaborative Planning Efforts

Throughout California, many organizations manage vegetation and control invasive species. These efforts are also conducted through various collaborative efforts at the local, State, and federal levels or by nonprofit organizations. During preparation of this Plan, representatives from these various organizations were contacted, and readily available information was collected to document the roles and responsibilities of these entities, the framework within which these entities work, the relationships among entities, and plans or guiding documents used to direct invasive species management. This information is summarized below. For those entities that actively manage invasive species within their jurisdiction, Figures 7-1 to 7-4 show the management boundaries of these entities within each of the CPAs.

7.1.1 Interagency Organizations and Collaborative Efforts

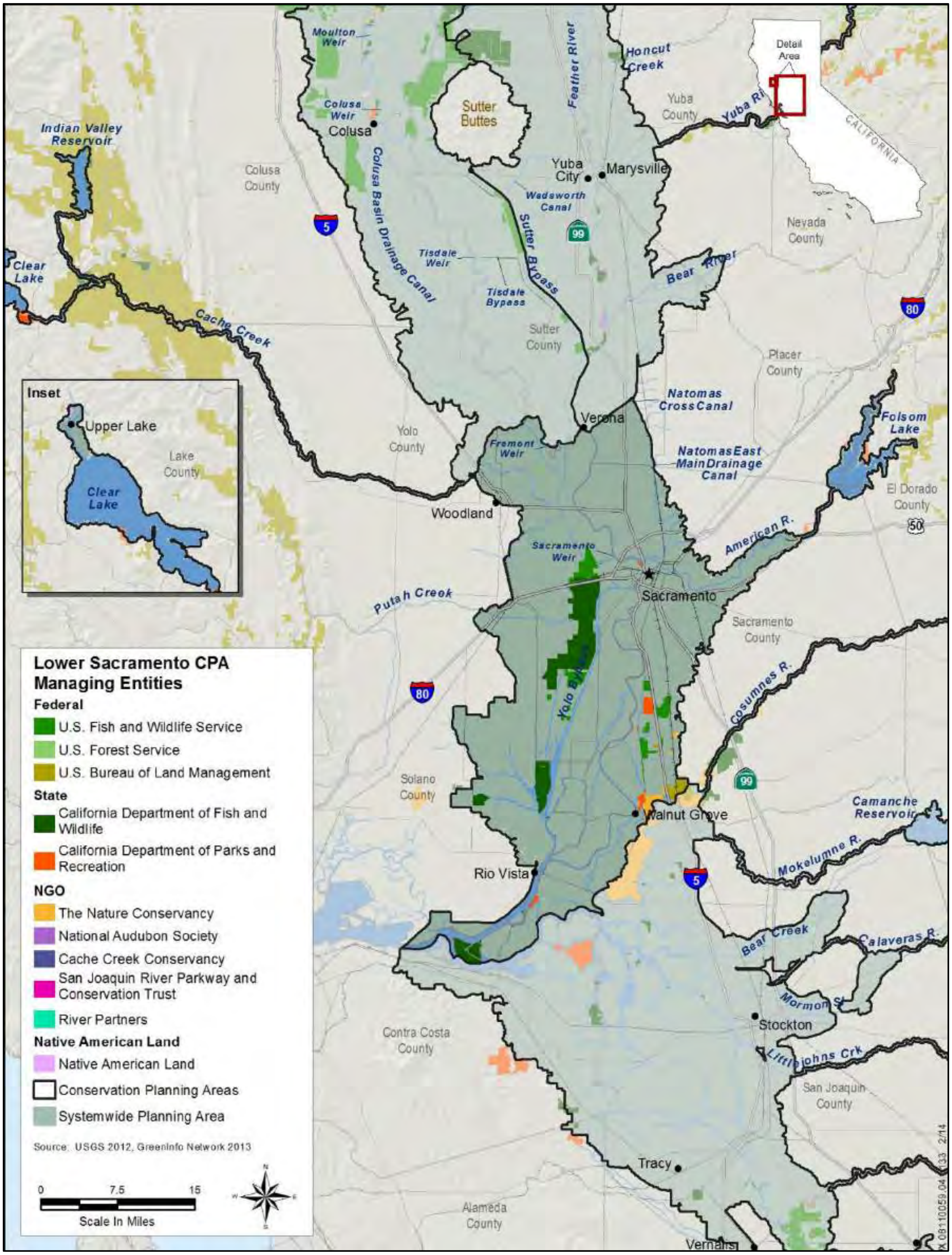
National Invasive Species Council

At the federal level, the National Invasive Species Council (NISC) is the primary agency responsible for coordinating invasive species control. The NISC is tasked by Executive Order 13112 to ensure that federal programs and activities to prevent and control invasive species are coordinated, effective, and efficient (NISC 2013). The NISC, established in 1999, is responsible for consulting with the California Invasive Species Advisory Committee (CISAC) (a nonfederal stakeholder advisory group), drafting and revising the National Invasive Species Management Plan, drafting the interdepartmental Invasive Species Performance Budget, reviewing progress under the plan, and working with the U.S. Department of State to provide input for international invasive species standards. The first National Invasive Species Management Plan was completed in 2001. The updated 2008–2015 plan was approved on 1 August 2008.



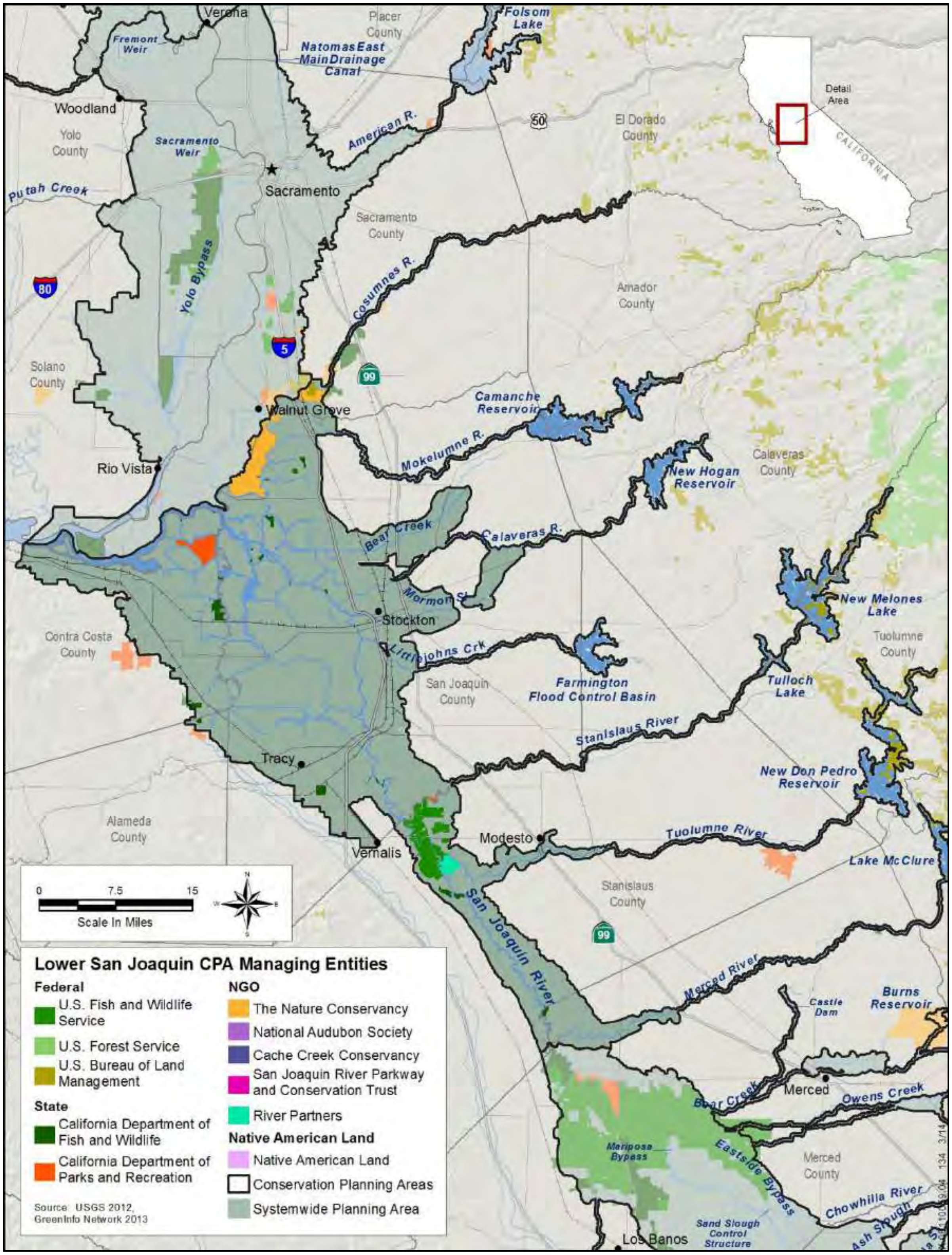
Sources: DWR 2010, Green Info Network 2013, and USGS 2012.

Figure 7-1. Upper Sacramento and Feather River CPA Land Management Entities



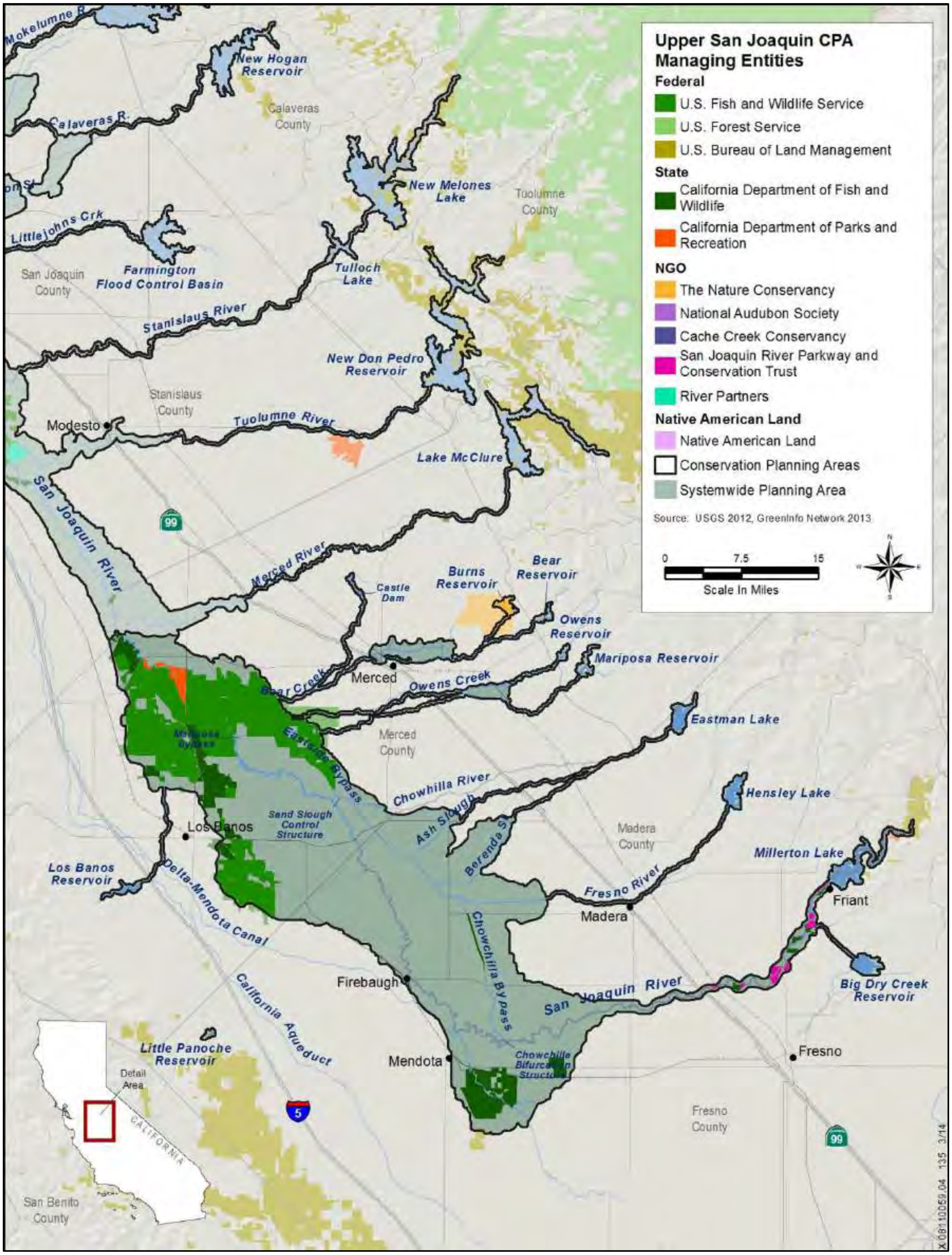
Sources: DWR 2010, GreenInfo Network 2013, and USGS 2012.

Figure 7-2. Lower Sacramento River CPA Land Management Entities



Sources: DWR 2010, GreenInfo Network 2013, and USGS 2012.

Figure 7-3. Lower San Joaquin River CPA Land Management Entities



Sources: DWR 2010, GreenInfo Network 2013, and USGS 2012.

Figure 7-4. Upper San Joaquin River CPA Land Management Entities

Federal Interagency Committee for the Management of Noxious and Exotic Weeds

The Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), established in 1994, is a formal partnership between 16 federal agencies with direct invasive plant management and regulatory responsibilities across the United States (FICMNEW 2013). The FICMNEW's responsibilities include sharing information with public and private organizations, fostering collaborative efforts, providing recommendations for management at national and regional levels, and sponsoring conferences and workshops. A primary initiative of the FICMNEW is to link the science behind invasive species management with federal control efforts.

California Interagency Noxious Weed Coordinating Committee

The California Interagency Noxious Weed Coordinating Committee (CINWCC), formed in 1995, changed its name to CINIPC (the California Interagency Noxious and Invasive Plant Committee). CINIPC facilitates, promotes, and coordinates the establishment of an IPM partnership between public and private land managers (CDFA 2013a). The committee initiated the War on Weeds Mini-Grants Program, developed the CINIPC website, developed the CalWeed Database, and sponsored the newsletter "Noxious Times," available at http://www.cdfa.ca.gov/plant/ipc/noxioustimes/noxtimes_hp.htm. The War on Weeds Mini-Grants Program was funded in 1999 and 2000. The CalWeed Database was integrated into the more comprehensive NRPI, described in Section 3.

California Biodiversity Council

The California Biodiversity Council (CBC), formed in 1991, established an interagency committee to strengthen relationships and encourage cooperation and coordination among various resource management and environmental protection organizations at the federal, State, and local levels (CBC 2008). The CBC focuses on developing strategies and complementary policies, including those to control invasive species, to conserve California's biodiversity.

Invasive Species Council of California

The Invasive Species Council of California (ISCC), formed in 2009, represents the highest State authority in the management of invasive species (ISCC 2013). It is chaired by the secretary of CDFA and is an interagency council that helps to coordinate and ensure complementary, cost-efficient, and environmentally sound and effective state activities to control invasive species. The ISCC established CISAC in 2009 to advise the ISCC (ISCC 2013). CISAC consists of various stakeholder representatives (federal, State, and local governments; tribal representation; research institutes; industry sector representatives; environmental organizations; and affected landowners). Its responsibilities include making recommendations to develop and prioritize an invasive species action plan, developing a regularly updated statewide "living list" of invasive species, creating a strategic framework for addressing invasive species, and engaging public participation in decision making. CISAC has prepared a strategic framework to protect California from invasive species (CISAC 2011).

California Invasive Weeds Awareness Coalition

The California Invasive Weeds Awareness Coalition (CALIWAC) is a partnership of nonprofit and industry groups working together to enhance weed control efforts and increase public awareness of noxious and invasive weeds in California (CDFA and CALIWAC 2005). Its goals include promoting sound State and national policy on invasive weeds, providing a public forum to increase awareness of the environmental and economic damage caused by invasive weeds, and increasing funding for management of invasive weeds (Cal-IPC 2013c). CALIWAC formally requested that CDFA initiate production of a statewide invasive species action plan. CALIWAC and CDFA ultimately were coauthors of the document (CDFA and CALIWAC 2005).

Natural Resources Project Inventory

The NRPI is an online database established as a collaborative effort between the ICE at the University of California, Davis, and CBC. Funding for NRPI has been provided by the U.S. Bureau of Land Management (BLM), the California Environmental Protection Agency and State Water Resources Control Board, DWR, CDFA, the California Department of Conservation, the Natural Resources Conservation Service (NRCS), CDFW, the San Francisco Bay Fund, the San Francisco Estuary Institute, the Resources Legacy Fund, the California Resources Agency, the California Coastal Conservancy, and CALFED Bay-Delta Program (ICE 2013). The NRPI database, which identifies more than 8,000 natural resource projects, is the most comprehensive, statewide database of such projects, including those focused on invasive plant treatment. The database includes projects originally identified in the CalWeed Database, created by CINIPC. The Delta Conservancy is currently updating the EcoAtlas for restoration projects; this atlas may become a more useful means of tracking treatment efforts if it effectively replaces the NRPI.

California Riparian Habitat Joint Venture

The California Riparian Habitat Joint Venture (RHJV) was started in 1994 as a collaborative project between federal, State, and private organizations to restore, enhance, and protect a network of functioning riparian habitat across California. The purpose of the project is to support the long-term viability of populations of riparian-associated birds and other wildlife (RHJV 2013). The RHJV's goals include identifying and developing technical information, based on sound science, for a strategic approach to conserving and restoring riparian areas in California; promoting and supporting riparian conservation on the ground by providing guidance, technical assistance, and a forum for collaboration; and developing and influencing riparian policies through outreach and education. In 2004, the RHJV completed the Riparian Bird Conservation Plan, a guidance document for riparian conservation actions centered on 14 riparian-associated bird species. RHJV emphasizes habitat restoration and enhancement for the focal species and, by extension, invasive species control.

Team Arundo del Norte

Team Arundo del Norte (Team) is a group of federal, State, and local organizations that came together in 1996. The Team is dedicated to the control of *Arundo donax* (giant reed) in central and northern California. The Team's responsibilities include exchanging information and cultivating partnerships in support of continuing *Arundo* eradication. The Team meets regularly in Sacramento.

7.1.2 Federal Agencies and Organizations

U.S. Fish and Wildlife Service

USFWS oversees the National Wildlife Refuge system and uses an IPM planning approach to manage invasive plant species in refuges across the United States (USFWS 2012). The agency has established a large volunteer program to help control invasive species throughout the system. In the SPA, both the Sacramento River National Wildlife Refuge and the San Joaquin River National Wildlife Refuge have been the focus of coordinated volunteer efforts.

In addition to its efforts in the refuges, USFWS works through various partnerships with other entities, including FICMNEW and NISC, to control the spread of invasive species on and off USFWS lands, and takes a proactive approach to address introductions. USFWS also has a Branch of Aquatic Invasive Species that leads the Aquatic Invasive Species Program.

U.S. Bureau of Land Management

BLM acts as the weed coordinator for almost 250 million acres of public land. It works with federal, State, and local agencies to reduce the spread of invasive species (BLM 2013). Its partners include entities working with most CDFA WMA groups in the SPA. BLM uses *Pulling Together: National Strategy for Invasive Plant Management* (FICMNEW 1998) to guide its invasive plant efforts, and emphasizes early detection of, and rapid response to, new invasions to reduce future cost and efforts. Support for the BLM Weed Management and Invasive Species Program is provided by several BLM programs affected by invasive species. The National BLM Weed Team has a representative in California, and several BLM field offices in California maintain lists of noxious weeds found in their areas. BLM also has prepared a list of weed prevention and management guidelines for public lands in California (BLM 2008).

U.S. Forest Service

USFS manages vegetation on national forest lands and provides technical and financial assistance for all forest lands through its weed coordinators (USFS 2013). Weed coordinators are designated at the national and regional levels and for each forest. The Pacific Southwest Region of USFS, which includes all of California, manages invasive species based on its Noxious Weed Management Strategy, which is modeled after the national strategy. USFS also standardizes inventory and mapping of invasive weeds across all national forest lands through its Natural Resource Information System Terra database. There are four national forests that intersect the SPA: Shasta-Trinity National Forest, Lassen National Forest, Plumas National Forest, and Stanislaus National Forest.

U.S. Geological Survey

USGS does not directly coordinate or manage invasive plant species; however, it is the primary research agency in the U.S. Department of the Interior, and invasive species ecology and management are topics of this research (USGS 2013). Through its Invasive Species Program, USGS supports cooperative efforts to document and monitor the introduction and spread of invasive species, studies the ecology of invaders and factors in the resistance of habitats to invasion, forecasts probabilities and locations of future invasions, provides methods and information to assess and manage risks, and develops methods to control and prevent the introduction of invasive species and minimize their environmental impacts. The USGS regional branch that conducts research in and near the SPA is the Western Ecological Research Center.

Natural Resources Conservation Service

NRCS, in the U.S. Department of Agriculture (USDA), is an organization established by Congress in 1935 (originally as the Soil Conservation Service) to help people conserve, maintain, and improve natural resources and the environment. NRCS facilitates invasive species control in four ways: technical and financial assistance to manage invasive species and pests, conservation initiatives that work at a landscape scale, conservation innovation grants with partner entities to support development and implementation of innovative approaches and strategies to address invasive species, and Plant Materials Center research geared toward invasive species management and restoration of areas where invasive species have been removed. NRCS has state offices, and within each state it has local service centers, typically organized by county. NRCS has four area offices in California; three of these (Areas 1, 2, and 3) cover portions of the SPA. Within each of these areas are multiple staff and field offices.

7.1.3 California Agencies and Organizations

California Department of Food and Agriculture

CDFA is the lead state agency for noxious weed management (CDFA 2013b). It is responsible for implementing weed control programs, overseeing eradication efforts for A-rated noxious weeds, coordinating work with WMA groups, operating border control stations, and distributing biological control agents. CDFA operates its weed management efforts under the California Noxious and Invasive Weed Action Plan (CDFA and CALIWAC 2005; available at http://www.cdfa.ca.gov/plant/ipc/noxweedinfo/pdfs/noxious_weed_plan.pdf). It also maintains an official list of noxious weeds in the California Code of Regulations and maintains the Noxious Weed Information Project, the purpose of which is to collect and process data on current weed management projects and provide maps and information to CDFA, biologists, and the general public.

California Department of Parks and Recreation

The California Department of Parks and Recreation (State Parks) manages 280 park units throughout the state (State Parks 2013a). It is responsible for preserving and restoring native plants and animals, and its resource management policies call for the systematic removal of populations of exotic plant species in wildland settings in the park system. Targets and priorities for invasive plant management are set at the park district level, often through park plans. Some districts have also conducted inventories of infestations using GIS. State parks in or adjacent to the SPA include Caswell Memorial State Park, Great Valley Grasslands State Park, Sutter Buttes State Park, South Yuba River State Park, and Bidwell–Sacramento River State Park.

California Department of Fish and Wildlife

The mission of CDFW's Invasive Species Program is to reduce the negative effects of nonnative invasive species on the wildlands and waterways of California (CDFW 2013). The program is housed in the Habitat Conservation Planning Branch of the Ecosystem Conservation Division of CDFW. Program managers are tasked with preventing the introduction of invasive species into the state, detecting and responding to introductions, and preventing the spread of nonnative invasive species that have become established. CDFW also maintains the California Aquatic Invasive Species Management Plan, which proposes actions for addressing aquatic invasive species.

CDFW began annual surveys of CDFW-managed lands in 2001. Each year, a sampling of the lands managed by CDFW is surveyed to identify the current status of weed infestations. CDFW Wildlife Areas in the SPA include the Feather River Wildlife Area and the Oroville Wildlife Area.

California State Parks, Division of Boating and Waterways

The Division of Boating and Waterways is legislatively mandated to control two invasive aquatic weeds, Brazilian waterweed and water hyacinth, in the Delta and its tributaries (State Parks 2013b). The Division maintains an extensive monitoring and reporting program to evaluate the effectiveness of its control programs for these two species.

California Department of Transportation

The California Department of Transportation (Caltrans) manages approximately 15,000 miles of highway and more than 230,000 miles of right-of-way throughout the state (Caltrans 1997). Vegetation management, including noxious weed control, is a large portion of Caltrans's management effort. In 1992, Caltrans adopted an integrated vegetation management program with a goal to reduce chemical use by 80 percent by 2012.

San Joaquin River Conservancy

The San Joaquin River Conservancy is a regionally governed State agency that was legislatively mandated to establish and manage the San Joaquin River Parkway, which extends from Friant Dam to State Route 99 (San Joaquin River Conservancy 2013). Its mission includes acquiring land to develop, operate, and manage for public access and recreation, and protecting, enhancing, and restoring riparian and floodplain habitat. The Conservancy is currently updating the Parkway Master Plan, its guiding policy document. Many projects funded or contracted by the San Joaquin River Conservancy involve invasive weed removal efforts and restoration.

University of California Division of Agriculture and Natural Resources

The University of California Division of Agriculture and Natural Resources runs the University of California Statewide Integrated Pest Management Program, which helps residents, growers, land managers, community leaders, and other professional pest managers prevent and solve pest problems with the fewest unintended impacts on people and their surroundings (Regents of the University of California 2013). The program works through the University of California Cooperative Extension to deliver information via seminars, workshops, and educational resources. The Cooperative Extension maintains the Weed Research and Information Center, which has information on invasive plant management.

Sacramento–San Joaquin Delta Conservancy

The Sacramento–San Joaquin Delta Conservancy (Delta Conservancy) was established by the 2009 Delta Reform Act to serve as a primary state agency to implement ecosystem restoration in the Delta and support efforts that advance environmental protection and the economic well-being of Delta residents. In 2012, the Delta Conservancy completed its Strategic Plan, which calls for leading efforts in protecting, enhancing, and restoring the Delta ecosystem in coordination with other governmental and nongovernmental entities and citizens in the Delta. The Delta Conservancy has developed an Arundo Control and Restoration Program that encompasses the entire Delta. This program will identify and map giant reed infestations, prioritize the control of giant reed, remove and treat infestations, and restore native vegetation where appropriate.

7.1.4 Local Agencies and Organizations

California Department of Food and Agriculture and County Agricultural Commissioners

CDFA, through individual County Agricultural Commissioners, plays a key role in coordination and local responsibility for noxious weed eradication and prevention (http://cacasa.org/). Each county generally operates eradication or control projects within its jurisdiction and coordinates efforts with CDFA and the WMA groups (see below).

Weed Management Areas

Beginning in 1999, California state laws were passed to coordinate invasive plant management efforts. Specifically, Section 7271 of the California Food and Agriculture Code (CFAC) designates CDFA as the lead agency in noxious weed management and established the CDFA Noxious Weed Management Account for funding a statewide network of WMAs. WMAs are local stakeholder groups working on weed projects, commonly led by a county agricultural department or the local Resource Conservation District (Cal-IPC 2013d). Each WMA develops a strategic plan that identifies its top priorities for local management. WMAs are responsible for collaboratively planning and implementing on-the-ground projects, mapping invasive species in their areas, and providing public education.

Funding for WMA activities was historically provided by the California Legislature, but State funding for WMAs stopped in 2008. Nonlegislative funding for WMA activities can be provided by CDFA's Adopt-A-Riverway Program, a government-volunteer partnership. The CFAC allows CDFA, through the Adopt-A-Riverway Program, to accept funds or services from any person and provide them to WMAs to implement integrated weed management plans. Currently, there are 14 WMAs active in the SPA, despite the lack of dedicated State funding. Of these, the Sacramento WMA has adopted a strategic plan.

California Association of Resource Conservation Districts

There are 99 Resource Conservation Districts in California; these districts are leaders in on-the-ground conservation efforts (California Department of Conservation 2013). The districts are often involved in practical, hands-on conservation projects that include invasive species eradication or control. They have a strategic plan (California Association of Resource Conservation Districts 2012) that guides their conservation efforts, and each district produces annual and long-range plans to guide its work program (California Department of Conservation 2013).

7.1.5 Nongovernmental Organizations

The Nature Conservancy
The Nature Conservancy (TNC) administered the Global Invasive Species Initiative (GISI) for more than 10 years. The efforts of GISI included addressing problems posed by invasive plants through a combination of prevention, early detection, eradication, restoration, research, and outreach (University of Georgia 2011). However, the GISI team was disbanded in 2009 because of budget cuts. The website http://invasive.org/, through the University of Georgia, hosts an archival copy of GISI's website and resources, including Invasipedia, the Weeds Information Management System database, a weed control methods handbook, and a management library. TNC has local field offices throughout California; these have been involved with smaller-scale weed management projects on TNC preserves.

National Audubon Society
The mission of the National Audubon Society is to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and Earth's biological diversity (National Audubon Society 2013). The society recognizes that invasive weeds choke out and destroy valuable bird and wildlife habitat. Through invasive species workshops and the "Stop Invasive Species" campaign, the society disseminates information about invasive species and their impacts on habitat for birds and other animals. It also works to develop and pass federal legislation to curb the invasive species threat. The National Audubon Society also works at the state level: its state chapter in California has approximately 48 local chapters. Audubon California manages several preserves that conduct invasive species management.

California Invasive Plant Council
Cal-IPC coordinates with agencies, industry, and other nongovernmental organizations, supporting the IPM approach to weed management. Cal-IPC's responsibilities include assessing the impact of invasive plants, supporting restoration workers, supporting research, promoting public education, advocating policy initiatives, reducing the introduction of invasive plants through horticulture, supporting development of biological control agents, and coordinating statewide weed mapping through CalWeed Mapper (Cal-IPC 2013b). Cal-IPC also maintains the online Invasive Plant Inventory (Cal-IPC 2013a), which categorizes nonnative invasive plants based on their levels of negative ecological impact in California.

California Native Plant Society
The California Native Plant Society (CNPS) works to preserve California's native plants and promote native plant appreciation, research, education, and conservation (CNPS 2013). CNPS works with other entities, such as Cal-IPC and CDFA, to identify the highest-risk invasive plants and to find methods to eradicate them. CNPS has five statewide programs and 34 regional chapters, many of which are involved in small-scale weed control and eradication projects. CNPS invasive plant management is guided by its Policy on Invasive Exotic Plants (CNPS 1996) and its policy on wildland invasive plants and integrated weed management (CNPS 2008).

California Horticultural Invasives Prevention

California Horticultural Invasives Prevention was established in 2004 with support from Cal-IPC (Cal-IPC 2013e). Members of this group represent the nursery and landscaping industries, environmental groups, academia, and government agencies. The group is responsible for developing voluntary measures to reduce the number of invasive plant species sold in California and for preventing further invasions from horticultural sources. The group has compiled a list of invasive ornamental plants and has developed the PlantRight campaign to help provide information to nurseries, gardeners, and landscape professionals.

Other Nongovernmental Organizations in the SPA

Several local nongovernmental organizations throughout the SPA conduct invasive weed management. Most of these organizations were established to preserve and restore specific or general riparian or watershed areas and resources. They often work in partnership with the public or private landowners, are volunteer-based, and have education and stewardship programs. These organizations often lead small-scale, on-the-ground invasive weed management projects. Nongovernmental organizations in the SPA include River Partners, the Putah Creek Council, the San Joaquin River Stewardship Program, and the Cache Creek Conservancy. Also, numerous land trusts and land conservancies are located throughout the Central Valley, and these may be involved in invasive plant management efforts in the SPA. A complete list of land trusts and conservancies active in California is available from the California Council of Land Trusts.

7.1.6 Corporate/Private Landowners

Private or corporate landowners often implement conservation or stewardship policies that involve invasive weed management. These landowners include electric and gas utility companies (e.g., the Sacramento Municipal Utility District and the Pacific Gas and Electric Company), railroads, and members of the timber harvest industry. In addition, agricultural landowners are often concerned with invasive plant management because noxious weeds have a significant effect on production and economics. Native American tribes represent another type of private landowner that manages invasive weeds on private lands (CDFA and CALIWAC 2005).

7.2 Funding Sources

Funding sources for invasive plant control include a variety of grants from federal, State, or nongovernmental organizations. The various sources of funding discussed below are highlighted because they could enable collaborative planning and treatment efforts that span lands in the SPA maintained by both DWR and other entities. DWR, or other LMAs directly responsible for maintenance of the SPA, may not be eligible to participate directly in some of these programs, but these programs may provide a source of funding that other entities (e.g., Resource Conservation Districts) could leverage in partnership with DWR to increase management of invasive plants within the SPA. Additionally, these funding sources could be used to fund invasive plant management on lands outside the SPA, where collaborative management of invasive plants outside the SPA would complement invasive plant management efforts by DWR and others within the SPA.

7.2.1 Federal Grant Programs and Initiatives

Natural Resources Conservation Service

NRCS administers several grant and technical assistance programs that, although not directly focused on invasive plant management, could potentially fund a variety of conservation projects that could include components focused on invasive plant assessment, planning, and treatment along with associated habitat restoration. As described above, DWR and other LMAs may not be eligible to apply for many of these programs, but they could partner with other, eligible organizations (e.g., resource conservation districts) to fund collaborative invasive plant management efforts.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits, such as improved water and air quality, conserved groundwater and surface water, reduced soil erosion and sedimentation, and improved or created wildlife habitat. Eligible program participants receive financial and technical assistance to implement conservation practices, or activities like conservation planning, that address natural resource concerns on their land. Payments are made to participants after conservation practices and activities identified in an EQIP plan of operations are implemented. Contracts can last up to 10 years. Agricultural producers and owners of nonindustrial private forestland and tribes are eligible to apply for EQIP. Eligible land includes cropland, rangeland, pastureland, nonindustrial private forestland, and other farm or ranch lands.

For more details about EQIP, see http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.

Conservation Stewardship Program

The Conservation Stewardship Program (CSP) encourages land stewards to improve their conservation performance by adopting additional activities and improving, maintaining, and managing activities on agricultural land and nonindustrial private forestland. CSP is available on tribal and private agricultural lands and nonindustrial private forestland in all 50 states and the Caribbean and Pacific Islands. The program provides equitable access to all producers, regardless of operation size, crops produced, or geographic location. Through CSP, NRCS will provide financial and technical assistance to eligible producers to conserve and enhance soil, water, air, and related natural resources on their land.

For more details about the CSP, see http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

Agricultural Conservation Easement Program

The Agricultural Conservation Easement Program provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps Indian tribes, state and local governments, and nongovernmental organizations protect working agricultural lands and limit nonagricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands. Agricultural land easements protect the long-term viability of the nation's food supply by preventing conversion of productive working lands to nonagricultural uses. Agricultural land easements provide additional public benefits, including improved environmental quality, historic preservation, protection of wildlife habitat, and protection of open space. Wetland reserve easements protect habitat for fish and wildlife, including threatened and endangered species; reduce flooding; allow groundwater recharge; protect biological diversity; and provide opportunities for educational, scientific, and limited recreational activities.

For more details about the Agricultural Conservation Easement Program, see http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

Healthy Forests Reserve Program

The Healthy Forests Reserve Program (HFRP) helps landowners restore, enhance, and protect forestland resources on private lands through easements and financial assistance. HRFP aids the recovery of endangered and threatened species protected under the ESA, improves plant and animal biodiversity, and enhances carbon sequestration. HFRP provides landowners with 10-year restoration agreements and 30-year or permanent easements for specific conservation actions. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Some landowners may avoid regulatory restrictions under the ESA by restoring or improving habitat on their land for a specified period. Land enrolled in HFRP easements must be privately owned or owned by Indian tribes and must be used to restore, enhance, or measurably increase the recovery of threatened or endangered species; improve biological diversity; or increase carbon storage.

For more details about HFRP, see http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/forests/?cid=stelprdb1242716

Regional Conservation Partnership Program

The Regional Conservation Partnership Program (RCPP) promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. RCPP encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales. Through RCPP, NRCS and its partners help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved. Conservation program contracts and easement agreements are implemented through the Agricultural Conservation Easement Program, EQIP, CSP, or HFRP. NRCS may also use the authorities under the Watershed and Flood Prevention Operations Program in the designated critical conservation areas.

For more details about RCPP, see http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/rcpp/

California Conservation Innovation Grants Program

The Conservation Innovation Grants program, administered by NRCS, is a competitive grant program for nongovernmental organizations or individuals who use EQIP funds. The program is intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection in conjunction with agricultural production. The desired result of the program is accelerated technology transfer, development and demonstration of cutting-edge ideas to improve conservation on private lands, and adoption of promising approaches that address some of the nation's most pressing natural resource concerns. Successful grant proposals demonstrate innovative approaches to improving soil health, conserving energy, managing nutrients, and enhancing wildlife habitat.

For more details about the Conservation Innovation Grants program, see http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/.

Watershed and Flood Prevention Operations Program

The Watershed and Flood Prevention Operations Program provides technical and financial assistance to states, local governments, and tribes (project sponsors) to plan and implement authorized watershed project plans for the purpose of watershed protection; flood mitigation; water quality improvements; soil erosion reduction; rural, municipal, and industrial water supply; irrigation; water management; sediment control; fish and wildlife enhancement; and hydropower. Under this program, NRCS cooperates with states and local agencies to carry out improvement projects for soil conservation and other purposes, including flood prevention; conservation, development, use, and disposal of water; and conservation and proper use of land.

For more details about the Watershed and Flood Prevention Operations Program, see http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/landscape/wfpo/?cid=nrcs143_008271

National Fish and Wildlife Foundation—California ReLeaf Pulling Together Initiative

The California ReLeaf Pulling Together Initiative grant program is administered by the National Fish and Wildlife Foundation and is designed to help control invasive plant species mostly by fostering the formation of public-private partnerships, such as cooperative weed management projects. Qualifying projects must prevent, manage, or eradicate invasive species through a coordinated program of public/private partnerships, and must raise public awareness of the adverse effects of introducing invasive species. Successful grant proposals will do the following:

- Focus on a well-defined area, such as a watershed, ecosystem, landscape, county, or WMA
- Incorporate on-the-ground management, eradication, or prevention
- Target a specific and measurable conservation outcome
- Support private landowners, State and local governments, and the regional and state offices of federal agencies

- Include a project steering committee of local cooperators working together across their jurisdictional boundaries
- Present a clear, long-term management plan based on an IPM approach
- Include a specific, ongoing, and adaptive public outreach/education component
- Integrate an early detection/rapid response approach

For more details about the California ReLeaf Pulling Together Initiative, see http://californiareleaf.org/grants/pulling-together-initiative-grants.

U.S. Environmental Protection Agency—Pesticide Registration Improvement Act Partnership Grant Program

The Pesticide Registration Improvement Act partnership was established in 2008 to fund grant projects that advance public-private partnerships focusing on pesticide stewardship efforts, especially those involving the use of IPM. Qualifying projects use demonstration, outreach, and/or education to increase the adoption of reduced-risk/IPM approaches. The partnership aims to achieve the following goals:

- Promote partnerships between farmers, ranchers, scientists, cooperative extensions, and government agencies to demonstrate, promote, and expand reduced-risk/IPM approaches.
- Measure and document the effects of implementing reduced-risk/IPM approaches on the environment, human health, and the community.
- Promote the economic benefits of using IPM approaches, and provide data and analysis on costs associated with adopting IPM to pesticide users.

For more details about the partnership, see http://www.epa.gov/pesp/pria2/index.html.

U.S. Fish and Wildlife Service—Neotropical Migratory Bird Conservation Act Grant Program

The Neotropical Migratory Bird Conservation Act grant program uses a portion of the funding available to the act to support public-private partnerships that conserve Neotropical migratory birds and their habitats throughout their migratory ranges, from breeding sites in Canada and the United States to wintering sites in Mexico, Central and South America, and the Caribbean. The grant program seeks to support projects that have the highest potential to leverage resources and interest into plans or programs that contribute significantly to the conservation of high-priority species in the next 5–10 years. Birds from all taxa are included, so proposals may benefit land birds, waterbirds, shorebirds, waterfowl, raptors, and others.

Various types of projects may be eligible, including projects involving maintenance, management, protection, and restoration of Neotropical migratory bird habitat. Of particular interest are on-the-ground conservation projects that directly improve the population status of these species. The grant program also considers research, monitoring, or assessment projects for a broader set of species of conservation concern, if the projects significantly contribute to filling information gaps that inhibit implementation of the most effective conservation actions. Successful projects demonstrate a measurable biological improvement in the population or increase knowledge and understanding of the population-limiting factors affecting these species.

For more details about Neotropical Migratory Bird Conservation Act grants, see http://www.fws.gov/birdhabitat/Grants/NMBCA/index.shtm.

U.S. Fish and Wildlife Service —Division of Bird Habitat Conservation, North American Wetlands Conservation Act of 1989—Standard Grants Program

The USFWS Division of Bird Habitat Conservation administers the North American Wetlands Conservation Act's Standard Grants Program, which is a matching grant program that supports public-private partnerships to implement projects in Canada, the United States, and Mexico. Each country has a program process through which eligible proposals are reviewed, ranked, and recommended by the North American Wetlands Conservation Council. Recommendations are then submitted to the Migratory Bird Conservation Commission for approval. Proposed projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated upland habitats for the benefit of all wetlands-associated migratory birds.

For more details about the Standard Grants Program, see http://www.fws.gov/birdhabitat/Grants/NAWCA/Standard/index.shtm.

U.S. Fish and Wildlife Service—Division of Bird Habitat Conservation, North American Wetlands Conservation Act of 1989—Small Grants Program

Like the Standard Grants Program, the North American Wetlands Conservation Act's Small Grants Program is a matching grant program supporting public-private partnerships. The Small Grants Program was developed to encourage new grantees and partners to carry out smaller-scale, long-term wetlands conservation projects that might not be able to compete for a grant through the Standard Grants Program. The Small Grants Program is for projects carried out in the United Sates that aim to further the goals of the North American Wetlands Conservation Act. As with the Standard Grants Program, qualifying projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated upland habitats for the benefit of all wetlands-associated migratory birds.

For more details about the North American Wetlands Conservation Act's Small Grants Program, see http://www.fws.gov/birdhabitat/Grants/NAWCA/Small/index.shtm.

Plant Conservation Alliance—Native Plant Conservation Initiative

The Native Plant Conservation Initiative is a matching grant program funded by USFWS, BLM, and USFS and conducted in cooperation with the Plant Conservation Alliance, a partnership of the National Fish and Wildlife Foundation, 10 federal agencies, and more than 209 nongovernmental organizations. Projects funded by this grant program focus on the conservation of native plants and pollinators in the context of collaboration, education, restoration, research, sustainability, and data linkages.

Proposed projects must provide conservation benefits for native plants, including associated pollinators; involve multiple partnerships; demonstrate the ability to find matching funds beyond the 1:1 federal/nonfederal minimum (including cash or in-kind contributions of goods or services, such as volunteer time); and use innovative ideas, such as a landscape approach, shareable new technologies, and teaching by example. Projects are encouraged to make connections with keystone species and habitats, as listed on the National Fish and Wildlife Foundation website. Grant applications for projects conducted on federal land should include letters of support from appropriate agency program managers familiar with the work.

For more details about the Native Plant Conservation Initiative, see http://www.nps.gov/plants/nfwf/rfp.htm.

7.2.2 State Grant Programs and Initiatives

California Department of Pesticide Regulation—Alliance Grant Program

The Alliance Grant Program funds projects that increase implementation and adoption of proven, effective IPM practices that reduce pesticide risks to human health and the environment. A key element of a successful proposal is the formation of an alliance composed of individuals representing State, local, public, private, educational, or other stakeholders interested in the adoption and implementation of urban and agricultural IPM practices. IPM practices should focus on one of these suggested areas: air quality, groundwater quality, surface water quality, worker and public health and safety, environmental health, and wildlife and endangered species health and habitat.

For more details about the Alliance Grant Program, see http://www.cdpr.ca.gov/dprgrants.htm.

California Wildlife Conservation Board—Inland Wetlands Conservation Program

Through the Inland Wetlands Conservation Program, the California Wildlife Conservation Board authorizes grants and loans to nonprofit organizations, local governmental agencies, and State departments to further the goals of the Central Valley Joint Venture to maintain a diverse, abundant, and healthy distribution of migratory bird populations in the Central Valley through habitat protection, restoration, and enhancement. All projects must satisfy one or more of the eight specific objectives identified in the *Central Valley Joint Venture 2006 Implementation Plan*:

- Protect all remaining unprotected wetlands in perpetuity.
- Restore and protect 108,527 acres of seasonal wetlands.
- Restore and protect 12,500 acres of semi-permanent wetlands.
- Enhance 23,884 acres of seasonal wetlands each year.
- Restore and protect 10,000 acres of riparian habitat over the next 5 years.
- Enhance 307,000 acres of wildlife-friendly agriculture.

- Protect wildlife-friendly agricultural lands through conservation easements in the American, Butte, Sutter, San Joaquin, and Delta basins.

- Protect agricultural lands through conservation easement in the American, Butte, Sutter, Delta, and San Joaquin basins to buffer existing wetlands from urban and residential development.

Partnerships are encouraged in the construction, operation, and maintenance of projects, and the grantee or landowner must provide a contribution of cash or in-kind services for all restoration projects on private lands. The grantee or landowner must also manage and maintain wetlands in perpetuity for easements and for 25 years for all projects on privately owned properties.

For more details about the Inland Wetlands Conservation Program, see https://www.wcb.ca.gov/Programs/Wetlands.aspx.

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9.0 List of Acronyms and Other Abbreviations

BLM .... U.S. Bureau of Land Management
BMPs .... Best Management Practices
Cal-IPC .... California Invasive Plant Council
CALIWAC .... California Invasive Weeds Awareness Coalition
Caltrans .... California Department of Transportation
CBC .... California Biodiversity Council
CDFA .... California Department of Food and Agriculture
CDFW .... California Department of Fish and Wildlife
CINIPC...................... California Interagency Noxious and Invasive Plant Committee
CINWCC .... California Interagency Noxious Weed Coordinating Committee
CISAC .... California Invasive Species Advisory Committee
CNPS .... California Native Plant Society
CPA .... Conservation Planning Area
CSP .... Conservation Stewardship Program
CVFPB .... Central Valley Flood Protection Board
CVFPP .... Central Valley Flood Protection Plan
Delta .... Sacramento–San Joaquin River Delta
Delta Conservancy.... Sacramento–San Joaquin Delta Conservancy
DES .... Division of Environmental Services
DFM/FMO .... DWR's Division of Flood Management/Flood Maintenance Office
DWR .... California Department of Water Resources
EQIP .... Environmental Quality Incentives Program
ESA .... federal Endangered Species Act
FESSRO .... FloodSAFE Environmental Stewardship and Statewide Resources Office
FICMNEW .... Federal Interagency Committee for the Management of Noxious and Exotic Weeds
GIS .... geographic information system
GISI .... Global Invasive Species Initiative
HACCP .... Hazard Analysis and Critical Control Point
HFRP .... Healthy Forests Reserve Program

ICE............................ Information Center for the Environment
IPM .... Integrated Pest Management
Plan .... Invasive Plant Management Plan
IPMSC .... invasive plant management steering committee
ISCC .... Invasive Species Council of California
LMAs .... Local Maintaining Agencies
LQA .... Licensed Qualified Applicator
MA .... Maintenance Area
Maintenance Yards ... DWR's Sacramento and Sutter Maintenance Yards
MOU .... Memorandum of Understanding
NISC .... National Invasive Species Council
NMFS .... National Marine Fisheries Service
NPDES .... National Pollutant Discharge Elimination System
NRCS .... Natural Resources Conservation Service
NRPI .... Natural Resources Project Inventory
NWP .... Nationwide Permit
O&M .... operation and maintenance
PCA .... Pest Control Advisor
RCPP........................ Regional Conservation Partnership Program
RHJV .... California Riparian Habitat Joint Venture
RMA.......................... Routine Maintenance Agreement
RWQCB.................... Regional Water Quality Control Board
SAA .... Streambed Alteration Agreement
SHPO .... State Historic Preservation Officer
SPA .... Systemwide Planning Area
SPFC .... State Plan of Flood Control
SSIA .... Systemwide Sustainable Investment Approach
State Parks .... California Department of Parks and Recreation
TNC .... The Nature Conservancy
USACE .... U.S. Army Corps of Engineers
USDA........................ U.S. Department of Agriculture
USFS .... U.S. Forest Service
USFWS..................... U.S. Fish and Wildlife Service

WHIPPET .... Weed Heuristics Invasive Populations Prioritization for Eradication Tool
WMA......................... Weed Management Area

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STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES