Appendix A

Letter to CDFW

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

CALIFORNIA natural resources AGENCY

EDMUND G. BROWN JR., *Governor*
JOHN LAIRD, *Secretary for Natural Resources*

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

1416 Ninth Street, Suite 1311, Sacramento, CA 95814 Ph. 916.653.5656 Fax 916.653.8102 http://resources.ca.gov

State of California | California Natural Resources Agency

Memorandum

Date: October 16, 2018

To: Charlton Bonham, Director
California Department of Fish and Wildlife
1416 Ninth Street
Sacramento, California 95814

From: **Department of Water Resources**

Subject: Yolo Regional Conservation Investment Strategy / Local Conservation Plan.

In accordance with California Fish and Game Code Section 1852(a), the California Department of Water Resources (DWR) 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. DWR believes 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), DWR 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.

KThomas
GErickson
CDibble
RMacedo

If you have any questions, please contact me at (916) 653-5805.

Sincerely,

Kristopher A. Tjernell
Deputy Director
Integrated Water Management

Appendix B
Public Outreach

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

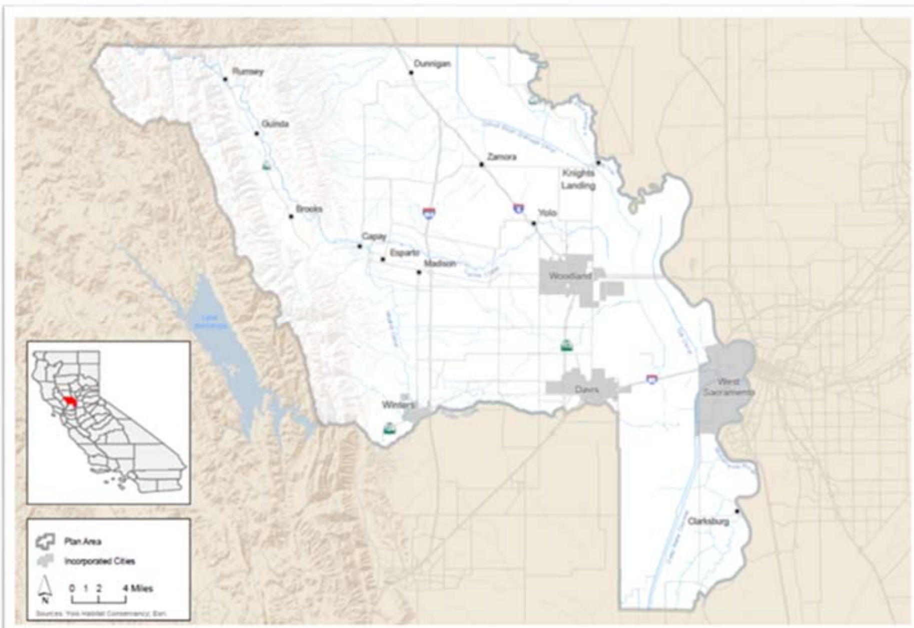
Common Name	*Scientific Name*	*Status (Federal/State/CNPS)*[a]
Plants		
alkali milk-vetch	*Astragalus tener* var. *tener*	-/-/1B
brittlescale	*Atriplex depressa*	-/-/1B
San Joaquin spearscale	*Atriplex joaquiniana*	-/-/1B
Heckard’s pepper-grass	*Lepidium latipes* var. *heckardii*	-/-/1B
Baker’s navarretia	*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 CONSISTENT 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 B
Public Comments

This appendix describes the public outreach conducted during Yolo RCIS/LCP development, and provides responses to written comments received on the Notice of Intent and on the Public Review Draft Yolo Regional Conservation Investment Strategy / Local Conservation Plan (RCIS/LCP).

Notice of Intent and Public Meeting

California Fish and Game Code (FGC) §1854(c)(1) states, "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." §1854(c)(3)(*A*) further states, "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."

A public meeting was held 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 website on August 15, 2017 (at least 30 days prior to the public meeting). The Conservancy provided the notice to CDFW, each city and county within or adjacent to the regional conservation investment strategy area, and to the Conservancy's general Listserv. The Notice of Intent is included in Attachment 1 to this appendix.

The Conservancy and other Steering Committee representatives invited interested persons to provide oral and written comments. The 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*.

A list of invite and meeting materials provided for each Public Meeting. These items are available upon request from the Conservancy.

Comments and Responses on Notice of Intent

FGC §1854(c)(3)(*B*) states, "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."

At the public meeting, the Conservancy provided comment cards and requested that individuals or parties wishing to provide comments shall provide written comments in order for those comments to be included in this RCIS with the RCIS proponent's response. Two written comments were received during or after (i.e., within 60 days) the public meeting held on September 14, 2017. The two written comments are included in Attachment 1. Summaries of the comments and responses are provided below.

1. West Sacramento Trail Riders, Dan Schatzel, September 14, 2017

Summary of Comment 1-1

This comment requested clarification on how the RCIS/LCP would work and an explanation of the acronyms used. The commenter suggests a public meeting be held in each community and notes "equestrian use seems to be completely consistent with these effort".

Response to Comment 1-1

Please read Chapter 4, Implementation, of the Yolo RCIS/LCP when it is circulated for Public Review to understand how the RCIS/LCP would work. The Yolo RCIS/LCP will include an index of acronyms for reference, to assist those who are not familiar with them. We will consider this approach for the public review process when the Yolo RCIS/LCP is complete. It will depend in part on the availability of funding to conduct multiple meetings. Thank you for your comment. Correct – the RCIS/LCP facilitates the establishment of an open space system, and does not prohibit equestrian use of the open space system. Thank you for your comments.

2. Delta Protection Commission, State of California – Natural Resources Agency, Erik Vink, Executive Director, September 14, 2017

Summary of Comment 1-1

The letter states that the Yolo RCIS/LCP meets the definition of "development" as described in Public Resources Code Section 29723(a), and must therefore be consistent with the Commission's Land Use and Resource Management Plan (LURMP).

Response to Comment 1-1

Thank you for your comment. As described in the LURMP glossary, "development" means ". . . change in the density or intensity of use of land, including, but not limited to any other division of land including lot splits, except where the land division is brought about in connection with the purchase of the land by a public agency for public recreational or fish and wildlife uses or preservation . . ." The definition further states that "development" does not include, "The planning . . .by a state agency or local agency of any water supply facilities or mitigation enhancement activities undertaken in connection therewith." The RCIS/LCP does not meet this definition of "development." We believe, however, that the RCIS/LCP is not inconsistent with the LURMP.

Public Review of the Yolo RCIS/LCP

The 45-day public review period and comment period for the Administrative Draft Yolo RCIS/LCP (March 2018) was from May 18 to August 28, 2018. The document was accessible at CDFW's https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=157451&inline.

Responses to Comments on Public Review Draft Yolo RCIS/LCP

Nine written public review comment letters were submitted to the Yolo Habitat Conservancy (Conservancy) and CDFW during the Yolo RCIS/LCP public comment period. **Table 1-1** summarizes the commenting party, comment letter signatory, and date of the comment letter.

Table 1-1. List of Public Review Comment Letters

Letter	Agency/Organization/Individual	Comment Letter Signatory	Date
1	California Native Plant Society, Sacramento Valley Chapter	Dr. Glen Holstein – Chapter Botanist	June 20, 2018
2	Institute for Ecological Health	Dr. John Hopkins - President	July 8, 2018
3	California Native Plant Society, Sacramento Valley Chapter	Dr. Glen Holstein – Chapter Botanist	August 12, 2018
4	California Native Plant Society, Sacramento Valley Chapter	Dr. Glen Holstein – Chapter Botanist	August 20, 2018
5	The Habitat Institute	Thomas O' Neill	August 27, 2018
6	Caltrans	Carin Loy – Senior Environmental Planner	August 28, 2018
7	Yolo County	Patrick S. Blacklock – Yolo County Administrator	August 28, 2018
8	Institute for Ecological Health	Dr. John Hopkins - President	August 28, 2018
9	U.S. Fish and Wildlife Service	Bronwyn Hogan	April 28, 2018

Comments and Responses

1. California Native Plant Society, Sacramento Valley Chapter, Dr. Glen Holstein, Chapter Botanist, June 20, 2018

Summary of Comment 1-1

The commenter requested an extension to the public review and comment period until after the Mitigation Credit Agreement (MCA) guidelines are available.

Response to Comment 1-1

Development of the RCIS was guided by FGC Sections 1850-1861, which include regulations and requirements for creation of credits through an MCA. The steering committee expects that CDFW's forthcoming MCA guidelines will be consistent with the FGC, and that the FGC provide enough information to evaluate how the RCIS will be implemented.

See the CDFW website for the latest MCA guidelines (https://www.wildlife.ca.gov/Conservation/Planning/Regional-Conservation).

2. Institute for Ecological Health, Dr. John Hopkins, President, July 8, 2018

Summary of Comment 2-1

The commenter stated that figures are missing from the draft document.

Response to Comment 2-1

Figures have been updated and inserted into the RCIS document. The comment period was extended for 45 days to provide sufficient time to review the RCIS with the figures.

3. California Native Plant Society, Sacramento Valley Chapter, Dr. Glen Holstein, Chapter Botanist, August 12, 2018

Summary of Comment 3-1

The comment notes the web page for accessing the Administrative Draft Yolo RCIS/LCP is no longer available.

Response to Comment 3-1

The web page error was resolved during the public comment period, and the comment period was extended to provide reviewers sufficient time to access the website.

4. California Native Plant Society, Sacramento Valley Chapter, Dr. Glen Holstein, Chapter Botanist, August 20, 2018

Summary of Comment 4-1

The commenter is impressed with the overall document, however, he provides multiple comments identifying minor editorial mistakes (i.e. typography, grammar, missing citations etc.).

Response to Comment 4-1

Revisions have be made to the draft Yolo RCIS/LCP to address the minor editorial mistakes.

In regard to the comment on moving Keck's checkerbloom from Group 3 to Group 1, per C. Deng and D. Potter's research, *Investigating the identities of populations of Sidalcea (Malvaceae) in the North Coast Ranges in California*, presented at the Northern California Botanist Symposium on January 13, 2020, intermediate plants from Northern California are more closely related to *S. diploscypha* and probably should not be treated as *S. keckii*. The research findings further suggest these individuals may represent a new taxon (e.g., variety, subspecies, or perhaps species). Based on this research, moving Keck's checkerbloom from Group 3 to Group 1 is not warranted, at this time.

Additionally, the Steering Committee did not identify a demand for generating mitigation credits for this species, since it is unlikely to be affected by activities planned within the next 10 years. Groups 2 and 3 of the LCP were based on whether species accounts were available for the species. Since completion of the LCP depended on a limited budget, the Advisory Committee agreed that species accounts would not need to be completed for those species they wished to add to the plan (i.e., the Group 3 species). If funding or volunteer effort becomes available to create a species account for Keck's checkerbloom, in the future, the LCP may be amended to move the species from Group 2 to Group 3. Similarly, if the need for mitigation arises associated with activities in the strategy area, an RCIS/LCP amendment would allow moving the species from Group 3 to Group 1.

Summary of Comment 4-2

The commenter requested consistency on reference to California prairie, noted that a description of the ecological value of California prairie is missing, and requested additional details about California prairie. The commenter also recommended Tuleyome be included as a "non-governmental organization in the SPA" to Appendix G, *Invasive Species Strategy*.

Response to Comment 4-2

Additional details on the ecological value of California prairie have been included in Appendix E, *Conservation Strategy Rationale*, E.2.2. Goal CP1: *Large contiguous patches of California prairie to support native species*. Inconsistencies regarding the use of "grassland" and "prairie" in Section F.2.2 have been resolved. Figure 2-9 has been revised and annual grassland has been renamed California prairie to be consistent with the RCIS/LCP text.

Regarding the nonprofit conservation organization, Tuleyome, while we recognize the organization's work in the Cache Creek watershed, Appendix G of the RCIS/LCP sites the Central Valley Flood Protection (CVFPP) Conservation Strategy. We have no authorization to make changes to the CVFPP Conservation Strategy.

Summary of Comment 4-3

The commenter noted that a list of persons who prepared the various sections of the RCIS/LCP, prepared significant background materials, or participated to a significant degree in preparing the RCIS/LCP is not included in the draft document.

Response to Comment 4-3

A list of contributors to the RCIS/LCP is now included as Chapter 5 of the Final RCIS/LCP.

5. The Habitat Institute, Thomas O' Neil, August 27, 2018

Summary of Comment 5-1

The commenter advocates use of the Habitat Institute's "Combined Habitat Assessment Protocols (CHAP)" as a way to address compensatory or advance mitigation needs. CHAP meets the "Best Available Science" criteria in the State of California for defining a mitigation metric for Mitigation Credit Agreement, as defined in Assembly Bill 2087.

Response to Comment 5-1

The Yolo RCIS/LCP Steering Committee (Steering Committee) respectfully acknowledge the value of CHAP as a possible tool for addressing advance mitigation and this tool would be worthwhile for considering for the development of MCAs.

See the CDFW website for the latest MCA guidelines (https://www.wildlife.ca.gov/Conservation/Planning/Regional-Conservation).

6. Caltrans, Carin Loy, Senior Environmental Planner, August 28, 2018

Summary of Comment 6-1

The commenter recommended that the RCIS/LCP incorporate roles of local County and City parks, local Federal and State land managers, UC reserves, local agricultural working lands, non-profit conservation organizations, and others in Yolo RCIS, acknowledging that though their land may not be protected with a conservation easement, they can be managed in a way that contributes to conservation in Yolo County.

Response to Comment 6-1

The revised Yolo RCIS/LCP added language in recognition of the various entities who contribute to conservation in the strategy area, and acknowledging that many lands in the strategy area are managed for conservation even if they are not protected under conservation easements. See revised language in Section 3.2.1, *Conservation Gap Analysis.*

Summary of Comment 6-2

The commenter recommended coordinating with transportation planning agencies (Metropolitan Planning Organizations, Regional Transportation Planning Agencies, County Transportation Commissions, and Caltrans) early in RCIS development to confirm proper transportation planning info is included.

Response to Comment 6-2

Comment has been noted and Section 2.13.2.1 *Transportation* has been revised. The section now includes information on reasonably foreseeable transportation projects in the RCIS strategy area. This section incorporates projects identified in the Yolo County General Plan, Caltran District 3 Corridor System Management Plan and Transportation Concept Report, the State Transportation Improvement Program, State Highway Operation and Protection Program, and Sacramento Region Metropolitan Transportation Plan.

Summary of Comment 6-3

The commenter suggested identifying non-listed species, such as large mammal species, with needs for connectivity, identify their CDFW management status, and reference or profile scientific studies on species' occurrences and connectivity needs, to assist in CEQA planning.

Response to Comment 6-3

The Yolo RCIS/LCP includes large mammals, such as tule elk, mountain lion, and American black bear, in Group 3 Conservation Species. Additionally, black-tailed deer and tule elk are included as Planning Species in the LCP. These species require large blocks of land and large-scale landscape connectivity to accommodate migration and foraging needs and are identified as rare or declining, and/or important to local conservation. Habitat connectivity is essential for wildlife, such as large mammals, to find mates, seasonal habitat, dispersal/migration habitat, and food important and to the long-term conservation and resilience of Yolo County ecosystems. Habitat Connectivity is discussed in the RCIS/LCP in Section 1.5.7.4 *Habitat Connectivity*, and in Section 2.9.4 *Habitat Connectivity and Linkages*.

The RCIS/LCP conservation strategy is composed of goals, objectives, actions, and conservation priority areas (see Table 3-3 *Conservation Goals and Objectives and Applicable Conservation Actions*). The RCIS/LCP identifies suites of conservation actions and habitat enhancement actions that if implemented, would contribute towards achieving the RCIS/LCP's habitat connectivity conservation goals and objectives. Landscape and natural community-level conservation goals and objectives can be used to guide conservation actions for large mammals. For example, Goal L.1 Large Interconnect Landscapes, Objective L1-1 Landscape Connectivity would establish landscape connectivity within and between natural communities and maintain connectivity within Yolo County and ecologically significant landscape elements outside of Yolo County. Objective L1-2.3, protects habitat for area-limited planning species, species with large home ranges or migratory patterns, such as American badger and black-tailed deer. Natural Community objectives, such as Objective CP1-2 Increase and enhance California prairie, would create large areas of native grasses and forbs and provide for native ungulate foraging habitat. Objective WF2.1 Protect upland oaks and Objective WF2.2 Increase upland Oaks, would prioritize protection of oak woodland surrounded by natural lands and increase the extent of upland oak woodland, thereby contributing to habitat and connectivity for large mammals. Likewise, Objective R1.1 Protect riparian areas and Objective R1.2 Increase riparian Habitat Areas would provide key landscape linkages thereby facilitating large mammal movement.

Summary of Comment 6-4

The commenter noted that the RCIS focuses primarily on establishing new conservation easements and recommended that the RCIS/LCP expand to include contribution of public land restoration and other conservation activities on public land.

Response to Comment 6-4

The intent of the RCIS/LCP is to include the contribution of public land restoration and conservation activities. See revisions in Section 3.2.1, *Conservation Gaps Analysis.*

Summary of Comment 6-5

The commenter recommended that protected areas data sources listed in Section 3.2.1, paragraph 4, be consistent with the data sources cited in Section 2.4, *Protected Areas*.

Response to Comment 6-5

Section 3.2.1, paragraph 4 has been revised so that the data sources are consistent with Section 2.4, *Protected Areas*.

Summary of Comment 6-6

The commenter noted that Section 2.11.2, page 2-87, and *References Cited*, Caltrans 2015 citation should be revised to “Caltrans 2017”. Yolo County Economic Forecast is from 2017.

Response to Comment 6-6

The citation and reference have been updated, now to 2019.

Summary of Comment 6-7

The commented noted Section 2.11.7, page 2-98, and *References Cited*, Caltrans 2015 citation should be revised to “Caltrans 2015 in CDFW 2015”. The commenter also request the addition of the Caltrans 2015 *California Transportation Plan 2040* to the References.

Response to Comment 6-7

The citation and reference have been properly updated.

Summary of Comment 6-8

The commenter suggested revisions to Section 2.13.2.1, *Transportation*. The commenter requested the addition of a “Sacramento Area Council of Government” subsection; revising the “California Department of Transportation” subheading; replacing the “Yolo County Transportation District” subheading; and adding subheadings for various cities in Yolo County.

Response to Comment 6-8

Section 2.13.2.1, *Transportation* has been revised following the preferred language and suggested text change as provided by Caltrans.

Summary of Comment 6-9

The commenter requested clarification on the terms “priority area” and “landscape matrix”.

Response to Comment 6-9

Priority areas are defined in Section 3.2.4.2, *Conservation Actions and Priority Areas*. The Yolo RCIS/LCP uses *priority area* for RCIS (Group 1) focal species to highlight important locations where conservation actions should occur in the next 10 years.

The term *landscape matrix* refers to landscape conditions that consist of multiple habitat types and non-habitat, consisting of natural lands, working lands, and developed areas. The entire landscape matrix must be considered when planning for habitat connectivity and climate change, and to accommodate population dynamics for species conservation.

Summary of Comment 6-10

The commenter requested clarification on Table 3-1, that success is to be measured only by increased number of protected lands, and if so, that the definition of protection should be broadened.

Response to Comment 6-10

Table 3-1 does not provide the conservation goals, objectives, or success criteria for the Yolo RCIS/LCP. Rather, it provides the results of the gap analysis, demonstrating how much land has been protected in the strategy area, and how much is still unprotected.

Success was not meant to be measured solely based on increases in the amount of land permanently protected. Rather, success is intended to be measured based on achievement of all of the conservation goals and objectives, including habitat enhancement actions and other actions that benefit focal species and other conservation elements without permanent protection. The RCIS allows for habitat enhancement on lands beyond those that have easements.

Protection with conservation easements is just one method to meet the conservation goals and objectives. Many of the conservation, goals, and objectives are related to management and enhancement, which may be done on lands that are already protected.

Summary of Comment 6-11

The commenter requested a conceptual model for how the combined efforts of securing easements, private land management, and public land management identified in Table 3-3 are expected to contribute to landscape-level goals, and lay out the strategy in such a way that it is clear and inclusive of various property ownerships so that MCAs are feasible with willing partners.

Response to Comment 6-11

A conceptual model is beyond the scope of the RCIS. A conceptual model or something similar may be worthwhile to pursue, to clarify how the pieces work together. This could be an implementation task if outside funding becomes available.

The RCIS/LCP is a voluntary, non-binding conservation strategy intended to be broad enough to guide conservation investment and mitigation on lands independent of how the land is owned. Use of MCA credits for compensatory mitigation will be dependent, in part, on the responsible regulatory agency's requirements, and rules and restrictions regulating the creation and use of MCAs (to be described in the MCA guidelines). Conservation goals can be achieved through a combination of permanent protection (i.e., including conservation easements) and restoration and enhancement of resources on public and private lands.

Summary of Comment 6-12

The commenter requested clarification on how Table 3-4 augments the biological goals and objective table (Table 3-3). The comment also notes that patch size and habitat configuration analysis and least cost path/ corridor analysis was performed.

Response to Comment 6-12

The text that references Table 3-4 on Page 3-62 of the RCIS has been updated to Table 3-3 in response to the comment.

Summary of Comment 6-13

The commenter requested clarification on how Table 3-5 (Greater sandhill crane habitat value) should be applied and augments the BGO table (Table 3-3).

Response to Comment 6-13

Table 3-5 in the RCIS provides the foraging habitat values for various crop types found within the strategy area in order to meet Objective GSHC1.1: *Protect Foraging Habitat* in Table 3-3, *Conservation Goals and Objectives and Applicable Conservation Measures*.

Summary of Comment 6-14

The commenter requestsed the addition of Fish and Game Code Section 1600 to regulations requiring mitigation.

Response to Comment 6-14

The regulations were added to Section 4.6.1, *Mitigation Credit Agreements*.

Summary of Comment 6-15

The commenter recommended a matrix of all conservation actions that would be suitable for Mitigation Credit Agreements (MCAs) under the RCIS.

Response to Comment 6-15

The Yolo RCIS/LCP identifies suites of conservation actions that if implemented, would contribute towards achieving the RCIS's conservation goals and objectives. The conservation actions are to be implemented as voluntary conservation investments or to create credits for focal species and other conservation elements. Any of the conservation actions could be implemented to create credits through an MCA if implementation of those actions contributes towards achieving one or many of this RCIS's conservation goals and objectives for focal species and/or other conservation elements. The conservation actions described for each focal species and other conservation element can be implemented to create credits under an MCA, to contribute towards achieving a corresponding goal and objective for a focal species or other conservation element. In many cases, implementing one conservation action could contribute towards achieving multiple objectives.

It is up to MCA sponsors to determine the conservation actions for each MCA based on site conditions, market forces, and other variables.

7. Yolo County, Patrick S. Blacklock, Yolo County Administrator, August 28, 2018

Summary of Comment 7-1

The County supports the multi-benefit approach to state infrastructure projects as discussed in Section 3.1, *Overview* and Section 3.2 *Multi-Benefit Approach,* and intends to promote the multi-benefit approach during RCIS/LCP implementation.

Response to Comment 7-1

The RCIS/LCP sponsors appreciate this comment.

Summary of Comment 7-2

The County is concerned that CDFW guidance on MCA is not yet available and would like the opportunity to review the MCA Guidelines before approving the Yolo RCIS/LCP.

Response to Comment 7-2

Fish and Game Code requires the Implementing Entity approval of an MCA within its permit area. Given this, the Implementing Entity has a strong mechanism for preventing creation of MCAs that would undermine successful implementation of the RCIS. Further information is provided in Chapter 4.2 Goals of Implementation, and 4.6, *Regulatory Uses of the RCIS*.

Summary of Comment 7-3

The County stated that they generally agree with the positions on RCIS implementation and recommend that the Conservancy continue to take a prominent implementation role in the RCIS/LCP to ensure consistency with the Yolo HCP/NCCP.

Response to Comment 7-3

The comment has been noted.

8. Institute for Ecological Heath, Dr. John Hopkins, President, August 28, 2018

Summary of Comment 8-1

The commenter noted there are multiple minor editorial corrections are required to figure titles, figure numbering, and figure legends etc. Additional minor corrections were requested to figure references, and clarification on figure descriptions,

Response to Comment 8-1

Corrections have been made in the final RCIS/LCP.

In regard the question on impacts on Yolo conservation if projects use out of county mitigation banks, the Steering Committee feel it is difficult to predict the impact on Yolo County conservation if projects use out of county mitigation banks, however the presence of an RCIS provides an opportunity to do MCAs, which increases the opportunities and therefore the likelihood of doing conservation in Yolo County.

Summary of Comment 8-2

Need to clarify which BGOs apply to the RCIS and which apply to the LCP. The comment states the BGOs are too broad – need to create clear 10-year achievable objectives for the RCIS and differentiate them from the broader long-term LCP "wish list".

Response to Comment 8-2

We have revised the goals and objectives, all of which now apply to both the RCIS and the LCP. We have also coordinated with CDFW to develop specific, measurable objectives that are achievable within a 10-year period.

Summary of Comment 8-3

The commenter stated that the RCIS/LCP must link monitoring and adaptive management plan for each MCA to the Yolo HCP/NCCP monitoring program, and that adaptive management should include consultation with Conservancy.

Response to Comment 8-3

Although MCA monitoring and adaptive management is not required to be linked to the Yolo HCP/NCCP, Section 3.5 has been revised to explain the Conservancy will ensure that monitoring and adaptive management strategies approved under the Yolo RCIS/LCP are compatible with and, to the extent possible, complement the Yolo HCP/NCCP adaptive management program.

Summary of Comment 8-4

The commenter stated that he would like progress reports and public meetings made mandatory, and that he supports the role of the Conservancy as a public advisory committee.

Response to Comment 8-4

The RCIS is a voluntary, non-binding conservation strategy, so progress reports and public meetings cannot be deemed mandatory as it is not required by Fish and Game Code as a condition of RCIS approval by CDFW. The RCIS implementation sponsor may voluntarily agree to this, subject to available funding.

Summary of Comment 8-5

The commenter stated that the plan short-changes the LCP and the species that aren't RCIS focal species.

Response to Comment 8-5

The RCIS/LCP incorporates the entire draft LCP prepared in close coordination with the Advisory Committee. The plan has not dropped any elements of the LCP, but has only added elements required for an RCIS.

Summary of Comment 8-6

Need to separate out the documents and create a free standing LCS.

Response to Comment 8-6

Thank you for your comment. From the beginning of the RCIS process, the LCP has been an integral component of this plan, focused on a long-term conservation strategy through conservation investments in Yolo County. This focus originated with extensive consideration by the Yolo Conservancy's Advisory Committee of a "county-wide conservation plan" that incorporated all "Conservation Species" identified in the RCIS/LCP, all of the Yolo County landscape, and extensive landscape connectivity as elements in the development of the now-adopted HCP/NCCP. Ultimately these elements were not included in the HCP/NCCP, and the LCP arose as a locally based conservation framework to achieve goals beyond the focus of the HCP/NCCP. Most of the plan is relevant to both the RCIS and the LCP, so it was infeasible to separate out the RCIS component from the LCP components without substantial work and a very redundant document. The Steering Committee, therefore, requested that CDFW accept a proposal that involved leaving the RCIS/LCP as a single plan, but more clearly distinguishing between the RCIS and LCP. CDFW responded with several options provided in an attachment to an email dated August 8, 2019. We implemented option #1 from that correspondence, which was very similar to our proposal.

A disclaimer has been included under the heading of each section to clearly identify which section is applicable to the RCIS and/or LCP or both.

Summary of Comment 8-7

The commenter recommended that the LCP to be occasionally (i.e., every 5 years) updated with new information and scientific understanding.

Response to Comment 8-7

The LCP may be updated as funding is available. A requirement to update the plan every five years may not be feasible if the funding is lacking.

9. U.S. Fish and Wildlife Service, Bronwyn Hogan, April 28, 2018

Summary of Comment 9-1

The commenter stated the RCIS/LCP should clearly spell out how the sponsor will track actions taken through the RCIS to ensure they are not also being accounted for as meeting Yolo HCP/NCCP mitigation requirements.

Response to Comment 9-1

RCIS actions and HCP/NCCP mitigation actions can overlap, provided the RCIS actions are not counted as mitigation under an MCA. The MCA agreement and tracking would need to ensure against overlap.

Any MCA proposed within the permit area must be approved by the Implementing Entity and shall not duplicate or replace mitigation requirements set forth in the natural community conservation plan. FGC 1856(j) provides details on how the Implementing Entity can approve an MCA for use as mitigation. If this is done, then the Implementing Entity will track mitigation provided through MCA credits as it would with other types of mitigation.

Summary of Comment 9-2a

The commenter requested clarification, stating that Section 2.10.2.4, *California Tiger Salamander Hybridization* is inconsistent with information in the Yolo HCP/NCCP

Response to Comment 9-2a

Section 2.10.24 has been updated consistent with the Yolo HCP/NCCP to state that California tiger salamander hybrids are not known to occur in the RCIS strategy area.

Summary of Comment 9-2b

The commenter requested clarification in Section 4.5.1.2 to state that both CDFW and FWS would determine if something is consistent with the Yolo HCP/NCCP.

Response to Comment 9-2b

Section 4.5.12 of the RCIS/LCP has been reorganized and is now replaced by Section 4.6.1, *Mitigation Credit Agreement*. The language currently in the RCIS is appropriate. The HCP/NCCP implementing entity is the party responsible for determining whether an MCA is consistent.

Summary of Comment 9-2c

The commenter requested that the RCIS authors double check that the NFWF ILF includes ESA rather than only credits for USACE resources in Section 4.6.3 In-Lieu Fee Programs.

Response to Comment 9-2c

The National Fish and Wildlife Foundation's (NFWF) In-Lieu Fee (ILF) was approved for impacts on aquatic species and habitat covered under the Clean Water Act, Rivers and Harbor Act, Porter-Cologne Water Quality Control Act, and Endangered Species Act (National Fish and Wildlife Federation 2019). NFWF ILF includes Endangered Species Act.

Appendix C
Species Accounts

C.1 Alkali Milk-Vetch (*Astragalus tener* var.*tener*)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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 dramatic range and population reductions experienced by alkali milk-vetch might explain the lack of neutral marker differentiation between the two populations and that the lack of interpopulational 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 2005). 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.1.4.1 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] 2019).

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, the Tule 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; University of California Davis Herbarium 2007; Dean 2009; CNDDB 2019).

C.1.4.2 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 C-1).

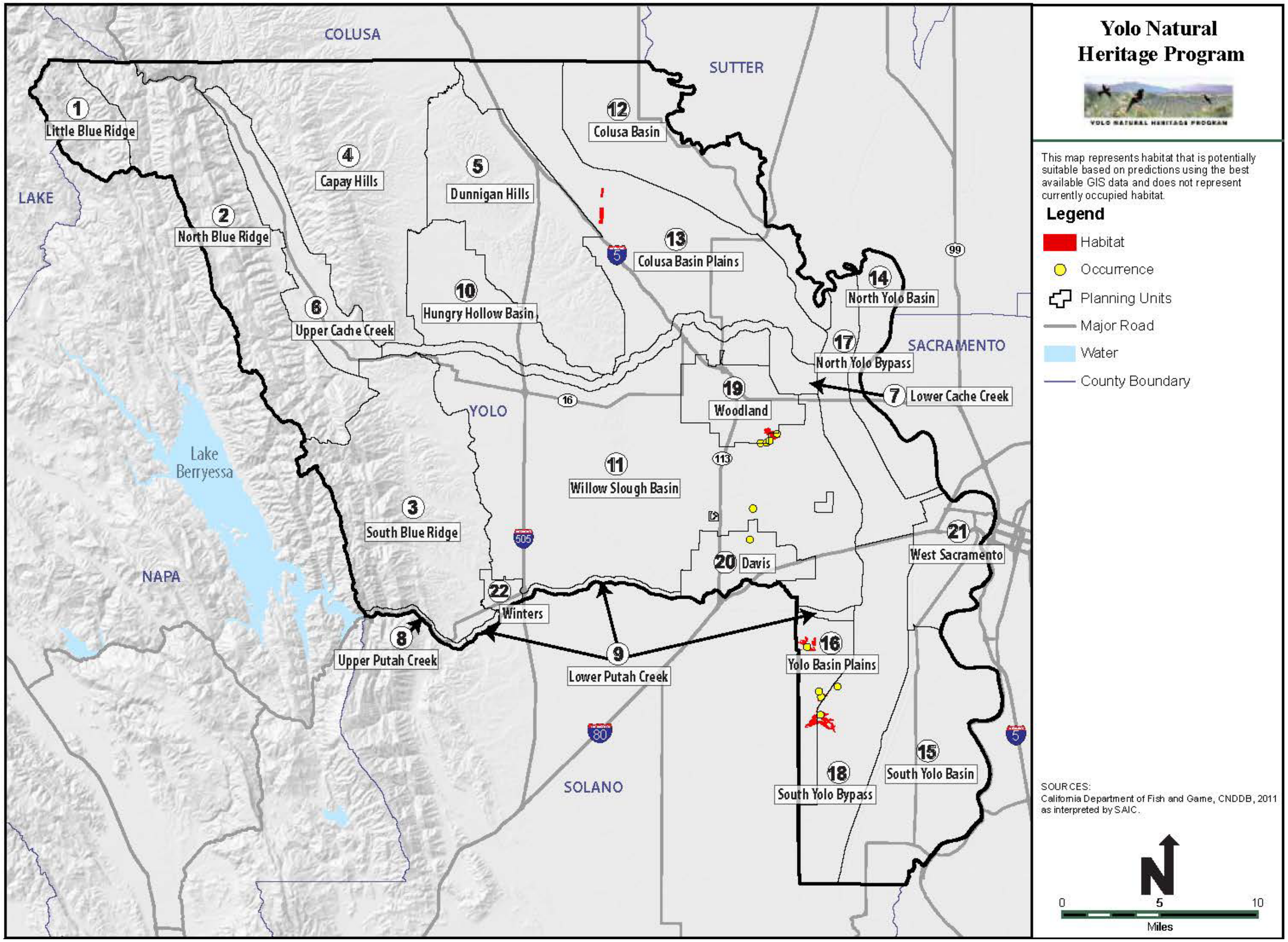
Mapped alkali milk-vetch habitat comprises the following vegetation types.

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.

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).

1 **Figure C-1. Alkali Milk-Vetch Mapped Habitat and Occurrences**



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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. 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] 2019; 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 2019).

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).

There are 60 known occurrences of the species and historically, brittlescale has been collected in the Central Valley from Glenn and Butte Counties south to Fresno County (CNDDB 2019). 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 2019). In the Sacramento and San Joaquin delta, it has been collected in, or adjacent to, salt marshes in Solano County (CNDDB 2019). 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 2019; EIP Associates 2003; Foothill Associates 2002; Showers 1996).

According to the CNDDB (2019), 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 2019; CNPS 2005; 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.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 C-2).

Mapped and modeled brittlescale habitat is comprised of the following vegetation types.

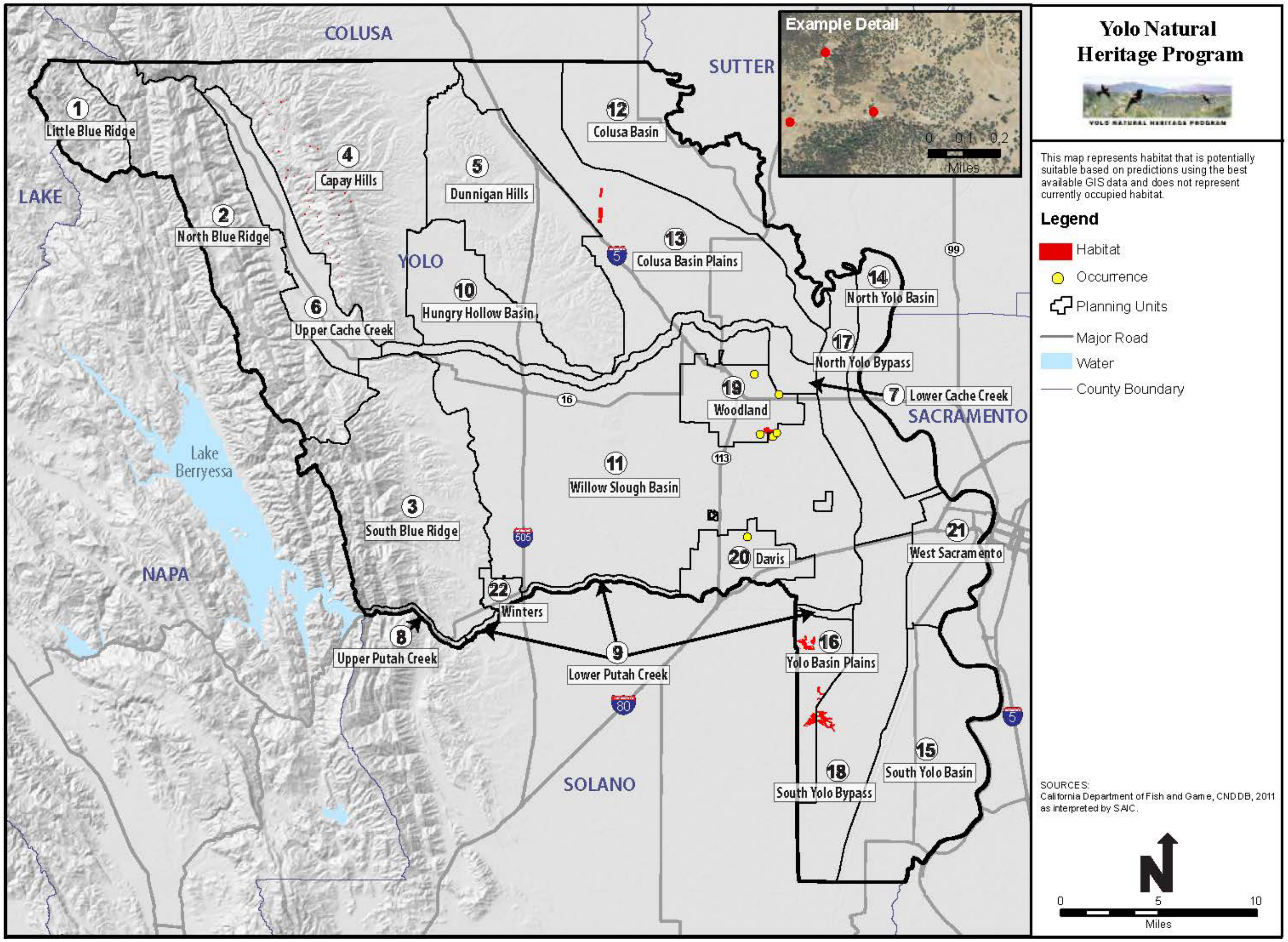
Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at the Grasslands Regional Park and Davis Communications Facility site and with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit based on the 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 Mapped Habitat and Occurrences



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C.3 San Joaquin Spearscale (*Extriplex 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 (*Etriplex 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] 2019). 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.3.5 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.3.6 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

A.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 C-3).

Mapped and modeled San Joaquin spearscale habitat is comprised of the following vegetation types.

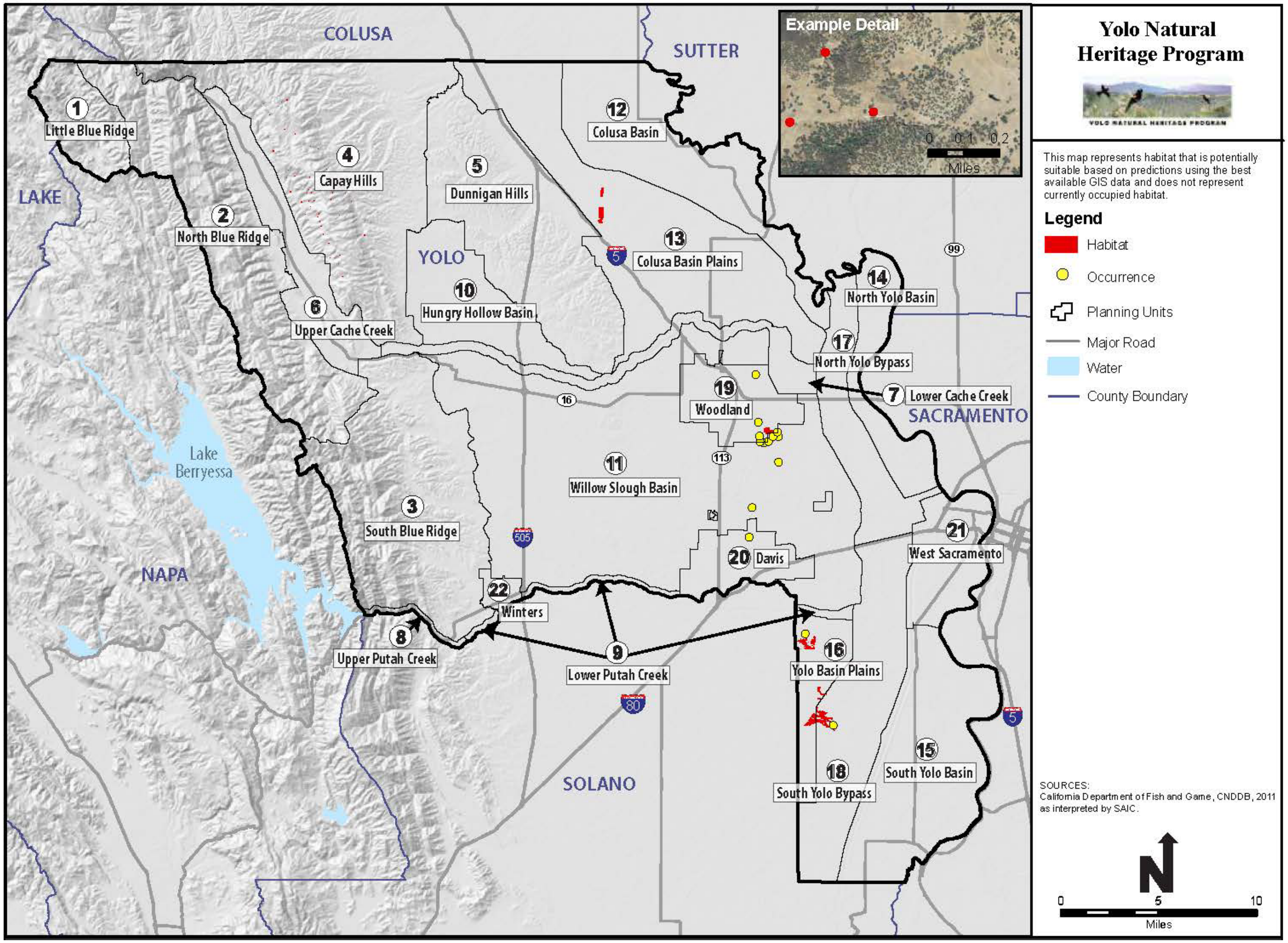
Vernal Pool Complex: This habitat consists of playa pools, vernal pools, and swales that were mapped on the ground to sub-meter accuracy at theGrasslands Regional Park and Davis Communications Facility site, with heads-up GIS digitization over aerial imagery of the DFW Tule Ranch Unit, based on the visual 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 Occurrences



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C.4 Palmate-Bracted Bird's-Beak (Chloropyron palmatum)

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).

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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. Recent research indicates that alkali heath (*Frankenia salina*) is the most important host plant for this species (Cypher 2015). 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 Wetlands Reserve, 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 four 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] 2019; Center for Natural Lands Management 2012; Crampton 1979; Dean 2009). Within the last 25 years, the species has been observed (most recently in 2017) 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; CNDDB 2019).

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).

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

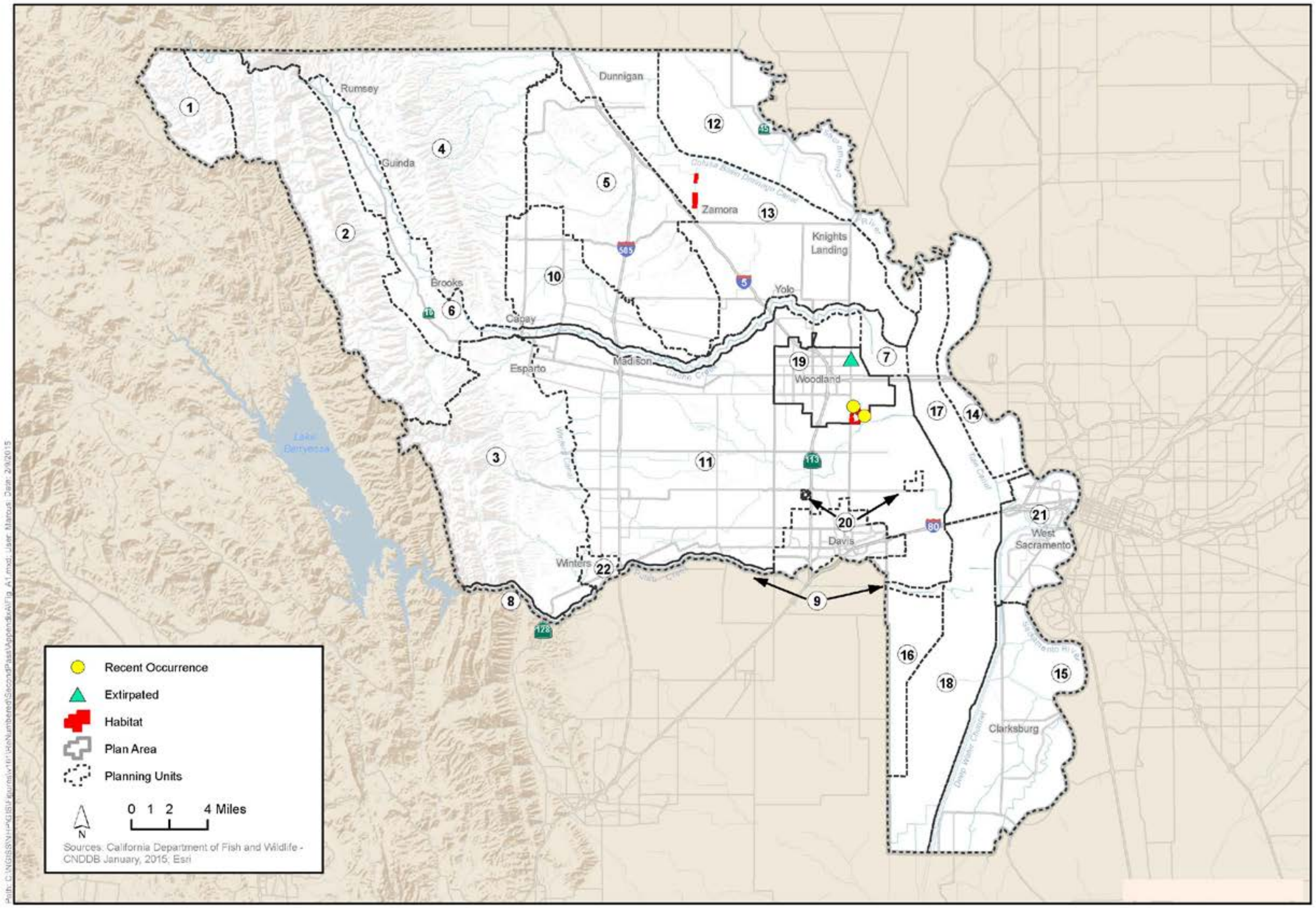
C.4.6.1 Geographic Information System (GIS) Map Data Sources

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 C-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 A.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.

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.

Figure C-4. Palmate-Bracted Bird's Beak Modeled Habitat and Occurrences



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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 2019). 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) (2019). Heckard's pepper-grass has been collected in Glenn, Merced, Sacramento, Solano, and Yolo Counties (Calflora 2007; CNDDB 2019). Populations of Heckard's pepper-grass in Yolo and Glenn Counties range in size from 10 to 500 plants (CNDDB 2019). 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 2019; Dean 2009; Showers 1996; Witham 2003).

C.5.4.2 Population Trends

Heckard's pepper-grass is extremely rare in California (Calflora 2007; CNPS 2019) 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 2019). All of these threats lead to loss of habitat or degradation of conditions the plant requires to survive.

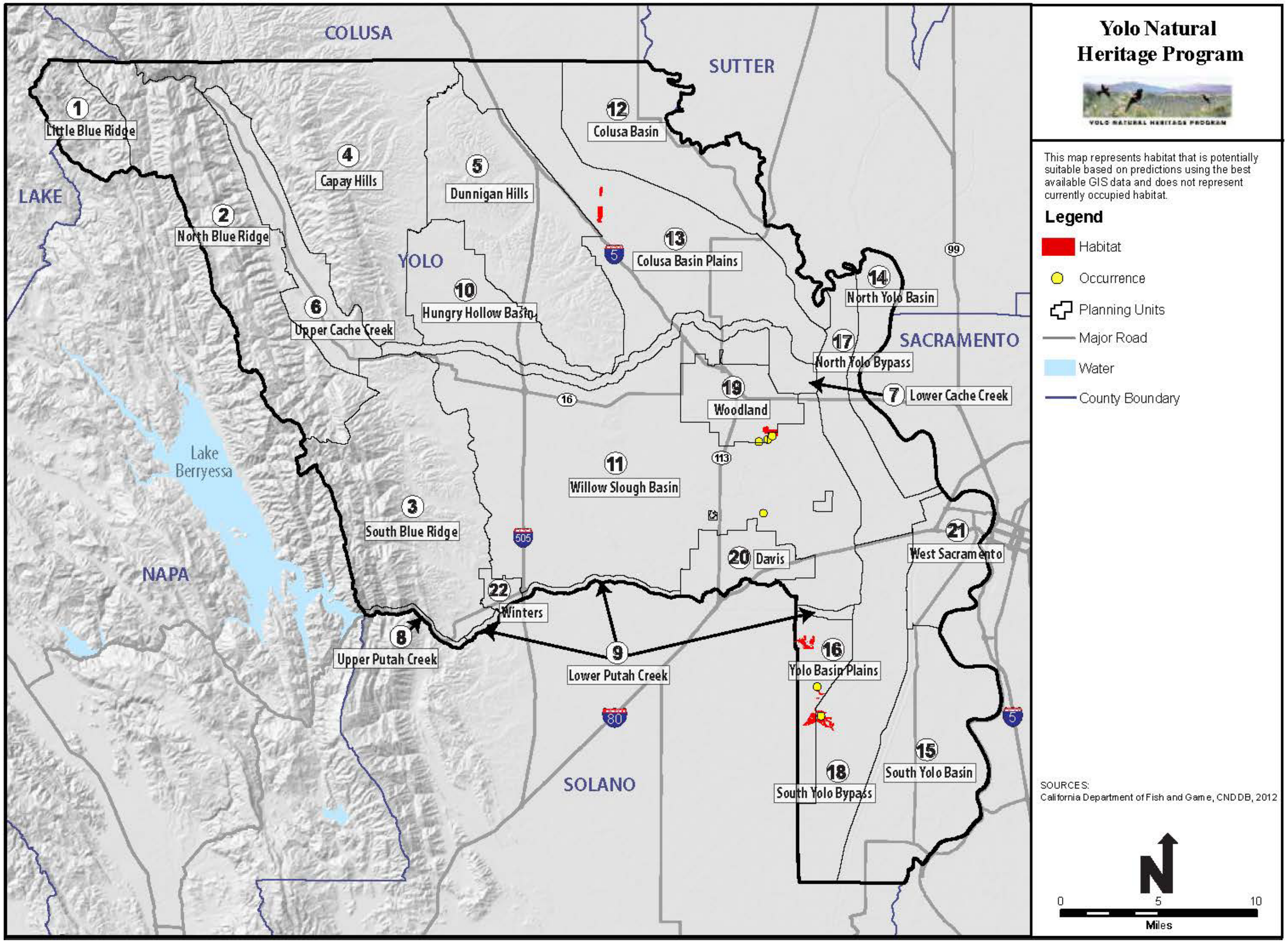
The species was more widely distributed in alkaline soils areas but known current occurrences on natural habitat in Plan Area are within alkali sink and vernal pool complex habitats.

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 C-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.

Figure C-5. Heckard's Pepper-Grass Mapped Habitat and Occurrences



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)

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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] 2019). 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 is based on 58 recorded observations (CNDDB 2019). 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 2019). 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 2019; 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

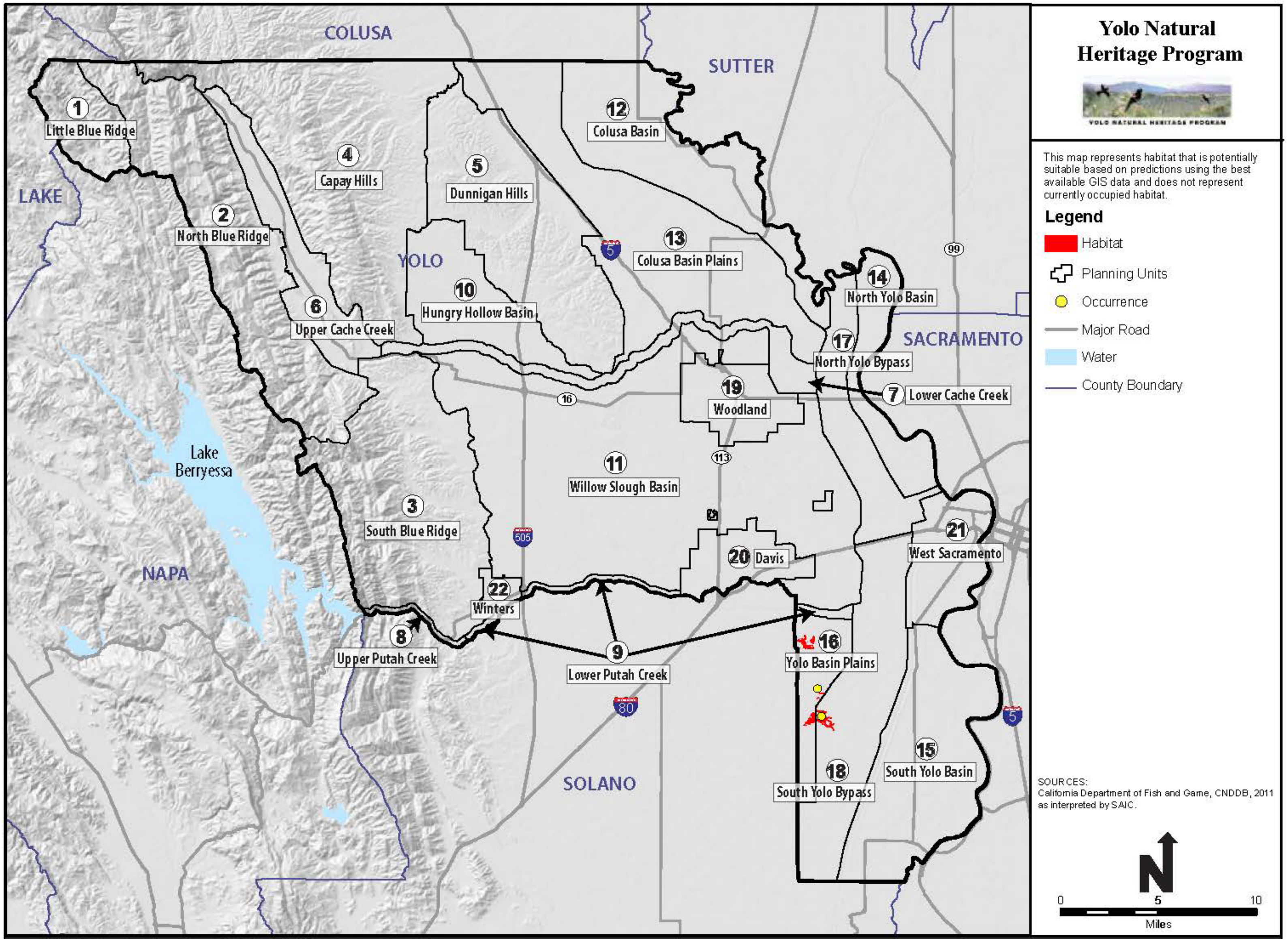
Baker's navarretia habitat is map-based and not modeled and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications facility site (Environmental Science Associates [ESA] and Yolo County 2005; Helm 2010; Gerlach 2011), and heads-up GIS digitization of the DFW Tule Ranch Unit (Figure C-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 C.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 2019).

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.

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C.7 Colusa Grass (Neostapfia colusana)

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C.7.1 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.7.2 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 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.7.3 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. 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.7.4 Species Distribution and Population Trends

C.7.4.1 Distribution

Currently, there are no more than 42 known extant occurrences scattered in Yolo, Solano, Merced, and Stanislaus counties (California Natural Diversity Database [CNDDB] 2019; 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.7.4.2 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 (2019) 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.7.5 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.

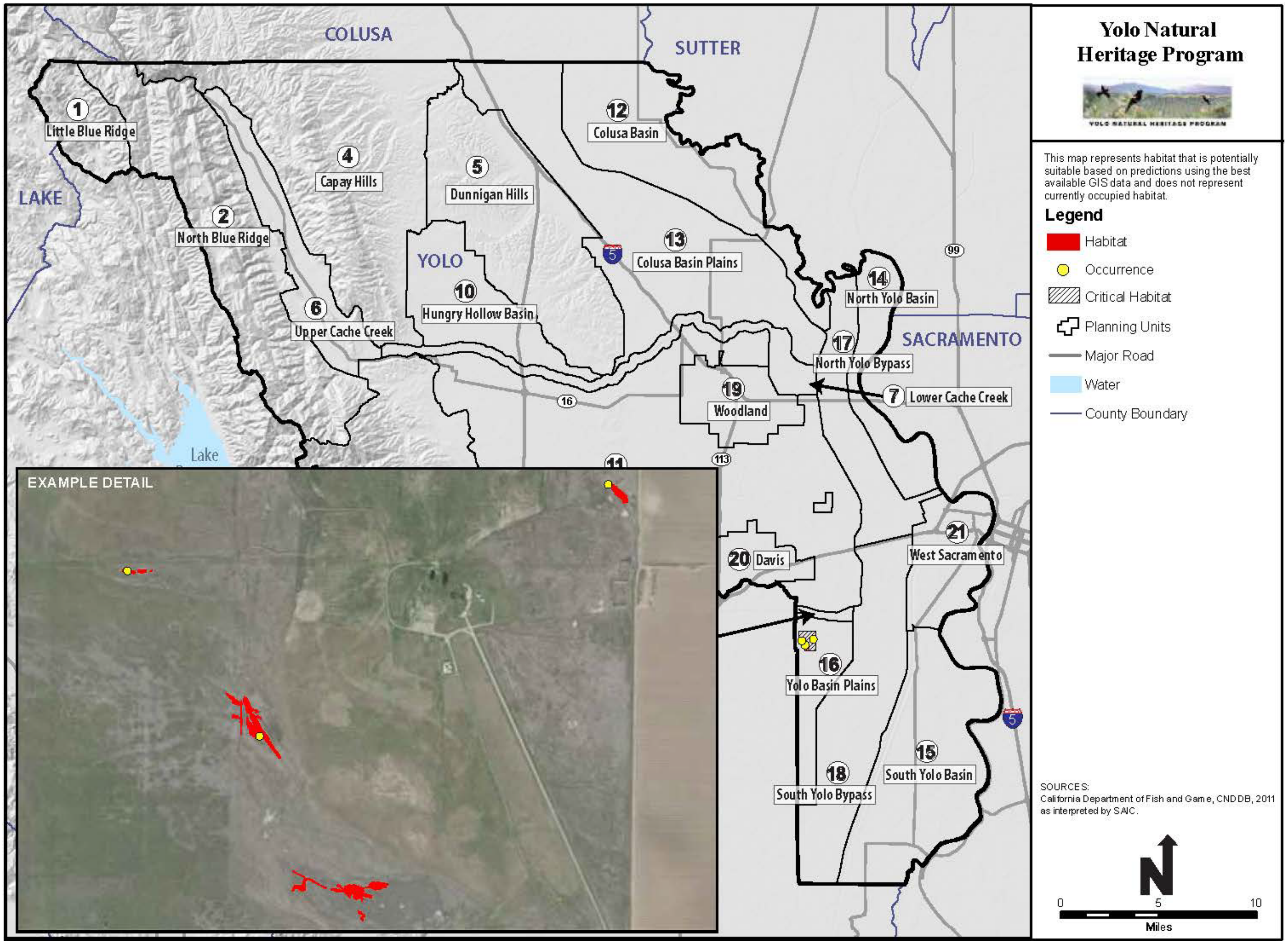
C.7.6 Recovery Plan Goals

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.7.7 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 C-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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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.

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C.8 Solano Grass (Tuctoria mucronata)

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C.8.1 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.8.2 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.8.3 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.8.4 Species Distribution and Population Trends

C.8.4.1 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.8.4.2 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.8.5 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.

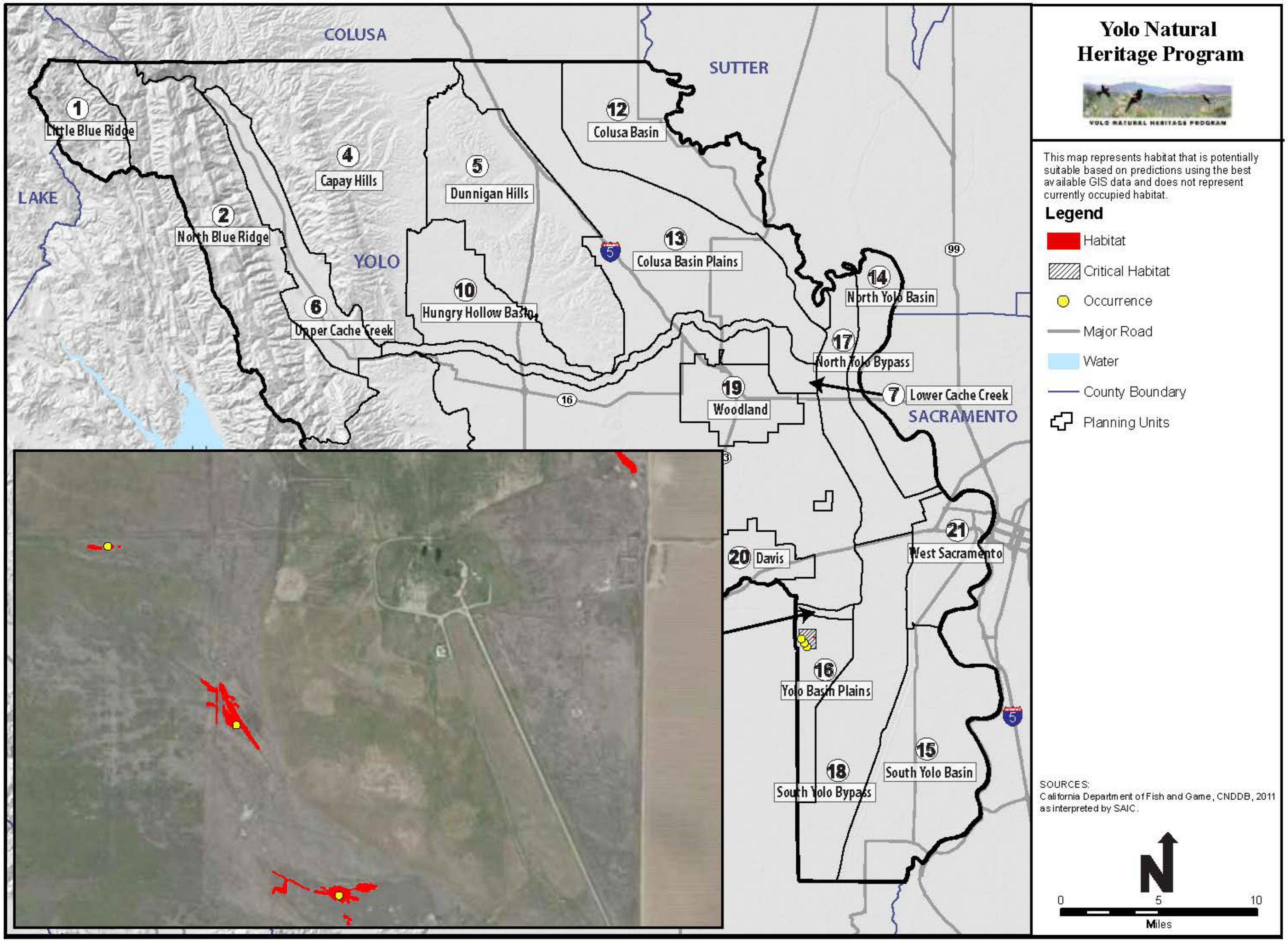
C.8.6 Recovery Plan Goals

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.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 2009, 2011) (Figure C-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.

1 **Figure C-8. Solano Grass Mapped Habitat and Occurrences**



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43 FR 44810. 1978. Determination of Five Plants as Endangered Species; Final Rule. *Federal Register* 43:44810.

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.8.8.2 Personal Communications

Carol Witham, California Native Plant Society. December 28, 2004 – email correspondence.

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C.9 Conservancy Fairy Shrimp (*Branchinecta conservatio*)

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C.9.1 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.9.2 Species Description and Life History

C.9.2.1 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.9.2.2 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.9.2.3 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.9.2.4 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.9.3 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.9.4 Species Distribution and Population Trends

C.9.4.1 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] 2019).

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 2019). 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.9.4.2 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.9.5 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.9.5.1 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.9.5.2 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.9.5.3 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.9.5.4 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.9.6 Recovery Plan Goals

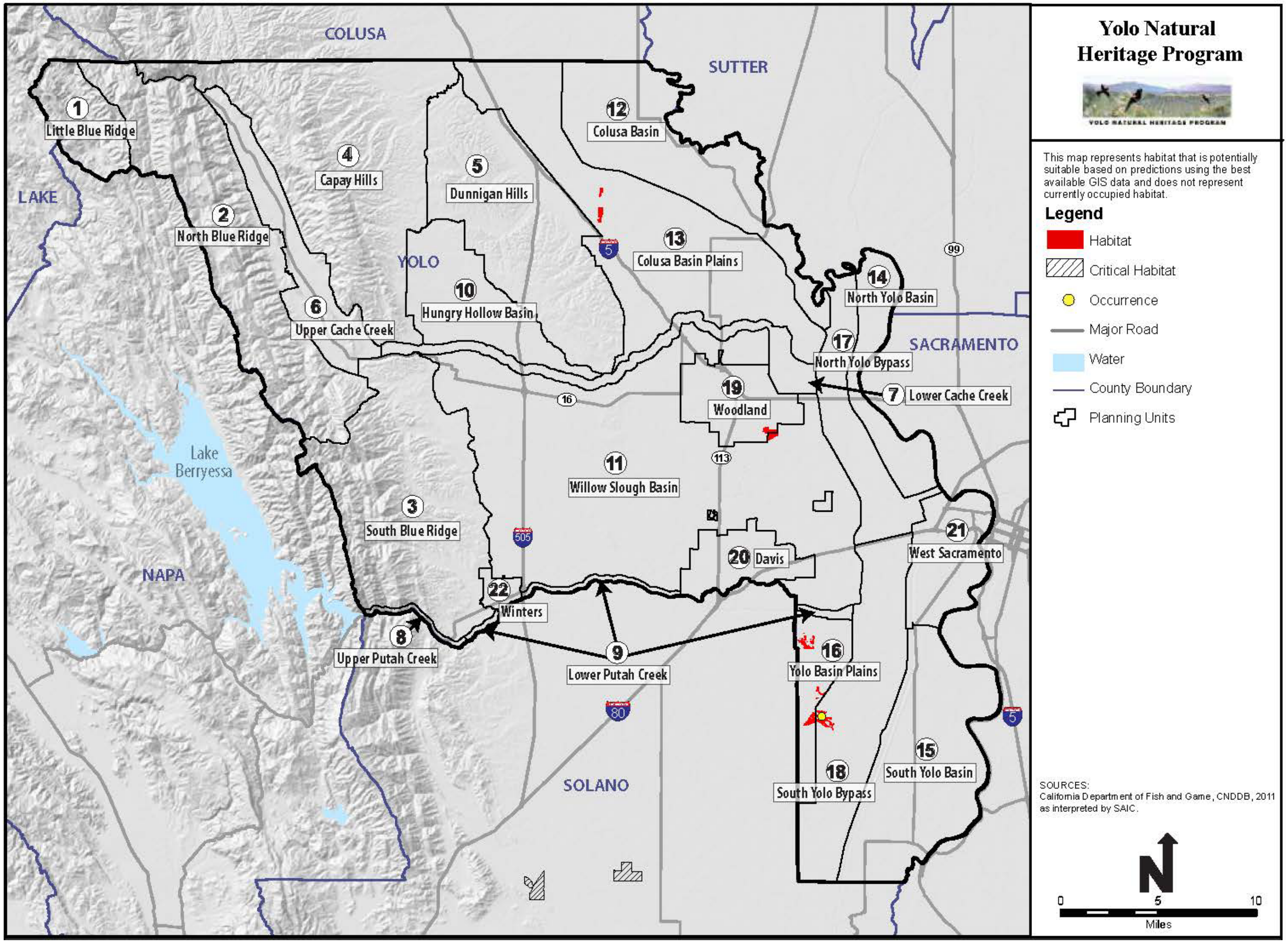
The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) includes Conservancy fairy shrimp but does not contain goals to be met for the species in the Plan Area.

C.9.7 Species Habitat Model and Location Data

C.9.7.1 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 C-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.

Figure C-9. Conservancy Fairy Shrimp Mapped Habitat and Occurrences



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.

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.10 Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

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C.10.1 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.10.2 Species Description and Life History

C.10.2.1 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.10.2.2 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.10.2.3 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.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 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.10.3 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.10.4 Species Distribution and Population Trends

C.10.4.1 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] 2019). 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 2019).

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 2019). 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 Yolo Bypass, DFW Tule Ranch Unit, the Grasslands Regional Park, and Davis Communications Facility site (CNDDB 2019). Areas that pond in the alkali sink area southeast of the City of Woodland are also potential habitat.

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 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.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 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.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 vernal pool 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 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 C-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.

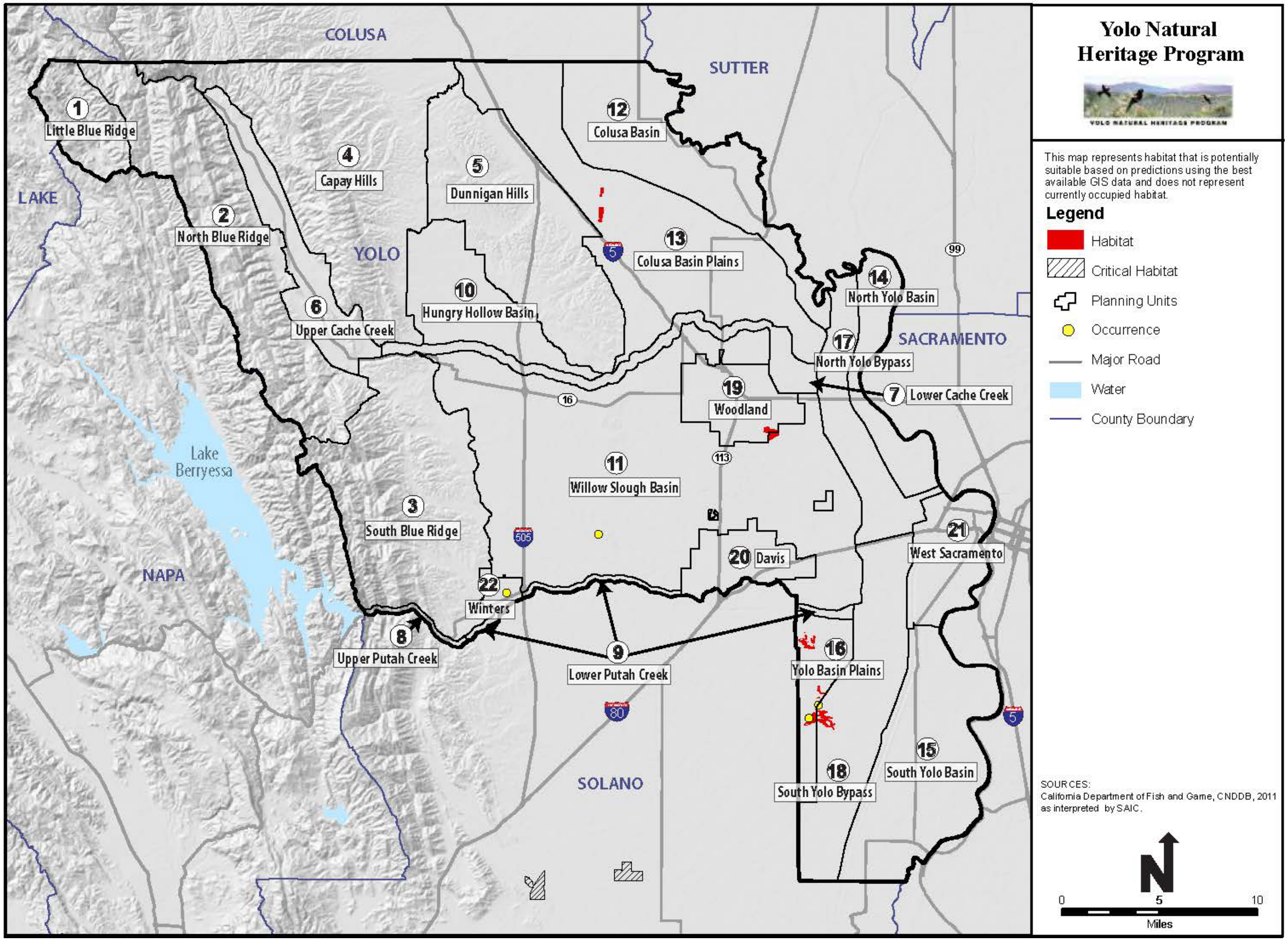
Mapped vernal pool fairy shrimp habitat is comprised of the following vegetation types.

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.

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 2019). 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.

1 **Figure C-10. Vernal Pool Fairy Shrimp Mapped Habitat and Occurrences**



2

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C.10.8.1 Federal Register Notices

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C.11 Midvalley Fairy Shrimp (*Branchinecta mesovallensis*)

C.11.1 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.11.2 Species Description and Life History

C.11.2.1 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.11.2.2 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.11.2.3 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.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 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.11.4 Species Distribution and Population Trends

C.11.4.1 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] 2019). 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 midvalley fairy shrimp, were identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005).

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). 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.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).

C.11.5.3 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.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).

C.11.6 Species Habitat Model and Location Data

C.11.6.1 Geographic Information System (GIS) Map Data Sources

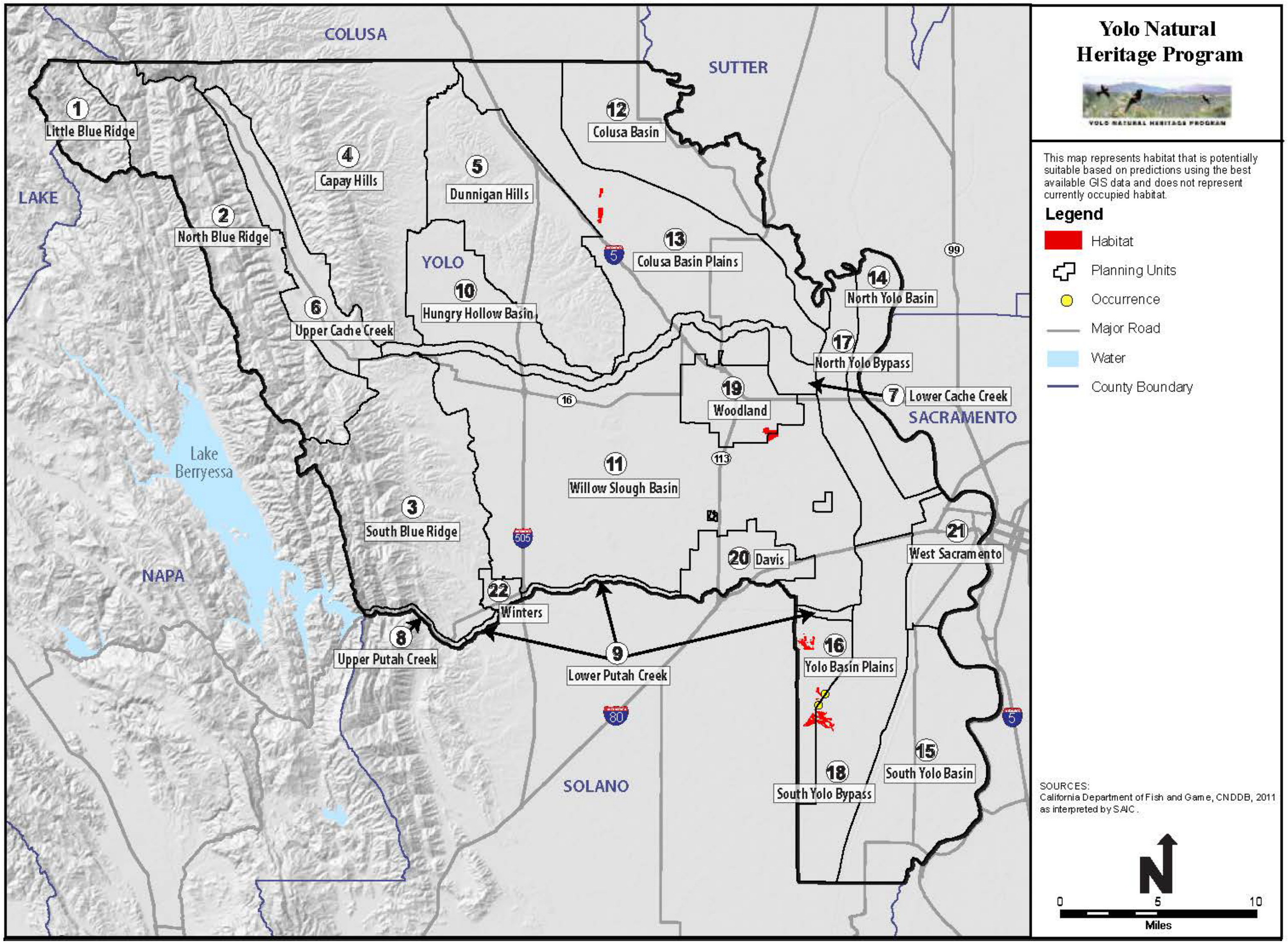
The midvalley fairy shrimp habitat model is map based and uses the Yolo NHP vegetation dataset, which is based on vernal pool complex mapping data for the Grasslands Regional Park and Davis Communications Facility site (ESA and Yolo County 2005; Helm 2010; J. Gerlach unpublished data), and heads-up digitization of the DFW Tule Ranch Unit and the alkali sink habitat in the NHP vegetation dataset (Figure C-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.

Figure C-11. Midvalley 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 within the Plan Area (USFWS 2005; CNDDB 2019). 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.12 California Linderiella Fairy Shrimp (*Linderiella occidentalis*)

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C.12.1 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.12.2 Species Description and Life History

C.12.2.1 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.12.2.2 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.12.2.3 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.12.2.4 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.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 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] 2019). 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.12.4 Species Distribution and Population Trends

C.12.4.1 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 2019) 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, Yolo Bypass near Levee Road, and ditches along Interstate 80 within the Plan Area (USFWS 2005; CNDDB 2019). 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 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.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).

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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).

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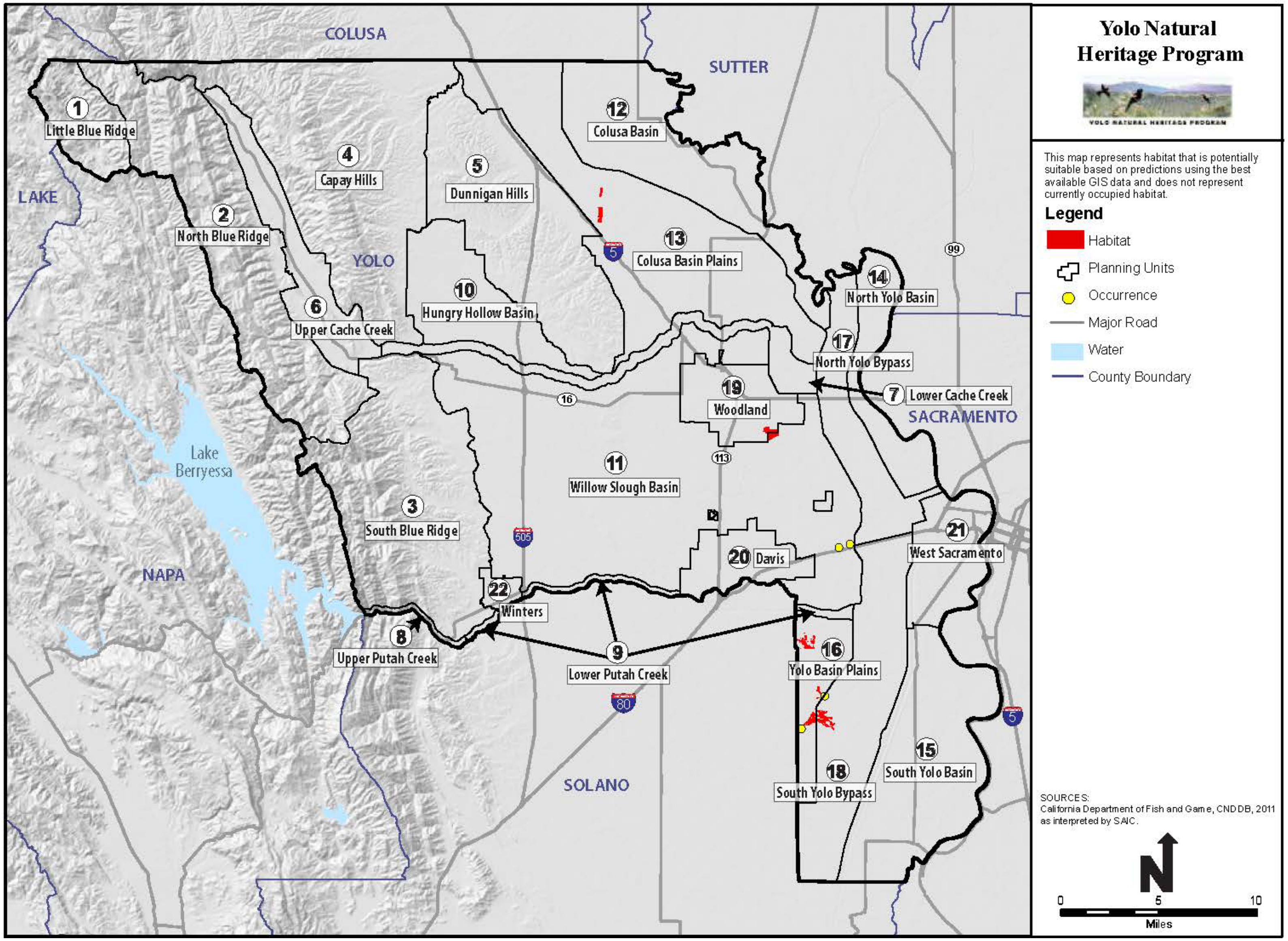
Human disturbances can alter the hydrology of temporary waters and result in a change in the timing, frequency, or duration of inundation in vernal pools, which can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005).

C.12.6 Species Habitat Model and Location Data

C.12.6.1 Geographic Information System (GIS) Map Data Sources

The 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 C-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.

1 **Figure C-12. California Linderiella Fairy Shrimp Mapped Habitat and Occurrences**



2

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.

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 2019). 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.13 Vernal Pool Tadpole Shrimp (*Lepidurus packardi*)

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C.13.1 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.13.2 Species Description and Life History

C.13.2.1 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.13.2.2 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.13.2.3 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.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 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.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 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.13.4 Species Distribution and Population Trends

C.13.4.1 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] 2019). 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 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.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, 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.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, 2007).

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, 2007).

C.13.6 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.13.7 Species Habitat Model and Location Data

C.13.7.1 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 C-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.

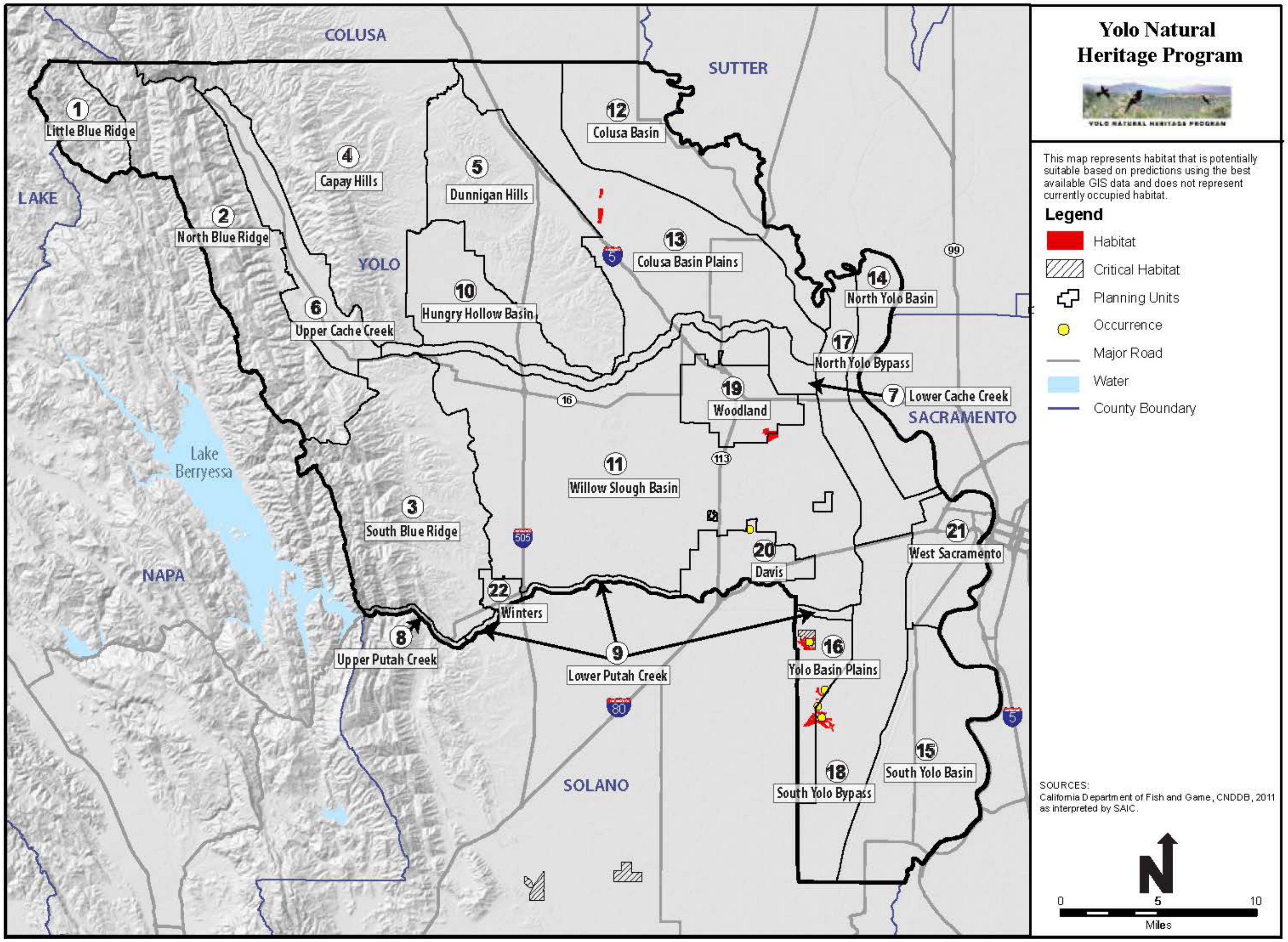
Mapped vernal pool tadpole shrimp habitat is comprised of the following vegetation types.

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 2019). 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.

Figure C-13. Vernal Pool Tadpole Shrimp Mapped Habitat and Occurrences



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C.13.8.1 Federal Register Notices

59 FR 48136. 1994. Endangered and Threatened Wildlife and Plants: Determination of Endangered Status for the Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, and the Vernal Pool Tadpole Shrimp; and Threatened Status for the Vernal Pool Fairy Shrimp; Final Rule. *Federal Register* 59:48136.

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C.14 Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)

C.14.1 Listing Status

© Theresa Sinicrope Talley, UC Davis

Federal: Threatened.

State: None.

Recovery Plan: 2019. Draft Revised Recovery Plan for the Valley Elderberry Longhorn Beetle.

C.14.2 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.14.3 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.14.4 Species Distribution and Population Trends

C.14.4.1 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] 2019), as well as along Putah Creek from Monticello Dam east to Davis (Eya 1976; USFWS 1984; Barr 1991; Collinge et al. 2001; CNDDB 2019) and along Cache Creek (Barr 1991; CNDDB 2019). 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.14.4.2 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.14.5 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.14.6 Recovery Plan Goals

The *Draft Revised Recovery Plan for Valley Elderberry Longhorn Beetle* (USFWS 2019) includes three management units, two of which overlap with the strategy area (Sacramento River Management Unit and Putah Creek Management Unit). The recovery criteria related to habitat conservation for each management unit are as follows:

1. Sufficient suitable habitat patches1 within each management unit should be protected (i.e., voluntary land acquisitions, conservation easements, or other similar mechanisms). Each HUC8 subbasin within the management unit should contain at least 5 500-800 meter patches of quality habitat. HUC8 subbasins that are small or where only a small portion of the subbasin is in the management area should contain at least 1 500-800 meter patch of quality habitat that meets the criteria in #3.

2. Valley elderberry longhorn beetles should be present in at least 3 locations within each HUC8 subbasin.

3. Protected suitable habitat patches within HUC8 subbasins should be no more than 12.4 mi (20 km) from the nearest adjacent protected suitable habitat patch.

4. Within the areas of protected suitable habitat, there should be a diversity of elderberry life stages and signs of natural recruitment.

5. All areas of protected suitable habitat need to have comprehensive management plans that maintain habitat values for the valley elderberry longhorn beetle and address potential threats such as Argentine ants and invasive plants as well as provide for habitat maintenance and enhancement. Implementation of habitat management plans is expected to also ameliorate threats described such as altered fire regime, vandalism and changes in environmental conditions resulting from climate change.

6. A control or eradication program for argentine ants should be implemented at each bank or other conservation area that has been established to support recovery of the valley elderberry beetle. Control is considered achieved when the population of Argentine ants on a site is not appreciably affecting valley elderberry longhorn beetle recruitment.

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C.14.7 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.14.3, *Habitat Requirements and Ecology* (Figure C-14).

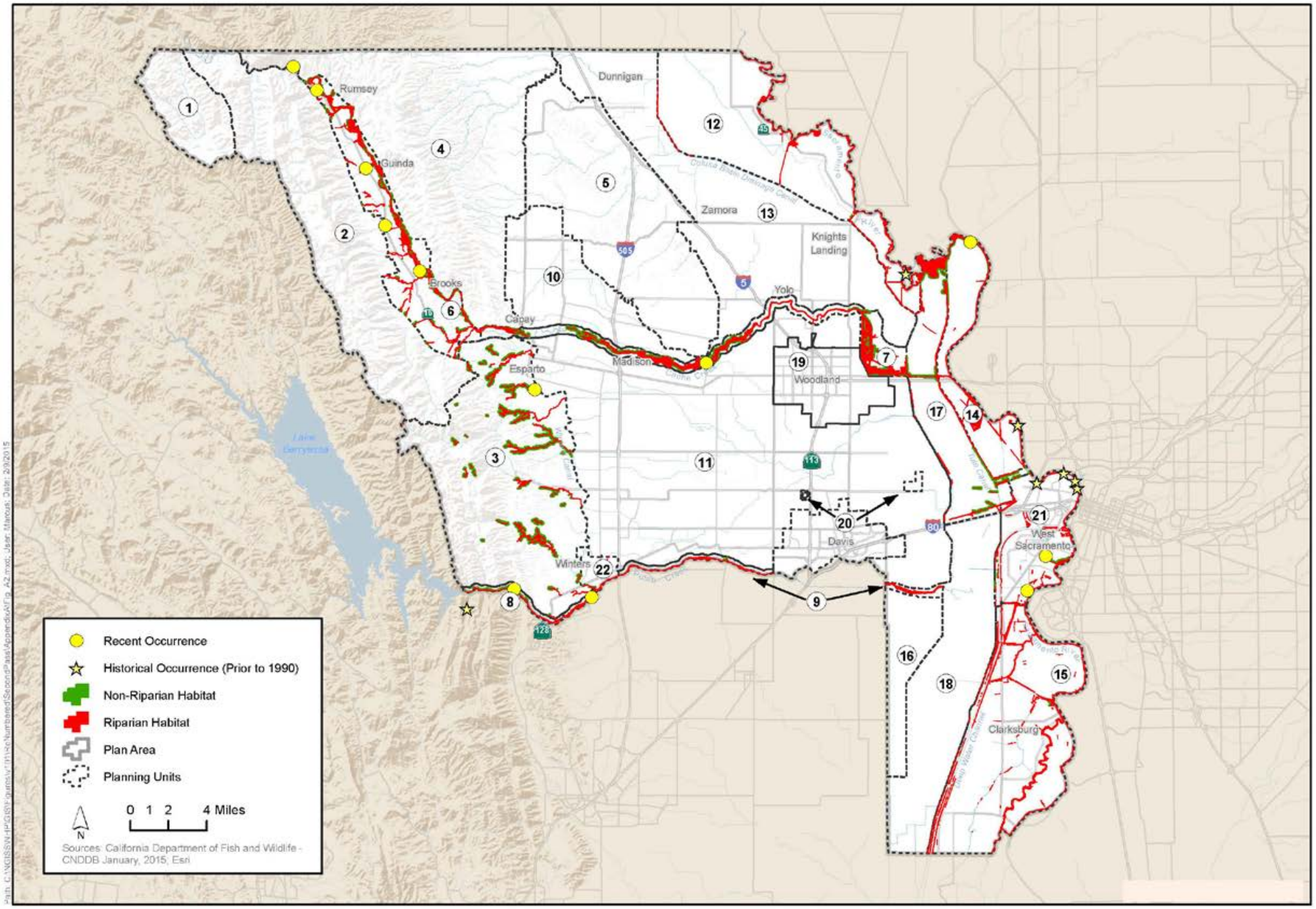
The model parameters include the following:

- 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.14.7.1 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 Modeled Habitat and Occurrences



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C.14.8.2 Federal Register Notices

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C.15 White Sturgeon (Acipenser transmontanus)

C.15.1 Listing Status

The white sturgeon is not listed under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA).

C.15.2 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.15.3 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.15.4 Species Distribution and Population Trends

C.15.4.1 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.15.4.2 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.15.5 Threats to the Species

C.15.5.1 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.15.5.2 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.15.5.3 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.15.5.4 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.15.5.5 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.15.5.6 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.15.5.7 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.15.5.8 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.15.5.9 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.15.6 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.16 Green Sturgeon (*Acipenser medirostris*)

C.16.1 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.16.2 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.16.3 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.16.4 Species Distribution and Population Trends

C.16.4.1 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.16.4.2 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.16.5 Threats to the Species

C.16.5.1 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.16.5.2 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.16.5.3 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.16.5.4 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.16.5.5 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.16.5.6 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.16.5.7 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.16.5.8 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. 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

[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.

have been investigated (U.S. Bureau of Reclamation and California Department of Water Resources 2012Navicky pers. comm.).

C.16.6 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 Delta Smelt (*Hypomesus transpacificus*)

C.17.1 Listing Status

Federal: Threatened

State: Endangered

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.17.2 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 population level effects are poorly understood) (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 a recent listing review, 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 (USFWS 2016). 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.17.3 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.

Feyrer et al. (2011) demonstrated that X2 in the fall correlates nonlinearly with an index of delta smelt abiotic habitat (see Figure 3 of Feyrer et al. 2011). The delta smelt fall abiotic habitat index is the surface area of water in the regions indicated by Figure 3 of Feyrer et al. (2011) weighted by the probability of presence of delta smelt based on water clarity (Secchi depth) and salinity (specific conductance) in the water. Feyrer et al.'s (2011) method found these two variables to be significant predictors of delta smelt presence in the fall and also concluded that water temperature was not a meaningful predictor of delta smelt presence in the fall, although it has been shown to be important during summer months when water temperatures are higher (Nobriga et al. 2008). The delta smelt fall abiotic habitat index is the surface area of water in the regions indicated by Figure 3 of Feyrer et al. (2011) weighted by the probability of presence of delta smelt based on water clarity (Secchi depth) and salinity (specific conductance) in the water. Feyrer et al.'s (2011) method found these two variables to be significant predictors of delta smelt presence in the fall and also concluded that water temperature was not a meaningful predictor of delta smelt presence in the fall, although it has been shown to be important during summer months when water temperatures are higher (Nobriga et al. 2008).

Various peer-reviewed studies have statistically examined linkages between fall abiotic habitat (often indexed by X2) and indices of delta smelt abundance or survival. Feyrer et al. (2007) found that delta smelt abundance in summer was positively related to prior fall abundance, and negatively related to prior fall salinity and water clarity. Mac Nally et al. (2010) found no evidence for a relationship between fall X2 and delta smelt fall abundance. Miller et al. (2012) found that neither fall X2 nor the volume of suitable fall habitat (with suitability based on salinity, water clarity, and temperature) were able to explain additional variability in trends in delta smelt fall-to-fall survival, beyond direct factors included in a best regression model.

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 sandy substrates have been inferred from laboratory observations and other smelt species (J. Lindberg, unpubl. data. 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. 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.17.4 Species Distribution and Population Trends

C.17.4.1 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 depending on suitable water temperatures (Nobriga et al. 2008; Sommer et al. 2011), 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.17.4.2 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 0 in 2018 to 1,673 in 1970. For comparison, Summer Townet Survey -derived indices have ranged from a low of 0 in 2015, 2016, and 2018 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 ~15 years. 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.17.5 Threats to the Species

C.17.5.1 Water Exports

The risk of entrainment of delta smelt at SWP and CVP export facilities is complex and varies seasonally and among years. The extent to which entrainment may cause population level effects to delta smelt is uncertain. Currently, all life stages except eggs are actively managed with respect to water operations.

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.17.5.2 Habitat Loss

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.

Suisun Marsh Salinity Control Gates

Several factors may have contributed to the reduction in delta smelt juvenile rearing habitat, including increased water temperatures, 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.17.5.3 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.17.5.4 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.17.5.5 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).

The invasive clam, *Potamocorbula amurensis,* has depressed both phytoplankton and zooplankton populations in the LSZ (Kayfetz and Kimmerer 2017).

C.17.5.6 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.17.5.7 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). Other species have been reported to have delta smelt in their stomachs, including striped bass (Stevens 1966), black crappie (Turner 1966a), and white catfish (Turner 1966b). Although predation effects on delta smelt are not well understood, it is generally acknowledged that predation is common for delta smelt and is likely the ultimate cause of mortality for most individuals (IEP MAST 2015).

C.17.5.8 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.17.6 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.

C.17.7 References

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C.18 Central Valley Steelhead (*Oncorhynchus mykiss*)

C.18.1 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.18.2 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.18.3 Habitat Requirements and Ecology

C.18.3.1 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.18.3.2 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.18.3.3 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.18.3.4 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.18.4 Species Distribution and Population Trends

C.18.4.1 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.18.4.2 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.18.5 Threats to the Species

C.18.5.1 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.18.5.2 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.18.5.3 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.18.5.4 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.18.5.5 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.18.5.6 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). 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.18.5.7 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.18.5.8 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. 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.18.6 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.

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C.19 Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*)

C.19.1 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.19.2 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.19.3 Habitat Requirements and Ecology

C.19.3.1 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.19.3.2 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.19.3.3 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.19.3.4 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.19.3.5 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.19.4 Species Distribution and Population Trends

C.19.4.1 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.19.4.2 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.19.5 Threats to the Species

C.19.5.1 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.19.5.2 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 improved growth rates 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.19.5.3 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.19.5.4 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.19.5.5 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.19.5.6 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.19.5.7 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.19.5.8 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.19.6 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.

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C.20 Central Valley Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*)

C.20.1 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.20.2 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.20.3 Habitat Requirements and Ecology

C.20.3.1 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.20.3.2 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.20.3.3 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.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 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.20.3.5 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.20.4 Species Distribution and Population Trends

C.20.4.1 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.20.4.2 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.20.5 Threats to the Species

C.20.5.1 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.20.5.2 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.20.5.3 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.20.5.4 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.20.5.5 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.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 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.20.5.7 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.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 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.20.6 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.21 Central Valley Fall- and Late Fall–Run Chinook Salmon (*Oncorhynchus tshawytscha*)

C.21.1 Listing Status

Federal: Species of Concern

State: Not listed.

C.21.2 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.21.3 Habitat Requirements and Ecology

C.21.3.1 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.21.3.2 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.21.3.3 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.21.3.4 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.21.3.5 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.21.4 Species Distribution and Population Trends

C.21.4.1 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).

Within the strategy area, adult fall-run Chinook salmon occur on the mainstem of the Sacramento River between October to April (Moyle et al. 1995). Fall-run Chinook salmon have intermittently occurred on Putah Creek, but are believed to be extirpated from Cache Creek (Yoshiyama et al. 2000). Migrating adults move relatively quickly north through the plan area to suitable spawning grounds. The majority of spawning occurs north of the plan area, in stream reaches between Red Bluff and Redding (Keswick Dame) (Moyle et al. 1995). Out-migrating smolts move into the river channel within a few weeks of emerging (April to June) and juveniles forage extensively on off-channel habitat and floodplains areas, such as the Yolo Bypass (between 7-13 months) (CDFG 2010) before emigrating to the ocean.

C.21.4.2 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.21.5 Threats to the Species

C.21.5.1 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.21.5.2 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.21.5.3 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.21.5.4 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.21.5.5 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.21.5.6 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.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, 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[1].

[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.

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). 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.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 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.21.6 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.

C.21.7 Species Model and Location Data

Geographic Information System (GIS) Map Data Sources.

C.21.8 References

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C.22 Sacramento Splittail (*Pogonichthys macrolepidotus*)

C.22.1 Listing Status

Federal: No listing

State: Species of Special Concern

C.22.2 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.22.3 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 [59F]) (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.22.4 Species Distribution and Population Trends

C.22.4.1 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.22.4.2 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.22.5 Threats to the Species

C.22.5.1 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.22.5.2 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.22.5.3 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.22.5.4 Food Resources

Reductions in productivity within have been attributed to changes in hydrology associated with water diversions, upstream reservoir operations, and ammonia[1] 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.22.5.5 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). 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

[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.

floodplains or in the estuary after the pesticides have entered stream and river channels through agricultural drainage.

C.22.5.6 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.22.5.7 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.22.6 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.

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C.23 California Tiger Salamander (*Ambystoma californiense*)

C.23.1 Listing Status

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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: Threatened.

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 Sonoma County (76 FR 54346) and Santa Barbara County (69 FR 68568) and within 20 counties in central California, including Yolo County (70 FR 49380).

Recovery Plan: Recovery Plan for the Central California Distinct Population Segment of the California Tiger Salamander (Ambystoma californiense). 2017; Recovery Plan for the Santa Barbara County Distinct Population Segment of the California Tiger Salamander (Ambystoma californiense) (2016); Recovery Plan for the Santa Rosa Plain (2016)

C.23.2 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). 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.23.3 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.23.4 Species Distribution and Population Trends

C.23.4.1 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 2019). 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 2019). 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 2019) (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 2019). Queries of the online databases of the California Academy of Sciences (2008) and Museum of Vertebrate Zoology (2008) yielded no additional occurrence records.

C.23.4.2 Population Trends

There is little current data regarding the absolute number of individuals of this species due to the fact that they spend most of their lives underground and are therefore difficult to observe. The available data suggest that most populations consist of relatively small numbers of breeding adults; breeding populations in the range of a few pairs up to a few dozen pairs are common, and numbers above 100 breeding individuals are rare (CDFG 2010). While, 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. Ten occurrences of California tiger salamander have been reported in Yolo County (CNDDB 2019). Eight of the ten 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. One occurrence was detected in a single livestock pond approximately 11 miles southwest from previously known occurrences in the Dunnigan Hills; tissue samples of this occurrence was analyzed at the University of California, Davis, and determined to be native California tiger salamander (CNDDB 2019; USFWS 2014). Another occurrence was detected in the City of Davis, and consisted of a live, solitary individual found in a parking lot across from a City of Davis owned wildlife habitat area meanaged by the Yolo Audubon Society (CNDDB 2019).

C.23.5 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 and highway can fragment breeding and dispersal migratory routes in areas where they traverse occupied habitat (U.S. Fish and Wildlife Service 2017). Features of road construction, such as solid road dividers, can further impede migration, as can other potential barriers such as berms, pipelines, and fences. Additionally, road mortality is a threat to the species because terrestrial habitat is used for interpond migration and overwintering movement (U.S. Fish and Wildlife Service 2017; Brehme et al. 2018). California tiger salamander migrate en masse and frequently cross roadways that occur between breeding and nonbreeding areas, and because of their sedentary nature, are more susceptible to being wounded or crushed by a vehicle.

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.

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.23.6 Recovery Goals

The strategy to recover the Central California tiger salamander focuses on alleviating the threat of habitat loss and fragmentation to increase population resiliency (ensure each population is sufficiently large to withstand stochastic events), redundancy (ensure a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events), and representation (conserve the breadth of the genetic makeup of the species to conserve its adaptive capabilities). The Dunnigan Hills portion of the strategy area overlaps with a core recovery area for California tiger salamander.

C.23.7 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 C-15). The model parameters include the following.

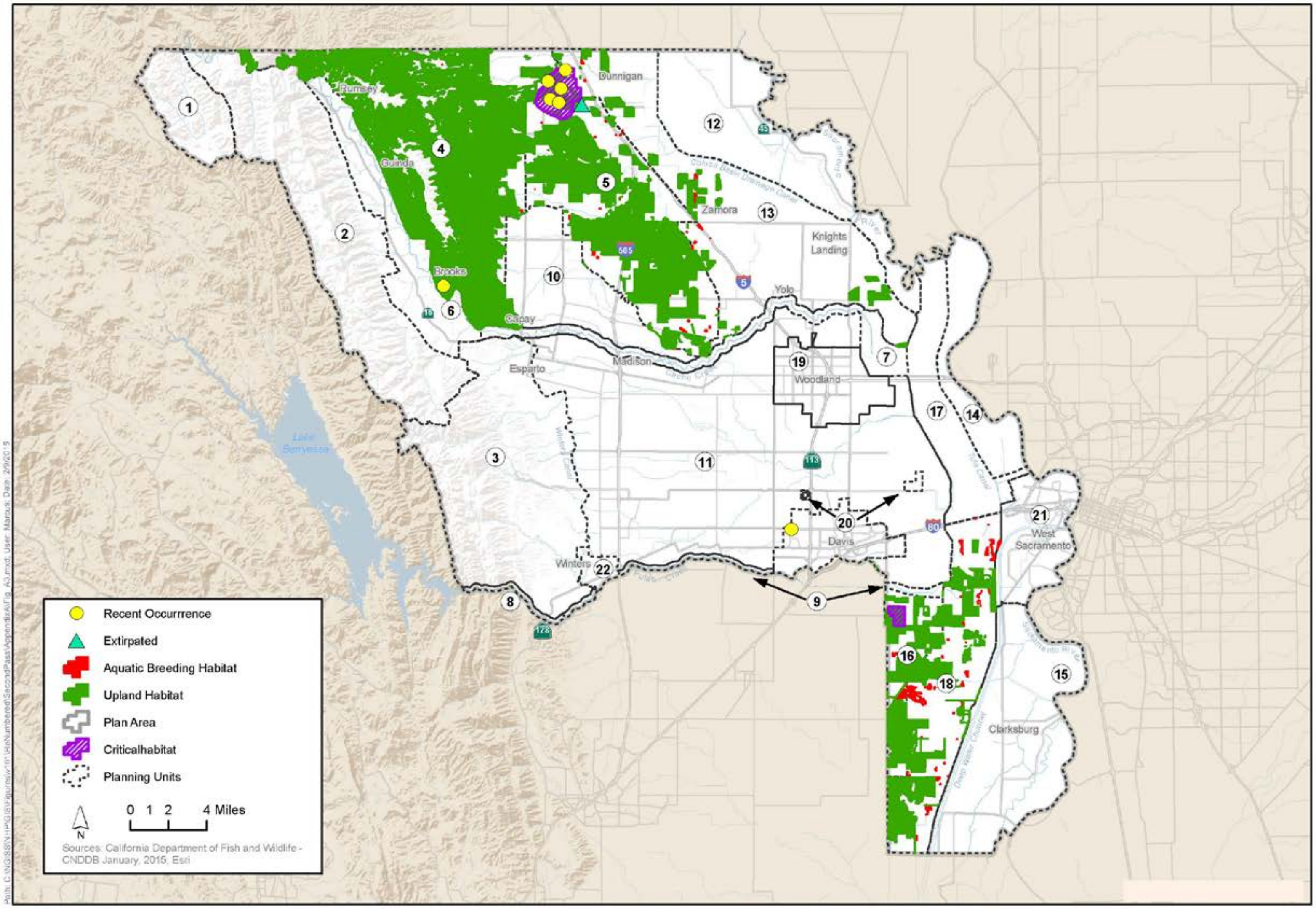
- Aquatic Breeding Habitat: This habitat includes all potentially suitable aquatic breeding areas and was modeled by selecting all mapped vernal pools, alkali sinks, and ponds (except those that are known to be perennial) as listed below that occur below an elevation 1,509 feet. Habitat located within 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.23.7.1 Upland Habitat – Vegetation Types

- All Annual Grassland
- Blue Oak Woodland
- All Blue Oak – Foothill Pine

- Valley Oak Alliance
- Pastures

Figure C-15. California Tiger Salamander Modeled Habitat and Occurrences



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C.25 Western Spadefoot Toad (*Spea* [Scaphiopus] *hammondii*)

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C.25.1 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.25.2 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] 2019).

C.25.3 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 2019), 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 2019). 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.25.4 Species Distribution and Population Trends

C.25.4.1 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), 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] (2019) lists four records of western spadefoots in Yolo County. Those records, from 1990,2000, and 2017, were from Buckeye Creek, 4.8 and 5.6 kilometers (3.0 and 3.5 miles) northwest of Dunnigan and 3.3 miles south of Harrington. No other extant records are known from Yolo County.

C.25.4.2 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.25.5 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.25.6 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.25.7 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.25.3, *Habitat Requirements and Ecology* (Figure C-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.[1]
- 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).

[1] Stream order dataset was developed by Technology Associates in support of western spadefoot toad habitat modeling.

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

Figure C-16. Western Spadefoot Modeled Habitat and Occurrences

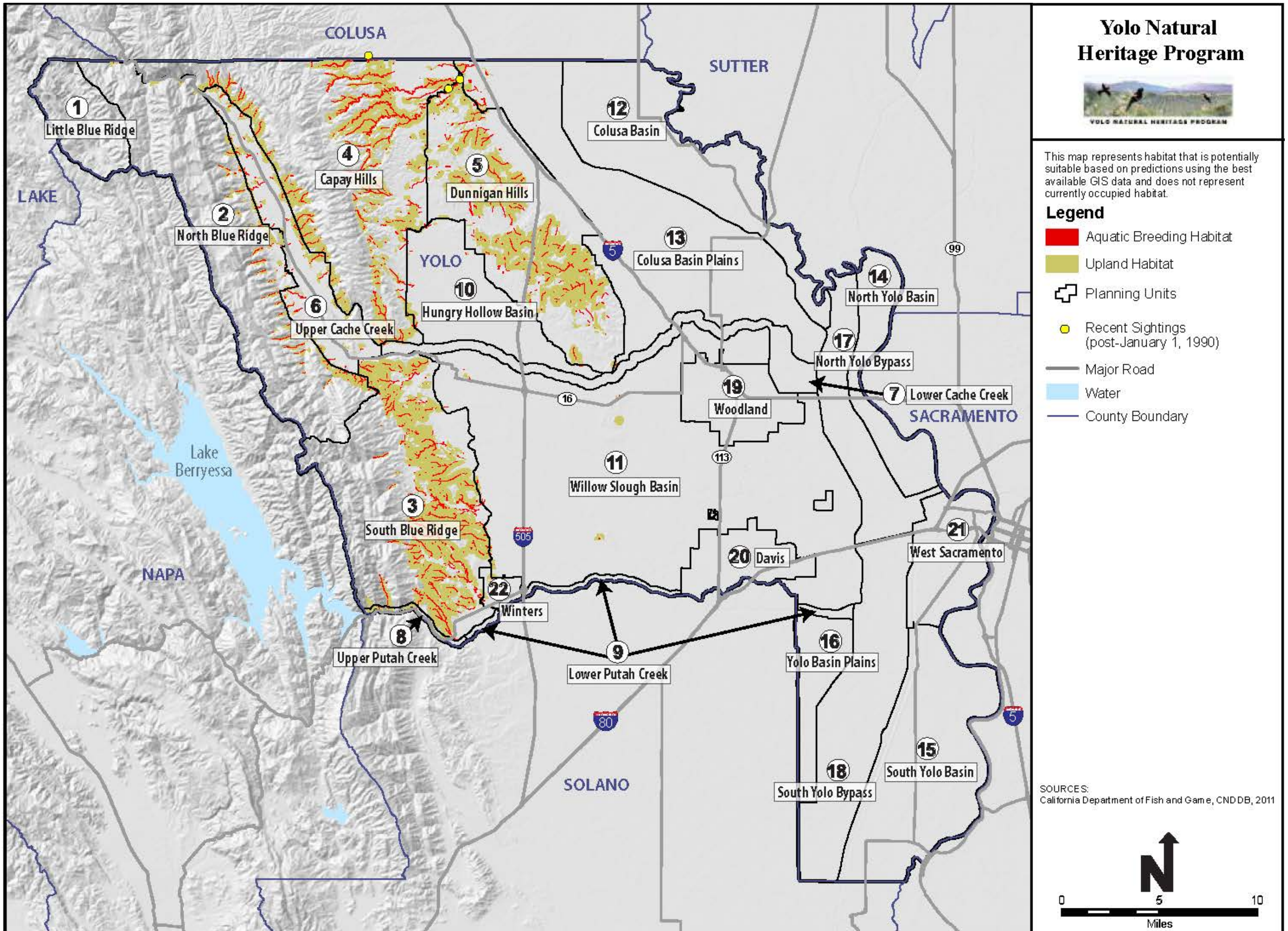

Figure A-16. Western Spadefoot Toad Modeled Habitat and Occurrences

C.25.8 References

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C.26 Northwestern Pond Turtle (*Actinemys marmorata*)

C.26.1 Listing Status

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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.26.2 Species Description and Life History

The northwestern 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 northwestern 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.26.3 Habitat Requirements and Ecology

The northwestern 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). 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. Northwestern pond turtles may overwinter in aquatic or upland habitats (Holland 1994). Like the giant garter snake (*Thamnophis gigas*), northwestern pond turtles inhabit the irrigation ditches servicing rice agriculture in the Central Valley. While rice fields probably confer little advantage for adult northwestern 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 northwestern 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.

Northwestern 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 northwestern 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; Slavens 1995). Nesting sites typically have a south-facing microslope, 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, northwestern 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 northwestern 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.

Northwestern 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.). Northwestern pond turtles also spend considerable time foraging (Holland 1994). Foraging may occur during the day or night. 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 northwestern pond turtles (Holland 1994).

Nonnative invasive species are a threat to northwestern pond turtles. Bullfrogs and exotic large predatory fish (e.g., largemouth bass) compete for invertebrate prey with northwestern 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. 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.

C.26.4 Species Distribution and Population Trends

C.26.4.1 Distribution

The range of the northwestern 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 northwestern 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 northwestern 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 northwestern 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 northwestern pond turtles, all from 1997. Two of those records were from Davis Creek, near Davis Creek Reservoir in northwestern 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 northwestern pond turtle in Yolo County. The California Natural Diversity Database (CNDDB) (2019) lists one record from 1990 of multiple northwestern 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. 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 northwestern 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 northwestern pond turtle have been made by Whisler (pers. comm., 2015). These include the following:

- Sacramento River at Gray's Bend (planning unit 12). Northwestern 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). Northwestern pond turtles observed throughout this area in 2014.
- Putah Creek Sinks (2010 and 2011) in the Yolo Bypass Wildlife Area: planning unit 18). Northwestern 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 northwestern 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): Northwestern 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 northwestern pond turtles in the borrow sloughs near the Water Treatment Plant south of Burrows Road in 2009.
- City Davis (planning unit 20). Several northwestern 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.26.4.2 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; 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).

In California, Jennings and Hayes (1994) consider the northwestern pond turtle as endangered from the Mokelumne River south and threatened elsewhere within the state. Loss of habitat is the most significant factor in northwestern 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, 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 northwestern 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 northwestern pond turtle within the Plan Area are unknown.

C.26.5 Threats to the Species

The most significant threats to the northwestern pond turtle are the continuing loss, degradation, and fragmentation of occupied habitats. 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. 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. 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 northwestern 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 northwestern 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 northwestern pond turtle. The Plan does not propose any conservation measures designed to benefit the northwestern 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 northwestern 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 northwestern 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 northwestern pond turtle habitat should be avoided when possible. Maintaining a natural flow regime within lotic habitats occupied by northwestern pond turtles is also of considerable importance in maintaining and improving existing habitat conditions. Considering the abundance of suitable aquatic habitat, northwestern pond turtles may be more widely distributed within the Plan Area than indicated by existing occurrence records.

C.26.6 Species Habitat Model and Location Data

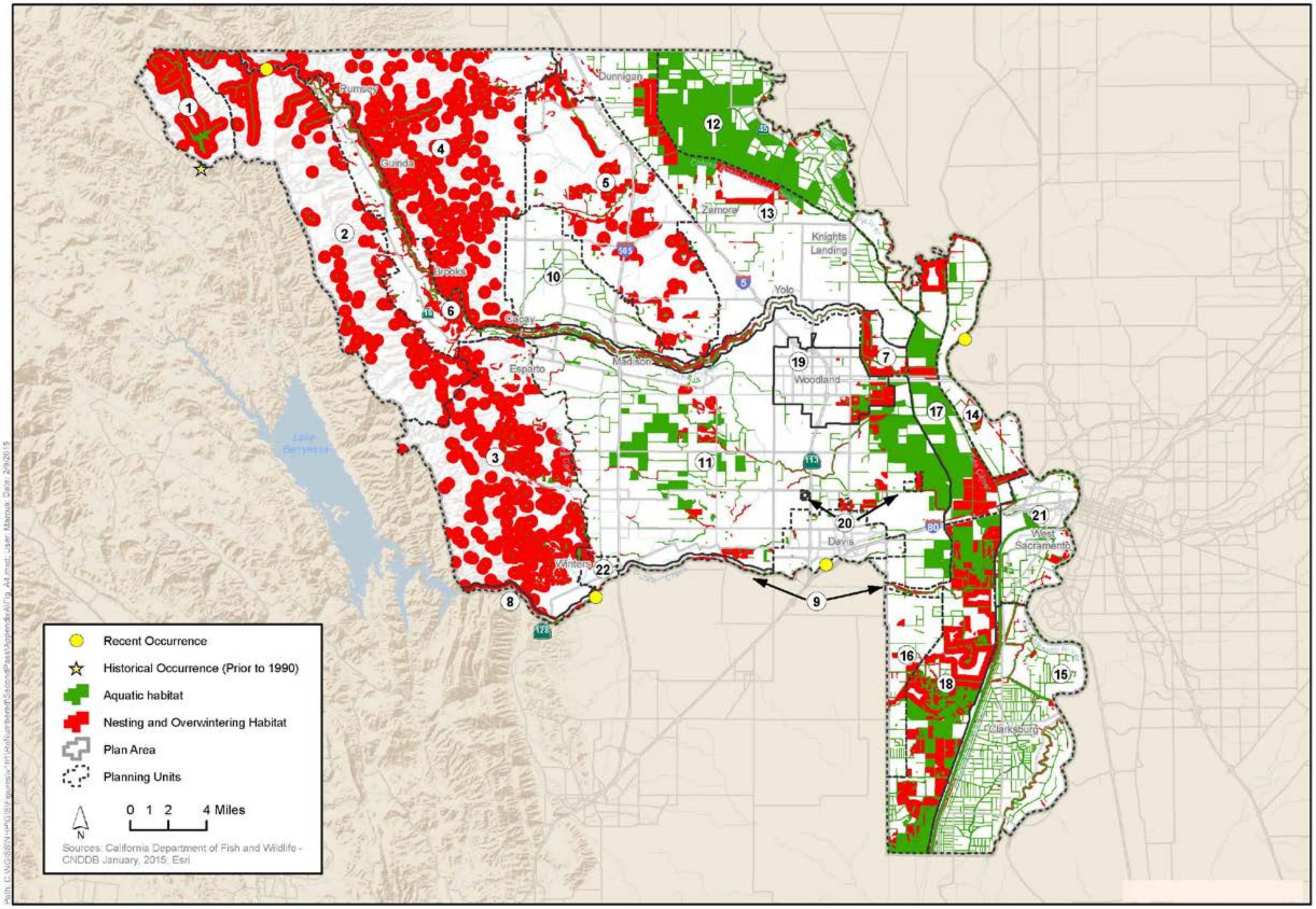
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.26.3, *Habitat Requirements and Ecology* (Figure C-17). The model parameters include the following.

- 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).
- 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.26.6.1 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; 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-17. Northwestern Pond Turtle Modeled Habitat and Occurrences



1.1.1 References

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C.27 Giant Garter Snake (*Thamnophis gigas*)

C.27.1 Listing Status

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Federal: Threatened.

State: Threatened.

Recovery Plan: Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (USFWS 1999).

Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (USFWS 2015)

Final Recorvery Plan for the Giant Garter Snake (*Thamnophis gigas*) (USFWS 2017)

C.27.2 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). The home ranges for snakes were documented to be smaller in localities where the surrounding land use provides the necessary components of giant garter snake habitat compared to localities where snakes had to travel to find these components (Hansen 2008a).

C.27.3 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 (Hansen 2007a).

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; USFWS 1999).

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). 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 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 (USFWS 1999; 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.27.4 Species Distribution and Population Trends

C.27.4.1 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] 2019; 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 2019; 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.

Following the release of the 2017 Recovery, USFWS now only recognize nine populations. This change is based on recent surveys, which indicate that two populations were extirpated, and on genetic research, which lead to the grouping together of some of the populations. One of these nine 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 2019).

Giant garter snakes are documented in two distinct concentrations along the eastern edge of Yolo County (CNDDB 2019; 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. 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 the Davis Wetlands complex south of Conaway Ranch between the Willow Slough Bypass, irrigation canals southwest of Conaway Ranch, main irrigation canal Conway Ranch, south and west of the Yolo Bypass, the Yolo Wildlife Area along the east and west edges of the Yolo Bypass west levee, adjacent ricelands west of the Yolo Wildlife Area, and Pope Ranch (CNDDB 2019).

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.). The USGS, studied giant garter snakes throughout the Sacramento Valley of California from 1995 to 2016 using capture-mark-recapture to study the growth, reproduction, and survival of this threatened species. Most of the data come from three regions, the Natomas Basin in Sacramento County and Sutter County, Gilsizer Slough in Sutter County, and the Colusa National Wildlife Refuge in Colusa Count, however, data from studies in Butte, Colusa, Glenn, Sacramento, Sutter, and Yolo Counties also contributed data on the growth and reproduction of giant garter snakes (Rose et al. 2017).

Genetic data was used to understand which vital rates contribute most to the growth rate of giant garter snake populations. The studies showed that giant garter snakes exhibit indeterminate growth; growth slows as individuals' age. Fecundity, probability of reproduction, and survival all increase with size, although survival may decline for the largest female giant garter snakes. The population growth rate of giant garter snakes is most influenced by the survival and growth of large adult females, and the size at which 1 year old recruits enter the population. Studies indicate that management actions benefitting these influential demographic parameters will have the greatest positive effect on giant garter snake population growth rates, and therefore population persistence (Rose et al. 2017).

Genetic analyses of tissue samples collected from giant garter snakes in the Yolo Wildlife Area and adjacent ricelands are ongoing. Engstrom (2010) 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 (Rose et al. 2017).

C.27.4.2 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 2019).

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). ICF estimated Yolo County giant garter snake densities by habitat type for the Yolo Habitat Conservation Plan/Natural Community Conservation Plan (ICF 2018). Table C-1, below, provides these density estimates, and the methods for developing these estimates are provided in Appendix O of the Yolo Habitat Conservation Plan/Natural Community Conservation Plan.

Table C-1. Density Estimates by Habitat Type for Giant Garter Snakes in Yolo County (± Symmetric Posterior 95% Credible Interval)

Habitat Type	Density (ind/ha)
Rice (Low)	1 (1-3)
Rice (High)	2 (2-5)
Fresh Emergent Marsh (Low)	5 (3-8)
Fresh Emergent Marsh (High)	18 (5-34)
Aquatic	0.83 (0.63-1.5)
Active Season Upland (Isolated)	6.6 (2.6-12.6)

C.27.4.3 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 (**Error! Bookmark not defined.Error! Bookmark not defined.**$\bar{x}$ =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.

<u>Seasonal/Managed Wetlands</u>: Some of the emergent wetland types and vegetation associations in the Colusa Basin Subpopulation and the Willow Slough/Yolo Bypass Subpopulation 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. Based on visual estimates from summer aerial imagery (September 2011), approximately 80 percent of the mapped seasonal wetlands are winter flooded, 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 et al. 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.27.4.4 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[a]			
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**

[a] 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[a]			
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**

[a] Excluding the Yolo Bypass (Planning Units 17 and 18) within which no conservation actions are proposed by the Implementing Entity.

C.27.5 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 2019; 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 (USFWS 1999).

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). 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. 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 2008b, 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 (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.27.6 Recovery Goals

The 2017 final recovery plan for giant garter snake includes recovery criteria for the present or threatened destruction, modification, or curtailment of its habitat or range. The recovery plan calls for a) sufficient habitat of suitable quality protected in each recovery unit, and b) connected blocks of habitat within each recovery unit. The strategy area includes the Yolo Basin recovery unit, and overlaps with a portion of the Colusa Basin recovery unit.

The recovery plan states that giant garter snake habitat will be preserved in multiples of two block pairings of habitat. Each block pair will consist of one 539-acre block of contiguous buffered perennial wetland habitat (existing, restored or enhanced) and one 1,578-acre block of contiguous active ricelands separated by no more than 5 miles. Alternatively, a pair of blocks may also consist of two 539-acre blocks of buffered perennial wetlands. The recovery plan states that block pairs should be evenly distributed among the management units. In addition, the habitat pairs must not be separated by more than 5 miles. The pairs of contiguous perennial wetlands and ricelands must be buffered by 0.5 kilometer (0.32 mile) of compatible habitat and the two blocks must be connected by a corridor of aquatic and upland habitat with a 0.8-kilometer (0.5-mile) minimum width.

The recovery plan also provides criteria for each recovery unit, including the following two units that overlap with the Yolo RCIS/LCP strategy area.

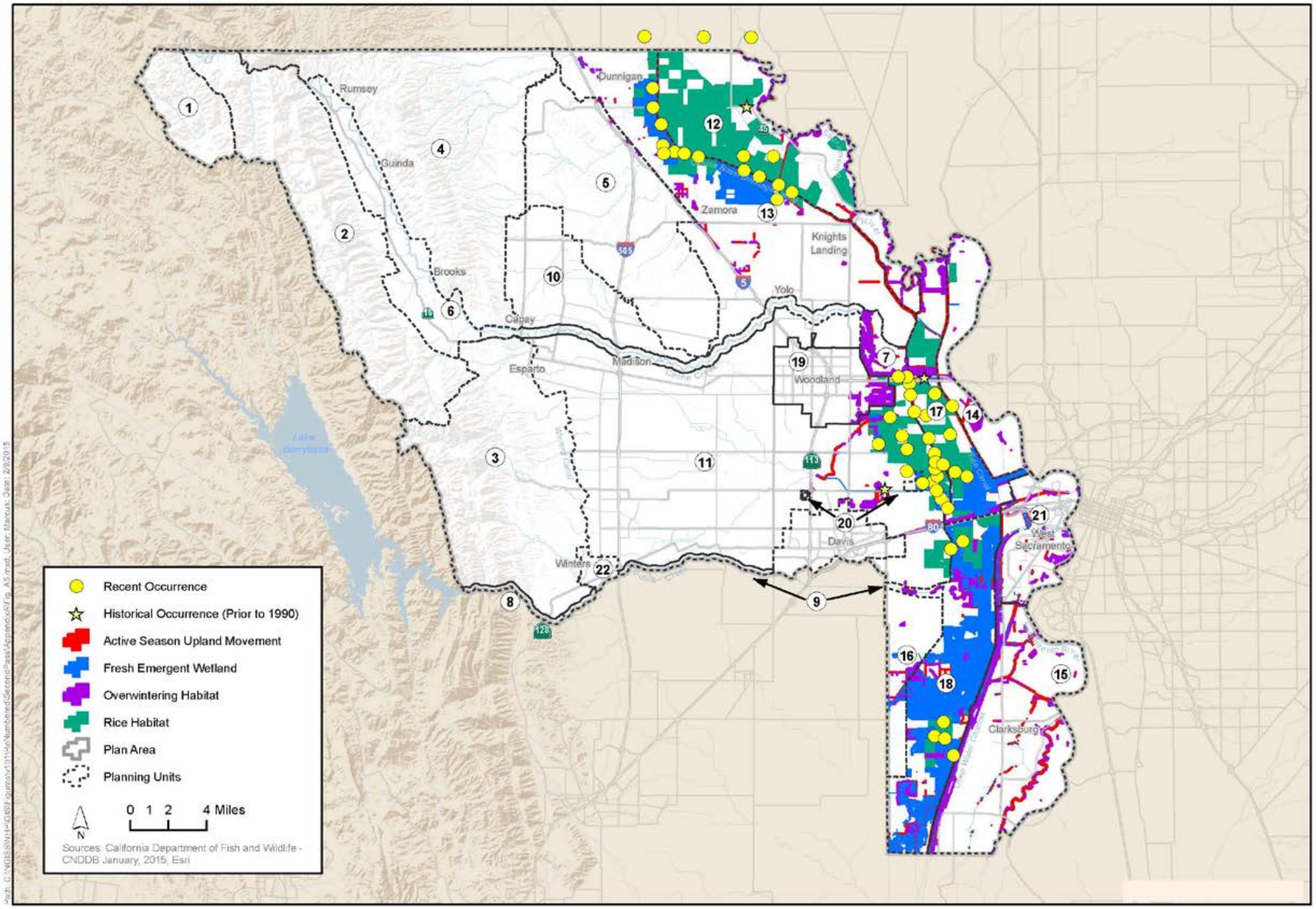
- **Yolo Basin Recovery Unit**. Minimum of five habitat block pairs with no less than one block pair per management unit in the Yolo Basin Recovery Unit (areas with high flooding flows within the Yolo Bypass should be considered as unsuitable habitat).
- **Colusa Basin Recovery Unit.** Minimum of six habitat block pairs with no less than two block pairs per management unit in the Colusa Basin Recovery Unit.

C.27.7 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.27.3, *Habitat Requirements and Ecology* (Figure C-18). 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 C-18). 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 C-18) 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-18. Giant Garter Snake Modeled Habitat and Occurrences



1.1.1 References

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C.28 Tricolored Blackbird (*Agelaius tricolor*)

© Ted Beedy

C.28.1 Listing Status

Federal: Under review for listing.

State: Threatened.

Recovery Plan: None; however, a conservation strategy for this species was prepared (Tricolored Blackbird Working Group 2007).

C.28.2 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 et al. 2018). 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 et al. 2018). 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 et al. 2018).

C.28.2.1 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 et al. 2018; 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.28.2.2 Reproduction

Tricolored blackbirds nest colonially, enabling them to synchronize their timing of nest building and egg laying (Beedy et al. 2018). 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 et al. 2018).

C.28.2.3 Home Range/Territory Size

In the 1930s, the largest tricolored blackbird breeding colony consisted of more than 300, 000 breeding birds; Neff (1937) estimated as many as 200,000 nests in a singl wetland colony. From 1935 to 1975, the average colony size declined significantly with the average colony size declining by more than 60% (California Department of Fish and Wildlife 2018). DeHaven et al. (1975) documented colonys of 20,000 – 30,000. Between 1994 and 2017, the size of the largest colony declined from more than 100,000 birds to less than 20,000 birds (California Department of Fish and Wildlife 2018). 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 et al. 2018). Fluctuations in colony site selection and colony size have been attributed to a reponse of the species to changes in local insect abundance within and across years (Orians 1961, Payne 1969, DeHaven et al. 1975).

C.28.2.4 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 late in the breeding seasin during the second nest attempts in the Sacramento Valley (Meese pers. comm. 2019). Tricolored blackbird 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 et al. 2018). 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 et al. 2018; Skorupa et al. 1980).

C.28.3 Habitat Requirements and Ecology

C.28.3.1 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 et al. 2018; 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 et al. 2018). 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 et al. 2018).

C.28.3.2 Foraging

Tricolored blackbirds typically forage in open areas or areas with low vegetation and in areas that provide abundant insects, including pastures, dry seasonal pools, agricultural fields such as alfalfa and rice, . 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, sunflower, and irrigated pastures as well as annual grasslands and shrublands (Beedy et al. 2018; Beedy 2008).

In recent years, an increasing percentage a of adult tricolored blackbirds 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 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 et al. 2018). 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 et al. 2018).

Some small breeding colonies may occur at private and public lakes, reservoirs, and parks provided that they are near suitable foraging habitats. Colonies may occur near urban development, but are only successful if adequate foraging habitat exists nearby.

C.28.4 Species Distribution and Population Trends

C.28.4.1 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 et al. 2018). 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.28.4.2 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 (Tricolored Blackbird Working Group 2009). 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) (Tricolored Blackbird Working Group 2009). Most of the large colonies observed by Neff were associated with freshwater emergent weltands in rice-growing areas of the Sacramento Valley. Several other colonies in Sacramento and Butte counties contained more than 100,000 nests (about 150,000 adults). In 1997, Beedy and Hamilton (1997) reported the largest colony contained approximately 80, 000 adults. Colonies of at leat 80,000 breeding birds continued through 2010 (Messe 2009, Meese 2010), however from 2008 to 2017, the maximum colony size decreased from 80,000 to fewer than 20,000 (Kelsey 2008, Kyle and Kelsey 2011, Meese 2017). By 2014, only three colonies consisted of 10,000 birds or more and only one colony consisted of more than 20,000 birds (Meese 2014). The proportion of birds observed in the ten largest colonies during the years 2000, 2011, 2014, and 2017 was 77% (306,000), 81% (208,800), 64% (93,000), and 55% (98,050) of the statewide population estimate for those years, respectively (California Department of Fish and Wildlife 2018). This reflects a downward trend in the size of the largest colonies.

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 2014 statewide survey for tricolored blackbirds, estimated tricolored statewide population dropped to 145,135 birds (Meese 2014), but in in the 2017 statewide population estimate went up to 177, 600 birds (Meese 2017). Christmas Bird Count data and eBird data have been also used to evaluate tricolored blackbird population changes in California; these data indicate a decline in tricolored blackbird populations (California Department of Fish and Wildlife 2018; Robinson et al. 2018; Meehan et al. 2019). The number of birds observed in 2017 represent a 55% decline in the population over the nine years since 2008 (California Department of Fish and Wildlife 2018).

C.28.4.3 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). In the mid 1990s, there were four tricolored blackbird colonies larger than 100,000 adults; three were in the rice-growing area in Colusa and Yolo counties and one was in Sacramento County (California Department of Fish and Wildlife 2018). Previous surveys revealed very few nesting colonies in Yolo County (Meese pers. comm. 2019). 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). The Yolo Bypass Wildlife Area has hosted small breeding colonies at three separate locations in wetlands and button willow shrubs (California Department of Fish and Wildlife 2018). Other 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. 2019). A total of 1,900 adults were observed at two colonies in the Yolo Bypass during the 2008 statewide survey (Kelsey 2008). The 2017 statewide survey documented three occupied sites in Yolo County with approximately 2,750 birds (Meese 2017). As of November 2019, breeding tricolored blackbird have been documented in 42 locations, including three previously undescribed sites, in Yolo County (Meese pers com. 2019).

Cccurrences of tricolored blackbird have been recorded in the RCIS Area. Over 300 individuals have been observed at the Woodland/Davis Water Treatment Plant in 2020 (eBird 2020). There have also been several more recorded observations throughout the RCIS Area in 2019. Sightings that have been recorded in 2020 include Conaway Ranch, County Road 102 drainage ponds, fields along County Road 103 and 104, Davis wetlands and water treatment plant, the Yolo Bypass Wildlife Area, and Willow Bank ditch (eBird 2020).

C.28.5 Threats to the Species

C.28.5.1 Habitat Loss and Degradation

The greatest threats to this species are the direct loss and degradation of habitat from human activities (Beedy et al. 2018). 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. Wetlands continue to be lost as lands are converted to agriculture, urban uses, or water availability limits the ability to maintain habitat through the breeding season. Widespread habitat loss due to urban expansion and agricultural conversions to vineyards and orchards has removed known breeding locations and caused the extirpation of breeding colonies from large regions of the state. Based on habitat preferences of tricolored blackbirds, the Natomas Basin supported about 1,998 acres of potential nesting habitat and 41,310 acres of potential foraging habitat (NBHCP 2003). A total of 449 acres (22%) of potential nesting habitat will be lost to urban development under the plan. A loss of 15,311 acres (37%) of potential foraging habitat will result from the planned development (California Department of Fish and Wildlife 2018).

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).[1] 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.28.5.2 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 et al. 2018; 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.28.5.3 Predation

Historical accounts documented the destruction of nesting colonies by a diversity of avian, mammalian, and reptilian predators (Beedy et al. 2018). 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.28.5.4 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 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

[1] http://www.nass.usda.gov/ca/.

sprayed by mosquito abatement oil failed to hatch (Beedy et al. 2018). Hosea (1986) attributed the loss of at least two colonies to aerial herbicide applications.

C.28.5.5 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 et al. 2018; 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 et al. 2018; 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.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.28.3, *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.28.6.1 Nesting Habitat – Vegetation Types

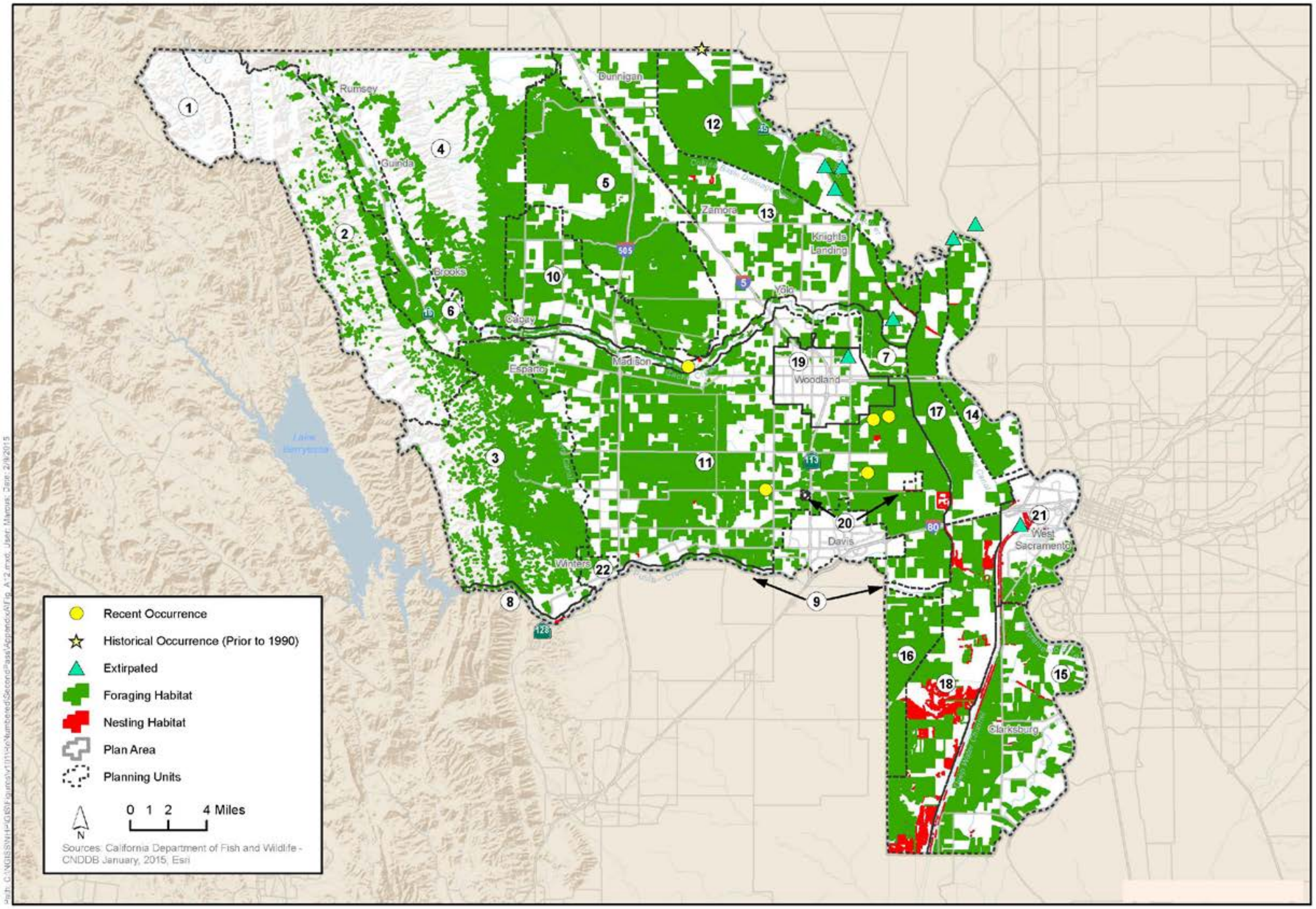
- Alkali Bulrush – Bulrush Brackish Marsh Not Formally Defined (NFD) Super Alliance

- Bullrush – Cattail Wetland Alliance
- Bulrush – Cattail Fresh Water Marsh NFD Super Alliance
- Blackberry NFD Super Alliance
- Undifferentiated Riparian Bramble and Other

C.28.6.2 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-28. Tricolored Blackbird Modeled Habitat and Occurrences



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C.29 Grasshopper Sparrow (*Ammodramus savannarum*)

© Peter

C.29.1 Listing Status

Federal: None

State: Species of Special Concern

Recovery Plan: None

C.29.2 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.29.2.1 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.29.2.2 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.29.2.3 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.29.2.4 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.29.3 Habitat Requirements and Ecology

C.29.3.1 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 (Shufford and Gardali 2008; Vickery 2020). Although they often occupy hillsides, they may also occur in flat terrain (Shufford and Gardali 2008; Zeiner et al. 1990). 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 (Zeiner et al. 1990). 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 (Zeiner et al. 1990; Shufford and Gardali 2008).

C.29.3.2 Foraging

Grasshopper sparrows primarily forage on the ground within or near their breeding territories (Vickery 1996).

C.29.4 Species Distribution and Population Trends

C.29.4.1 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 (Shufford and Gardali 2008; Zeiner et al. 1990). However, their statewide distribution is still best described as sparse and irregular.

C.29.4.2 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.29.4.3 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).

A recent occurrence (2015) has been recorded in the Plan Area on Tule Ranch (CNDDB 2019). Other recent occurrences on grasshopped sparrow include recorded sightings at the Yolo Bypass Wildlife Area (2017), Grasslands Regional Park (2018), along County Road 155 (2019), Putah Creek (2014), and Davis Wetlands (2014) (eBird 2019). There have also been several recorded sightings, some as recent as 2018, in various locations along County Road 105 near Dixon (eBird 2019).

C.29.5 Threats to the Species

The primary population threats to this species is loss of habitat from both agricultural intensification and urban development. Grasshopper sparrows avoid highly fragmented grasslands in California and elsewhere (Vickery 2020, 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 , 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.29.6 Species Habitat Model and Location Data

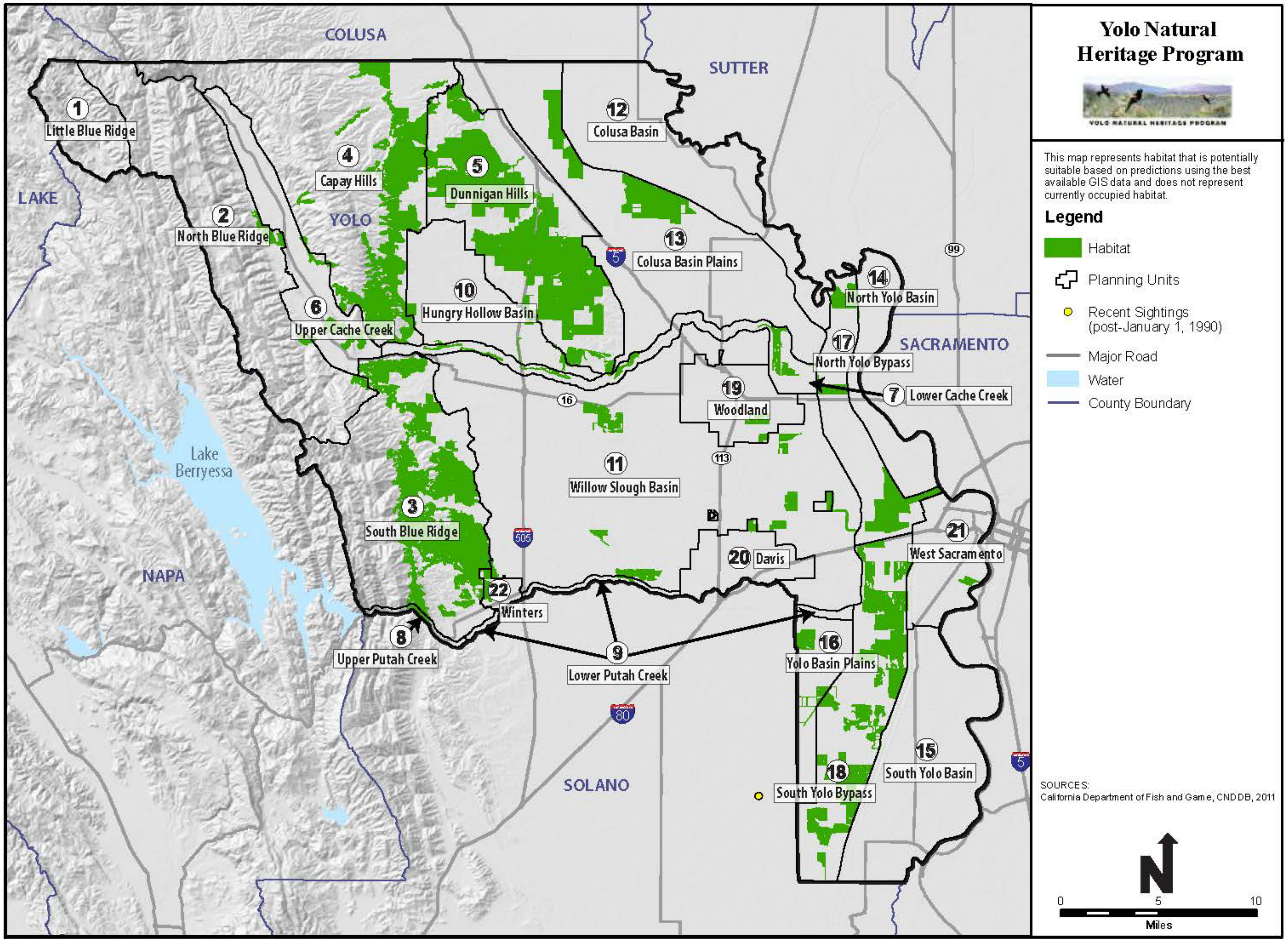
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section A.30.3, *Habitat Requirements and Ecology* (Figure A-30). The model parameters include the following.

- 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.29.6.1 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-19. Grasshopper Sparrow Modeled Habitat and Occurrences



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C.30 Western Burrowing Owl (*Athene cunicularia hypugaea*)

C.30.1 Listing Status

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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.30.2 Species Description and Life History

Western burrowing owls (*Athene cunicularia hypugaea*) inhabit much of the western United States, Florida, the Caribbean, and southern interior of western Canada (Poulin et al. 2011). They are unique among the North American owls in that they are active during the day and nest and roost in underground 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 (Poulin et al. 2011).

C.30.2.1 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 (Poulin et al. 2011). 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.30.2.2 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.30.2.3 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 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) (Plumpton and Lutz 1993b). 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.30.2.4 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.30.3 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 (Poulin et al. 2011). 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.30.3.1 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, dried livestock manure, feathers or other material (Poulin et al. 2011).

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 (Poulin et al. 2011).

C.30.3.2 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.30.4 Species Distribution and Population Trends

C.30.4.1 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 (Poulin et al. 2011).

Burrowing owls were once widespread and generally common over western North America, in treeless, well-drained grasslands, steppes, deserts, prairies, and agricultural lands (Poulin et al. 2011). 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 (CNDDB 2019). Other sites include some urban and semi-urban areas, particularly in and around the City of Davis, Vaughn Ranch, West Sacramento, north side of Willow Slough, and other scattered locations associated with edges of cultivated lands (CNDDB 2019).

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.

In 2019, there were two recorded sightings of burrowing owl located northeast of Davis along County Road 30B (eBird 2019).

C.30.4.2 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. One of the largest concentration of burrowing owls in California (estimated at 5,600 pairs) are in the Imperial Valley, an area that represents less than 2 percent of the state's landmass (DeSante et al. 2004). 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 A-1. 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, a 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] 2019). More recently, a small colony on the north side of Winters was displaced by grading activities in preparation of a new development project. Population estimates for Middle Central Valley in 2007 was 545 pairs, an 8% decline compared to

1993 (Wilkerson and Siegel 2010). A 2014 burrowing owl census showed that, since 2007, there has been a 76% decline in burrowing owl numbers, with only two pairs detected within City of Davis limits (Davis Enterprise 2015). In 2014, Yolo County burrowing owl pairs declined from 62 to 14 (77% decline) compared to 2007 (Burrowing Owl Consortium 2015).

In 2015, only 15 pairs of owls were documented in Yolo County and the only know documented breeding pair in the City of Davis was in East Davis, in a vacant lot, however, since then, the lot has been developed into a Marriott Inn (Davis Enterprise 2015; Davis Enterprise 2017). Formerly 30 or more pairs of owls near the Wildhorse Golf Course in the City of Davis; in 2014, only three pairs remain. As of 2015, there is only one pair at Wildhorse Golf Course and it hasn't bred (UC Davis - Friends of Burrowing Owl YEAR). Only three pairs of owls remain in City of Davis as of 2016. (Burrowing Owl Prervation Society, 2016). No burrowing owls are known to use the Yolo County Grassland Park mitigation cite (Burrowing Owl Consortium 2015).

Habitat restoration efforts by the California Department of Fish and Wildlife (DFW) at the Yolo Bypass Wildlife Area may 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.30.5 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 construction, shooting, and burrow destruction adversely affect this species (Zarn 1974; Poulin et al. 2011). 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.

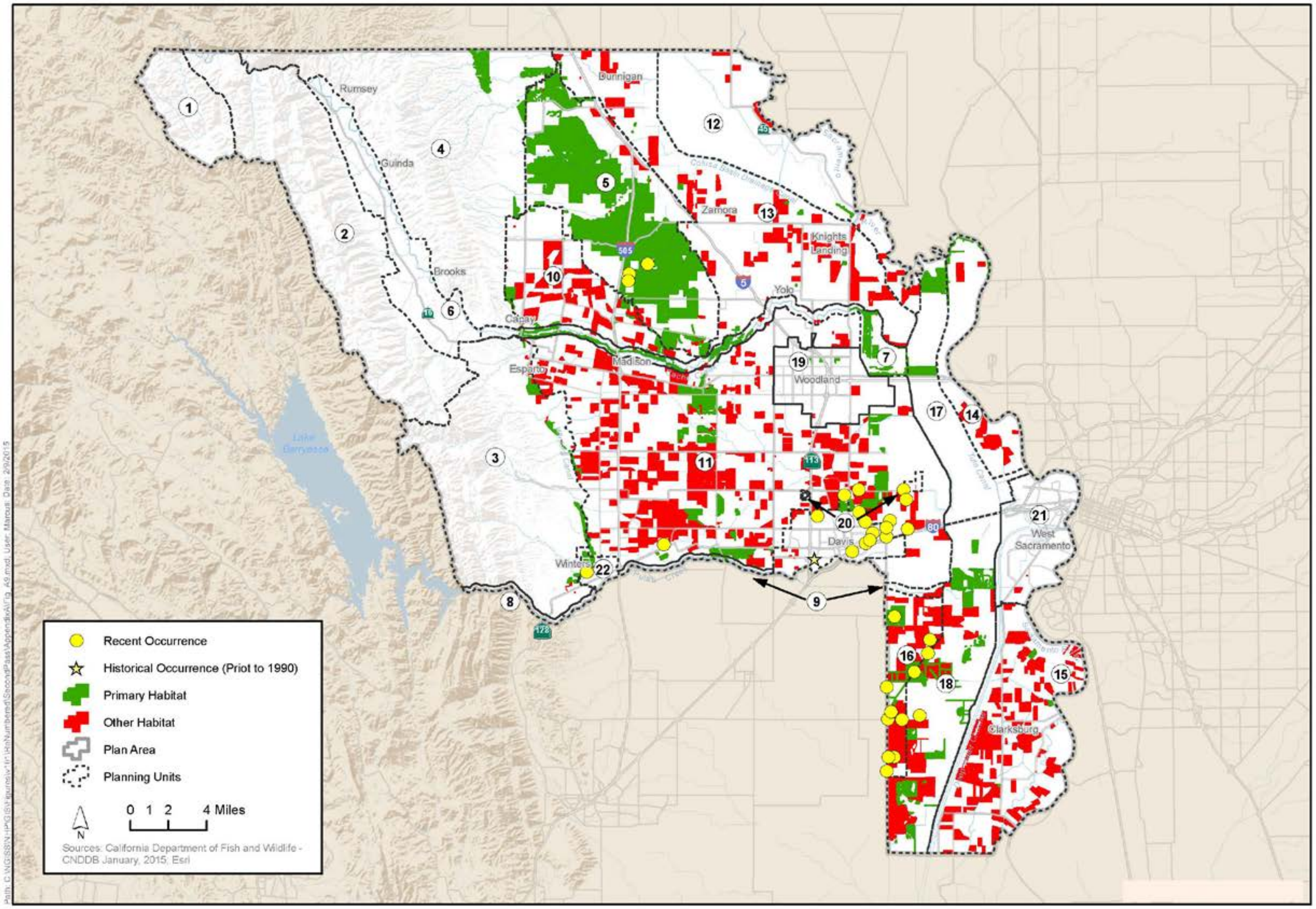
C.30.6 Species Habitat Model and Location Data

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 C-20). 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.

Figure C-20. Western Burrowing Modeled Habitat and Occurrences



C.30.6.1 Primary Habitat – Vegetation Types

- California Annual Grasslands Alliance
- Upland Annual Grasslands and Forbs Formation
- Barren – Anthropogenic
- Native Pasture

C.30.6.2 Other Habitat – Vegetation Types

- Mixed Pasture
- Miscellaneous Grasses (grown for seed)
- Alfalfa

C.30.7 References

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C.31 Swainson's Hawk (*Buteo swainsoni*)

C.31.1 Listing Status

Federal: Bird of Conservation Concern (U.S. Fish and Wildlife Service [USFWS] 2008).

State: Threatened.

Recovery Plan: None.

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C.31.2 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 main plumage morphological types: light, rufous, and dark (Woodbridge 1985). 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 plumage morphologies 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.

Historically, Swainson's hawk was a species adapted to open grasslands and prairies, but the species has become increasingly dependent on agriculture as native plant communities have veen converted to agricultural lands (California Department of Fish and Wildlife 2016). The hawks also forage in managed wetlands during the summer months when vegetation is being mowed or disced (California Department of Fish and Game 2016).

C.31.2.1 Seasonal Patterns

Swainson's hawks arrive on their breeding grounds in the Central Valley from early March to early April (Bechard et al. 2020). 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. The species winter range occurs in isolated areas of California, Mexico and Central America, through South America and as far south as Argentina (Bechard et al. 2020, Kochert et al. 2011). Central Valley Swainson's hawks winter from Central Mexico, to northern and central South America (California Department of Fish and Wildlife 2016). 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). Swainson's hawk are generally found in wintering areas from early November through mid-March (Kochert et al. 2011).

C.31.2.2 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, Bechard et al. 2020). Pairs are generally 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 (Bechard et al. 2020). 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 2008). The rate of young fledged per nest in the Central Valley is among the lowest recorded in the entire species range. In Yolo County, fledging rates ranged from 1.15 to 1.96 young per successful nest from 1988 to 2000 (Table 1) (Estep 2008).

After fledging, young remain near the nest and are dependent on the adults for about four weeks (Estep 1989), after which they permanently leave the breeding territory (Anderson et al. in progress). In the Central Valley, most young fledge during the first part of July (Bradbury pers. comm. 2012, as cited in California Department of Fish and Game 2016).

C.31.2.3 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, Bechard et al. 2010). In the Central Valley, home range size varies from 2760 to 4038 ha (California Department of Fish and Game 2016). 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.31.2.4 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.31.3 Habitat Requirements and Ecology

C.31.3.1 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). Nest sites are generally adjacent to, or within flying distance to sutiable foraging habitat and near large tracts of agricultural lands (California Department of Fish and Game 2016). 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.), however any suitable tree may be used (Estep 1989, England et al. 1995, Bechard et al. 2020). Nests occur at the periphery of and in riparian woodlands, in roadside trees, trees along field borders, isolated trees, small groves, and on the edges of remnant oak woodlands. Nest trees are located adjacent to suitable foraging habitat. 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 C-1 and C-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-1. 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-2. 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.31.3.2 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 and relatively sparse shrublands 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 (California Department of Fish and Game 2016).

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 irrigated hay crops, grain and row crops, fallow fields, dryland pasture, grassy ruderal lots, and annual grasslands (Swologaard et al. 2008, Anderson et al. 2011). Alfalfa fields are more routinely used by foraging Swainson's hawk than any other crop type (Swologaard et al. 2008, Anderson et al. 2011). 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, mature orchards, cotton fields, and vineyards, provide little to no value because of reduced accessibility and relatively low prey populations (California Department of Fish and Game 2016).

C.31.4 Species Distribution and Population Trends

C.31.4.1 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 (Airola et al. 2019).

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 (California Department of Fish and Game 2016).

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 and east of Woodland along Farmer's Road; 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 (Esteep 2009b; eBird 2020).

C.31.4.2 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 2006 statewide population estimate for California was 2,081 breeding pairs (Anderson et al. 2006) and was 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). Gifford et al. (2012) conducted surveys of nesting Swainson's hawk in a portion of the Central Valley (Butte to San Joaquin counties) between 2002 and 2009; 593 breeding pairs were estimated in 2002; in 2003 the estimate was 1,008 breeding pairs; and in 2009 the estimate was 941 breeding pairs (Gifford et al. 2012).

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 C-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-3. Swainson's Hawk Activity Data: Yolo County Study Area 1988–2000[a]

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

[a] From Estep, J. A. In preparation. Ecology of the Swainson's Hawk in the Central Valley of California.

C.31.5 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 (California Department of Fish and Game 2016; England et al. 1997; England et al. 1995). Loss of lone trees along roadsides to road maintenance and implementation of levee vegetation removal policies also affect the availability of suitable nesting habitat (California Department of Fish and Game 2016). 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. 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). Application of rodenticide, specially targeting ground squirrels, may also impact Swainson's hawk and result in secondary poisoning (California Department of Fish and Game 2016).

Climate change adds uncertainty to existing suitable breeding and foraging habitats and to hawk populations (California Department of Fish and Game 2016). Changes in climate pattersn will likely affect the availalbity of water in the summer and may change the prevalence of high-quality foraging habitat (i.e., alfalfa). Long-term changes in precipitation may affect prey abundance and consequently affect breeding success and survival (California Department of Fish and Game 2016).

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). 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.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 A.6.3, *Habitat Requirements and Ecology* (Figure C-21). 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. 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

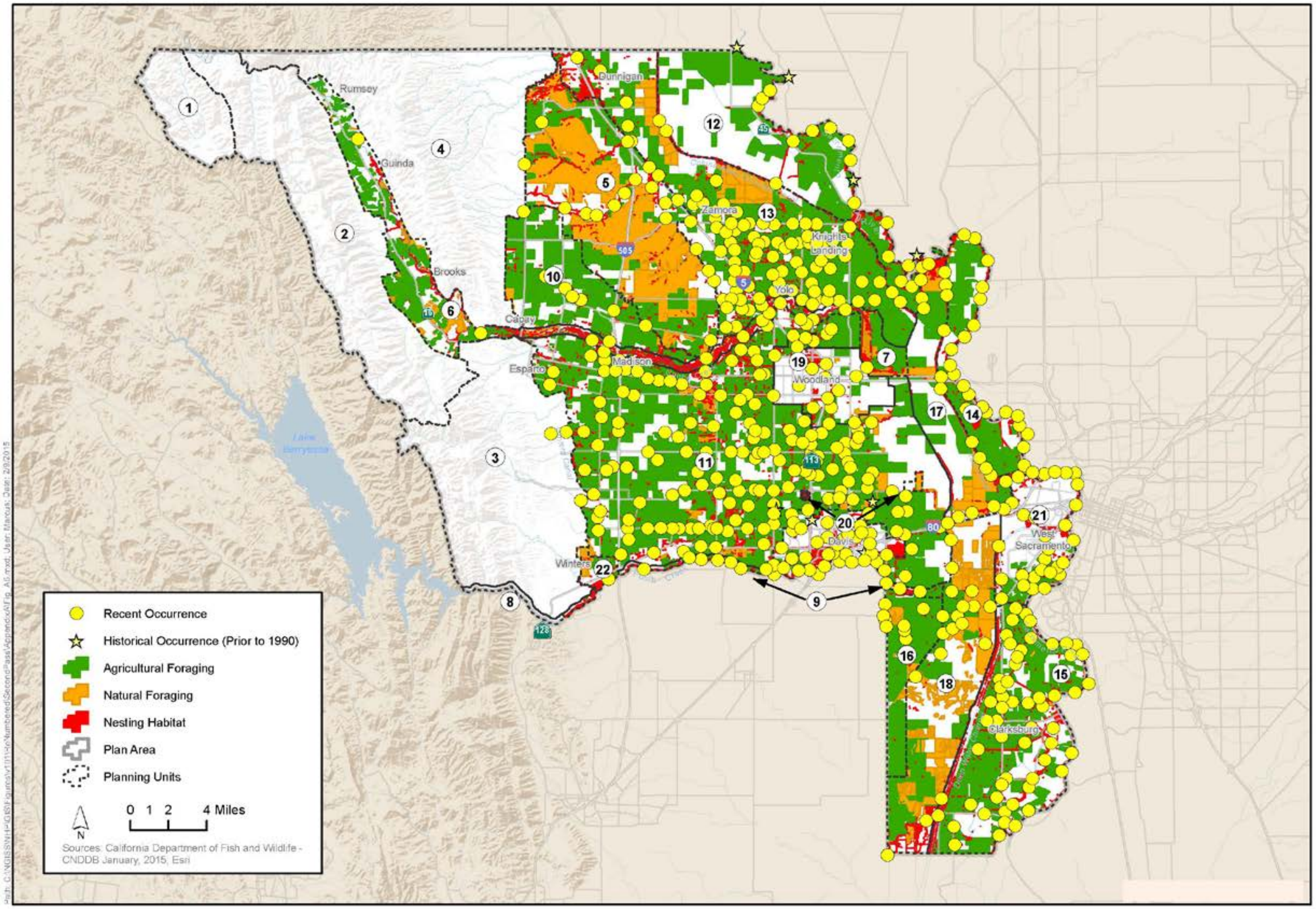
- Natural Foraging Habitat: This modeled habitat type includes the uncultivated grassland and seasonal wetland land cover types listed below that occur at an elevation of 500 feet or lower. These land cover types generally produce less available microtine prey due to dryer conditions or periodic inundation. 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.31.6.1 Cumulative Nest Locations and Sightings

Figure C-21 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-21. Swainson's Hawk Modeled Habitat and Occurrences



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C.32 Greater Sandhill Crane (*Grus canadensis tabida*)

C.32.1 Listing Status

Federal: No listing

State: Threatened

C.32.2 Species Description and Life History

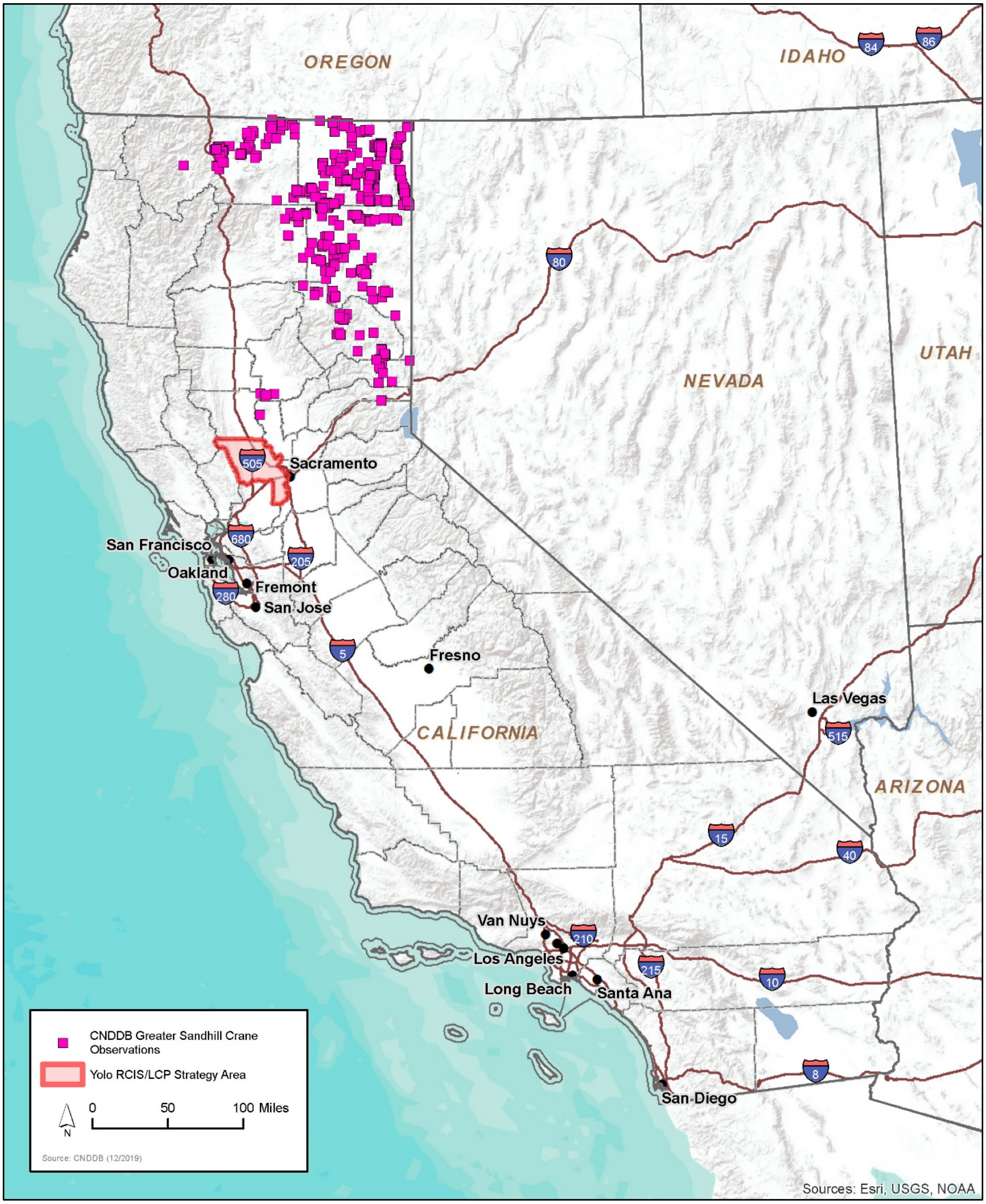
The greater sandhill crane is one of six subspecies of sandhill crane in North America; three of which are nonmigratory and occupy ranges in the southeastern United States and Cuba (Littlefield and Ivey 2000). The remaining three are migratory and include the lesser and greater subspecies, both of which 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 C.22-1), 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.

Figure C-22.1. Greater Sandhill Crane Statewide Distribution



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.32.3 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 a key habitat requirement for cranes and the quality of the roost site can influence individual fitness (Pearse et al. 2017). Additionally, flying long distances between roosting and foraging sites can be energeticially expensive for cranes, thus roost sites situated close to foraging sites would signify energy savings (Anteau et al. 2011, Chudzińska et al. 2015). Pearse et al. (2017) showed roosting sandhill cranes generally preferred wider channels with shorter bank vegetation situated farther from human disturbance. Pearse et al. (2107) also found the amount of foraging habitat (e.g. cornfields) surrounding a roost site positively influenced the use of narrow channels and channels with shorter bank vegetation. 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.32.4 Species Distribution and Population Trends

C.32.4.1 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[1], although all known roosting colonies are east and south of Yolo County. Most all of the recent recorded sightings of sandhill crane have been located east of Davis and Woodland between the Woodlands/David Water Treatment Plant and Mace Blvd. (eBird 2019). As shown in Figure C-22-2, modeled foraging habitat occurs in the panhandle area around Clarksburg.

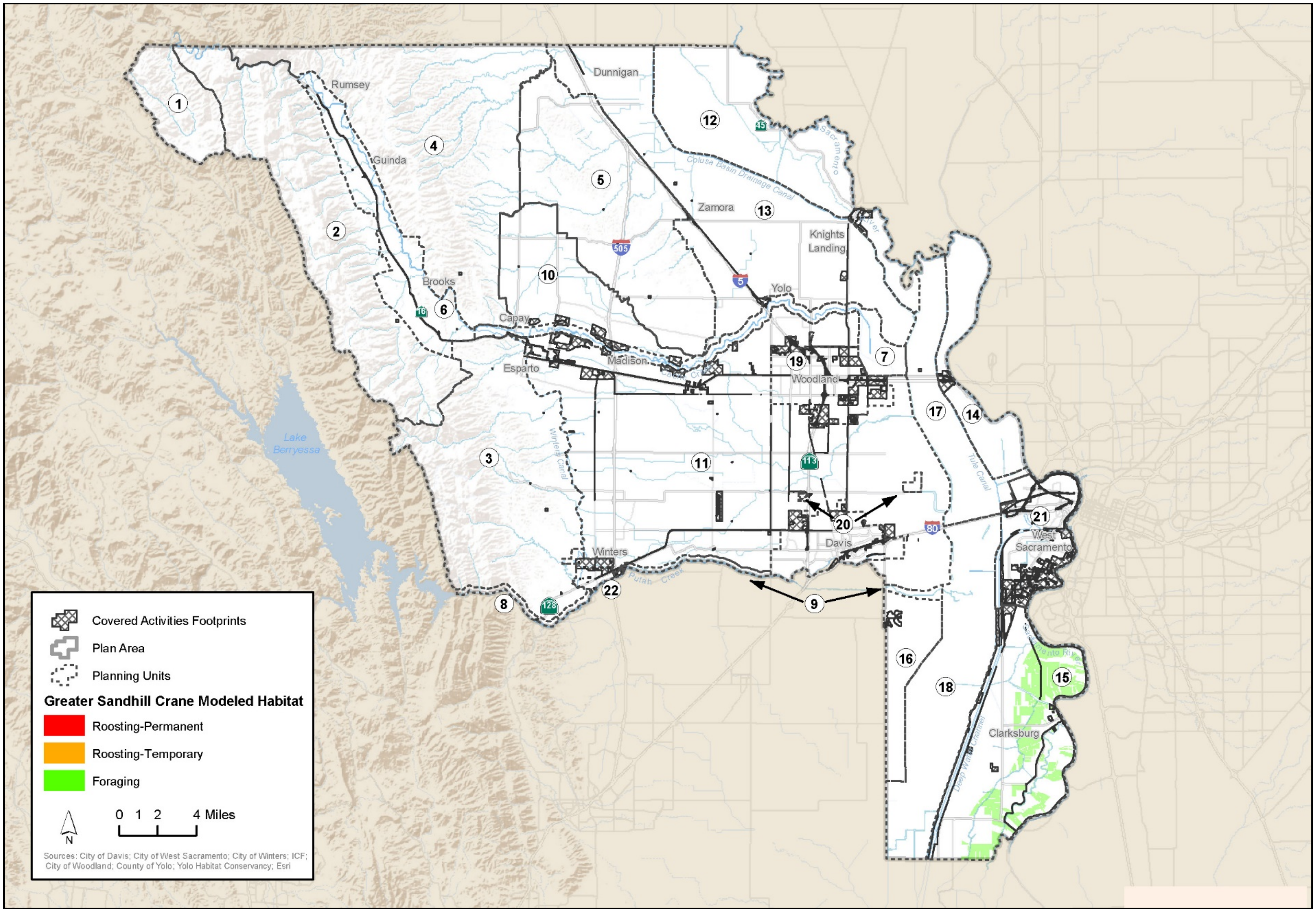
C.32.4.2 Population Trends

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

[1] https://www.inaturalist.org/check_lists/6853-Yolo-Bypass-Wildlife-Area-Check-List

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 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.

Figure C-22.2. Greater Sandhill Crane Habitat Model



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.32.5 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.32.6 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.32.7 Species Model and Location Data

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.32.8 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 et al. 2016) is based on the greater sandhill crane range in the Plan Area.

The permanent and temporary roosting and foraging model types (Ivey et al. 2016) 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 multiflorum–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
    - *Distichlis 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

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C.33 Northern Harrier (*Circus cyaneus*)

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C.33.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.33.2 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.33.2.1 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.33.2.2 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.33.2.3 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.33.2.4 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.33.3 Habitat Requirements and Ecology

C.33.3.1 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.33.3.2 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.33.4 Species Distribution and Population Trends

C.33.4.1 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. California Natural Diversity Database (CNDDB) includes a single nesting occurrence (2015) of this species, located in a wheat field north of County Road 29, north of Davis (CNDDB 2019). Nests have also 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 identified in eBird (2019) occur in the managed wetlands and pasturelands of the Yolo Basin south of Interstate 5 east of Woodlands extending south to Davis, including the Conaway Ranch, Yolo Bypass Wildlife Area, and other private lands south to the southern end of the panhandle (eBird 2019). 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.33.4.2 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.33.5 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).

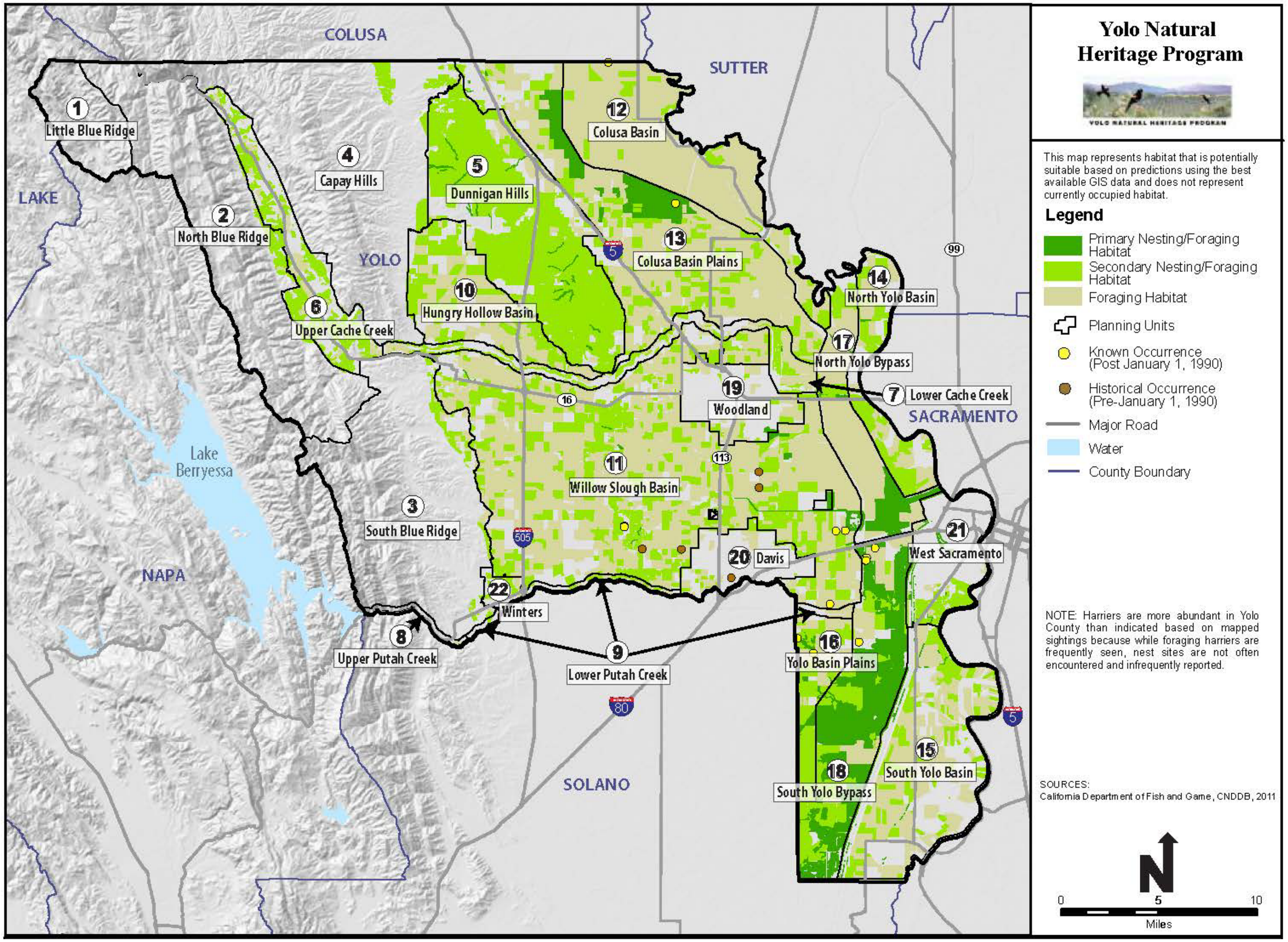
Furthermore, wetland preservation for waterfowl and habitat management practices for upland game birds are beneficial to the overall conservation of the species. Habitat management recommendations for the northern harrier include the acquisition and protection of undisturbed habitat in which early successional 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.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.32.3, *Habitat Requirements and Ecology* (Figure C-22). 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-22. Northern Harrier Modeled 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. 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 (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.
  - Field Crops
  - Rice
  - Pasture (alfalfa)
  - Truck and Berry Crops

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C.34 Black Tern (*Chlidonias niger*)

C.34.1 Listing Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.34.2 Species Description and Life History

Black terns (*Chlidonias niger*) is a long-distance migrant, and the winter range is mostly marine off the coasts of central and south America (Heath et al. 2009). The species does not typically winter in the United States but does breed in California, concentrated in zone of highly productive wetlands (Heath et al. 2009). During the breeding season, black terns are primarily black and gray with white undertail coverts.

C.34.2.1 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 (Heath et al. 2009).

C.34.2.2 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.34.2.3 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). The home range of black tern is unknown, but nesting birds have been documented traveling up to 4 km to forage (Mosher 1986).

C.34.2.4 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 freshwater fish and insects when available (Heath et al. 2009). 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.34.3 Habitat Requirements and Ecology

C.34.3.1 Nesting

In California, black terns are restricted to flooded rice fields and freshwater marshes with emergent vegetation, 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; Heath et al. 2009). 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). Nesting habitat suitability appears to be determined at the landscape level (i.e. wetland complex) rather than at the local vegetation condition within wetlands, and black terns prefer wetlands located in high-density wetland landscapes (Naugle et al. 1999, Niemuth and Solberg 2003). At the nest-site level, nests are located in areas of still freshwater with tall sparse vegetation or short dense vegetation (Naugle et al. 2000). Vegetation structure appears more important than plant species in the nest-site selection process (Heath et al. 2009). Floating, dead vegetation is abundant at most nest sites and water depth at nests is typically 0.5-1.2 meter but can be less (Heath et al. 2009).

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.

Black terns are believed to exhibit low nest site fidelity, which may be related to year-to-year habitat suitability variation resulting from changes in water level, vegetation density, and nest substrate availability (Heath et al. 2009).

C.34.3.2 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 (Welham and Ydenberg 1993). They may catch large insects in midair, especially dragonflies (Heath et al. 2009). During migration at inland sites, black tern may concentrate on swarming insects (e.g., caddisflies and flying ants). In marine areas, the diet mainly consists of small fish, but can also include plankton, and insects hawked near shore (Heath et al. 2009). Breeding birds may travel up to 4 km to forage (Mosher 1986).

C.34.4 Species Distribution and Population Trends

C.34.4.1 Distribution

Black terns breed throughout much of northern 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. Breeding is sparse and uncommon in the northeast and along the southern edge of the breeding range (Heath et al. 2009).

The summer nonbreeding range mainly includes marine and marine coastal areas from the Gulf Coast through Central America to northern South America. There are scattered occurrence records of black tern inland (Heath et al. 2009). They winter primarily in the nearshore of the Pacific Ocean and the Caribbean Sea off the coasts of Mexico, Central America, and South America, with scattered records inland (Heath et al. 2009).

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; CNDDB 2019). There have been recent recorded sightings of black terns in eastern Yolo County, east of Woodland at the Woodland/Davis Water Treatment Plant as well as the Davis Water Treatment Plant (eBird 2020). 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.

C.34.4.2 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 1966–1996, with most decline evident prior to 1980 (Heath et al. 2009), however, these data are inadequate to provide a trend assessment for California (Sauer et al. 2005; Shuford 2008).

C.34.5 Threats to the Species

Loss of wetlands on breeding grounds and migration routes is likely a major cause of decline in this species, but food supplies may have been reduced through agricultural control of insects and overfishing in the marine winter range. The management of wetlands can also modify emergent vegetation levels and thus affect breeding habitat suitability (Heath et al. 2009). 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, chick and adult survival rates, factors limiting nest success, effects of pesticides as well as diet and foraging ecology (Heath et al. 2009). Many large rice land areas in the Central Valley appear to be unoccupied, but apparently represent suitable habitat for black terns. Knowledge of migration and wintering biology, including stop-over times and locations, and data on food sources and availability is also needed (Heath et al. 2009).

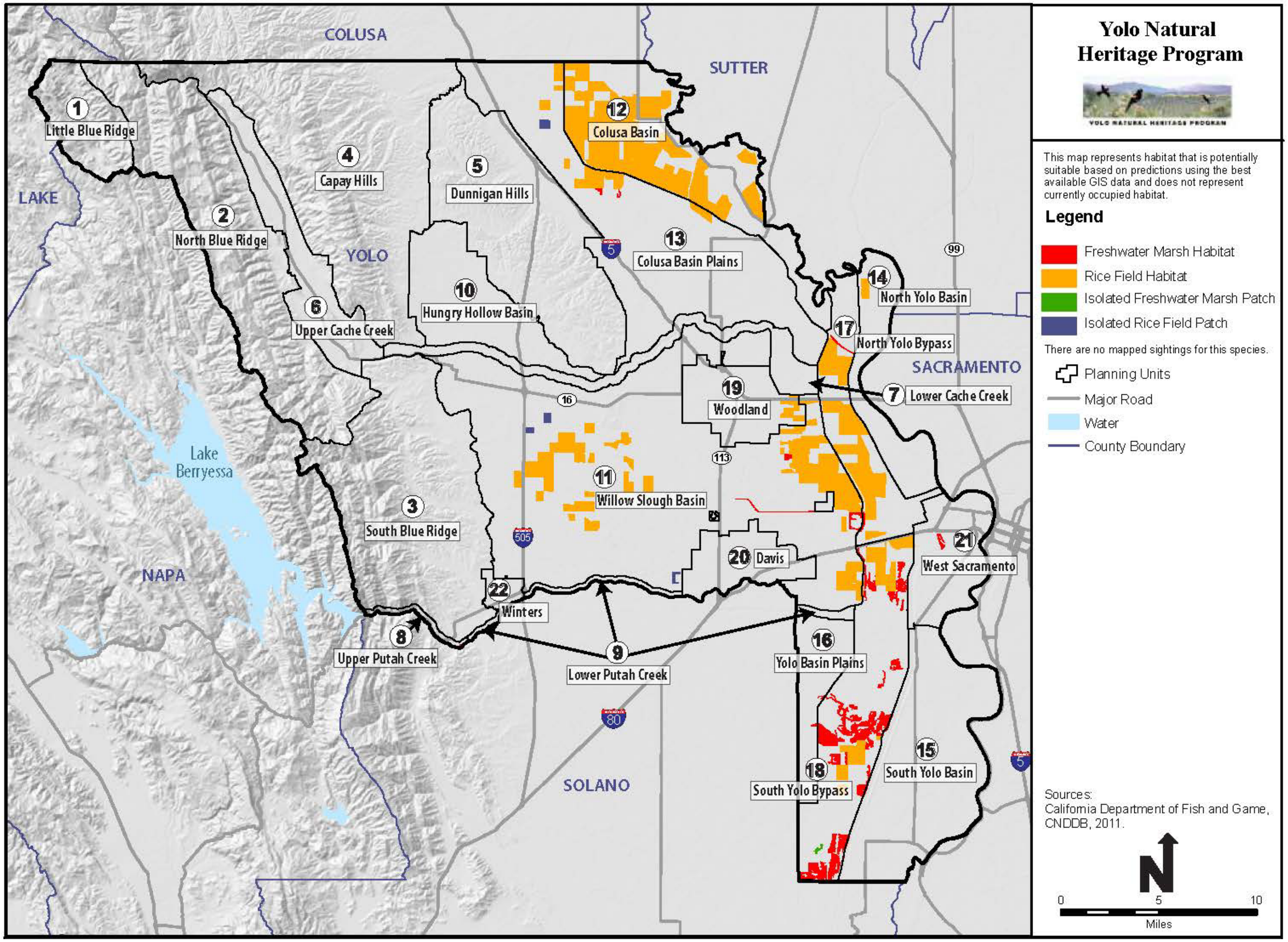
C.34.6 Species Habitat Model and Location Data

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.34.3, *Habitat Requirements and Ecology* (Figure C-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

Figure C-23. Black Tern Modeled Habitat and Occurrences



- 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.

C.34.6.1 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.34.6.2 Rice Habitat/Isolated Rice Patch – Vegetation Types

- Rice

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C.35 Western Yellow-Billed Cuckoo (*Coccyzus americanus*)

C.35.1 Listing Status


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Federal: Threatened.

State: Endangered.

Recovery Plan: None.

C.35.2 Species Description and Life History

C.35.2.1 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.35.2.2 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.35.2.3 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.35.2.4 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.35.2.5 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.35.3 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.35.4 Species Distribution and Population Trends

C.35.4.1 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.35.4.2 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).

C.35.4.3 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

- Putah Creek 2013 (CNDDB 2019)

These records were reported in Gaines (1974), Yolo Audubon Society Checklist Committee (2004), Yolo Audubon Society (2005), and by Steve Hampton.[1] 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.

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.

More recent western yellow-billed cuckoo surveys along the Feather and Sacrament rivers were conducted in 2010, 2012 and 2013 (Dettling et al. 2015). During these surveys there were no detections along the Feather River, and along the Sacramento River, yellow-billed cuckoos were detected on 8 occasions in 2012 and 10 occasions in 2013. Each year there was one detection in restored riparian forest as well as one detection in narrow remnant riparian forest with adjacent restored forest. These results seem to indicate that there has not been any increase in the population. In 2018 there was a recorded observation of a single individual at the Freemont Weir Wildlife Area (eBird 2019).

C.35.5 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.

[1] http://www.geocities.com/rainforest/canopy/6181/yolo.html.

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 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.35.6 Species Habitat Model and Location Data

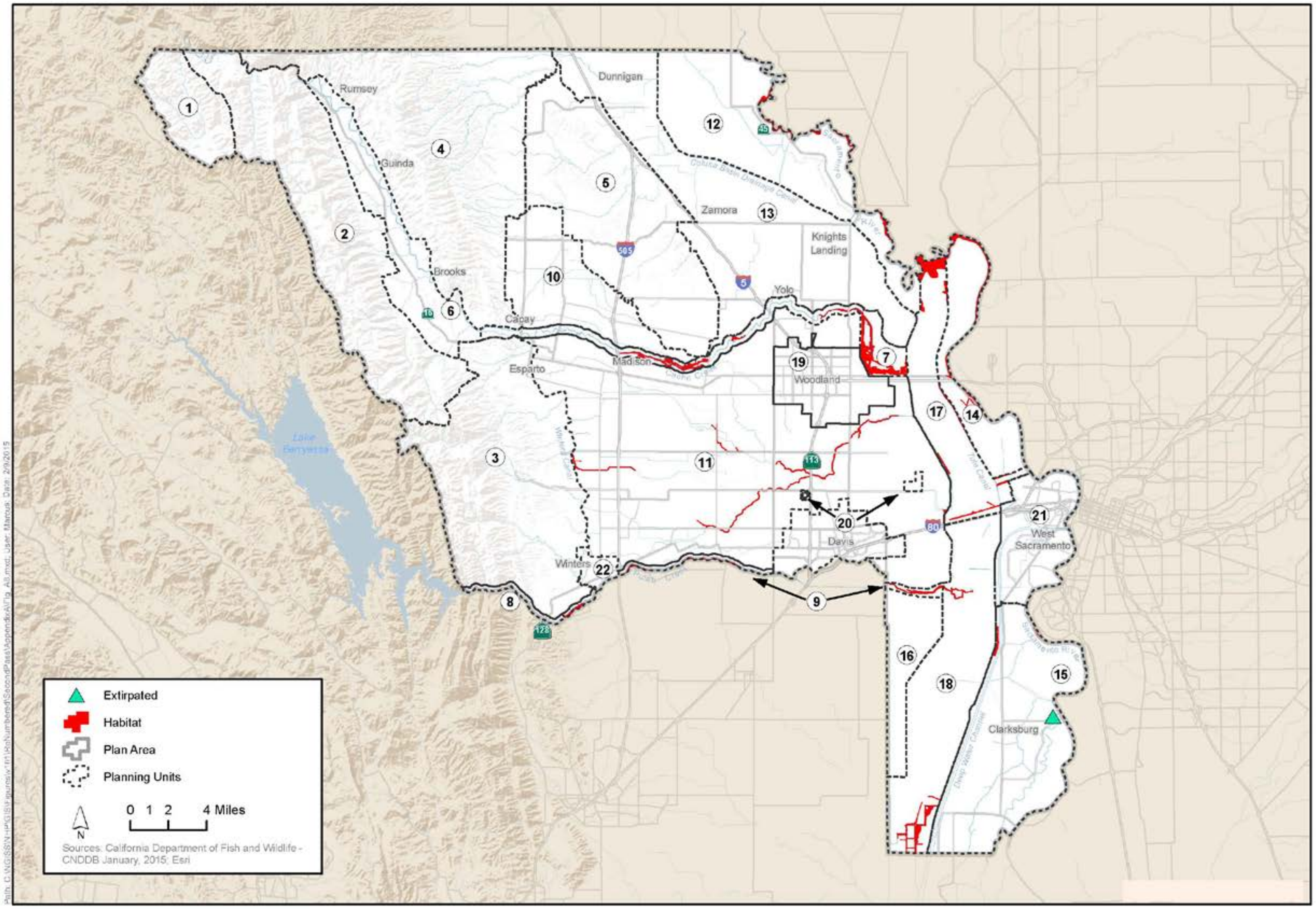
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.35.3, *Habitat Requirements and Ecology* (Figure C-23). The model parameters include the following.

- 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.35.6.1 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-23. Western Yellow-Billed Cuckoo Modeled Habitat and Occurrences



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C.36 White-Tailed Kite (*Elanus leucurus*)

C.36.1 Listing Status

Federal: None.

State: Fully Protected.

Recovery Plan: None.

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C.36.2 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.36.2.1 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.36.2.2 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.36.2.3 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.36.2.4 Foraging Behavior and Diet

White- tailed kites can hunt from a central perch over areas as large as 3 square kilometers (km^2) (Warner and Rudd 1975), however, this species often hunts on the wing and can be seen in hovering while active foraging. 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.36.2.5 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.36.3 Habitat Requirements and Ecology

C.36.3.1 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.36.3.2 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.36.4 Species Distribution and Population Trends

C.36.4.1 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).

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 2019) with only seven nest sites reported, six in the vicinity of Davis and one recent (2017) nesting site located in West Sacramento. There are a number of recorded sightings in eastern Yolo County in the between Woodlands and Davis (eBird 2019)..

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.

C.36.4.2 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.36.5 Threats to the Species

C.36.5.1 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.36.5.2 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.

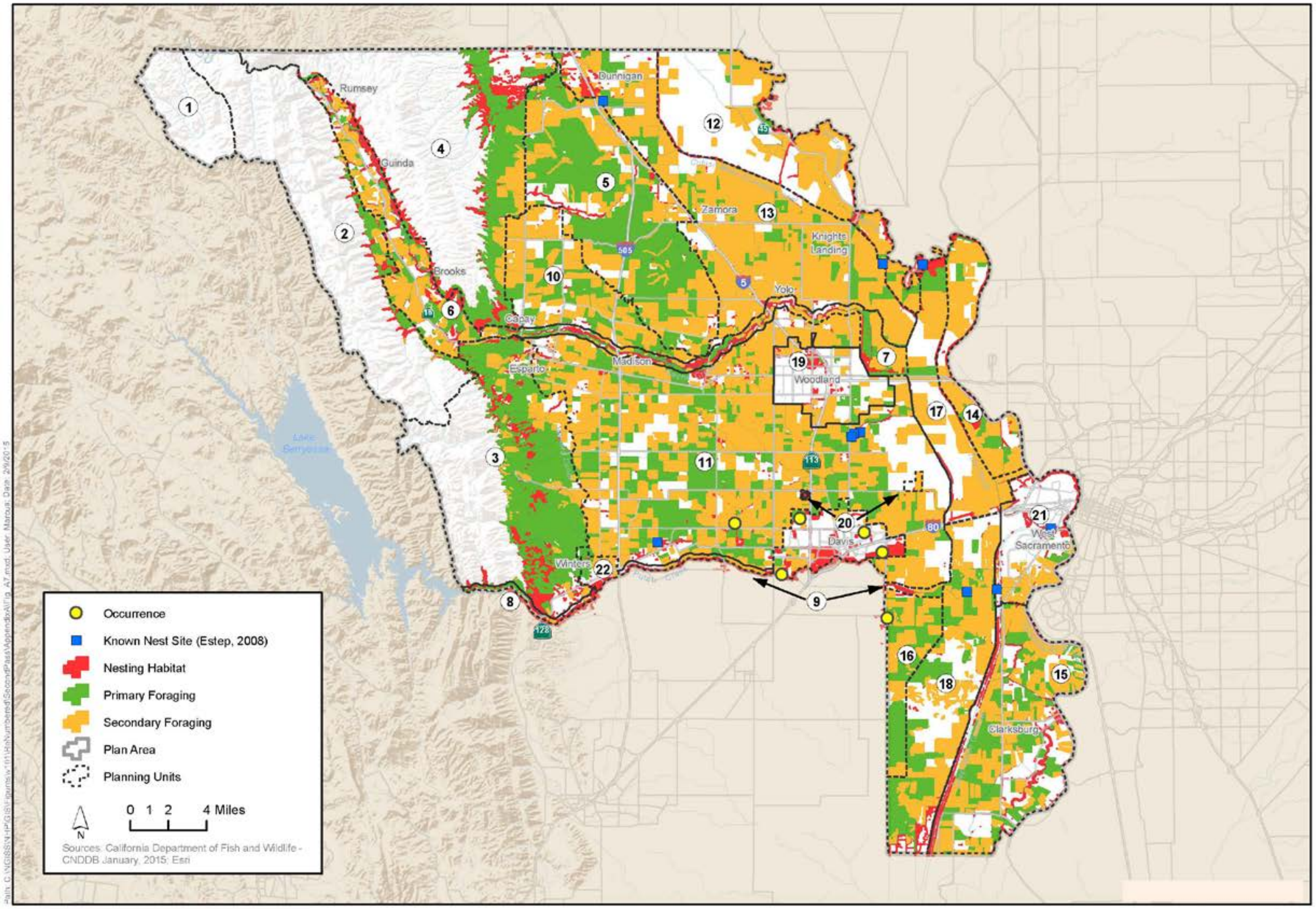
C.36.6 Species Habitat Model and Location Data

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.36.3, *Habitat Requirements and Ecology* (Figure C-24). 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)[1] 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.

[1] GIS layer prepared by J. Tuil in 2008 for Yolo County NHP.

Figure C-24. White-Tailed Kite Modeled Habitat and Occurrences



C.36.6.1 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

C.36.6.2 Primary Foraging Habitat – Vegetation Types

- All pasture types (including alfalfa)
- Annual grassland

C.36.6.3 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.37 California Black Rail (*Laterallus jamaicensis coturniculus*)

C.37.1 Listing Status

Federal: No listing

State: Threatened

C.37.2 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.37.3 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.37.4 Species Distribution and Population Trends

C.37.4.1 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). The California Natural Diversity Database (CNDDB) lists a recent (2017) occurrence in West Sacramento located in a pond between the Sacramento Deep Water Ship Channel and Southport Parkway.

C.37.4.2 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.37.5 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.37.6 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.37.7 Species Model and Location Data

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.37.8 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*

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C.38 Loggerhead Shrike (*Lanius ludovicianus*)

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C.38.1 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.38.2 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.38.2.1 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.38.2.2 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.38.2.3 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.38.2.4 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.38.3 Habitat Requirements and Ecology

C.38.3.1 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) (2019) 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.38.3.2 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.38.4 Species Distribution and Population Trends

C.38.4.1 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).

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. Loggerhead shrikes are considered fairly common in the lowland and foothill areas of the County, with recorded sightings throughout the County (eBird 2019). 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.38.4.2 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), . 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 2019). 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.38.5 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.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.38.3, *Habitat Requirements and Ecology* (Figure C-25). 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)[1] 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.

Nesting/Perching Habitat – Vegetation Types

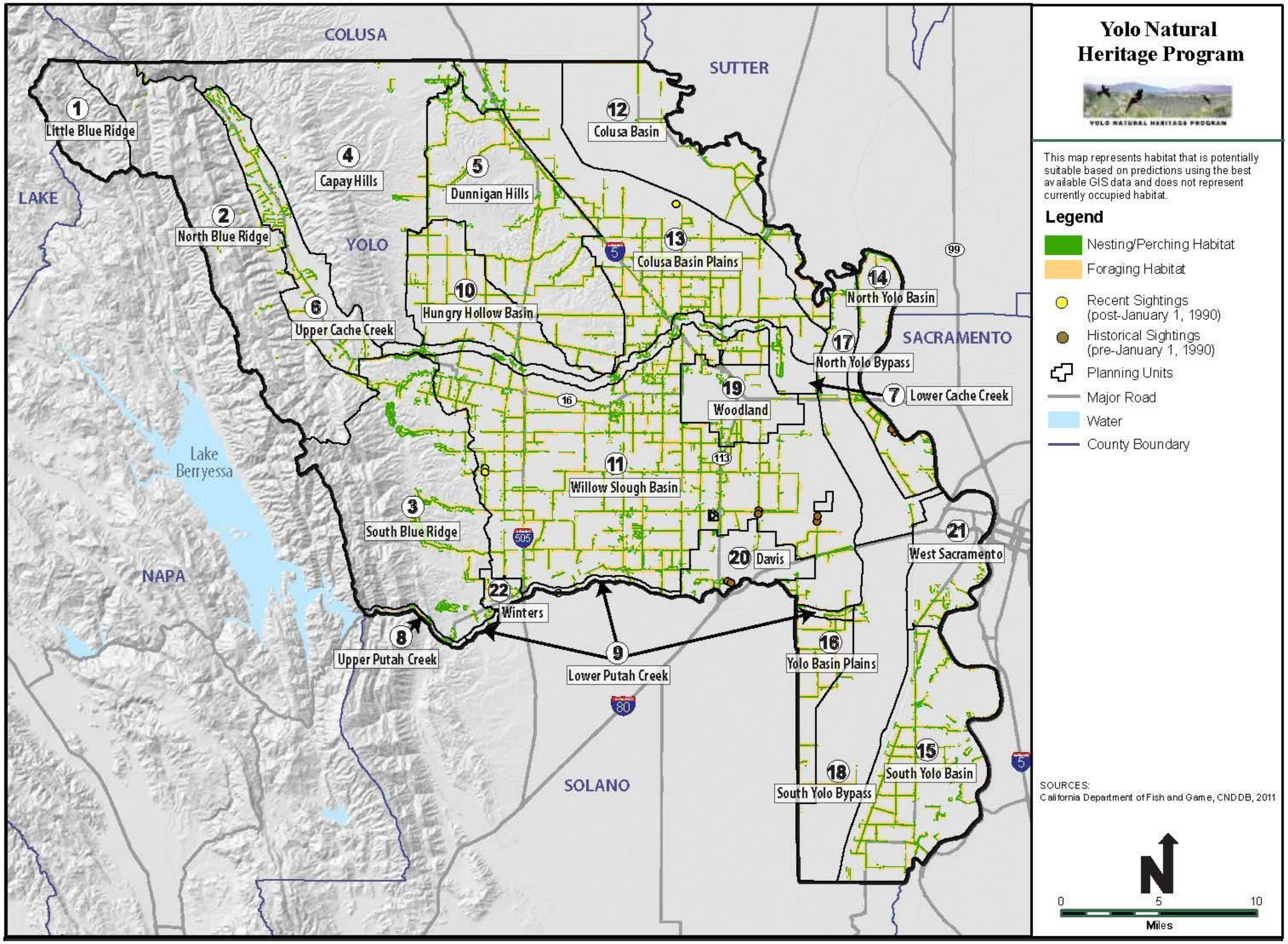
- All Blue Oak – Foothill Pine
- All Chamise Alliance
- All Closed-Cone Pine-Cypress
- Eucalyptus
- Juniper
- All Mixed Chaparral
- All Montane Hardwood
- All Serpentine
- Valley Oak Woodland
- Valley Foothill Riparian

Foraging– Vegetation Types

- All Annual Grassland
- All Pasture
- All Field Crops
- All Truck/Nursery/Berry Crops
- Grain/Hay Crops

[1] GIS layer prepared by J. Tuil in 2008 for Yolo County NHP.

Figure C-25. Loggerhead Shrike Modeled Habitat and Occurrences



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C.39 Yellow-Breasted Chat (*Icteria virens*)

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C.39.1 Conservation Status

Federal: None.

State: Species of Special Concern.

Recovery Plan: None.

C.39.2 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.39.2.1 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.39.2.2 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.39.2.3 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.39.2.4 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.39.3 Habitat Requirements and Ecology

C.39.3.1 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.39.3.2 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.39.4 Species Distribution and Population Trends

C.39.4.1 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.39.4.2 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).

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, all were on the Solano County side of the creek, and nesting has not been confirmed in Yolo County in recent decades (CNDDB 2019). 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 (eBird.org 2020).

There have been a number of recent recorded sightings around Davis including sightings at Grasslands Regional Park (2018), Yolo Bypass Wildlife Area (2019), and Putah Creek, as well as Conway Ranch (2017) and near Woodland (eBird 2019).

C.39.5 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.39.6 Species Habitat Model and Location Data

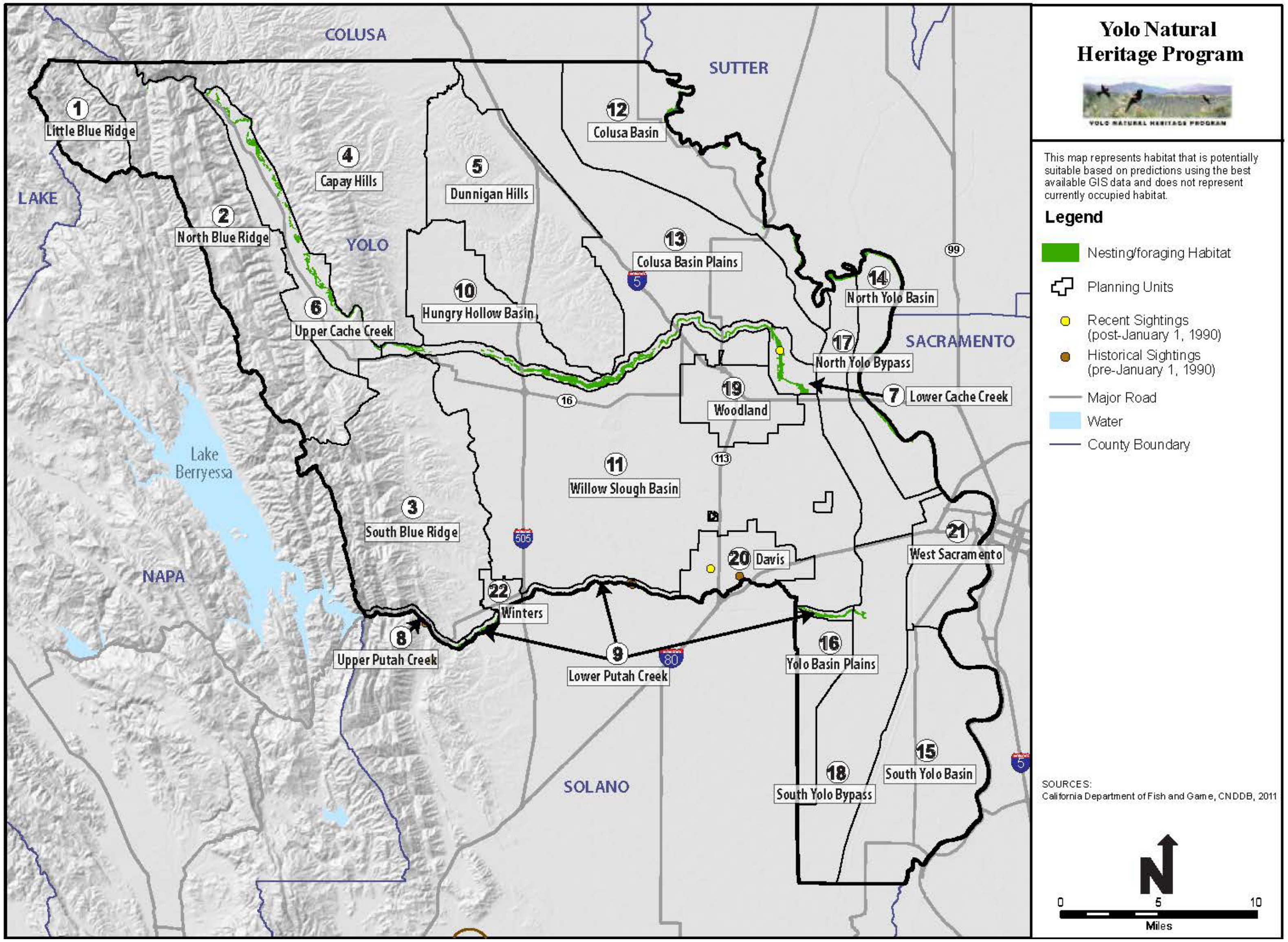
The habitat model for this species was based on the distribution of land cover types that are known to support its habitat as described above in Section C.39.3, *Habitat Requirements and Ecology* (Figure C-26). The model parameters include the following.

- 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., 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. This habitat was modeled by selecting all riparian vegetation types as listed below that occur within 1,000 feet of these streams and rivers.

C.39.6.1 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

Figure C-26. Yellow-Breasted Chat Modeled Habitat and Occurrences



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C.40 Least Bell's Vireo (*Vireo bellii pusillus*)

C.40.1 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.40.2 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.40.2.1 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.40.2.2 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.40.2.3 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.40.2.4 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.40.3 Habitat Requirements and Ecology

C.40.3.1 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.40.3.2 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.40.4 Species Distribution and Population Trends

C.40.4.1 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.40.4.2 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).

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 (CNDDB 2019). 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).

There is a recorded occurrence in the California Natural Diversity Database (CNDDB) along south Putah Creek. During surveys in 2010, 2011, 2012, and 2013, two pairs were observed in the same location (CNDDB 2019). During surveys in 2015, no least Bell's vireos were detected (CNDDB 2019). There are also two recorded sightings in the Yolo Bypass Wildlife Area from 2010 and 2011 (eBird 2019).

C.40.5 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.40.6 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.40.3, *Habitat Requirements and Ecology* (Figure C-27).

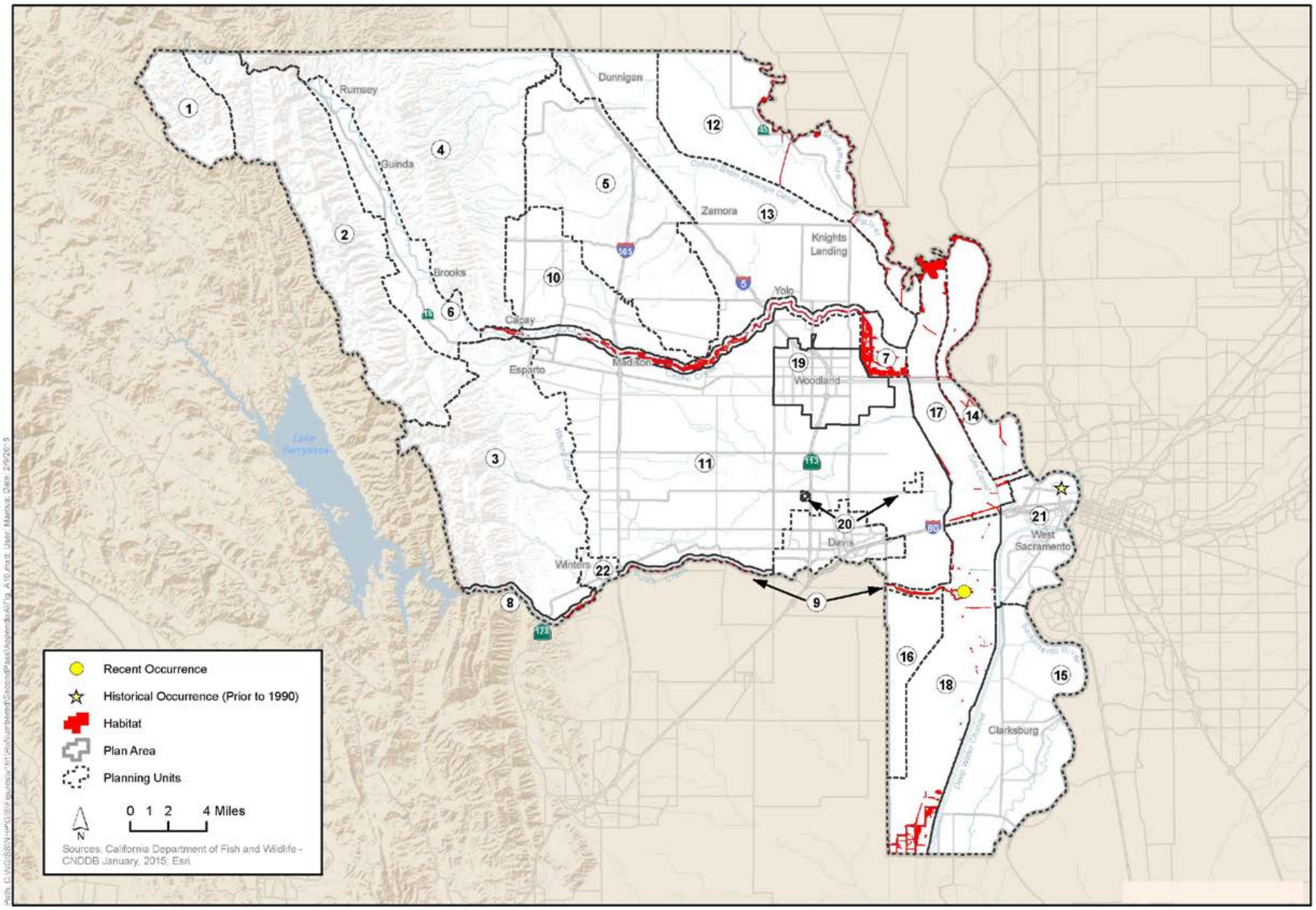
The model parameters include the following.

- 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.40.6.1 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

Figure C-27. Least Bell's Vireo Modeled Habitat and Occurrences



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C.40.7.1 Federal Register Notices

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C.41 Bank Swallow (*Riparia riparia*)

C.41.1 Listing Status

Federal: None.

State: Threatened.

Recovery Plan: Recovery Plan: Bank Swallow *(Riparia riparia)* (California Department of Fish and Game [DFG] 1992).

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C.41.2 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.41.2.1 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.41.2.2 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.41.2.3 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.41.2.4 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.41.3 Habitat Requirements and Ecology

C.41.3.1 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.41.3.2 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.41.4 Species Distribution and Population Trends

C.41.4.1 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.41.4.2 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] 2019). 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).

April 10, 2011, Whisler (pers. comm. 2015) observed bank swallows nest-building in the bank of the cross-channel from the Port of West Sacramento to the Sacramento River. The colony failed when the Sacramento River rose from heavy rains that spring. This was likely the southernmost colony along the Sacramento River, and in the most urban area along the Sacramento River. No colonies have been detected since then (Whisler pers. comm. 2015).

C.41.5 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.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.41.3, *Habitat Requirements and Ecology* (Figure C-28).

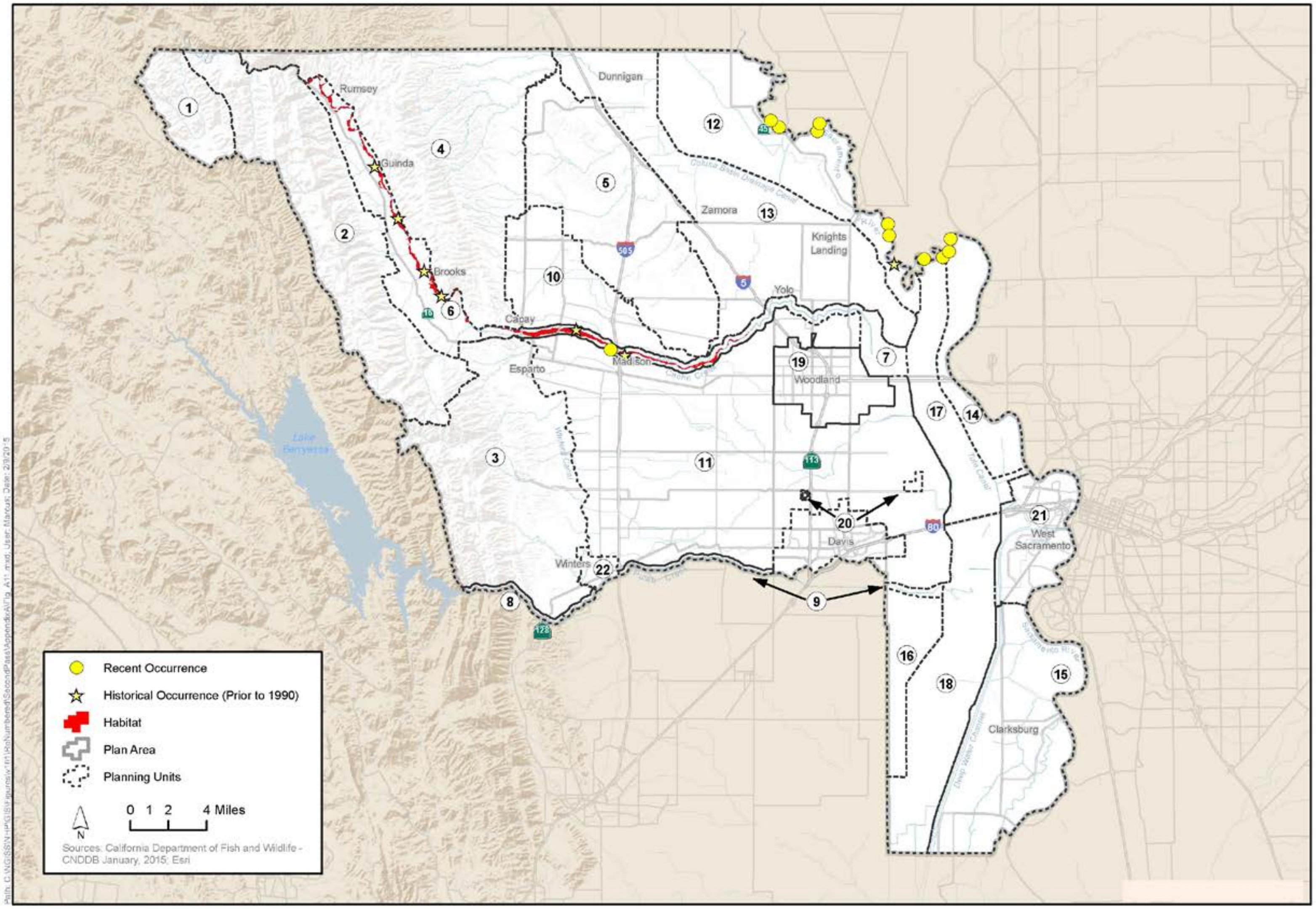
The model parameters include the following.

- 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.
- Limited modeling to the following Planning Units: 6, 7, 12, 14, 17.

C.41.6.1 Breeding – Land Cover Type

- Barren – Gravel and Sand Bars

Figure C-28. Bank Swallow Modeled Habitat and Occurrences



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C.41 Townsend's Big-Eared Bat (*Corynorhinus townsendii*)

C.41.1 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.41.2 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.41.3 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.41.3.1 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. However, Morrison and Szewczak (2017) that found 80% of 86 roosts surveyed, to be located in caves and mines, and only 20% in buildings and other structures (bridges, culverts, etc.).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). Although considered a habitat generalist, the persistence of Townsend's big-eared bat is limited to regions with appropriate roosting habitat (roost sites) in the maternity and winter seasons.

C.41.3.2 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.41.4 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] 2019) 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 (2019) 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.

According to a species status review conducted by CDFW (2016), Townsend's big-eared bat appears to be fairly well distributed throughout much of its historic range in California and there is no evidence of a range contraction with the possible exception of highly populated areas near the coast. CDFW compiled information from a number of maternity and hibernation roosts from around California where monitoring is conducted in order to assess trends in colony size at specific sites where management is in place. Of the six monitoring studies conducted, five concluded that the site specific populations were stable or increasing, while the sixth is stable to decreasing. While this does not result in a statistically valid estimate of the Townsend's big-eared bat population size or trend statewide, it does illustrate how colony sizes and threats vary around the state (California Department of Fish and Wildlife 2016).

There is a single recorded occurrence of Townsend's big-eared bat in the Plan Area. The California Natural Diversity Database reports a single occurrence (1987) of four individuals in the Harrison and Soda Springs mines located near Knoxville.

C.41.5 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.

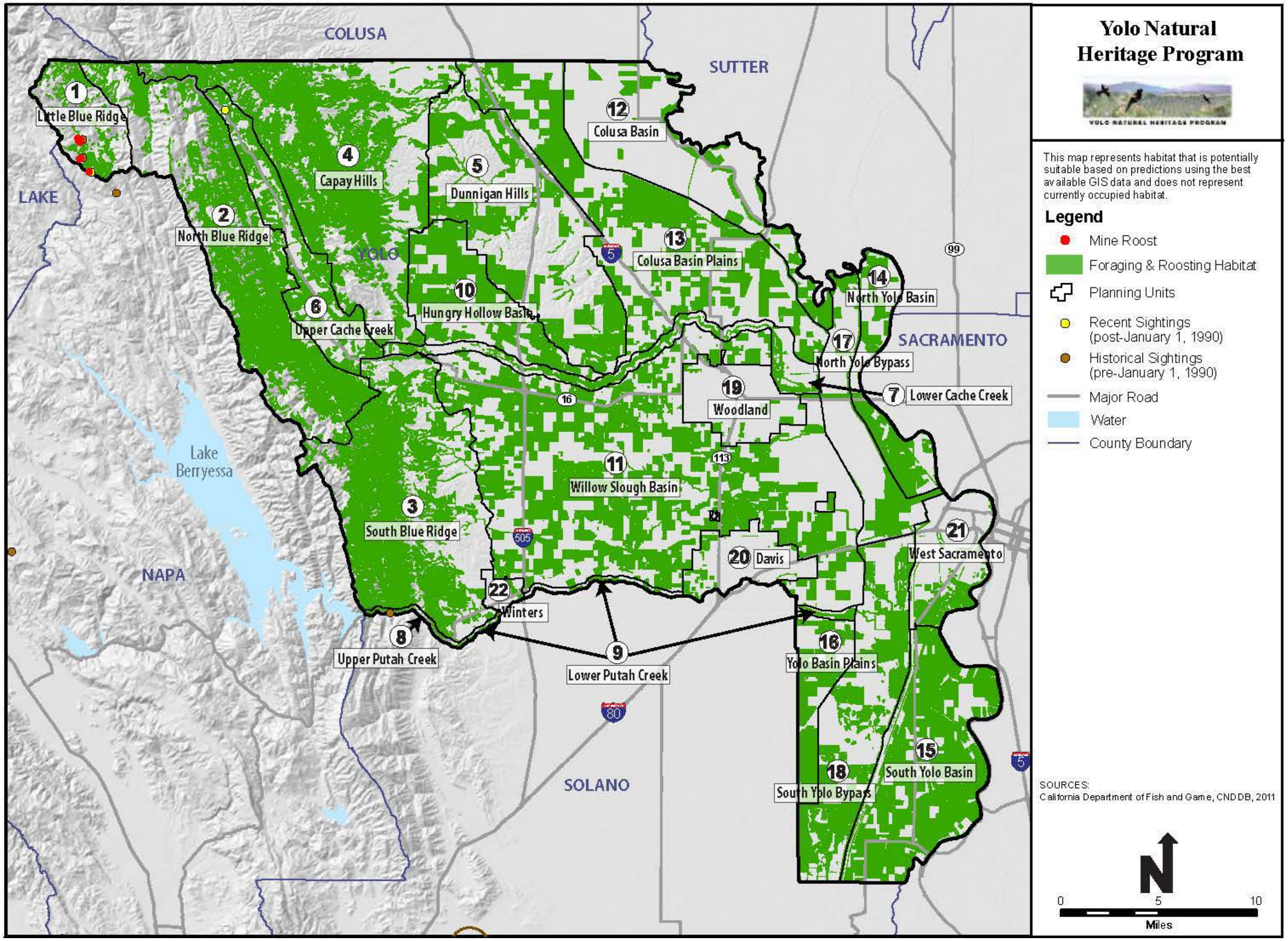
Monitoring is needed to determine current population trends and status. More information is needed to help determine the seasonal home ranges and movements, particularly during winter months, and the foraging requirements in different habitats. In addition, information is needed to determine the amount of relatedness within and between different populations to help conserve populations.

C.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.42.3, *Habitat Requirements and Ecology* (Figure C-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., 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-29. Townsend's Big-Eard Bat Modeled Habitat and Occurrences



C.41.6.1 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.41.7.1 Federal Register Notices

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C.41.7.2 Personal Communications

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Appendix D
Focal Species Evaluation

Table D-1. Yolo RCIS Potential Focal Species

Status[a]					Criteria[b] (columns shaded gray are required screening criteria)							
Species	State/ CNPS	Federal	SWAP Species of Conservation Need[c]	Climate Vulnerable[d]	Occurs in RCIS Area	Data	Near Term Mitigation Needs	Indicator Species	Wide-Ranging Species	Recommend as Focal Species[e]	Indicator of	Evaluation Notes
Ancient Ant *Pryamica reliquia*	–	–	N	N	Y	N	N	N	N	N	N/A	Only one occurrence found within the RCIS area; no near term mitigation needs.
Vernal pool fairy shrimp *Branchinecta lynchi*	–	FT	Y	N	Y	Y	N	Y	N	Y	Vernal pool ecosystem health and function	Found within CIS area; species of conservation need.
Vernal pool tadpole shrimp *Lepidurus packardi*	–	FE	Y	N	Y	Y	N	Y	N	Y	Vernal pool ecosystem health and function	Found within RCIS area; species of conservation need.
California linderiella *Linderiella occidentalis*	–	–	N	N	Y	N	N	Y	N	Y	Vernal pool ecosystem health and function	Found within RCIS area; species of conservation need.
Conservancy fairy shrimp *Branchinecta conservatio*		FE	Y	N	N	Y	N	Y	N	Y	Vernal pool ecosystem health and function	Found within RCIS area; species of conservation need.
Midvalley Fairy Shrimp *Branchinecta mesovallensis*	–	–	N	N	N	Y	N	Y	N	Y	Vernal pool ecosystem health and function	Found within RCIS area; in need of mitigation.

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Species	**State/ CNPS**	**Federal**	**SWAP Species of Conservation Need[c]**	**Climate Vulnerable[d]**	**Occurs in RCIS Area**	**Data**	**Near Term Mitigation Needs**	**Indicator Species**	**Wide-Ranging Species**	**Recommend as Focal Species[e]**	**Indicator of**	**Evaluation Notes**
Molestan beetle *Lytta molesta*	SSC	–	N	N	Y	N	N	N	N	N	N/A	No recent occurrences in RCIS area. This species may benefit from the implementation of the conservation strategy for vernal pools.

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Species	**State/ CNPS**	**Federal**	**SWAP Species of Conservation Need[c]**	**Climate Vulnerable[d]**	**Occurs in RCIS Area**	**Data**	**Near Term Mitigation Needs**	**Indicator Species**	**Wide-Ranging Species**	**Recommend as Focal Species[e]**	**Indicator of**	**Evaluation Notes**
Valley elderberry long-horn beetle *Desmocerus californicus dimorphus*	–	FT	Y	N	Y	Y	Y	Y	Y	Y	Riparian floodplain ecosystem health and function; sensitive to fragmentatio n	Found within RCIS area; species of conservation need; occurs in floodplain.

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Species	**State/ CNPS**	**Federal**	**SWAP Species of Conservation Need[c]**	**Climate Vulnerable[d]**	**Occurs in RCIS Area**	**Data**	**Near Term Mitigation Needs**	**Indicator Species**	**Wide-Ranging Species**	**Recommend as Focal Species[e]**	**Indicator of**	**Evaluation Notes**
Delta smelt *Hypomesus transpacificus*	SE	FT	Y	Y	N	Y	N	Y	Y	Y	Stream health and function, including in-stream habitat	Found within RCIS area; in need of mitigation; considered species of conservation need.
Longfin smelt *Spirinchus thaleichthys*	ST	FC	Y	Y	Y	Y	N	Y	Y	N	Stream and estuarine health and function, including in-stream habitat	This species may benefit from the implementation of conservation strategies developed for ecological processes and conditions, the riverine and riparian natural community, and focal fish species, but there are no near term mitigation needs.

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Species	**State/ CNPS**	**Federal**	**SWAP Species of Conservation Need[c]**	**Climate Vulnerable[d]**	**Occurs in RCIS Area**	**Data**	**Near Term Mitigation Needs**	**Indicator Species**	**Wide-Ranging Species**	**Recommend as Focal Species[e]**	**Indicator of**	**Evaluation Notes**
Hardhead *Mylopharodon conocephalus*	–	–	Y	Y	N	N	N	N	Y	N	Stream health and function, including in-stream habitat and connectivity	Not found in RCIS area; no near-term mitigation needs.
Pacific lamprey *Entosphenus tridentatus*	SCC	–	–	Y	Y	Y	N	Y	Y	N	Stream health and function, including in-stream habitat and connectivity	This species may benefit from the implementation of conservation strategies developed for ecological processes and conditions, the riverine and riparian natural community, and focal fish species, but there are no near term mitigation needs.

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Species	**State/ CNPS**	**Federal**	**SWAP Species of Conservation Need[c]**	**Climate Vulnerable[d]**	**Occurs in RCIS Area**	**Data**	**Near Term Mitigation Needs**	**Indicator Species**	**Wide-Ranging Species**	**Recommend as Focal Species[e]**	**Indicator of**	**Evaluation Notes**
River lamprey *Lampetra ayresii*	SCC	–	–	Y	Y	Y	N	Y	Y	N	Stream health and function, including in-stream habitat and connectivity	This species may benefit from the implementation of conservation strategies developed for ecological processes and conditions, the riverine and riparian natural community, and focal fish species, but there are no near term mitigation needs.
White sturgeon *Acipenser transmontanus*	SCC	–	–	Y	Y	Y	N	Y	Y	Y	Stream health and function, including in-stream habitat and connectivity	Found within RCIS area; in need of mitigation; considered species of conservation need.
Sacramento splittail *Pogonichthys macrolepidotus*	SSC	FD	Y	N	Y	Y	N	Y	Y	Y	Stream health and function, including in-stream habitat	Found within RCIS area; in need of mitigation; considered species of conservation need.

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Species	State/ CNPS	Federal	SWAP Species of Conservation Need[c]	Climate Vulnerable[d]	Occurs in RCIS Area	Data	Near Term Mitigation Needs	Indicator Species	Wide-Ranging Species	Recommend as Focal Species[e]	Indicator of	Evaluation Notes
Sacramento perch	–	–	Y	Y	N	N	N	N	N	N	Stream health and function, including in-stream habitat and connectivity	Not found in RCIS area; no recent occurrences; no near-term mitigation needs.
Green sturgeon *Acipenser medirostris*	–	FT	Y	Y	Y	Y	Y	Y	Y	Y	Stream health and function, including in-stream habitat and connectivity	Found within RCIS area; in need of mitigation; considered species of great conservation need.
Central Valley steelhead *Oncorhynchus mykiss*	–	FT	Y	Y	Y	Y	Y	Y	Y	Y	Stream health and function, including in-stream habitat and connectivity	Found within RCIS area; in need of mitigation; indicator species.
Sacramento River winter-run Chinook salmon *Onchorhynchus tshawytscha*	SE	FE	N	Y	Y	Y	Y	Y	Y	Y	Stream health and function, including in-stream habitat and connectivity	Found within RCIS area; in need of mitigation; indicator species.
Central Valley spring-run Chinook salmon *Onchorhynchus tshawytscha*	ST	FT	Y	Y	Y	Y	Y	Y	Y	Y	Stream health and function, including in-stream habitat and connectivity	Found within RCIS area; in need of mitigation; indicator species.

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Central Valley fall/late fall-run Chinook salmon *Onchorhynchus tshawytscha*	SSC	SOC	N	Y	Y	Y	Y	Y	Y	Y	Stream health and function, including in-stream habitat and connectivity	Found within RCIS area; in need of mitigation; indicator species.
California tiger salamander *Ambystoma californiense*	ST	FT	Y	Y	Y	Y	N	Y	Y	Y	Wetland, pond, and vernal pool complex ecosystem health and function	Found within RCIS area; in need of mitigation; indicator species.
Foothill yellow-legged frog *Rana boylii*	CT	–	Y	Y	Y	Y	N	N	Y	N	Stream health and function	Found within RCIS area but western area where no development proposed; indicator species.
Western spadefoot *Spea hammondii*	SSC	UR	Y	N	Y	Y	N	Y	Y	Y	Wetland and vernal pool complex ecosystem health and function	Found within RCIS area; in need of mitigation; indicator species.
California red-legged frog *Rana (aurora) draytonii*	ST	FT	Y	N	N	Y	N	Y	Y	N	Wetland and pond ecosystem health and function	No occurrences within the RCIS area.

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Species	State/ CNPS	Federal	SWAP Species of Conservation Need[c]	Climate Vulnerable[d]	Occurs in RCIS Area	Data	Near Term Mitigation Needs	Indicator Species	Wide-Ranging Species	Recommend as Focal Species[e]	Indicator of	Evaluation Notes
Giant garter snake *Thamnophis gigas*	ST	FT	Y	N	Y	Y	Y	Y	Y	Y	Water availability in wetlands, canals, ditches, and ricelands.	Found within RCIS area; in need of mitigation.
Western pond turtle *Emys marmorata*	SSC	UR	Y	N	Y	Y	Y	Y	Y	Y	Wetland and pond ecosystem health and function	In need of mitigation; indicator species.
San Joaquin Whipsnake *Masticophis flagellum ruddocki*	–	–	N	N	N	Y	N	N	N	N	N/A	No occurrence documented in the RCIS area; no near term mitigation needs
Coast Horned Lizard	SSC	–	N	N	N	Y	N	N	N	N	N/A	RCIS Area in known range of species; no known occurrences; no near term mitigation needs.
Burrowing owl *Athene cunicularia*	SSC	–	Y	N	Y	Y	N	Y	N	Y	Grassland communities with ground squirrel populations	Known to occur in RCIS Area; species of conservation concern: mitigation needs.
Greater sandhill crane *Grus canadensis tabida*	ST	–	Y	N	Y	Y	N	N	Y	Y	N/A	State threatened species.

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Bald eagle *Haliaeetus leucocephalus*	SE/FP	FD, BGPA	Y	N	Y	Y	N	N	N	N	N/A	Fully protected species; no near term mitigation needs.
Snowy egret *Egretta thula*	–	–	N	–	Y	Y	N	Y	N	N	N/A	Not State or Federally listed species. No near term mitigation needs.
Osprey *Pandion haliaetus*	–	–	N	–	Y	Y	N	N	N	N	N/A	Occurrences within RCIS, however, not a species of great conservation need or immediate mitigation need.
Swainson's hawk *Buteo swainsoni*	ST	–	Y	Y	Y	Y	Y	N	Y	Y	N/A	Found within RCIS area; in need of mitigation.
Northern harrier *Circus cyaneus*	SSC	–	Y	N	Y	Y	N	N	Y	Y	N/A	Found within RCIS area; in need of mitigation.
Tricolored blackbird *Agelaius tricolor*	ST	UR	Y	N	Y	Y	Y	Y	Y	Y	Freshwater wetland and pond health and function	Found within RCIS area; in need of mitigation.
California black rail *Laterallus jamaicensis coturniculus*	ST/FP	–	Y	Y	N	Y	Y	Y	N	Y	Tidal marsh and perennial emergent wetland health and function	State threatened; has near term mitigation needs.

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Mountain plover *Charadrius montanus*	SSC	–	Y	N	Y	Y	N	N	Y	N	N/A	Does not nest in the RCIS area; not State or Federally listed species.
Western snowy plover *Charadrius alexandrinus nivosus*	ST	FT	N	Y	N	Y	N	Y	Y	N	Coastal dune ecosystem health and function	Does not nest within RCIS area.
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	SE	FT	Y	Y	Y	Y	Y	Y	Y	Y	Riparian ecosystem health and function; sensitive to fragmentation	State and Federally listed; considered species of conservation need; near term mitigation requirements.
Bank swallow *Riparia riparia*	ST	–	Y	N	Y	Y	Y	Y	N	Y	River health, process, and function	State listed; considered species of conservation need; near term mitigation requirements.
Least Bell's vireo *Vireo bellii pusillus*	SE	FE	Y	Y	N	Y	Y	Y	N	Y	Riparian ecosystem health and function	State and Federally listed; considered species of conservation need; near term mitigation requirements.

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Grasshopper sparrow *Ammodramus savannarum*	–	–	Y	N	Y	Y	Y	Y	N	Y	Grassland ecosystem health and function	Occurs in RCIS Area; indicator species; species of great conservation need.
Black tern *Chlidonias niger*	SSC	–	Y	Y	N	Y	Y	N	Y	Y	N/A	The species continues to occupy most of its historical range in northeastern California; stability of population over long-term; species of conservation need; climate vulnerable.
Loggerhead shrike	–	–	Y	N	Y	Y	Y	N	Y	Y	N/A	Thought to occur in the RCIS Area; species of great conservation need.
Yellow-breasted chat	–	–	Y	N	Y	Y	Y	Y	N	Y	Riparian ecosystem health and funaction	This species occurs in riparian habitat and has been reported from upper Putah Creek; species of conservation need.

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Golden eagle *Aquina chrysaetos*	SE/FP	FD, BGPA	N	N	Y	Y	N	N	Y	N	N/A	The golden eagle is a state Fully Protected species. It is also protected under the federal Bald and Golden Eagle Protection Act. No near-term mitigation needs.
Bell's sparrow *Artemisiospiza belli*	–	–	N	N	N	Y	N	N	N	N	N/A	No known occurrences in RCIS Area; no near-term mitigation needs.
Short-eared owl *Asio flammeus*	–	–	Y	N	N	Y	N	N	Y	N	N/A	No known occurrences in RCIS Area; no near-term mitigation needs.
Redhead *Aythya americana*	–	–	Y	N	N	Y	N	N	N	N	N/A	No known occurrences in RCIS Area; no near-term mitigation needs.
American peregrine falcon *Falco peregrinus anatum*	FP	BCC	N	N	N	Y	N	N	Y	N	N/A	No known occurrences in RCIS Area; no near-term mitigation needs.

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Prairie falcon *Falco mexicanus*	–	–	N	N	Y	Y	N	N	Y	N	N/A	Not Species of Special Concern or SWAP Species of Conservation Need; no near-term mitigation needs.
Yellow-billed magpie *Pica nuttalli*	–	–	N	N	Y	Y	N	N	Y	N	N/A	Not Species of Special Concern or SWAP Species of Conservation Need; no near-term mitigation needs.
Purple martin *Progne subis*	–	–	Y	N	N	N	N	N	Y	N	N/A	Not known to occur in RCIS Area; no near-term mitigation needs.
Yellow-headed blackbird *Xanthocephalus xanthocephalus*	–	–	Y	N	Y	Y	N	N	Y	N	N/A	Not federally or state listed species; no near-term mitigation needs.
Long-eared owl *Asio otus*	–	–	Y	N	N	N	N	N	Y	N	N/A	Not known to occur in RCIS Area; no near-term mitigation needs.
Least bittern	–	–	Y	N	N	N	N	N	Y	N	N/A	Not known to occur in RCIS Area; no near-term mitigation needs.

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River otter *Lontra canadensis*	–	–	N	N	Y	Y	N	Y	N	N	Riverine health and function	Not Species of Special Concern or SWAP Species of Conservation Need; salmonids, green sturgeon, and bank swallow selected as riverine indicator species; no near-term mitigation needs.
Townsend's big-eared bat *Corynorhinus townsendii*	SSC	–	Y	N	Y	Y	N	N	N	Y	N/A	State species of special concern; known to occur in RCIS Area; species of great conservation need.
San Joaquin pocket mouse *Perognathus inornatus*	–	–	Y	N	Y	N	N	N	N	N	N/A	No recent occurrence records from the RCIS area.
Yuma myotis *Myotis yumanensis*	–	–	N	--	Y	N	N	N	Y	N	N/A	Not State or Federally listed species; no recent occurrence records from RCIS area.

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Pallid bat *Antrozous pallidus*	SSC	–	Y	N	N	N	N	N	Y	N	N/A	No occurrences within RCIS area; flood management activities not likely to impact species.
Western red bat *Lasiurus blossevillii*	SSC	–	N	–	Y	N	N	N	Y	N	N/A	Not State or Federally listed species; no recent occurrence records from the RCIS area.
American badger *Taxidea taxus*	SSC	–	Y	N	Y	Y	N	N	Y	N	N/A	Not State or Federally listed species. No near-term mitigation needs.
Ringtail *Bassariscus astutus*	FP	–	Y	N	N	Y	N	N	Y	N	N/A	Fully Protected; no near-term mitigation needs
Plants												
Adobe-lily *Fritillaria pluriflora*	1B	–	N	N/E	Y	Y	N	N	N	N	N	This species is broadly distributed on gently sloping hillsides with clay soils from Yolo County; no near-term mitigation needs.

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Alkali milk-vetch *Astragalus tener* var. *tener*	1B	–	N	N/E	Y	Y	N	Y	N	Y	Wetland and vernal pool health and function	Found throughout RCIS Area; indicator species.
Brittlescale *Atriplex depressa*	1B	–	N	N/E	Y	Y	Y	N	N	Y	N	Known to occur in RCIS Area; declining due to loss of habitat through current and future development; in need of near-term mitigation
Baker's navarretia *Navarretia leucocephala ssp. bakeri*	1B	–	Y	N/E	Y	Y	Y	N	N	Y	N	Known to occur in RCIS Area; declining due to loss of habitat through current and future development; in need of near-term mitigation; species of conservation need.
Bent-flowered fiddleneck *Amsinckia lunaris*	1B	–	N	N/E	Y	Y	Y	N	N	Y	N	Not a federally or state listed species; no recent records from the RCIS Area; no need for near-term mitigation.

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Colusa grass *Neostapfia colusana*	SE/1B	FT	Y	N/E	Y	Y	N	Y	N	Y	Wetland and vernal pool health and function	Federal and State listed species; SWAP species of conservation need; indicator species.
Colusa layia *Layia septentrionalis*	1B	–	N	N/E	N	N	N	N	N	N	N	Historic occurrence (1938) in the RCIS area; likely no longer occurs in the RCIS area.
Coulter's goldfields *Lasthenia glabrata ssp. coulteri*	1B	–	Y	N/E	N	N	N	N	N	N	N	One historic occurrence (1917) in the RCIS area; likely no longer occurs in the RCIS area.
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	1B	–	N	N/E	N	Y	Y	N	N	Y	N	Not a federally or state listed species; no recent records from the RCIS Area; no need for near-term mitigation.
Drymaria-like Western flax *Hesperolinon drymarioides*	1B	–	N	N/E	N	Y	Y	N	N	Y	N	Not a federally or state listed species; no recent records from the RCIS Area; no need for near-term mitigation.

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Dwarf downingia *Downingia pusilla*	2B	–	N	N/E	N	Y	N	Y	N	N	Vernal pool health and function	This species is not known to occur in the RCIS Area; current status uncertain. This species may benefit from the implementation of the conservation strategy for vernal pools.
Ferris milk-vetch *Astragalus tener var. ferrisiae*	1B	–	Y	N/E	Y	N	N	N	N	N	N	No Federal or State listing; no near-term mitigation needs.
Hall's harmonia *Harmonia hallii*	1B	–	N	N/E	Y	N	N	N	N	N	N	No Federal or State listing; no near-term mitigation needs.
Heartscale *Atriplex cordulata* var. *cordulata*	1B	–	N	N/E	Y	N	N	N	N	N	N	No recent occurrence in RCIS Area, and likely will not need mitigation.
Heckard's pepper-grass *Lepidium latipes* var. *heckardii*	1B	–	N	N/E	Y	N	N	N	N	Y	N	Occurs in RCIS Area, in need of near-term mitigation.
Jepson's Milk-Vetch *Astragalus rattanii*	1B	–	N	N/E	Y	N	N	N	N	N	N	No Federal or State listing; no near-term mitigation needs.

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Palmate bracted bird's-beak *Chloropyron palmatum*	SE/1B	FE	Y	N/E	Y	Y	Y	Y	N	Y	Alkali wetland and grassland ecosystem health and function.	Federal and State listed species; occurs in RCIS Area; SWAP species of conservation need.
Mason's lilaeopsis *Lilaeopsis masonii*	R/1B	–	Y	N/E	Y	Y	N	N	Y	N	N	Occurs is RCIS Area; no near term mitigation needs.
Morrison's jewelflower *Streptanthus morrisonii* ssp. *Morrisonii*	1B	–	N	N/E	N	N	N	N	N	N	N	No Federal or State listing; no occurrences in RCIS Area; no near-term mitigation needs.
Rose mallow	1B	–	N	N/E	N	N	N	N	N	N	N	No Federal or State listing; no occurrences in RCIS Area; no near-term mitigation needs.
Round-leaved filaree *California macrophylla*	1B	–	Y	N/E	N	N	N	N	N	N	N	Historic occurrences of this species in the RCIS area; likely no longer occurs in the RCIS area.
San Joaquin spearscale *Extriplex joaquinana*	1B	–	N	N/E	Y	Y	Y	N	N	Y	N	Occurs in RCIS Area, in need of near-term mitigation.

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Serpentine cryptantha *Cryptantha dissita*	1B	–	N	N/E	N	Y	N	N	N	N	N	Is not known to occur in RCIS Area.
Snow Mountain buckwheat *Eriogonum nervulosum*	1B	–	Y	N/E	Y	N	N	N	N	N	N	No Federal or State listing; not known to occur in RCIS Area.
Solano grass *Tuctoria mucronata*	E	E	Y	N/E	Y	Y	Y	Y	N	Y	Vernal pool ecosystem health and function	Federal and State listed species; SWAP species of conservation need; indicator species.
Vernal pool smallscale *Atriplex persistens*	1B	–	N	N/E	N	Y	N	Y	N	N	Vernal pool ecosystem health and function	Not known to occur in RCIS Area; not likely to need near-term mitigation.

Notes

[a] Status

State Status

FP = Fully Protected.

SE = State listed as endangered.

ST = State listed as threatened.

SC = listed as a candidate species. A candidate species is one that the California Fish and Game Commission has formally declared a candidate species.

SR = State listed as rare.

SSC = California special concern species (July 2005 list).

Federal Status

BGPA = Bald Eagle and Golden Eagle Protection Act.

FE = Federally endangered.

FT = Federally threatened.

State Wildlife Action Plan (SWAP) Species of Great Conservation Need

Y = Listed as species of great conservation need in SWAP.

N = Not listed as species of great conservation need in SWAP.

[b] Criteria

Occurs in RCIS Area: The species is known or likely to occur in the strategy area. Occurrence data should be based on credible evidence.

Data: Drawing on best available science and emerging data, sufficient data on the species' life history, habitat requirements, and occurrence within the strategy area are available to set conservation goals and objectives, assess stressors and pressures, and propose viable conservation actions.

Near Term Mitigation Needs: Species anticipated to need mitigation by potential projects in the RCIS area in the near-term.

Indicator Species: A species whose presence or absence is indicative of a particular habitat, community, or set of environmental conditions.

Wide-Ranging Species: Species that require large, contiguous, or connected blocks of habitat, whereby these species could effectively inform habitat enhancement actions

Species	Status[a]			Criteria[b] (columns shaded gray are required screening criteria)						
		SWAP			Near Term Mitigation Needs	Indicator Species	Wide-Ranging Species	Recommend as Focal Species[e]	Indicator of	Evaluation Notes

FC = Candidate for federal listing.
FPT = Federally proposed for threatened listing.
FPD = Federally proposed for delisting.
FD = Federally delisted.
UR = Under review. Species that have been petitioned for listing and for which a 90 day finding has not been published or for which a 90 day substantial has been published but a 12 Month finding have not yet been published in the Federal Register. Also includes species that are being reviewed through the candidate process, but the Candidate Notice of Review has not yet been signed.
SOC = Species of Concern (National Marine Fisheries Service designation).

California Native Plant Society (CNPS) Ranking

1A = Presumed extinct in California.
1B = Rare or endangered in California and elsewhere.
2 = Rare or endangered in California, more common elsewhere.
3 = Plants about which more information is needed.
4 = Plants of limited distribution.

involving habitat connectivity and other important ecological processes within the MUSR RCIS area.

[c] State Wildlife Action Plan Criteria

Criterion 1 – Listed species.
Criterion 2 – Species with a conservation concern (similar to CDFW's species of concern).
Criterion 3 – Climate vulnerable species.

For additional information on SWAP criteria for species, see Chapter 1, Introduction, Section 1.6.3.1, Focal Species Selection.

[d] Climate Vulnerable (as identified in the SWAP).

Y = listed as climate vulnerable by SWAP.
N = not listed as climate vulnerable by SWAP.
-- = not included as a SWAP species of greatest conservation need
N/E = plants were not evaluated for climate vulnerability in SWAP.

[e] Recommended Focal Species Status.

Y = recommended as focal species in RCIS.
N = not recommended as focal species in RCIS.

State Wildlife Action Plan Species of Greatest Conservation Need

The SWAP identifies species of greatest conservation needs based on the following three criteria.

Criterion 1 – Listed species

Criterion 1 requires that the species is listed as threatened, endangered or a candidate species in California under the ESA or CESA.

Criterion 2 – Species with a conservation concern

Criterion 2 is defined as species with a conservation concern, which is similar to California Species of Special Concern. Although this designation carries no legal protection, it is intended to focus attention on the species and stimulate research on those species in an effort to address the declining trends before the species meeting the criteria for state or federal listing. Species where take or harvest is prohibited by CDFW or NMFS are included under Criterion 2 (e.g., marine plants, fish), as well as plants with a California Rare Plant Rank of 1B.2. Invertebrates with a NatureServe Ranking of S1, which designates those species as critically imperiled.

Criterion 3 – Climate vulnerable species

Criterion 3 includes species CDFW considered in the SWAP to be highly vulnerable to climate change. Plants were not addressed under Criterion 3.

The SWAP, which encompasses these three criterion, is addressed in the species evaluation table (Appendix D, Table D-1) in the SWAP column. If a species is included in SWAP, it received a yes (Y) in the SWAP column, and if it is not included in SWAP they received a no (N). Species identified in the SWAP as climate vulnerable received a yes (Y) in the climate vulnerable column. In the status column, if a species is not federally or state listed but is considered a SWAP Species of Greatest Conservation Need, the species could be included as a focal species (if it met the optional criteria) because the SWAP listing indicates the species is seriously imperiled in California and may be state or federally listed in the next 10 years.

The SWAP was also used to inform those species included as indicator species. Indicator species are species that occur in specialized habitats, are sensitive to habitat modification, and occur in habitats that have declined and may continue to decline in the future. Many of the indicator species that occur in the RCIS area are associated with aquatic habitat, such as fish and amphibians. In addition species that occur in specialized grassland habitat, such as alkali plants, mountain plover, and American badger are also included as indicator species. Most of the indicator species are also expected to be affected by climate change. The SWAP includes a climate change vulnerability assessment, which determined the climate vulnerability evaluation in Appendix D, Table D-1.

Appendix E
Conservation Strategy Rationale

Appendix E
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.

E.1 Landscape-Level Strategy, Rationale

E.1.1 Goal L1: Large interconnected landscapes

E.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).

E.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.

E.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).

E.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.

E.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).

E.1.2 Goal L2: Ecological Processes and Conditions

E.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.

E.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*).

E.1.3 Goal L3: Landscape-level Stressors

E.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.

E.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.

E.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.

E.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.

E.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.

E.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.

E.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.

E.2 Natural Community-Level Strategy, Rationale

E.2.1 Goal CL1: Cultivated land habitat conservation

E.2.1.1 Objective CL1.1: Protect Cultivated Lands 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.

E.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.

E.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*).

E.2.2 Goal CP1: Large contiguous patches of California prairie to support native species

E.2.2.1 Objective CP1.1: California prairie protection

Rationale. Large intact stretches of California prairie support a diversity of native species, such as garter snake, northern harrier, barn owl, western kingbird, Say's phoebe, western meadowlark, savannah and grasshopper sparrow, Townsend's mole, Botta's pocket gopher, western harvest mouse, and California vole. Other native species utilize California prairie as foraging habitat, such as American kestrel, red-tailed hawk, big brown bat and black tailed deer (Kie 2005). Plant species typically consist of perennial grasses intermixed with forbs, such as California oatgrass, purple needlegrass, silver hairgrass, English daisy, soft chess, Sandberg bluegrass, Idaho fescue, red fescue, and Italian ryegrass (Kie 2005, Sawyer et al. 2008). California prairie also provides some of the most important movement corridors in the RCIS area, such as the Dunnagin Hills area (Holstein pers. comm.) 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 (including California prairie)conservation in the Valley Landscape Unit, but does not conserve these areas in the Hill and Ridge Landscape Unit or in the southern portion of planning unit 5, where California tiger salamander is absent. The RICS/LCP will protect additional areas of California prairie in Yolo County, with a focus those planning units that were not prioritized in the Yolo HCP/NCCP.

E.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.

E.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).

E.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).

E.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.

E.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.

E.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.

E.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.

E.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).

E.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).

E.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).

E.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).

E.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.

E.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.

E.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.

E.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.

E.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.

E.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

E.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.

E.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).

E.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.

E.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.

E.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.

E.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."

E.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.

E.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])

E.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.

E.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.

E.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])

E.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.

E.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.

E.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.

E.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.

E.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.

E.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.

E.2.11 Goal AP1: Alkali Prairie Conservation

E.2.11.1 Objective VP1.1: Protect Alkali Prairie

Protect 7 acres of alkali prairie natural community. 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.

E.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.

E.3 Focal Species Strategies

E.3.1 Focal Plant Species

E.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

Protect currently known but unprotected or newly discovered unprotected habitat for focal plant species, prioritizing occupied habitat.

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

Maintain or increase the mean annual abundance of focal plant species in protected habitat within Yolo County.

> ***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).

Objective PLANT1.3. Protect Focal Plant Species Habitat.

Protect 7 acres of modeled alkali milk-vetch, brittlescale, Heckard's pepper-grass, palmate bracted birds-beak, and San Joaquin spearscale habitat.

> ***Rationale***. Protecting alkali milk-vetch, brittlescale, Heckard's pepper-grass, palmate bracted birds-beak, and San Joaquin spearscale habitat will help reduce the stressor of habitat loss, and enable the protected occurrences to be managed for sustainability.

Objective PLANT1.4. Enhance focal plant species habitat.

Enhance 64 acres consisting of modeled Baker's navarretia, Colusa grass, and Solano grass habitat and surrounding uplands within the vernal pool watershed.

> ***Rationale***. Enhancing 64 acres of modeled Baker's navarretia, Colusa grass, and Solano grass habitat and surrounding uplands within the vernal pool watershed habitat will help to ensure that protected habitat in Yolo County will continue to sustain focal plant species.

E.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

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.

[1] Definition for each criteria and additional information the vulnerability assessment can be found at https://www.wildlife.ca.gov/Data/Analysis/Climate

E.3.2 Focal Vernal Pool Invertebrates

E.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: Enhance vernal pool invertebrate habitat

Enhance 64 acres consisting of both modeled vernal pool fairy shrimp, vernal pool tadpole shrimp, California linderiella, Conservancy fairy shrimp, and Midvalley fairy shrimp habitat and surrounding uplands within the vernal pool watershed.

Rationale. Enhancing vernal pool invertebrate habitat will help ensure the species' ongoing existence in Yolo County with any future changes in environmental conditions (e.g., climate change).

E.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.

E.3.3 Valley Elderberry Longhorn Beetle

E.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

Protect 10 elderberry shrubs and successfully establish 30 elderberry shrubs in protected riparian areas. .

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.

E.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.

E.3.4 Focal Fish Species

E.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 northern end of the Sacramento Deep Water Ship Channel (NMFS 2014). Adults stray into the Deep Water Ship Channel due to false cues from the Sacramento River passing through the lock (). Preventing water from the Sacramento River from leaking through the lock would reduce the risk of straying into the Deep Water Ship Channel.

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 (Sommer et al. 2001b).

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). Inundation of the Yolo Bypass is expected to increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production (Sommer et al. 2001a, Benigno and Sommer 2008, Opperman 2012).

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 provide benefits to juvenile Chinook salmon and other native species (Opperman 2012). Takata et al. (2017) found that total growth rate of juvenile Chinook salmon in the Yolo Bypass was positively associated with floodplain duration. Further, Sommer et al. (2001b) noted that growth, survival, feeding success, and prey availability in the Yolo Bypass were all higher in a high flow year (1998) relative to a lower flow year (1999).

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 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.

Objective FISH1.9: Restore focal fish species fresh emergent wetland habitat.

Restore 50 acres of fresh emergent wetland in Yolo Bypass to benefit Delta smelt, white sturgeon, Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley fall/late fall-run Chinook salmon.

Rationale. Restoring fresh emergent wetland habitat in Yolo Bypass will benefit focal fish species by increasing and improving the amount of habitat in the RCIS area.

Objective FISH1.10: Restore and manage focal fish species riparian habitat.

Restore and manage at least five acres of valley foothill riparian natural community along Tule canal to benefit green sturgeon, Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley fall/late fall-run Chinook salmon..

Rationale. Restoring and managing valley foothill riparian habitat along the Tule canal will benefit focal fish species by increasing and improving the amount of habitat in the RCIS area.

E.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.

E.3.5 California Tiger Salamander

E.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

Protect at least 400 acres of modeled upland habitat within 1.3 miles of aquatic habitat for California tiger salamander.

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 Aquatic Habitat

Within the protected lacustrine and riverine natural community, protect at least 7 acres of California tiger salamander aquatic habitat.

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.

Objective CTS1.3: Restore and Enhance Habitat

Increase the acreage and value of California tiger salamander habitat through restoration and enhancement.

Rationale. Restoring and enhancing habitat is critical because providing for enough 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.

E.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.

E.3.6 Western Spadefoot

E.3.6.1 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: Upland Habitat Protection.

Protect at least 400 acres of modeled upland habitat within 1.3 miles of aquatic habitat for western spadefoot..

Rationale. Protecting adjacent uplands will provide for western spadefoot aestivation and movement between aquatic areas.

Objective WS1.1: Aquatic Habitat Protection.

Protect at least 7 acres of western spadefoot aquatic habitat.

Rationale. Protection of aquatic breeding habitat for western spadefoot is necessary to ensure ongoing reproduction.

E.3.6.2 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.

E.3.7 Western Pond Turtle

E.3.7.1 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 Manage Habitat

Protect at least 480 acres of modeled western pond turtle aquatic habitat and sufficient adjacent uplands to sustain protected turtles occupying the protected aquatic habitat. ***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.

Objective WPT1.1: Protect Breeding Occurrence

Protect at least one breeding occurrence of western pond turtle.

Rationale. Protection of at least one breeding pair of western pond turtle is necessary to ensure ongoing reproduction.

E.3.7.2 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.

E.3.8 Giant Garter Snake

E.3.8.1 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 Giant Garter Snake Habitat .

Protect and manage at least 280 acres of protected rice land, 232 acres of upland natural communities, 100 acres of fresh emergent wetland and 84 acres of lacustrine/riverine land cover in modeled giant garter snake habitat. Suitable emergent marsh can be substituted for rice land.

Rationale. Rice lands are one of the primary land cover types that sustain giant garter snakes in Yolo County. This objective helps to ensure that protected habitat in Yolo County will continue to sustain giant garter snakes.

Objective GGS1.2: Manage and Enhance Giant Garter Snake Habitat

Manage and enhance giant garter snake habitat to maintain and enhance habitat value for giant garter snake. ***Rationale.*** 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).This objective helps to ensure that protected habitat in Yolo County will continue to sustain giant garter snakes.

Objective GGS1.2: Protect, Manage, and Restore Giant Garter Snake Aquatic Habitat

Protect, restore, and manage at least 100 acres of fresh emergent wetland natural community and 84 acres of the lacustrine/riverine natural community to conserve the giant garter snake.

Rationale. This objective provides for the protection and restoration of aquatic habitat necessary for the giant garter snake.

E.3.8.2 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
- 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.

E.3.9 Tricolored Blackbird

E.3.9.1 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 Habitat.

Within the protected fresh emergent wetland natural community, site at least 40 acres in modeled tricolored blackbird nesting habitat. ***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 TRBL1.2: 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.

E.3.9.2 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.

E.3.10 Western Burrowing Owl

E.3.10.1 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

Protect at least 600 acres of modeled western burrowing owl habitat..

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.

E.3.10.2 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-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 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.

E.3.11 Swainson’s Hawk

E.3.11.1 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 Swainson's hawk habitat.

Protect at least 2,872 acres of unprotected Swainson's hawk habitat.

Rationale. Protecting modeled Swainson's hawk habitat will help maintain or increase nesting success, by maintaining nesting habitat and prey availability necessary to rear and fledge young.

Objective SWHA1.2: Maintain Agricultural Habitat.

Within the protected non-rice cultivated land natural community, maintain crop types that support Swainson's hawk foraging habitat.

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 SWHA1.3: 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.

E.3.11.2 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-5. 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.

E.3.12 Greater Sandhill Crane

E.3.12.1 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[2] 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

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2 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).

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.

Table F-6. 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

E.3.12.2 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-7. 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.

E.3.13 Northern Harrier

E.3.13.1 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.

Objective NH1.1: Protect habitat

Protect at least 3,000 acres of modeled northern harrier habitat.

Rationale. Protection of modeled habitat for northern harrier is necessary to ensure nesting and foraging habitat is available for the species.

E.3.13.2 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-8. 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.

E.3.14 Bank Swallow

E.3.14.1 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

Protect at least 10 acres of unprotected bank swallow habitat. ***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).

E.3.14.2 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-9. 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.

E.3.15 Black Tern

E.3.15.1 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.

Objective BT1.1: Protect or Restore Habitat

Protect or restore at least 72 acres of suitable habitat for black tern.

Rationale. This objective provides for the protection and restoration of habitat necessary for the black tern.

E.3.15.2 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-10. 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.

E.3.16 Western Yellow-Billed Cuckoo

E.3.16.1 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: Restore western yellow-billed cuckoo habitat

Design at least 12 acres of the restored valley foothill riparian to provide suitable habitat for western yellow-billed cuckoo.

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.

E.3.16.2 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-11. 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.

E.3.17 Least Bell's Vireo

E.3.17.1 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.

E.3.17.2 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-12. 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.

E.3.18 White-Tailed Kite

E.3.18.1 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.

E.3.18.2 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-13. 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.

E.3.19 California Black Rail

E.3.19.1 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

Protect at least 50 acres of fresh emergent wetland natural community providing suitable habitat for California black rail. 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).

***Rationale**.* Protection of habitat ensures emergent wetlands and adjacent uplands will be available for California black rail.

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).

E.3.19.2 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-14. 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.

E.3.20 Loggerhead Shrike

E.3.20.1 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.

Objective LHSH1.1: Protect Loggerhead Shrike Habitat

Protect at least 700 acres of loggerhead shrike habitat.

***Rationale**.* Protection of habitat ensures benefits loggerhead shrikes by providing nesting and perching habitat.

Objective LHSH.2: Enhance Loggerhead Shrike Habitat

Enhance loggerhead shrike habitat by increasing its ability to support the species.

***Rationale**.* Enhancing habitat will help provide high quality habitat for loggerhead shrike in Yolo County.

E.3.20.2 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-15. 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.

E.3.21 Yellow-Breasted Chat

E.3.21.1 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.

Objective LHSH1.1: Protect Loggerhead Shrike Habitat

Protect at least 700 acres of loggerhead shrike habitat.

Rationale. Protection of habitat ensures benefits loggerhead shrikes by providing nesting and perching habitat.

E.3.21.2 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 E-16. 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.

E.3.22 Townsend's Big-Eared Bat

E.3.22.1 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.

E.3.22.2 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.

E.4 Other Conservation Elements

Table E-18 lists each of the "other conservation elements" described in Section 1.5.7, *Other Conservation Elements,* and indicates which components of the Yolo RCIS/LCP conservation strategy address each conservation element.

Table E-178. How the Conservation Strategy Addresses Other Conservation Elements

Conservation Element	Conservation Goals and Objectives or Other Aspects of Conservation Strategy
Biodiversity	Objective L1-3: Environmental Gradients.
	Objective L1-5: Ecotone Conservation
	Goal L4: Biodiversity, Ecosystem Function, and Resilience
Environmental Gradients	Objective L1-3: Environmental Gradients.
Existing Protected Areas	Goal L1: Large Interconnected Landscapes (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.)
	See gap analysis regarding conservation needs in the context of existing protected lands.
	Enhancement and restoration may occur on existing protected areas.
Habitat Connectivity	Goal L1: Large Interconnected Landscapes
Important Ecological Processes	Goal L2: Ecological Processes and Conditions
	Goal L4: Biodiversity, Ecosystem Function, and Resilience
	Objective LR1.1. Fluvial equilibrium.
	Objective LR1.4: Stream processes and conditions.
Natural Communities and Habitat	Objective L1-4: Natural Community Restoration
	Goal CL1: Cultivated land habitat conservation
	Goal CP1: Large contiguous areas of California prairie to support native species
	Goal CH1: Chaparral conservation.
	Goal WF1. Valley oak protection and restoration
	Goal WF2. Upland oak protection and restoration/enhancement
	Goal WF4. Oak woodland management
	Goal FW1: Fresh Emergent Wetland Conservation.
	Goal R1: Riparian Conservation
	Goal LR1: Stream conservation
	Goal AP1: Alkali Prairie Conservation.
	Goal VP1: Vernal Pool Conservation
	Goal VP1: Vernal Pool Conservation
Water Resources	Objective L2-1: Hydrologic and Geomorphic Processes

Conservation Element	Conservation Goals and Objectives or Other Aspects of Conservation Strategy
	Goal LR1: Stream conservation
	Goal FW1: Fresh Emergent Wetland Conservation

Appendix F
Consistency with Other Plans

Appendix F
Consistency with Approved Conservation Strategies and Recovery Plans

California Fish and Game Code 1852(c)(11) states that an RCIS shall have "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 2.12 of the Yolo RCIS/LCP describes each of the conservation plans and recovery plans relevant to the Yolo RCIS/LCP and that overlap the strategy area. This appendix explains how this RCIS is consistent with these plans and strategies. The tables at the end of this appendix provide comparisons between the Yolo RCIS/LCP and other local conservation plans, to show overlapping components between the plans. This appendix also provides summaries of conservation and recovery plans that are more detailed than the information provided in Section 2.12. See Section 2.12 of the RCIS/LCP for all document citations, which are not repeated here.

F.1 Consistency with NCCPs and HCPs

F.1.1 Yolo HCP/NCCP

The Yolo RCIS/LCP strategy area overlaps all of the Yolo HCP/NCCP plan area in Yolo County (approximately 653,359 acres). Because the Yolo HCP/NCCP provides regulatory federal and state Endangered Species Act (ESA) coverage for 12 species that are also Santa Clara County RCIS focal species (11 wildlife species and one plant species), this RCIS was designed to be consistent with, and complementary to, the Yolo HCP/NCCP to support collaborative conservation efforts between the two plans.

This RCIS/LCP and the Yolo HCP/NCP have conservation and biological goals, objectives, and actions that aim to protect species and their habitat, and enhance and restore habitat and natural communities. This RCIS/LCP and the Yolo HCP/NCCP also include conservation and biological goals, objectives, and actions to protect and enhance habitat connectivity and corridors for movement by organisms through landscapes. This RCIS/LCP's goals, objectives, and conservation actions emulate those in the HCP/NCCP, which provides a strong strategy for conservation of landscapes, natural communities, and focal species in the region. Therefore, all RCIS/LPC conservation goals, objectives, actions, and priorities are consistent with, and complementary to, the Yolo HCP/NCCP's biological goals, objectives, and conservation actions for focal species, habitats, and natural communities that overlap between this RCIS/LCP and the Yolo HCP/NCCP.

This RCIS/LCP prioritizes the protection of any known or newly discovered occurrences for all focal species that are covered species under the Yolo HCP/NCCP. Coordination with the Conservancy on protection of any known and newly discovered occurrence inside the HCP/NCCP plan area would benefit these species. Occurrences should only be targeted for protection if protecting the occurrence(s) does not affect the Conservancy's ability to achieve the goals and objectives of the HCP/NCCP. Close coordination between the Conservancy and CDFW on preparation and implementation of MCAs will be necessary to ensure consistency between the RCIS/LCP and the HCP/NCCP. Entities and/or individuals seeking to create mitigation credits within the HCP/NCCP plan area must comply with California Fish and Game Code 1856(j).

The enhancement and restoration actions and priorities in the RCIS/LCP are intended to address the pressures and stressors affecting the focal species, natural communities, and landscape connectivity. The protection, enhancement and restoration actions, and conservation priorities in this RCIS/LCP for conservation elements covered by the HCP/NCCP are based largely on those in the HCP/NCCP, because the pressures and stressors on these resources in the same for the HCP/NCCP and the RCIS/LCP, given that the two plans completely overlap. Furthermore, having similar, consistent conservation actions aimed at enhancing and restoring habitats will facilitate collaborative partnerships between the two plans. Since the Conservancy will be implementing the HCP/NCCP and supporting the use of the RCIS/LCP, this will also ensure consistency between the two plans in implementation.

Comparison of Focal Species Conservation Strategies

Following is a summary about how the RCIS/LCP's objectives and actions are consistent and compatible with the Yolo HCP/NCCP's biological objectives and actions for habitat enhancement and restoration objectives for focal species that are also Yolo HCP/NCCP covered species.

Palmate-Bracted Bird's Beak

The HCP/NCCP will protect, manage, and enhance the only known population of palmate-bracted bird's beak in Yolo County. The RCIS/LCP conservation actions include protecting, monitoring, and adaptively managing newly discovered population of palmate-bracted bird's beak or other focal species found in Yolo County. The RCIS/LCP conservation strategy therefore complements the HCP/NCCP strategy.

Valley Elderberry Longhorn Beetle

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions to protect and increase valley elderberry longhorn beetle habitat and populations, as follows.

- Protect populations of valley elderberry longhorn beetle in occupied habitat.
- Restore riparian habitat adjacent to valley longhorn beetle populations, and include elderberry shrubs in the restored riparian habitat.

California Tiger Salamander

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for California tiger salamander as follows.

- Protect California tiger salamander upland and aquatic habitat in the Dunnigan Hills Planning Unit, in addition to the upland habitat protected under the Yolo HCP/NCCP, particularly in designated critical habitat.
- Restore California tiger salamander aquatic habitat.

Western Pond Turtle

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for western pond turtle as follows.

- Protect western pond turtle habitat, prioritizing occupied areas.
- Enhance western pond turtle habitat by adding structures and vegetation for basking sites.

Giant Garter Snake

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for giant garter snake, as follows.

- Protect giant garter snake habitat in large, interconnected blocks.
- Manage and enhance protected giant garter snake habitat.

Tricolored Blackbird

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions to improve habitat for tricolored blackbird, as follows.

- Protect nesting and foraging habitat.
- Protect occupied colonies.
- Manage and enhance protected habitat.

Swainson's Hawk

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for Swainson's hawk, as follows.

- Protect foraging and nesting habitat.
- Protect active nest trees.
- Restore nesting habitat.

White-Tailed Kite

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions at the landscape and natural community levels that provide for the protection of white-tailed kite foraging habitat, and the protection and restoration of white-tailed kite nesting habitat. Both plans also prioritize protection of occupied areas.

Western Yellow-Billed Cuckoo

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for western yellow-billed cuckoo to protect and restore nesting habitat for this species.

Western Burrowing Owl

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for western burrowing owl, as follows.

- Protect habitat, prioritizing occupied areas.
- Manage and enhance habitat.

Least Bell's Vireo

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for least Bell's vireo, as follows.

- Protect and restore nesting habitat.
- Manage and enhance habitat (including brown-headed cowbird control, if needed).

Bank Swallow

This RCIS/LCP and the Yolo HCP/NCCP include conservation objectives and actions for bank swallows, to protect colonies and manage occupied habitat.

UC Davis HCPs

The conservation strategy for this RCIS/LCP and the UC Davis HCPs are consistent and compatible. The UC Davis HCPs involved restoration of 158 acres of valley elderberry longhorn beetle along Putah Creek. The RCIS/LCP conservation strategy involves protecting and restoring additional habitat for this species, prioritizing protection of occupied habitat and restoration of habitat adjacent to occupied areas.

Teichert Esparto Mining Project HCP

The conservation strategy for this RCIS/LCP and the Teichert Esparto Mining Project HCP are consistent and compatible. The Teichert Esparto Mining Project HCP involved planting and maintaining 22 elderberry replacement seedlings with associated native plants. The RCIS/LCP conservation strategy involves protecting and restoring additional habitat for this species, prioritizing protection of occupied habitat and restoration of habitat adjacent to occupied areas.

F.1.2 Approved Recovery Plans

There are six federally approved recovery plans that address species or resources within the strategy area. Each is discussed below. The purpose of federally approved recovery plans is to provide a framework for the conservation and survival of the listed species addressed in the recovery plan (ESA Section 4(f)(1)) that focuses and prioritizes threat abatement and restoration actions necessary to recover, and eventually delist, a species.

Recovery Plan for Central California Distinct Population Segment of California Tiger Salamander

The strategy to recover the Central California tiger salamander focuses on alleviating the threat of habitat loss and fragmentation to increase population resiliency (ensure each population is sufficiently large to withstand stochastic events), redundancy (ensure a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events), and representation (conserve the breadth of the genetic makeup of the species to conserve its adaptive capabilities).

Section 2.12.4.1 of the Yolo RCIS/LCP describes the recovery plan and its recovery goals for the Central California tiger salamander. The Yolo RCIS/LCP helps achieve the recovery plan's goals by protecting, restoring, managing, and enhancing large connected areas of California tiger salamander habitat, prioritizing occupied areas in the Dunnigan Hills where the area overlaps with designated critical habitat and a core recovery area for this species.

Sacramento-San Joaquin Delta Native Fishes Recovery Plan

The Sacramento-San Joaquin Delta Native Fishes Recovery Plan covers six fish species that are Yolo RCIS/LCP focal species: Delta smelt, Sacramento spittail, longfin smelt, green sturgeon, spring-run Chinook, and late-fall-run Chinook.

This recovery plan provides restoration objectives and restoration criteria for each species, and outlines an implementation schedule to accomplish over 70 management actions. Table 1, below, compares Yolo RCIS/LCP objectives with objectives in the recovery plan.

Table F-1. Comparison of Yolo RCIS/LCP Conservation Objectives and Recovery Plan Management Actions

Yolo RCIS/LCP	Recovery Plan Management Actions
Objective FISH1.1: Shaded riverine aquatic habitat. Increase the area of shaded riverine aquatic habitat in Yolo County that supports focal fish species.	**112** Develop additional shallow-water riparian vegetation zones and tidal marsh **.**
Objective FISH1.2: In-stream marsh habitat. Increase the area of in-stream marsh habitat in Yolo County that supports the focal fish species.	**112** Develop additional shallow-water riparian vegetation zones and tidal marsh.
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.	**11221** Restore shallow-water spawning habitat in upstream freshwater. **12** Reduce entrainment losses to water diversions. **12112** Provide transport flows to protect Sacramento River salmon smolts.
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.	**11221** Restore additional shallow-water spawning habitat in upstream freshwater.

Recovery Plan for Giant Garter Snake

The 2017 final recovery plan for giant garter snake includes recovery criteria for the present or threatened destruction, modification, or curtailment of its habitat or range. The recovery plan calls for a) sufficient habitat of suitable quality protected in each recovery unit, and b) connected blocks of habitat within each recovery unit. The strategy area includes the Yolo Basin recovery unit, and overlaps with a portion of the Colusa Basin recovery unit.

The recovery plan states that giant garter snake habitat will be preserved in multiples of two block pairings of habitat. Each block pair will consist of one 539-acre block of contiguous buffered perennial wetland habitat (existing, restored or enhanced) and one 1,578-acre block of contiguous active ricelands separated by no more than 5 miles. Alternatively, a pair of blocks may also consist of two 539-acre blocks of buffered perennial wetlands. The recovery plan states that block pairs should be evenly distributed among the management units. In addition, the habitat pairs must not be separated by more than 5 miles. The pairs of contiguous perennial wetlands and ricelands must be buffered by 0.5 kilometer (0.32 mile) of compatible habitat and the two blocks must be connected by a corridor of aquatic and upland habitat with a 0.8-kilometer (0.5-mile) minimum width.

The recovery plan also provides criteria for each recovery unit, including the following two units that overlap with the Yolo RCIS/LCP strategy area.

- **Yolo Basin Recovery Unit**. Minimum of five habitat block pairs with no less than one block pair per management unit in the Yolo Basin Recovery Unit (areas with high flooding flows within the Yolo Bypass should be considered as unsuitable habitat).

- **Colusa Basin Recovery Unit.** Minimum of six habitat block pairs with no less than two block pairs per management unit in the Colusa Basin Recovery Unit.

The Yolo RCIS/LCP is consistent with the recovery plan in that its objectives call for increasing existing protected areas 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. The objectives also call for managing and enhancing the aquatic habitat by providing sufficient water during the active season.

Vernal Pool Recovery Plan

The vernal pool recovery plan includes the following Yolo RCIS/LCP focal species: Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. The vernal pool recovery plan does not include goals to be met in Yolo County for Conservancy fairy shrimp and vernal pool fairy shrimp. For vernal pool tadpole shrimp, Solano grass, and Colusa grass, the recovery plan calls for 95% protection of the suitable species habitat at the Davis Communications Annex, in the Solano-Colusa Core Area in Yolo County. The Davis Communications Annex is now owned by the Yolo County and National Park Service, however, and is expected to remain fully protected and managed for the vernal pool species.

The Yolo RCIS/LCP provides for monitoring and adaptively managing 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. This is consistent with recovery action #2 of the vernal pool recovery plan, which is to manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern.

Valley Elderberry Longhorn Beetle Recovery Plan

In the 1984 recovery plan for valley elderberry longhorn beetle, there was insufficient information regarding the species' life history, distribution and habitat requirements to create long-term objectives. The USFWS outlined interim objectives and actions in the recovery plan focusing on preventing the further loss and degradation of the beetle's existing habitat. Interim objectives included: protect the three localities known at that time, 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. The protection, monitoring, and adaptive management of valley elderberry longhorn beetle outlined in the Yolo RCIS/LCP is not inconsistent with the recovery plan goals, and provides conservation beyond what was envisioned in the recovery plan when there were only three known localities.

Bank Swallow Recovery Plan

CDFW's 1992 bank swallow recovery plan and the subsequent 2013 bank swallow conservation plan prepared by the Bank Swallow Technical Advisory Committee emphasize protection of bank swallow colonies and maintaining fluvial processes along rivers and streams to create and maintain bank swallow habitat. The landscape level goals and objectives for the Yolo RCIS/LCP emphasize the need to maintain natural fluvial processes along rivers and creeks where possible. Additionally, the Yolo RCIS/LCP provides for managing and enhancing bank swallow habitat, consistent with the 1992 and 2013 recovery guidance on the bank swallow.

Appendix F1: Yolo RCIS/LCP Goals and Objectives Crosswalk[a]

The following crosswalk table identifies goals and objectives from other conservation plans that are similar or generally consistent with those listed in the Yolo RCIS/LCP. In some situations the applicable goals and objectives are the same, while in other situations the goal or objective listed for the RCIS/LCP may be either broader or narrower in scope than those identified for other conservation plans. The ID codes used for goals and objectives from other conservation plans coincide with the IDs shown in the column 'RCIS/LCP Cross-Walk ID' for each of the tables in Appendix F.

Yolo RCIS/LCP Goals and Objectives	Cache Creek Resources Management Plan (CCRMP)	Capay Valley Watershed Stewardship Plan (CVSP)	Colusa Basin Watershed Management Plan (CBWP)	Hungry Hollow Watershed Stewardship Plan (HH)	Lower Putah Creek Watershed Management Action Plan (LPC)	Willow Slough Watershed Integrated Resources Management Plan (WSMP)	Yolo Bypass Wildlife Area Land Management Plan (YBWA)	Yolo County Oak Woodland Conservation and Enhancement Plan (OWP)
Landscape Level Goals and Objectives (L)								
Goal L1: Large interconnected landscapes.	G10, G11	G4	G7	G4			G1, G2, G3, G4, G5, G6, G7, G9, G17	
Objective L1.1: Landscape Connectivity.		O4.1, O4.3	O7.3	O4.1, O4.3				
Objective L1.2: Areas to support sustainable populations.				O4.1				
Objective L1.3: Environmental Gradients.								
Objective L1.4: Natural community restoration.		O4.2						
Objective L1.5: Ecotone conservation.								
Goal L2: Ecological processes and conditions.	G2		G7		G1		G11, G12, G13, G14, G15, G16, G18	
Objective L2.1: Hydrologic and geomorphic processes.	O15							
Objective L2.2: Fire.								
Goal L3: Landscape-level stressors.								
Objective L3.1: Invasive species.		O4.4	G4	O4.4			G10	
Objective L3.2: Pollutants and toxins.	O10, O12							
Objective L3.3: Hazardous human land uses.								
Goal L4: Biodiversity, ecosystem function, and resilience.	G15	G4, G5	G8		G1		G9, G11, G12, G13, G14, G15, G16, G18	
Objective L4.1: Heterogeneity within agricultural matrix.								
Objective L4.2: Resilience to climate change.								
Objective L4.3: Natural community and habitat resilience with climate change.			O8.2					
Objective L4.4: Population viability and biodiversity resilience with climate change.			O8.2					
Natural Community Level								
Natural Community Level: Cultivated Land (CL)								
Goal CL1: Cultivated land habitat conservation.	G22	G5		G5		G7	G14, G15, G19	
Objective CL1.1: Mixed agricultural uses with habitat values.		O5.2		O5.4				
Objective CL1.2: Incorporation of habitat elements.	O26	O5.2	O7.1					
Objective CL1.3: Cultivated land pollinators.								
Natural Community Level: California Prairie (CP)								
Goal CP1: Large contiguous patches of California prairie to support native species.	G11	G4	G7			G3, G7	G14, G15	
Objective CP1.1: California prairie protection.				O4.1				
Objective CP1.2: Restore and enhance California prairie.								
Objective CP1.3: Burrowing rodents.								
Objective CP1.4: Grazing regimes.			O7.4					
Objective CP1.5: California prairie pollinators.								

Yolo RCIS/LCP Goals and Objectives	Cache Creek Resources Management Plan (CCRMP)	Capay Valley Watershed Stewardship Plan (CVSP)	Colusa Basin Watershed Management Plan (CBWP)	Hungry Hollow Watershed Stewardship Plan (HH)	Lower Putah Creek Watershed Management Action Plan (LPC)	Willow Slough Watershed Integrated Resources Management Plan (WSMP)	Yolo Bypass Wildlife Area Land Management Plan (YBWA)	Yolo County Oak Woodland Conservation and Enhancement Plan (OWP)
Natural Community Level: Chaparral (CH)								
Goal CH1: Chaparral conservation.			G7			G3		
Objective CH1.1: Protect chamise chaparral for connectivity.		O4.1						
Objective CH1.2: Protect mixed chaparral.								
Objective CH1.3: Manage chaparral.								
Objective CH1.4: Chaparral pollinators.								
Natural Community Level: Woodland and Forests (WF)								
Goal WF1: Valley oak protection and restoration.		G4	G7			G3, G7		G1, G7
Objective WF1.1: Increase valley oaks.		O4.2		O4.2				
Objective WF1.2: Protect valley oaks.		O4.1		O4.1				
Goal WF2: Upland oak protection and restoration/ enhancement.	G11	G4	G7			G3, G7		G1, G7
Objective WF2.1: Protect upland oaks.		O4.1		O4.1				
Objective WF2.2: Restore upland oaks.		O4.2						
Goal WF3: Riparian oak protection and restoration.	G19	G4	G7			G3, G7		G1, G7
Objective WF3.1: Protect riparian oaks and Oak Woodlands.		O4.1		O4.1				
Objective WF3.2: Restore and enhance riparian oaks and Oak Woodlands.				O4.2				
Goal WF4: Oak woodland management.		G4				G7		G1, G5
Objective WF4.1: Manage and enhance oak woodlands.								
Objective WF4.2: Oak woodland pollinators.								
Objective WF4.3: Burrowing rodents.								
Objective WF4.4: Grazing regimes.			O7.4					
Natural Community Level: Fresh Emergent Wetlands (FW)								
Goal FW1: Fresh emergent wetland conservation.		G4	G7			G3, G7	G11, G16, G18	
Objective FW1.1 Protect fresh emergent wetlands.		O4.1		O4.1				
Objective FW1.2: Increase fresh emergent wetland areas.		O4.2						
Objective FW1.3: Maintain or enhance fresh emergent wetland habitat areas.			O7.2					
Natural Community Level: Riparian (R)								
Goal R1: Riparian conservation.	G10, G11, G12, G19	G4		G4		G3, G7	G12, G13	
Objective R1.1: Protect riparian areas.	O14	O4.1		O4.1				
Objective R1.2: Increase riparian habitat areas.	O15	O4.2						
Objective R1.3: Maintain or enhance riparian habitat areas.	O14, O15		O7.2	O4.2				
Natural Community Level: Lacustrine/Riverine (LR)								
Goal LR1: Stream Conservation.	G11, G19	G1, G4	G7			G7	G16, G18	
Objective LR1.1: Fluvial equilibrium.	O5	O1.1, O1.2, O1.3, O1.4						
Objective LR1.2: American beavers.				O4.1				
Objective LR1.3: Native vegetation.	O15, O18, G12	O4.1, O4.2	O7.6					
Objective LR1.4: Stream processes and conditions.	O5		O7.2					
Natural Community Level: Alkali Prairie (AP)								
Goal AP1: Alkali prairie conservation.								

Yolo RCIS/LCP Goals and Objectives	Cache Creek Resources Management Plan (CCRMP)	Capay Valley Watershed Stewardship Plan (CVSP)	Colusa Basin Watershed Management Plan (CBWP)	Hungry Hollow Watershed Stewardship Plan (HH)	Lower Putah Creek Watershed Management Action Plan (LPC)	Willow Slough Watershed Integrated Resources Management Plan (WSMP)	Yolo Bypass Wildlife Area Land Management Plan (YBWA)	Yolo County Oak Woodland Conservation and Enhancement Plan (OWP)
Objective AP1.1: Protect Alkali Prairie.								
Natural Community Level: Vernal Pool (VP)								
Goal VP1: Vernal Pool Complex.								
Objective VP1.1: Protect vernal pool complexes.								
Objective VP1.2: Vernal pool pollinators.								
Species Level: Focal Plant Species (PLANT)								
Goal PLANT1: Conserve focal and conservation[c] plant species populations.								
Objective PLANT1.1: Protect focal and conservation plant species habitat and occurrences.			O7.3					
Objective PLANT1.2: Maintain or increase focal plant species abundance.				O4.2				
Species Level: Vernal Pool Invertebrates (VPI)								
Goal VPI1: Vernal pool invertebrate conservation.								
Objective VPI1.1: Maintain or increase vernal pool invertebrate populations.								
Species Level: Valley Elderberry Longhorn Beetle (VELB)								
Goal VELB1: Maintenance of valley elderberry longhorn beetle populations.								
Objective VELB1.1: Protect and manage valley elderberry longhorn beetle populations.				O4.1				
Objective VELB1.2: Valley elderberry longhorn beetle habitat amount, connectivity, and quality.								
Species Level: Focal Fish Species (FISH)								
Goal FISH1: Protected and enhanced focal fish species habitat.							G17	
Objective FISH1.1: Shaded riverine aquatic habitat.								
Objective FISH1.2: In-stream marsh habitat.								
Objective FISH1.3: Passage barriers.								
Objective FISH1.4: Large woody material.								
Objective FISH1.5: Yolo Bypass inundation.								
Objective FISH1.6: Restore Putah Creek fish habitat.								
Objective FISH1.7: Non-native predators.								
Objective FISH1.8: Research.								
Species Level: California Tiger Salamander (CTS)								
Goal CTS1: California tiger salamander conservation.								
Objective CTS1.1: Protect Upland Habitat.				O4.1				
Objective CTS1.2: Protect and restore aquatic habitat.			O7.2	O4.1				
Species Level: Western Spadefoot (WS)								
Goal WS1: Maintenance of western spadefoot distribution and abundance.								
Objective WS1.1: Habitat Protection.								
Species Level: Western Pond Turtle (WPT)								
Goal WPT1: Maintenance of western pond turtle distribution and abundance.								
Objective WPT1.1: Protect and enahnce habitat.			O7.2					
Species Level: Giant Garter Snake (GGS)								
Goal GGS1: Giant garter snake conservation. *C*								
Objective GGS1.1: Protect and manage rice land. *I*								
Objective GGS1.2: Protect and manage active season upland movement habitat.								

Yolo RCIS/LCP Goals and Objectives	Cache Creek Resources Management Plan (CCRMP)	Capay Valley Watershed Stewardship Plan (CVSP)	Colusa Basin Watershed Management Plan (CBWP)	Hungry Hollow Watershed Stewardship Plan (HH)	Lower Putah Creek Watershed Management Action Plan (LPC)	Willow Slough Watershed Integrated Resources Management Plan (WSMP)	Yolo Bypass Wildlife Area Land Management Plan (YBWA)	Yolo County Oak Woodland Conservation and Enhancement Plan (OWP)
Objective GGS1.3: Protect, restore, and manage aquatic non-rice habitat.			O7.2					
Objective GGS1.4: Protect large interconnected habitat blocks.								
Objective GGS1.5: Enhance giant garter snake habitat. *Enhance giant garter snake habitat by improving water quality, and incorporating refugia from floodwaters and basking sites for improved thermoregulation.*								
Species Level: Tricolored Blackbird (TRBL)								
Goal TRBL1: Tricolored blackbird conservation. *Conservation of tricolored blackbird populations in the Strategy Area.*							G7	
Objective TRBL1.1: Protect fresh emergent wetland.				O4.1				
Objective TRBL1.2: Protect nesting colonies.								
Objective TRBL1.3: Protect foraging habitat.				O4.1				
Objective TRBL1.4: Manage and enhance habitat.								
Species Level: Grasshopper Sparrow (GRSP)								
Goal GRSP1: Maintenance of grasshopper sparrow distribution and abundance.							G6	
Objective GRSP1.1: Protect habitat.								
Objective GRSP1.2: Maintain and enhance habitat.								
Species Level: Western Burrowing Owl (WBO)								
Goal WBO1: Western burrowing owl conservation.							G4, G6	
Objective WBO1.1: Protect habitat and active nest sites.								
Objective WBO1.2: Manage and enhance habitat.								
Species Level: Swainson's hawk (SWHA)								
Goal SWHA1: Swainson’s hawk conservation.							G4, G6	
Objective SWHA1.1: Protect agricultural foraging habitat.								
Objective SWHA1.2: Protect grassland foraging habitat.				O4.1				
Objective SWHA1.3: Protect nest trees.								
Objective SWHA1.4: Maintain or enhance nest tree density.								
Species Level: Greater Sandhill Crane (GSHC)								
Goal GSHC1: Protection and expansion of greater sandhill crane.							G7	
Objective GSHC1.1: Protect foraging habitat.								
Objective GSHC1.2: Create high-value foraging habitat.								
Objective GSHC1.3: Create managed wetland roosting habitat.								
Objective GSHC1.4: Create flooded cornfield roosting and foraging habitat.								
Species Level: Northern Harrier (NH)								
Goal NH1: Northern harrier habitat.								
Species Level: Bank Swallow (BS)								
Goal BS1: Bank swallow conservation.								
Objective BS1.1: Protect habitat.				O4.1				
Objective BS1.2: Manage and enhance habitat.								
Species Level: Black Tern (BT)								
Goal BT1: Black tern habitat.							G6	
Species Level: Western Yellow-Billed Cuckoo (WYBC)								
Goal WYBC1: Western yellow-billed cuckoo habitat.							G6	

Yolo RCIS/LCP Goals and Objectives	Cache Creek Resources Management Plan (CCRMP)	Capay Valley Watershed Stewardship Plan (CVSP)	Colusa Basin Watershed Management Plan (CBWP)	Hungry Hollow Watershed Stewardship Plan (HH)	Lower Putah Creek Watershed Management Action Plan (LPC)	Willow Slough Watershed Integrated Resources Management Plan (WSMP)	Yolo Bypass Wildlife Area Land Management Plan (YBWA)	Yolo County Oak Woodland Conservation and Enhancement Plan (OWP)
Objective WYBC 1.1: Protect western yellow-billed cuckoo habitat.								
Objective WYBC 1.2: Restore western yellow-billed cuckoo habitat.								
Species Level: Least Bell's Vireo (LBV)								
Goal LBV1: Least Bell's vireo habitat.								
Objective LBV1.1: Protect and Manage Least Bell's Vireo Habitat.								
Objective LBV1.2: Restore least Bell's vireo habitat.								
Species Level: White-Tailed Kite (WTK)								
Goal WTK1: White-tailed kite habitat.							G4	
Species Level: California Black Rail (CBR)								
Goal CBR1: California black rail habitat. *Suitable habitat conditions for California black rail in Yolo County.*							G7	
Objective CBR1.1: Protect California black rail habitat.								
Objective CBR1.2: Restore California black rail habitat.								
Objective CBR1.3: Enhance black rail habitat.			O7.2					
Species Level: Loggerhead Shrike (LS)								
Goal LS1: Loggerhead shrike habitat.							G6	
Species Level: Yellow-Breasted Chat (YBC)								
Goal YBC1: Yellow-breasted chat distribution and abundance. *S*								

a. The codes associated with other conservation plans refer to the RCIS/LCP crosswalk ID codes assigned to each goal and objective identified in other conservation plans in Appendix F where the letter indicates if it is a goal (G) or objective (O) and the number refers to the sequence that it appears in the conservation plan document.

Appendix Xb: Goals and Objectives From Other Conservation Plans

The following crosswalk tables list all goals and objectives explicitely identified in other conservation plans whose applicable planning area overlaps with at least a portion of the Yolo RCIS/LCP Strategy Area. The goals and objectives from these other conservation plans that are similar or generally consistent one or more of the Yolo RCIS/LCP goals and objectives are identified in the far righthand column where associated Yolo RCIS/LCP goals and objectives are identified by their ID code. In some situations the goal or objective listed from the Yolo RCIS/LCP is the same as the one from the other conservation plan, while in other situations the goal or objective listed for the RCIS/LCP may be either broader or narrower in scope than those identified for other conservation plans.

Cache Creek Resources Management Plan (CCRMP)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CCRMP-G1	2.2-1	32	Goal	Recognize that Cache Creek is a dynamic system that naturally undergoes gradual and sometimes sudden changes during high flow events	
CCRMP-G2	2.2-2	32	Goal	Establish a more natural channel floodway capable of conveying floodwaters without damaging essential structures, causing excessive erosion or adversely affecting adjoining land uses.	L2
CCRMP-G3	2.2-3	32	Goal	Coordinate land uses and improvements along Cache Creek so that the adverse effects of flooding and erosion are minimized.	
CCRMP-G4	2.2-4	32	Goal	Ensure that the floodway is maintained to allow other beneficial uses of the channel, including groundwater recharge, recreation, and riparian habitat, without adversely affecting flood flow conveyance capacity.	
CCRMP-O1	2.3-1	32	Objective	Support flood management objectives as required to protect the public health and safety.	
CCRMP-O2	2.3-2	32	Objective	Integrate the CCRMP with other planning efforts to create a comprehensive, multi-agency management plan for the entire Cache Creek watershed.	
CCRMP-O3	2.3-3	32	Objective	Recommend actions to create a more stable channel configuration with flood flow conveyance capacity that is consistent with regional flood management programs.	
CCRMP-O4	2.3-4	32	Objective	Protect permanent in-channel improvements (e.g., pipelines, bridges, levees, and dams) from structural failure caused by erosion and scour.	
CCRMP-O5	2.3-5	32	Objective	In order to allow the creek to aggrade and create a more natural channel system, restrict the amount of aggregate removed from Cache Creek, except where necessary to: increase flood flwo capacity; protect existing structures, infrastructure, and/pr farmland; minimize bank erosion; implement the Channel Form Template; enhance creek stability; establish riparian vegetation; or for recreation and/or open space uses consistent with the Parkway Plan.	LR1.1, LR1.4
CCRMP-O6	2.3-6	33	Objective	Establish monitoring programs for the continued collection of data and information to be used in managing the resources of Cache Creek.	
CCRMP-O7	2.3-7	33	Objective	Manage Cache Creek so that the needs of the various uses dependent upon the creek, such as flood protection, wildlife, groundwater, structural protection, and drainage, are appropriately balanced.	
CCRMP-G5	3.2-1	43	Goal	Improve the gathering and coordination of information about water resources so that effective policy decisions can be made.	
CCRMP-G6	3.2-2	43	Goal	Promote the conjunctive use of surface and groundwater to maximize the availability of water for a range of uses, including habitat, recreation, agriculture, water storage, flood control, and urban development.	
CCRMP-G7	3.2-3	43	Goal	Maintain the quality of surface and groundwater so that nearby agricultural productivity and available drinking water supplies are not diminished.	
CCRMP-G8	3.2-4	43	Goal	Enhance the quality of water resources by stressing prevention and stewardship rather than costly remediation.	
CCRMP-G9	3.2-5	43	Goal	Provide habitat restoration without increasing the generation of mosquitoes.	

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CCRMP-O8	3.3-1	43	Objective	Encourage the development of a groundwater recharge program, where appropriate, within the Cache Creek basin. The program may specify use of reclaimed mining pits and open lakes to the greatest extent feasible, while maintaining consistency with the other goals, objectives, actions, and standards of both the CCRMP and OCMP	
CCRMP-O9	3.3-2	43	Objective	Use the CCRMP as a basis for developing a comprehensive watershed plan for Cache Creek that eventually integrates the area above Clear Lake to the Yolo Bypass, relying on coordinated interagency management.	
CCRMP-O10	3.3-3	43	Objective	Eliminate water quality impacts from the use of pesticides, fertilizers, and other soil amendments in the channel. Promote public education programs that encourage the use of innovative methods and practices for enhancing the water quality of Cache Creek through the voluntary cooperation of local landowners	L3.2
CCRMP-O11	3.3-4	43	Objective	Establish monitoring programs for the continued collection of data and information to be used in managing surface and groundwater resources.	
CCRMP-O12	3.3-5	43	Objective	Promote the safe use and handling procedures of hazardous materials during creek management activities.	L3.2
CCRMP-O13	3.3-6	44	Objective	Minimize mosquito generating potential in habitat restoration areas	
CCRMP-G10	4.2-1	55	Goal	Provide for a diverse, native riparian ecosystem within the CCRMP area that is self-sustaining and capable of supporting native wildlife.	L1, R1
CCRMP-G11	4.2-2	56	Goal	Create a continuous corridor of riparian, upland, and herbaceous vegetation spanning the CCRMP area.	L1, R1, CP1, LR1, WF2
CCRMP-G12	4.2-3	56	Goal	Develop high quality natural habitat that is dominated by native plants	R1, LR1.3
CCRMP-G13	4.2-4	56	Goal	Manage riparian habitat so that it contributes to channel stability	
CCRMP-G14	4.2-5	56	Goal	Establish monitoring programs for the continued collection of data and information to be used in measuring the success of revegetation efforts.	
CCRMP-G15	4.2-6	56	Goal	Integrate climate-smart adaptation strategies to increase resiliency and prepare for future uncertainty.	L4
CCRMP-O14	4.3-1	56	Objective	Conserve and protect existing riparian habitat within the CCRMP area to the greatest extent possible. Where channel maintenance or improvement activities result in the removal of riparian habitat, require disturbed areas to be restored. Where vegetation has been removed within the channel to maintain or improve flood flow conveyance capacity and/or erosion control purposes, restoration shall be done in nearby areas that do not adversely affect flood flow conveyance capacity.	R1.1, R1.3, LR1.3
CCRMP-O15	4.3-2	56	Objective	Establish conditions to encourage the development of a variety of natural riparian habitat types within the CCRMP area in order to support biological resources associated with Cache Creek.	L2.1, R1.2, R1.3, LR1.3
CCRMP-O16	4.3-3	56	Objective	Adopt standards for planning, implementating, and monitoring habitat revegetation and restoration projects in order to ensure consistency, maximize success, and account for future uncertainty due to climate change.	
CCRMP-O17	4.3-4	56	Objective	Ensure that the establishment of habitat does not significantly divert streamflow or cause excessive erosion or damage to nearby structures and/or property.	
CCRMP-O18	4.3-5	56	Objective	Encourage the use of alternative methods and practices for erosion control that incorporate riparian vegetation in the design.	LR1.3
CCRMP-O19	4.3-6	56	Objective	Coordinate restoration programs with relevant planning efforts of both the County and other private and public agencies. Encourage regional mitigation to occur within the CCAP plan area , consistent with the program and the Parkway Plan.Require mitigation obligations resulting from mining applications to be implemented within the CCAP plan area, consistent with the Parkway Plan.	
CCRMP-G16	5.2-1	71	Goal	Improve scenic resources within the Cache Creek channel.	
CCRMP-G17	5.2-2	71	Goal	Establish a variety of outdoor recreational and educational opportunities along Cache Creek for use by the public.	

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CCRMP-G18	5.2-3	71	Goal	Ensure the compatibility of recreational facilities with surrounding land uses and sensitive wildlife habitat, in order to minimize adverse impacts.	
CCRMP-O20	5.3-1	71	Objective	Create a continuous corridor of natural open space along the creek and provide for limited access, at specific locations, to recreational and educational uses.	
CCRMP-O21	5.3-2	71	Objective	Continue to use the "Open Space" designation for areas where resource management and habitat protection is warranted.	
CCRMP-G19	6.2-1	76	Goal	Use the removal of in-channel aggregate deposits as an opportunity to reclaim, restore, and/or enhance the channel stability and habitat of Cache Creek.	LR1
CCRMP-G20	6.2-2	76	Goal	Provide for effective and systematic monitoring and reclamation of aggregate removal activities within Cache Creek.	
CCRMP-O22	6.3-1	76	Objective	Reduce duplication of effort and conflicting regulatory authorities in order to encourage implementation of appropriate management measures and practices within and adjacent to Cache Creek.	
CCRMP-O23	6.3-2	76	Objective	Revise existing regulatory measures to more accurately reflect the environmental processes of Cache Creek.	
CCRMP-O24	6.3-3	76	Objective	Enlist the cooperation of private and public interests to assist in maintenance and channel reshaping efforts.	
CCRMP-G21	7.2-1	88	Goal	Protect farmland along Cache Creek from land uses that may conflict with agricultural operations.	
CCRMP-G22	7.2-2	88	Goal	Develop opportunities where restoration efforts and agriculture can provide mutual benefits.	CL1
CCRMP-O25	7.3-1	88	Objective	Ensure the compatibility of planned habitat and the channel floodplain with adjoining agricultural land, so that productivity is not adversely affected.	
CCRMP-O26	7.3-2	88	Objective	Coordinate with local farmers to employ existing agricultural practices in improving the quality of riparian habitat.	CL1.2
CCRMP-O27	7.3-3	88	Objective	Manage Cache Creek to reduce the loss of farmland from erosion and increase the recharge potential of the channel.	

Capay Valley Watershed Stewardship Plan (CVSP)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CVSP-G1	1	27	Goal	To manage watershed lands to minimize unnatural rates of erosion and sedimentation.	LR1

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CVSP-O1.1	1.1	27	Objective	Reduce streambank instability and erosion	LR1.1
CVSP-O1.2	1.2	27	Objective	Reduce erosion resulting from agricultural activities	LR1.1
CVSP-O1.3	1.3	28	Objective	Reduce erosion from new and existing roads	LR1.1
CVSP-O1.4	1.4	28	Objective	Increase the use of erosion control techniques and practices for existing land uses	LR1.1
CVSP-O1.5	1.5	28	Objective	Make the community aware of the causes of erosion	
CVSP-G2	2	29	Goal	To use and manage both surface and ground water wisely to meet current and future needs.	
CVSP-O2.1	2.1	29	Objective	Determine water resources for the tributary watersheds and Cache Creek in Capay Valley	
CVSP-O2.2	2.2	29	Objective	Increase water use efficiency	
CVSP-O2.3	2.3	29	Objective	Use a watershed approach for analyzing flooding issues	
CVSP-O2.4	2.4	29	Objective	Support creative and collaborative solutions to water supply needs	
CVSP-O2.5	2.5	30	Objective	Make the community aware of water supply issues	
CVSP-G3	3	30	Goal	To maintain and improve water quality for all water users.	
CVSP-O3.1	3.1	30	Objective	Prevent ground water and surface water contamination from nutrients, chemicals and sediment.	
CVSP-O3.2	3.2	30	Objective	Determine sources of water quality impairment	
CVSP-O3.3	3.3	30	Objective	Make the community aware of causes (i.e. products and practices) of water quality impairment	
CVSP-G4	4	31	Goal	To maintain and improve watershed habitats to support a diversity of native plants and animals.	L1, L4, LC1, CP1, WF1, WF2, WF3, WF4, R1, LR1
CVSP-O4.1	4.1	31	Objective	Protect existing native plant and animal communities, habitats, and wildlife corridors	L1.1, LR1.3, CH1.1, WF1.2, WF2.1, WF3.1, FW1.1, R1.1
CVSP-O4.2	4.2	31	Objective	Reestablish native plant communities	L1.4, WF1.1, WF2.2, LR1.3, FW1.2, R1.2
CVSP-O4.3	4.3	31	Objective	Establish and maintain wildlife corridors between open spaces	L1.1
CVSP-O4.4	4.4	32	Objective	Manage non-native invasive vegetation	L3.1
CVSP-G5	5	32	Goal	To promote land management practices that maintain and improve local natural resources and habitats and support a productive and sustainable agricultural economy.	L4, CL1
CVSP-O5.1	5.1	32	Objective	Use a watershed approach when making natural resource decisions	
CVSP-O5.2	5.2	32	Objective	Increase the awareness and use of sustainable agricultural practices	CL1.1, CL1.2
CVSP-O5.3	5.3	33	Objective	Support a marketing effort that promotes Capay Valley products	
CVSP-O5.4	5.4	33	Objective	Encourage appropriate land protection measures to allow willing farmers to keep their land in agricultural production	
CVSP-G6	6	33	Goal	To promote a watershed approach for decisions involving Cache Creek by supporting communication and collaboration among all stakeholders.	
CVSP-O6.1	6.1	33	Objective	Support an open forum for meaningful discussion of issues concerning the watershed including public-private land management issues	
CVSP-O6.2	6.2	33	Objective	Increase awareness of watershed issues	

Colusa Basin Watershed Management Plan (CBWP)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CBWP-G1	1	19	Goal	Protect, maintain and improve water quality	
CBWP-O1.1	1	21	Objective	Evaluate current conditions	
CBWP-O1.2	2	21	Objective	Recommend water quality improvement measures	
CBWP-O1.3	3	23	Objective	Encourage and implement measures to protect groundwater from contaminants	

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CBWP-O1.4	4	24	Objective	Recommend Best Management Practices (BMPs) for agricultural and rangeland areas to reduce soil erosion and associated sediment loading into drainages	
CBWP-G2	2	25	Goal	Promote activities to ensure a dependable water supply for current and future needs	
CBWP-O2.1	1	28	Objective	Encourage wise use and management of surface and ground water	
CBWP-O2.2	2	29	Objective	Provide strategies to adjust to drought conditions	
CBWP-O2.3	3	30	Objective	Investigate and implement practices that enhance groundwater recharge	
CBWP-O2.4	4	31	Objective	Provide current local and statewide water supply information to communities	
CBWP-G3	3	33	Goal	Preserve agricultural land and open space	
CBWP-O3.1	1	35	Objective	Create public awareness of the benefits of agriculture and open space	
CBWP-O3.2	2	36	Objective	Preserve working agricultural lands and open space	
CBWP-G4	4	37	Goal	Manage and reduce invasive plant populations	L3.1
CBWP-O4.1	1	40	Objective	Regularly identify invasive species concerns to facilitate early detection	
CBWP-O4.2	2	41	Objective	Maintain the Colusa Basin Watershed GIS weed map with current status of mapped species	
CBWP-O4.3	3	41	Objective	Promote education and public awareness	
CBWP-O4.4	4	42	Objective	Develop tools to control invasive species of concern as they become known	
CBWP-O4.5	5	44	Objective	Promote BMPs for all types of invasive species management and abatement	
CBWP-O4.6	6	45	Objective	Acquire funding for collaborative weed eradication projects	
CBWP-G5	5	47	Goal	Reduce destructive flooding	
CBWP-O5.1	1	49	Objective	Assess the status and functionality of flood control infrastructure (e.g., drainage canals, ditches, canal banks, levees) and identify areas of risk	
CBWP-O5.2	2	50	Objective	Manage flood water for short-term retention and groundwater recharge where appropriate and promote recharge infrastructure	
CBWP-O5.3	3	50	Objective	Develop and implement measures to control runoff in foothills and on agricultural lands	
CBWP-G6	6	54	Goal	Enhance soil quality and reduce erosion	
CBWP-O6.1	1	55	Objective	Reduce channel instability and stream bank erosion	
CBWP-O6.2	2	56	Objective	Advocate alternatives to non-vegetated streambanks and irrigation ditches	
CBWP-O6.3	3	57	Objective	Provide natural soil protection measures to reduce soil erosion and improve soil quality on farm land and range land	
CBWP-O6.4	4	58	Objective	Assist land managers with soil erosion reduction measures and soil quality improvements	
CBWP-G7	7	59	Goal	Preserve and enhance native habitat	L1, L2, CP1, CH1, WF1, WF2, WF3, FW1, LR1
CBWP-O7.1	1	63	Objective	Encourage installation of on-farm habitat features	CL1.2
CBWP-O7.2	2	64	Objective	Improve or enhance freshwater wetland habitat, waterways and ponds	FW1.3[a], R1.3, LR1.4, CTS1.2, WPT1.1, GGS1.3, CBR1.3
CBWP-O7.3	3	65	Objective	Maintain existing native plant habitat and reestablish native habitat stands, emphasizing areas with greatest potential for connectivity	L1.1, PLANT1.1[b]
CBWP-O7.4	4	66	Objective	Promote healthy grassland/oak woodland habitat through managed livestock grazing	CP1.4, WF4.4
CBWP-O7.5	5	67	Objective	Promote wise management of all watershed habitats utilizing a variety of proven tools and methods	
CBWP-O7.6	6	67	Objective	Encourage and promote the use of native plants throughout the watershed	LR1.3
CBWP-G8	8	68	Goal	Address unknown future effects of climate change	L4
CBWP-O8.1	1	70	Objective	Maintain a collaborative partnership with the research community to stay current on science related to climate change, and disseminate information gained	
CBWP-O8.2	2	71	Objective	Enhance biodiversity conservation and ecosystem services to promote sustainable natural ecosystems and human wellbeing	L4.3, L4.4

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
CBWP-O8.3	3	73	Objective	Support programs that promote carbon sequestration and greenhouse gas (GHG) reduction	

a. The Admin Review Draft of the Yolo RCIS/LCP did not include any enhancement objectives specific to the fresh emergent wetland natural community. Chris
b. The plant species goals and objectives for plants in the Admin Review Draft of the Yolo RCIS/LCP are specific to focal species. Chris Alford recommends that

Hungry Hollow Watershed Stewardship Plan (HH)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
HH-G1	NA	31	Goal	To manage watershed lands to minimize unnatural rates of erosion and sedimentation	
HH-O1.1	NA	31	Objective	Reduce streambank instability and erosion in the foothills	
HH-O1.2	NA	32	Objective	Reduce erosion resulting from agricultural activities	
HH-O1.3	NA	32	Objective	Increase the use of erosion control techniques and practices for existing land use	
HH-O1.4	NA	32	Objective	Make the Hungry Hollow community aware of the causes of erosion	
HH-G2	NA	33	Goal	To use and manage surface, groundwater, and stormwater wisely to meet current and future needs	
HH-O2.1	NA	33	Objective	Use a watershed approach for analyzing flooding issues	
HH-O2.2	NA	33	Objective	Support creative and collaborative solutions to surface and stormwater conveyance needs	
HH-O2.3	NA	33	Objective	Make the Hungry Hollow community aware of surface and stormwater conveyance needs	
HH-O2.4	NA	34	Objective	Increase water use efficiency	
HH-G3	NA	34	Goal	To maintain and improve water quality for all water users	
HH-O3.1	NA	34	Objective	Prevent groundwater and surface water contamination from nutrients, chemicals and sediment	
HH-O3.2	NA	35	Objective	Determine sources of water quality impairment	
HH-O3.3	NA	35	Objective	Make the community aware of causes (i.e. products and practices) of water quality impairment	
HH-G4	NA	35	Goal	To maintain and improve watershed habitats to support a diversity of native plants and animals	L1, R1
HH-O4.1	NA	35	Objective	Protect existing native plant and animal communities, habitats, and wildlife corridors[a]	L1.1, L1.2, CP1.1, WF1.2, WF2.1, WF3.1,FW1.1, R1.1, LR1.2, VELB1.1, CTS1.1, CTS1.2, TRBL1.1, TRBL1.3, SWHA1.2, BS1.1
HH-O4.2	NA	35	Objective	Reestablish native plant communities in appropriate areas	R1.3, PLANT1.2, WF1.1, WF3.2
HH-O4.3	NA	36	Objective	Establish and maintain wildlife corridors between open spaces	L1.1
HH-O4.4	NA	36	Objective	Manage non-native invasive vegetation	L3.1
HH-G5	NA	37	Goal	To promote land management practices that support a sustainable and productive agricultural economy.	CL1
HH-O5.1	NA	37	Objective	Use a watershed approach when making natural resource decisions	
HH-O5.2	NA	37	Objective	Increase the awareness and use of sustainable agricultural practices	
HH-O5.3	NA	38	Objective	Support a marketing effort that promotes Hungry Hollow products	
HH-O5.4	NA	38	Objective	Encourage appropriate land protection measures to allow willing farmers to keep their land in agricultural production	CL1.1
HH-G6	NA	38	Goal	To promote a watershed approach for decisions involving Hungry Hollow by supporting communication and collaboration among all stakeholders.	
HH-O6.1	NA	38	Objective	Support an open forum for meaningful discussion of issues concerning the watershed including public-private land management issues	

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
HH-O6.2	NA	39	Objective	Increase awareness of watershed issues	

a. Species-specific objectives identified include only the species specifically mentioned in the Hungry Hollow Watershed Stewardship Plan. There may be other focal or conservation species within the plan area that have compatible species-specific objectives.

Lower Putah Creek Watershed Management Action Plan (LPC)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
LPC-G1	NA	iii	Goal	Restore and enahance the lower Putah Creek watershed to a self-sustaining ecological condition.	L2, L4

Willow Slough Watershed Integrated Resources Management Plan (WSMP)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
WSMP-G1	NA	I-3	Goal	to control flooding and avoid the effects of flooding,	
WSMP-G2	NA	I-3	Goal	to conserve and manage water resources	
WSMP-G3	NA	I-4	Goal	to establish natural and wildlife areas,	CP1, CH1, WF1, WF2, WF3, FW1, R1
WSMP-G4	NA	I-4	Goal	to control erosion and practice soil management,	
WSMP-G5	NA	I-4	Goal	to maintain good road conditions,	
WSMP-G6	NA	I-4	Goal	to avoid, mitigate, or eliminate hazards and nuisances	
WSMP-G7	NA	I-4	Goal	to improve the quantity and quality of wildlife habitat	CL1, CP1, WF1, WF2, WF3, WF4, FW1, R1, LR1
WSMP-G8	NA	I-4	Goal	to maintain and enhance the physical and economic conditions for agriculture,	
WSMP-G9	NA	I-4	Goal	to decrease problems associated with flooding,	
WSMP-G10	NA	I-4	Goal	to decrease the cost of vegetation maintenance along roads and canals,	
WSMP-G11	NA	I-4	Goal	to minimize undesirable sediment deposition,	
WSMP-G12	NA	I-4	Goal	to minimize erosion and topsoil loss,	
WSMP-G13	NA	I-4	Goal	to improve water quality,	
WSMP-G14	NA	I-4	Goal	to increase groundwater recharge.	
WSMP-O1	NA	I-5	Objective	implementation of any actions should be voluntary on the part of the landowner,	
WSMP-O2	NA	I-5	Objective	the plan should emphasize small-scale projects and management practices that can be implemented by individual landowners or groups of landowners,	
WSMP-O3	NA	I-5	Objective	implementation measures should be compatible with agricultural production	
WSMP-O4	NA	I-5	Objective	agency participation should be to assist landowners in meeting the plan goals or to facilitate large projects	

Yolo Bypass Wildlife Area Land Management Plan (YBWA)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
YBWA-G1	SG-1	5-7	Goal	Manage and maintain habitat communities for waterfowl species.	L1
YBWA-G2	SG-2	5-9	Goal	Manage and maintain habitat communities for shorebird and wading bird species.	L1
YBWA-G3	SG-3	5-10	Goal	Maintain and enhance habitat for upland game species.	L1
YBWA-G4	SG-4	5-11	Goal	Manage and maintain habitat communities for raptors.	L1, SWHA1, WBO1, WTK1
YBWA-G5	SG-5	5-12	Goal	Manage and maintain habitat communities for cavity-nesting bird species	L1

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
YBWA-G6	SG-6	5-13	Goal	Manage and maintain communities for neotropical bird species.	L1, GRSP1, WBO1, SWHA1, BT1, LS1, WYBC1, YBC1
YBWA-G7	SG-7	5-14	Goal	Manage and maintain communities for a variety of other waterbird species including grebes, rails, bitterns, ibis and songbirds associated with emergent marsh vegetation.	L1, TRBL1, GSHC1, CBR1
YBWA-G8	SG-8	5-14	Goal	Maintain and enhance foraging opportunities for the presence of breeding colonies of bats roosting under the Yolo Causeway	
YBWA-G9	SS-1	5-16	Goal	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.	L1, L4
YBWA-G10	IS-1	5-17	Goal	Prevent the introduction and spread of invasive nonnative species that have no benefit to wildlife or that impact special status plants.	L3-1
YBWA-G11	SPW-1	5-19	Goal	Following accepted scientific principles and practices, restore and enhance wetlands to conditions that provide desired ecological functions.	L2, L4, FW1[a]
YBWA-G12	R-1	5-21	Goal	Maintain and enhance riparian communities for native species diversity and abundance (including special-status species).	L2, L4, R1
YBWA-G13	R-2	5-22	Goal	Restore and enhance riparian communities to conditions that provide desired ecological functions.	L2, L4, R1
YBWA-G14	GU-1	5-23	Goal	Maintain and enhance grassland and upland communities for diversity and abundance of native species (including special-status species).	L2, L4, CP1, CL1
YBWA-G15	GU-2	5-24	Goal	Restore and enhance grassland and upland communities to conditions that provide desired ecological functions.	L2, L4, CP1, CL1
YBWA-G16	AE-1	5-25	Goal	Maintain and enhance aquatic ecosystems for diversity and abundance of native species (including special-status species).	L2, L4, FW1, LR1
YBWA-G17	AE-2	5-26	Goal	Maintain and enhance habitat for game fish species	L1, FISH1
YBWA-G18	AE-3	5-26	Goal	Restore and enhance aquatic ecosystems to conditions that provide desired ecological functions.	L2, L4, FW1, LR1
YBWA-G19	AR-1	5-29	Goal	Use agricultural techniques to maintain and enhance habitat for native wildlife and plants.	CL1
YBWA-G20	AR-2	5-30	Goal	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.	
YBWA-G21	CR-1	5-32	Goal	Catalog and preserve all cultural resources that have yielded or have the potential to yield information important to the prehistory or history of the Yolo Bypass Wildlife Area or that otherwise would meet significance criteria according to the California Register of Historical Resources (CRHR).	
YBWA-G22	PU-1	5-33	Goal	Increase existing and provide new long-term opportunities for appropriate wildlifedependent activities by the public.	
YBWA-G23	PU-2	5-36	Goal	Support and expanded public use of the Yolo Bypass Wildlife Area for environmental education and interpretation.	
YBWA-G24	PU-3	5-39	Goal	Coordinate public access to and use of facilities including tour routes, parking areas, Putah Creek, the planned Pacific Flyway Center, and other areas to accommodate a variety of different user groups	
YBWA-G25	PU-4	5-41	Goal	Continue to foster community partnerships	
YBWA-G26	PU-5	5-42	Goal	Continue and expand the volunteer program.	
YBWA-G27	PU-6	5-43	Goal	Minimize competition and conflicts among users and facilitate compatibility between public uses.	
YBWA-G28	PU-7	5-43	Goal	Support use of the Yolo Bypass Wildlife Area by Native Americans for activities such as gathering native plant materials for cultural purposes.	
YBWA-G29	PU-8	5-44	Goal	Facilitate safe use of the Yolo Bypass Wildlife Area by informing the public of potential risks, and also develop an emergency response plan.	
YBWA-G30	UPU-1	5-44	Goal	Prevent unauthorized use of the Yolo Bypass Wildlife Area	

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
YBWA-G31	F-1	5-46	Goal	Management and operation of the Yolo Bypass Wildlife Area in coordination with state and federal flood operations in the Yolo Bypass.	
YBWA-G32	F-2	5-47	Goal	Construction, maintenance, and removal of facilities.	
YBWA-G33	F-3	5-47	Goal	Effectively manage existing facilities and/or structures for resource protection, safety,and prevention of unauthorized uses.	
YBWA-G34	F-4	5-48	Goal	Construct, operate and maintain the Pacific Flyway Center and other associated facilities.	
YBWA-G35	F-5	5-48	Goal	Maintain equipment necessary for future management of the Wildlife Area.	
YBWA-G36	F-6	5-49	Goal	Consider the construction and operation of an outdoor shooting range for bi-annual use by local game warden squad for periodic firearm use qualification process.	
YBWA-G37	A-1	5-49	Goal	Maintain current data on the management and resources of the Yolo Bypass Wildlife Area.	
YBWA-G38	FM-1	5-51	Goal	Develop and implement a wildfire plan for the Yolo Bypass Wildlife Area	
YBWA-G39	SRM-1	5-54	Goal	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.	
YBWA-G40	MC-1	5-57	Goal	Coordinate with federal, state, and local agencies regarding plans and projects that may affect habitats and/or management at the Yolo Bypass Wildlife Area	
YBWA-G41	MC-2	5-57	Goal	Coordinate with flood control agencies regarding flood control and management in the Yolo Bypass.	
YBWA-G42	MC-3	5-58	Goal	Coordinate with other law enforcement agencies	
YBWA-G43	MC-4	5-58	Goal	Coordinate with local public-service agencies including the SYMVCD and the Yolo County Health Department.	
YBWA-G44	MC-5	5-59	Goal	Maintain relationships with neighbors and tenants to address management issues.	
YBWA-G45	MC-6	5-60	Goal	Coordinate activities associated with managing cholera, avian flu, and other disease outbreaks.	

a. The Admin Review Draft of the Yolo RCIS/LCP did not include any enhancement objectives specific to the fresh emergent wetland natural community. Chris Alford recommends adding an objective FW1-3, which addresses this. If the group decides not to add this proposed objective then remove reference to FW1-3

Yolo County Oak Woodland Conservation and Enhancement Plan (OWP)

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
OWP-G1	NA	44	Goal	Protect existing oak woodlands by creating a voluntary program, including landowner incentives, for oak woodland conservation and enhancement.	WF1, WF2, WF3, WF4
OWP-G2	NA	44	Goal	Encourage the use of land use and infrastructure planning strategies that are consistent with oak woodland conservation efforts.	
OWP-G3	NA	44	Goal	Direct conservation and enhancement funding and effort to areas that have the highest oak woodland resource values.	
OWP-G4	NA	44	Goal	Direct mitigation for oak woodland impacts to areas that have the highest oak woodland resource values.	
OWP-G5	NA	44	Goal	Encourage the long-term stewardship of existing oak woodlands to maintain or improve oak woodland resource values.	WF1, WF2, WF3, WF4
OWP-G6	NA	44	Goal	Provide funding and technical assistance for oak woodland enhancement efforts that achieve multiple benefits.	
OWP-G7	NA	44	Goal	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.	WF1, WF2, WF3

RCIS/LCP Cross-Walk ID	ID in Plan	Page in Plan	Identification in Plan	Language	RCIS/LCP Goals & Objectives
OWP-G8	NA	44	Goal	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.	
OWP-G9	NA	45	Goal	Coordinate oak woodland conservation and enhancement efforts with the Yolo County Habitat Conservation Plan/Natural Community Conservation Plan, the Yolo County General Plan, the Parks and Open Space Master Plan, the Cache Creek Resources Management Plan, and other local and state applicable conservation plans.	

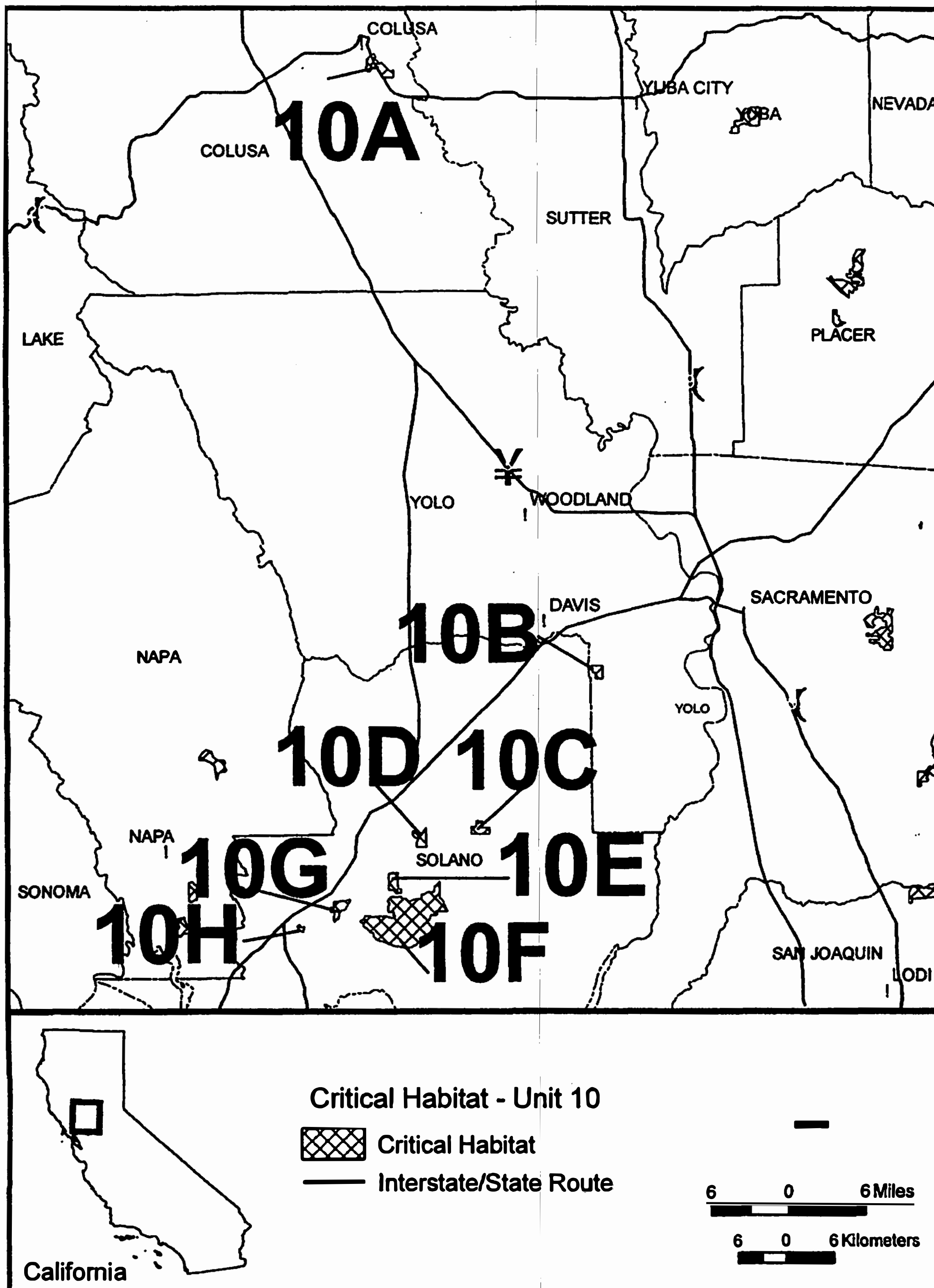
Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

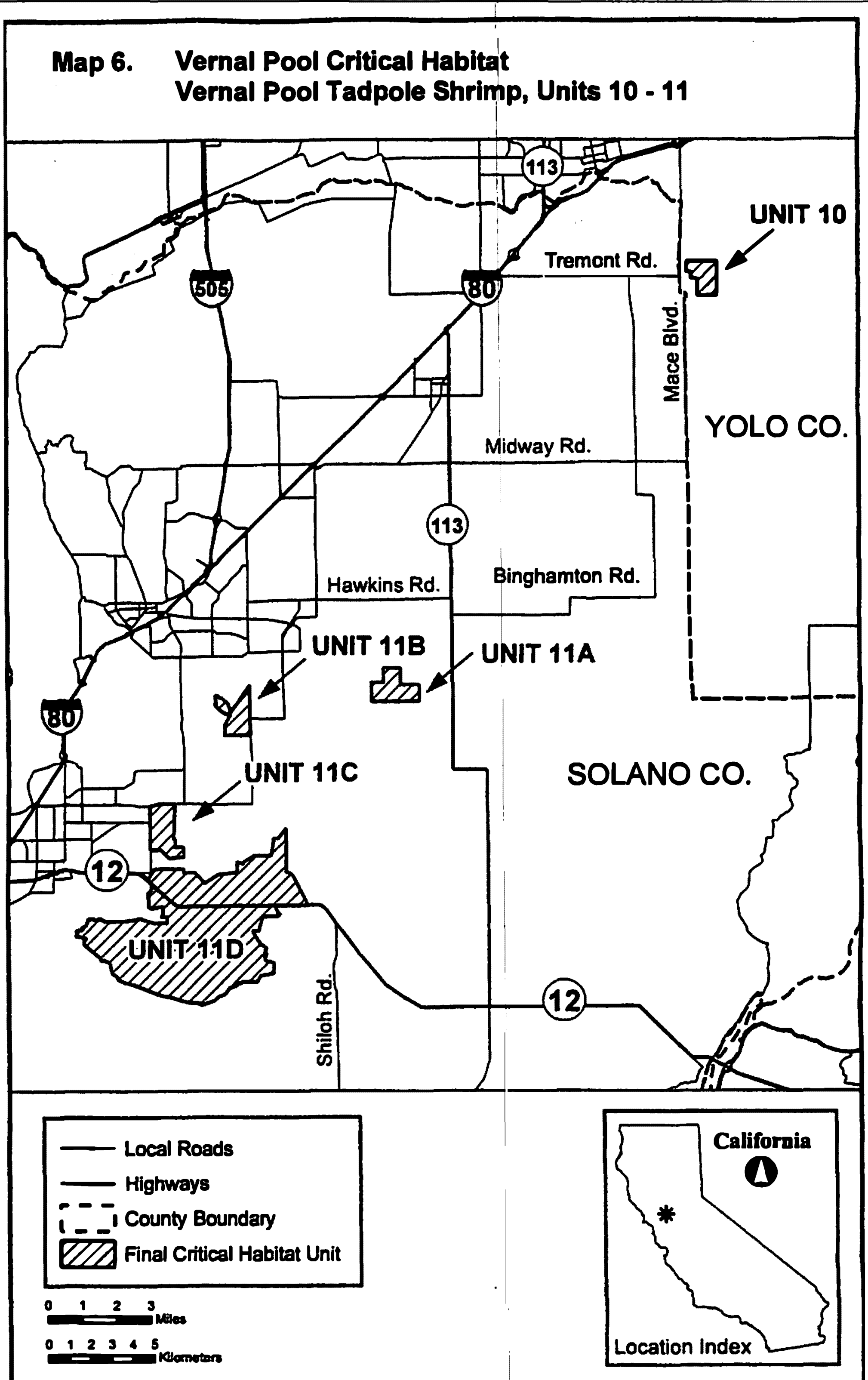
<table>
<tr><td>Title:</td><td>Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions from August 2003 Final Designation</td><td>Binder:</td><td>1
web</td></tr>
<tr><td>Lead Agency:</td><td colspan="3">Federal Register: Department of the Interior, U.S. Fish and Wildlife Service
2003, updated in 2005, map locations refined in 2006</td></tr>
<tr><td>Goals & Purpose:</td><td colspan="3">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)).</td></tr>
<tr><td>Status:</td><td colspan="3">Completed 2006</td></tr>
<tr><td rowspan="2">LCP/RCIS</td><td>Group 1</td><td>Group 2</td><td>Group 3</td></tr>
<tr><td>Conservancy fairy shrimp
Vernal pool fairy shrimp
Vernal pool tadpole shrimp
Colusa grass
Solano grass</td><td></td><td></td></tr>
<tr><td>Plan/Program</td><td colspan="3">The State of California and Southern Oregon</td></tr>
<tr><td>Yolo County</td><td colspan="3">Attached maps for one area in Yolo County that contains critical habitat for Solano grass, Colusa grass and vernal pool tadpole shrimp</td></tr>
<tr><td>LCP/RCIS</td><td colspan="3">Vernal pool complex natural communities, and fresh emergent wetland (they call it ephemeral freshwater habitat)</td></tr>
<tr><td>Implementation</td><td colspan="3">Final Rule adopted in 2006</td></tr>
<tr><td>Governance:</td><td colspan="3">Section 7 requires consultation on Federal actions that could affect critical habitat.</td></tr>
<tr><td>Funding:</td><td colspan="3">No funding needed, must consult with U.S. Fish and Wildlife Service before impacting critical habitat.</td></tr>
</table>

Doc 2005


COLUSA
YUBA CITY
YUBA
NEVADA
10A
COLUSA
SUTTER
PLACER
LAKE
YOLO
WOODLAND
DAVIS
SACRAMENTO
10B
NAPA
YOLO
10D
10C
NAPA
10G
SOLANO
10E
SONOMA
10H
10F
SAN JOAQUIN
LODI
Critical Habitat - Unit 10
Critical Habitat
Interstate/State Route
6 0 6 Miles
6 0 6 Kilometers
California

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

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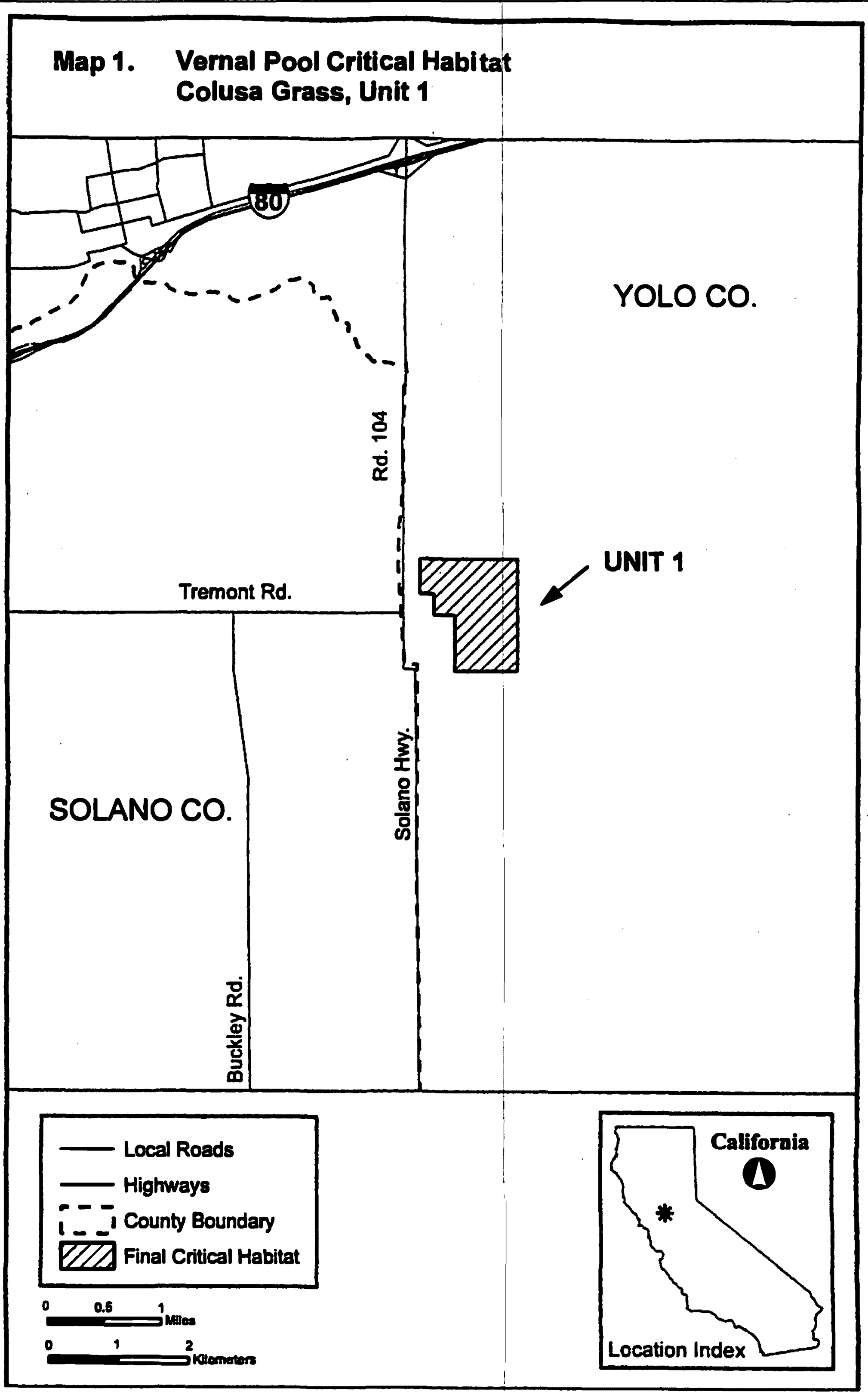

BILLING CODE 4310-55-C

(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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(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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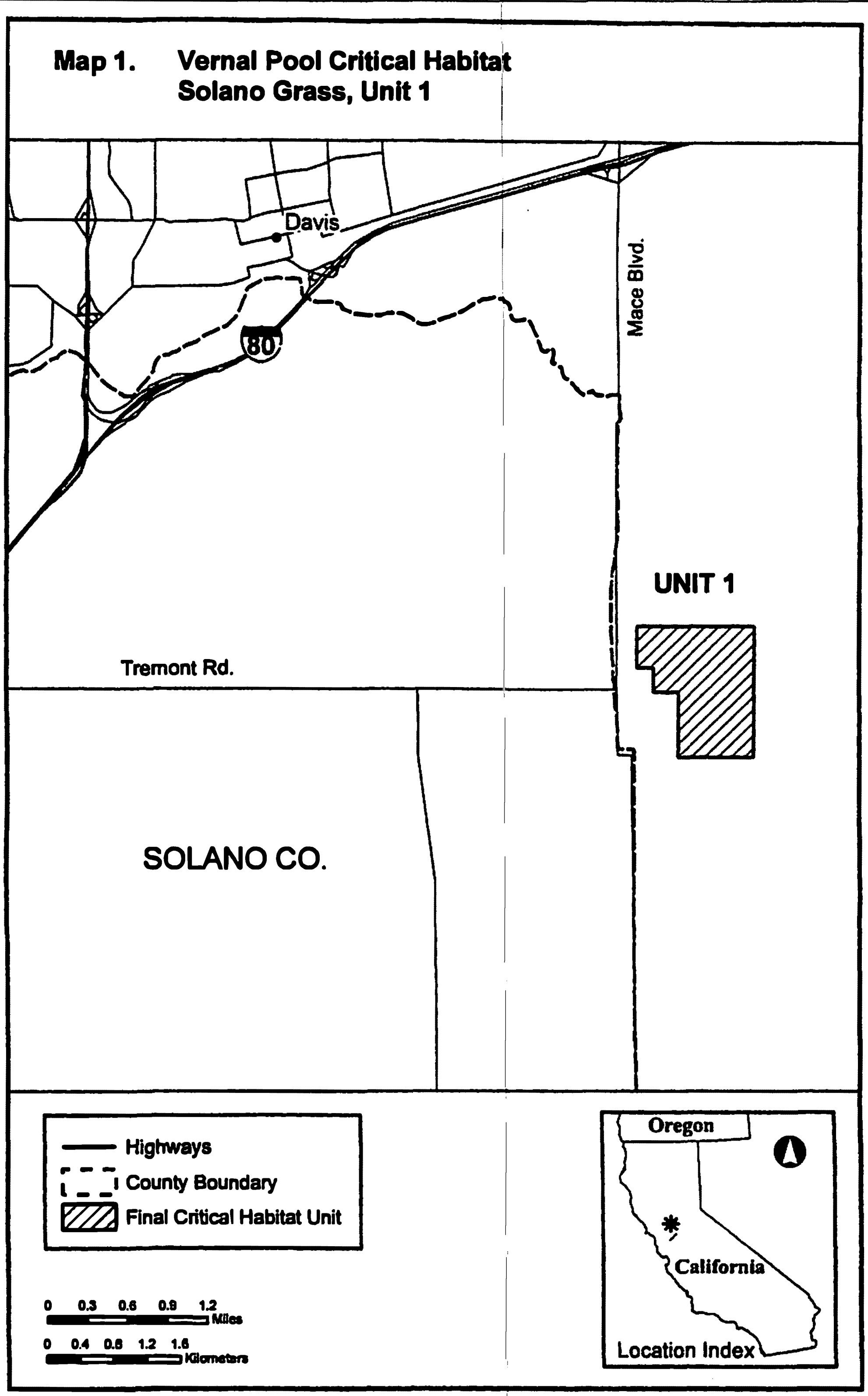


BILLING CODE 4310–55–C

§ 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:	Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes				1
Lead Agency:	U.S. Fish & Wildlife Service Approved November 26, 1996				
Goals & Purpose:	This recovery plan is intended to fulfill one of the primary purposes under section 2 of the Endangered Species Act of 1973 – to provide a means for the conservation of ecosystems upon which endangered and threatened species depend…the purpose and scope of this recovery plan is to outline a strategy for the conservation and restoration of the Sacramento-San Joaquin Delta that currently supports or has the potential to support Delta native fishes. The basic objective of the Delta Native Fishes Recovery Plan is to establish self-sustaining populations of the species of concern that will persist indefinitely... the basic strategy for recovery is to manage the estuary in such a way that it is better habitat for aquatic life in general and for the fish species of concern in particular.				
Status:					
LCP/RCIS Species	*Group 1*	*Group 2*	*Group 3*		
	• Green sturgeon • Delta smelt • Sacramento splittail • Spring run Chinook Salmon • Fall run chinook salmon				
Plan/Program Boundaries:	Sacramento-San Joaquin Delta; Sacramento-San Joaquin Estuary (Fig.1.1, pg. 14) Delta smelt critical habitat – Fig.2.6, pg. 44 Delta smelt restoration criteria stations – Fig.2.7, pg. 45 Longfin smelt restoration criteria stations – Fig.3.5, pg. 65				
Yolo County	The portion of the Sacramento-San Joaquin Delta located in Yolo County.				
LCP/RCIS Natural	Riverine natural community				
Implementation	Implementation Schedule spanned from 1995 – 1999; Reference pg. 163				
Governance:	U.S. Fish and Wildlife Service; Delta Native Fishes Recovery Team				
Cost and Funding:	In 1996, the estimated cost of recovery was $125.8 million to begin delisting of the delta smelt, if the recommended management actions resulted in achievement of the restoration and delisting criteria outlined in the plan. No known funding sources.				

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

Title:	Teichert Esparto Mining Project Habitat Conservation Plan			**Binder:**	1 **(web)**
Lead Agency:	A. Teichert and Son				
Goals & Purpose:	A. Teichert and Son developed the Teichert Esparto Mining Project Habitat Conservaton Plan (HCP) to seek coverage for take of the federally listed valley elderberry longhorn beetle incidental to mining activity for the Esparto Mining Project in Yolo County, California. The incidental take occurred on a 98-acre site in Yolo County. The site supported four blue elderberry shrubs, which constituted beetle habitat that could potentially be occupied by the species.				
Status:	Plan completed and permit issued in December 1999.				
LCP/RCIS Species	*Group 1*	*Group 2*	*Group 3*		
	Valley elderberry longhorn beetle				
Plan/Program	Yolo County, CA; total area covered: 148 acres (document not available, so no map				
Yolo County	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.				
LCP/RCIS Natural	Cultivated Lands, Riparian and Wetland				
Implementation	Permit duration is 5 years or until 2004				
Governance:	Teichert is solely responsible for implementing the HCP with oversight from the Service.				
Costs and Funding:	Teichert is responsible for funding mitigation required by the HCP.				

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

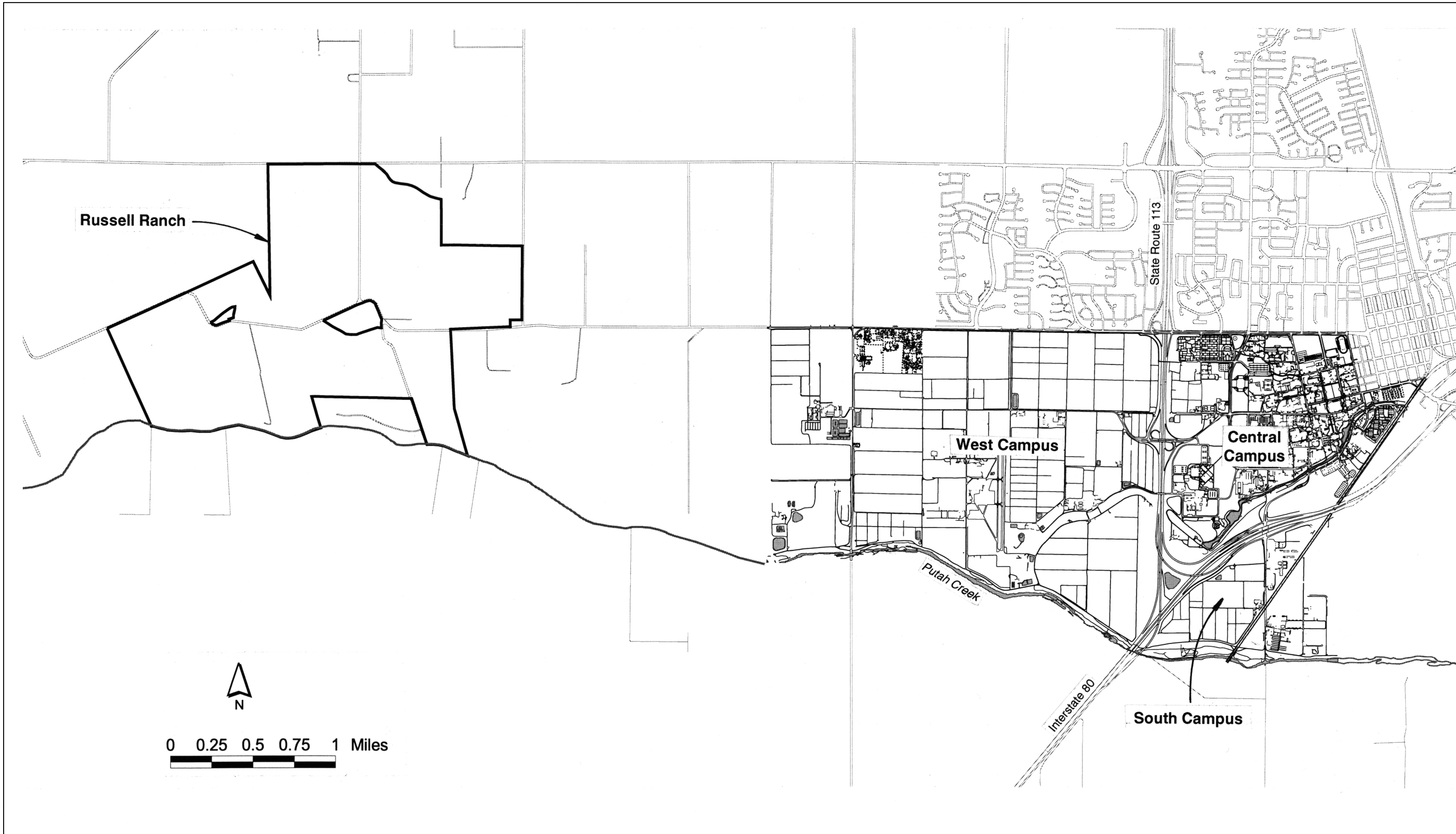
Title:	2002 Campus Projects Habitat Conservation Plan	**Binder:**	1
Lead Agency:	University of California, Davis Jones & Stokes		
Goals & Purpose:	The Board of Regents of the University of California constructed five capital improvement and maintenance projects at the University of California, Davis (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).		
Status:	Plan completed and permit issued in July 2002.		

LCP/RCIS Species	*Group 1*	*Group 2*	*Group 3*
	Valley elderberry longhorn beetle		

Plan/Program	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	The total project area is approximately 12.25 acres.
LCP/RCIS Natural	Riparian natural community
Implementation	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

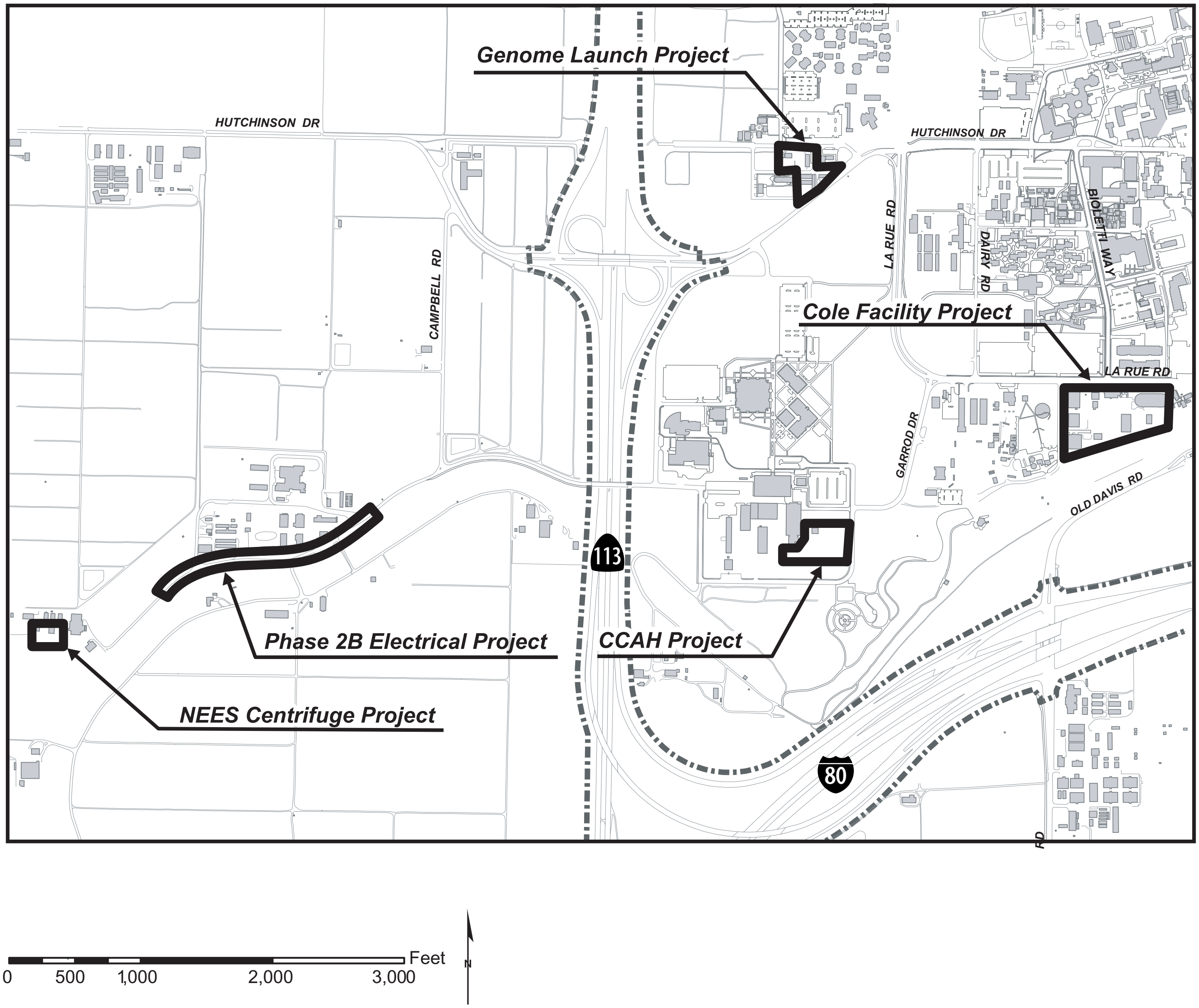


Source: UC Davis Planning and Budget Office 1989.

08275.98 (11/01)

Jones & Stokes

Figure 1
University of California, Davis



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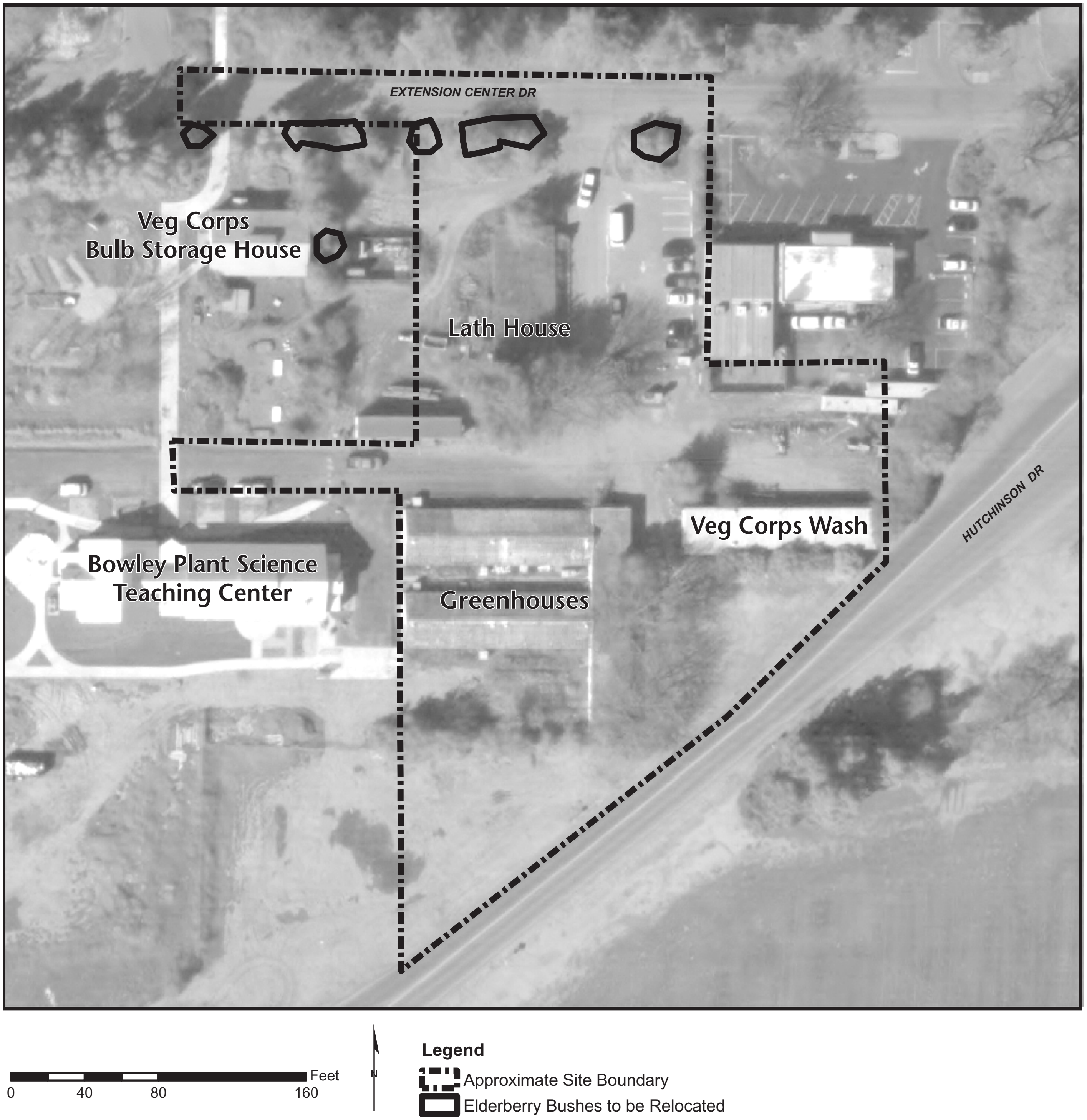
Jones & Stokes

Figure 2
Location of the Project Sites on the UC Davis Campus



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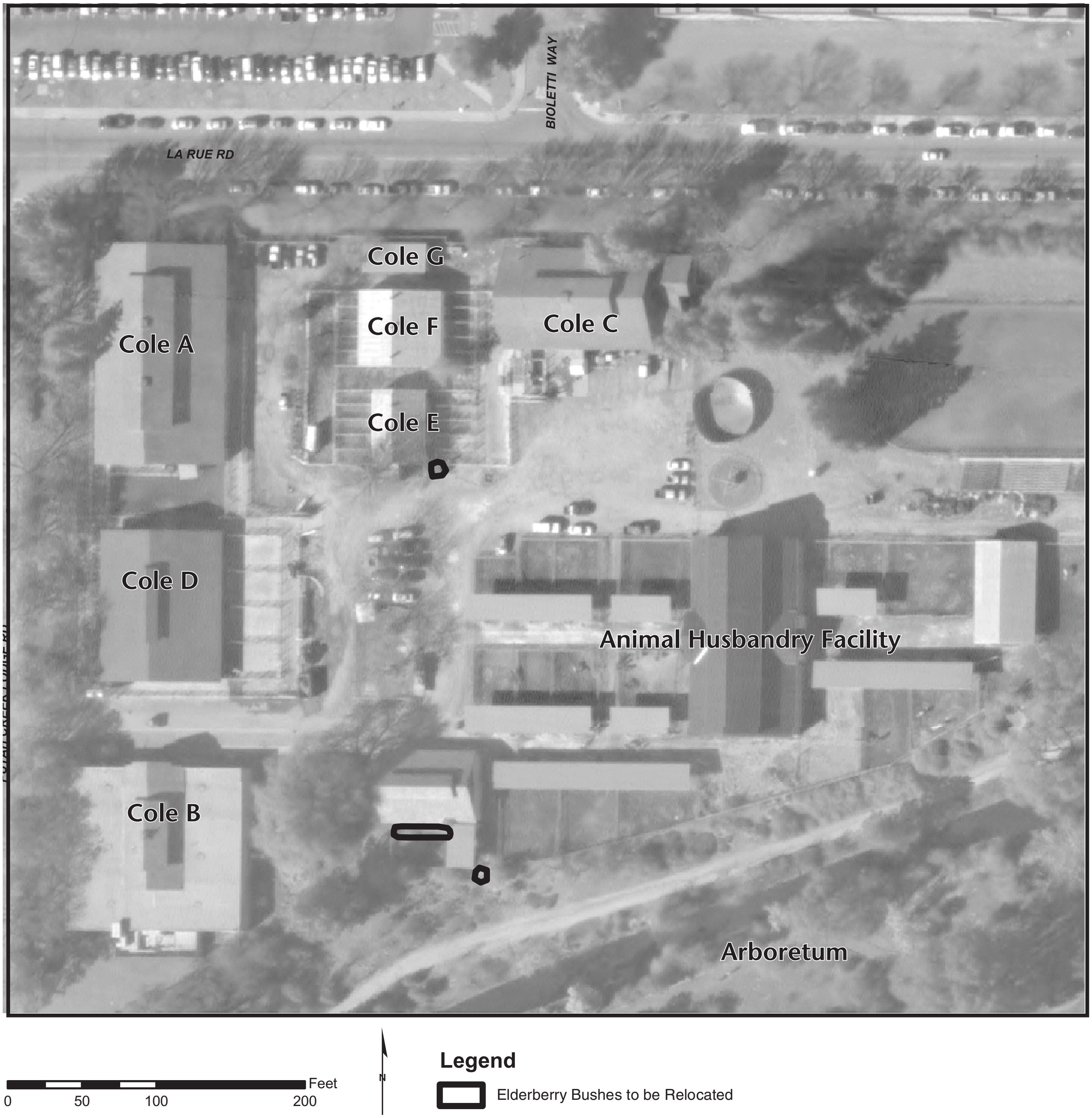
Jones & Stokes

Figure 3
Location of Elderberry Shrubs on the Genome Launch Facility Project Site



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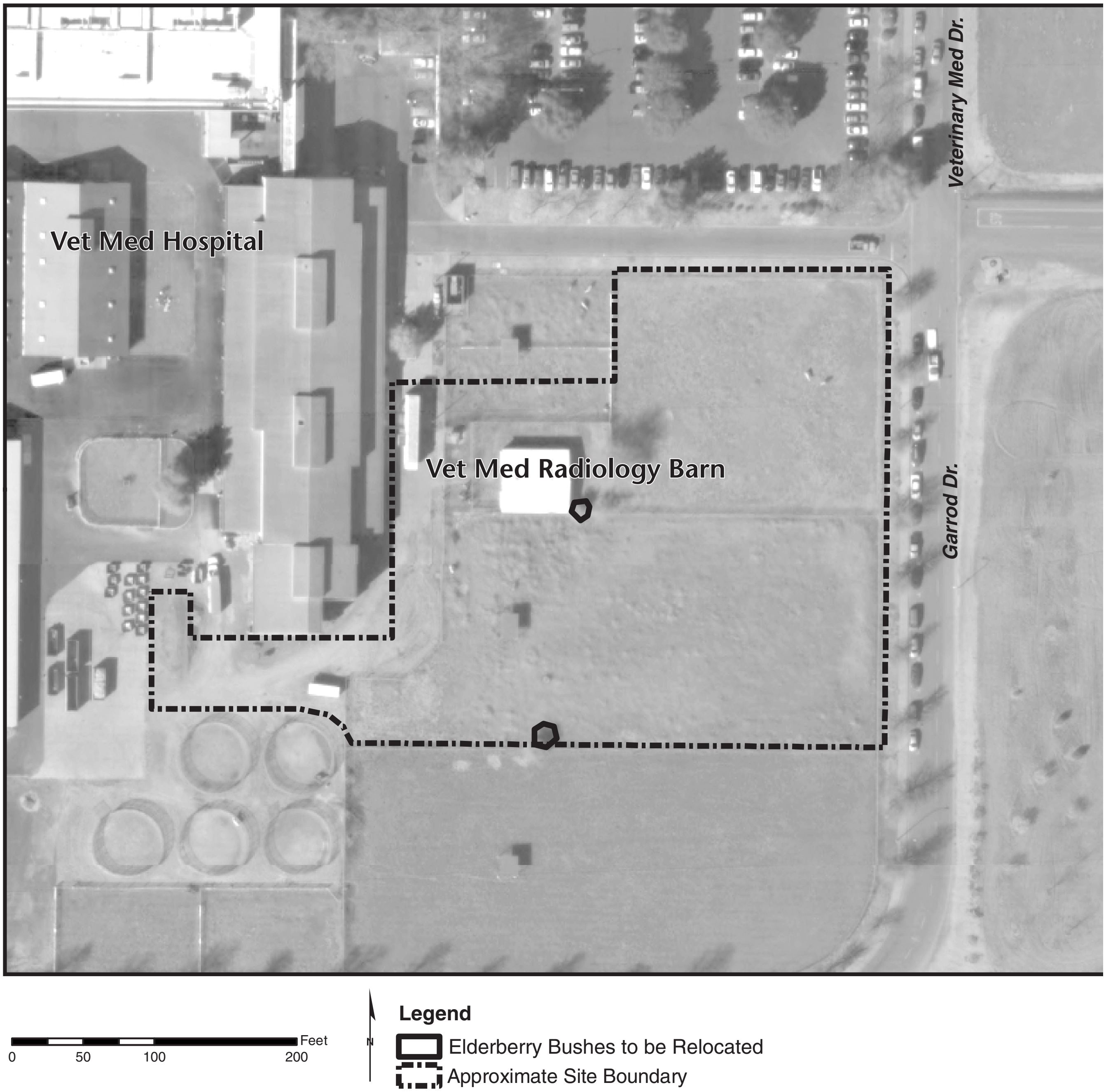
Jones & Stokes

Figure 4
Location of Elderberry Shrubs on the Cole Facility Project Site



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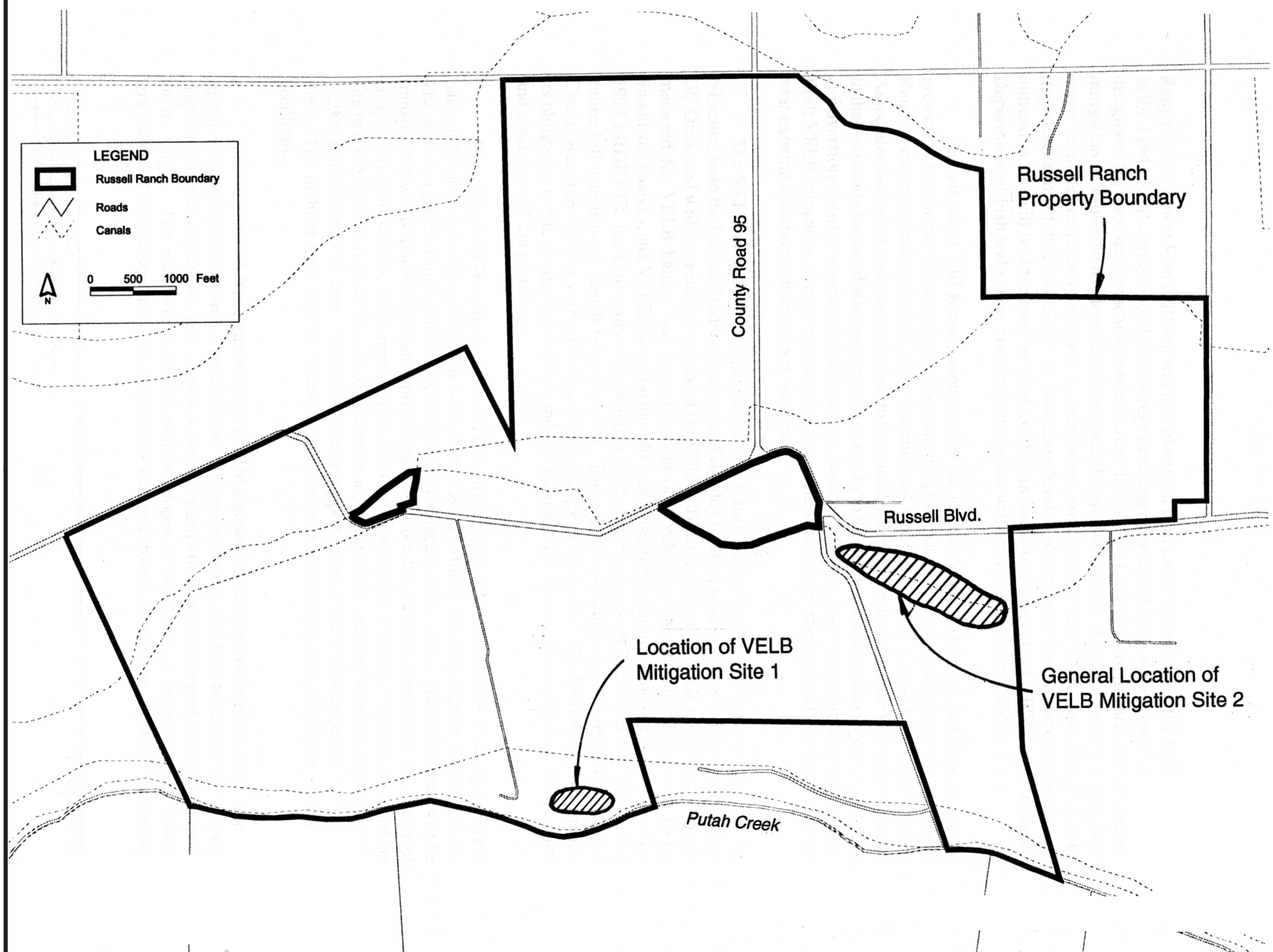
Jones & Stokes

Figure 5
Location of Elderberry Shrubs on the Center for Companion Animal Health Facility Project Site



Source: UC Davis Planning and Budget Office 1989.

Figure 6
Location of Russell Ranch Mitigation Sites

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

<table>
<tr><th>Title:</th><td colspan="2">La Rue Housing/Bowley Center
Habitat Conservation Plan</td><th>Binder:</th><td>1</td></tr>
<tr><th>Lead Agency:</th><td colspan="4">University of California, Davis</td></tr>
<tr><th>Goals & Purpose:</th><td colspan="4">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.</td></tr>
<tr><th>Status:</th><td colspan="4">Plan completed and permit issued March 10, 1999</td></tr>
<tr><th rowspan="2">LCP/RCIS Species</th><td>Group 1</td><td>Group 2</td><td colspan="2">Group 3</td></tr>
<tr><td>Valley elderberry longhorn beetle</td><td></td><td colspan="2"></td></tr>
<tr><th>Plan/Program</th><td colspan="4">University of California, Davis campus in Yolo County</td></tr>
<tr><th>Yolo County</th><td colspan="4">Total project area encompasses 16.7 acres; impacts were to 14 elderberry shrubs with 168 stems greater than 1”diameter

The La Rue Student Housing Project is located in the western portion of the University’s Central Campus and composed of four or more ‘‘neighborhoods.’’ The Bowley Center consists of a Plant Science Teaching Center and includes laboratories, greenhouses, offices, and a lecture room. This facility is located in the western portion of the Central Campus.</td></tr>
<tr><th>LCP/RCIS Natural</th><td colspan="4">Grassland and cultivated land.</td></tr>
<tr><th>Implementation</th><td colspan="4">Permit duration was 10 years, so it is assumed that the construction and mitigation is complete.</td></tr>
</table>

Governance:	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. USFWS 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 USFWS has jurisdiction over all other fish and wildlife species.
Costs and Funding:	Not applicable since the Service issue the permits and mitigation is assumed complete.

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

<table>
<tr><td>Title:</td><td colspan="2">Hungry Hollow Watershed Stewardship Plan</td><td></td><td>2</td></tr>
<tr><td>Lead Agencies:</td><td colspan="4">Yolo County Resource Conservation District in coordination with the Hungry Hollow Stakeholders Group
December 2011</td></tr>
<tr><td>Goals & Purpose:</td><td colspan="4">The purpose of the Hungry Hollow Watershed Stewardship Plan is to provide a community-based framework for maintaining and improving watershed health in Hungry Hollow. The goals of the plan are as follows:

Goal #1: To manage watershed lands to minimize unnatural rates of erosion and sedimentation.
Goal #2: To use and manage surface, groundwater, and stormwater 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 that supports a sustainable and productive agricultural economy.
Goal #6: 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. (See attached excerpt from pages 31-39.)</td></tr>
<tr><td>Status:</td><td colspan="4">Done</td></tr>
<tr><td rowspan="2">LCP/RCIS</td><td>Group 1</td><td>Group 2</td><td colspan="2">Group 3</td></tr>
<tr><td>Burrowing owl
California tiger salamander
Swainson’s hawk
Tricolor blackbird
Bank swallow
Valley elderberry longhorn beetle
(page 25)</td><td>Gold eagles
Bald eagles
Badger
Ringtail
Red fox
Red bat
(page 25)</td><td colspan="2">N/A</td></tr>
<tr><td>Plan/Program Boundaries:</td><td colspan="4">Hungry Hollow is a 35,000-acre sub-watershed of the Lower Cache Creek watershed located in Yolo County. Cache Creek forms the southern boundary, Capay Hills the western boundary, Dunnigan Hills the eastern boundary and Oat Creek is the northern boundary (See attached map from page 5.)</td></tr>
<tr><td>Yolo County</td><td colspan="4">A portion of Yolo County where the Hungry Hollow watershed is located. (See attached map from page 6.)</td></tr>
<tr><td>LCP/RCIS</td><td colspan="4">Riparian natural community (riparian in the HH plan), fresh emergent wetland or lacustrine and riverine natural community (aquatic in the HH plan), California prairie (grasslands in the HH plan), and mixed chaparral, interior live oak-gray pine, blue oak, and valley oak (valley/foothill hardwoods in the HH plan). (See attached description of categories and related map on pages 26 & 39.)</td></tr>
<tr><td>Implementation Timeline:</td><td colspan="4">None. The plan guides two tiers of implementation: 1) projects, studies, and educational programs implemented by the stakeholders group; and 2) projects implemented by individual landowners or small groups. The Yolo County Resource Conservation District in cooperation with the Stakeholders Group can provide technical, coordinating, and grantwriting support for individual and larger projects. There is no timeline for implementation of the objectives and actions associated with the plan, although establishment of a timeline is listed as a next step.</td></tr>
<tr><td>Governance:</td><td colspan="4">Hungry Hollow Stakeholders Group and the Yolo County Resource Conservation District</td></tr>
<tr><td>Cost and Funding:</td><td colspan="4">No information available.</td></tr>
</table>

Notes:	P. Marchand requested an update from the Resource Conservation District (7/17)

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

<table>
<tr><th>Title:</th><td>Yolo Bypass Wildlife Area Land Management Plan</td><th>Binder:</th><td>4</td></tr>
<tr><th>Lead Agency:
Date Completed:</th><td colspan="3">CA Dept. of Fish & Wildlife (nee Fish & Game); in assoc. with Yolo Basin Foundation & EDAW
2008</td></tr>
<tr><th>Goals & Purpose:</th><td colspan="3">The stated purposes of the Yolo Bypass Wildlife Area Land Management Plan are to:

Guide the management of habitats, species, appropriate public use, and programs to achieve DFG’s mission;
Direct an ecosystem approach to managing the Yolo Bypass Wildlife Area in coordination with the objectives of the CALFED ERP;
Identify and guide appropriate, compatible public-use opportunities within the Yolo Bypass Wildlife Area;
Direct the management of the Yolo Bypass Wildlife Area in a manner that promotes cooperative relationships with adjoining private-property owners;
Establish a descriptive inventory of the sites and the wildlife and plant resources that occur in the Yolo Bypass Wildlife Area;
Provide an overview of the Yolo Bypass Wildlife Area’s operation, maintenance, and personnel requirements to implement management goals, and serve as a planning aid for preparation of the annual budget for the Bay-Delta Region (Region 3); and
Present the environmental documentation necessary for compliance with state and federal statutes and regulations, provide a description of potential and actual environmental impacts that may occur during plan management, and identify mitigation measures to avoid or lessen these impacts.

Goals:

Species Guilds Goal 1 (SG-1): Manage and maintain habitat communities for waterfowl species
Species Guilds Goal 2 (SG-2): Manage and maintain habitat communities for shorebird and wading bird species.
Species Guilds Goal 3 (SG-3): Maintain and enhance habitat for upland game species.
Species Guilds Goal 4 (SG-4): Manage and maintain habitat communities for raptors.
Species Guilds Goal 5 (SG-5): Manage and maintain habitat communities for cavity-nesting bird species.
Species Guilds Goal 6 (SG-6): Manage and maintain communities for neotropical bird species.
Species Guilds Goal 7 (SG-7): Manage and maintain communities for a variety of other water bird species including grebes, rails, bitterns, ibis and songbirds associated with emergent marsh vegetation.
Species Guilds Goal 8 (SG-8): Maintain and enhance foraging opportunities for the presence of breeding colonies of bats roosting under the Yolo Causeway.
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.
Invasive Species Goal 1 (IS-1): Prevent the introduction and spread of invasive nonnative species that have no benefit to wildlife or that impact special status plants.
Seasonal and Permanent Wetland Ecosystems Goal 1 (SPW-1): Following accepted scientific principles and practices, restore and enhance wetlands to conditions that provide desired ecological functions.
Riparian Goal 1 (R-1): Maintain and enhance riparian communities for native species diversity and abundance (including special-status species).
Riparian Goal 2 (R-2): Restore and enhance riparian communities to conditions that provide desired ecological functions.
Grassland and Upland Goal 1 (GU-1): Maintain and enhance grassland and upland
</td></tr>
</table>

	communities for diversity and abundance of native species (including special-status species). • **Grassland and Upland Goal 2 (GU-2):** Restore and enhance grassland and upland communities to conditions that provide desired ecological functions. • **Aquatic Ecosystems Goal 1 (AE-1):** Maintain and enhance aquatic ecosystems for diversity and abundance of native species (including special-status species). • **Aquatic Ecosystems Goal 2 (AE-2):** Maintain and enhance habitat for game fish species. • **Aquatic Ecosystems Goal 3 (AE-3):** Restore and enhance aquatic ecosystems to conditions that provide desired ecological functions. • **Agricultural Resources Goal 1 (AR-1):** Use agricultural techniques to maintain and enhance habitat for native wildlife and plants. • **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. • **Cultural Resources Goal 1 (CR-1):** Catalog and preserve all cultural resources that have yielded or have the potential to yield information important to the prehistory or history of the Yolo Bypass Wildlife Area or that otherwise would meet significance criteria according to the California Register of Historical Resources (CRHR). • **Public-Use Goal 1 (PU-1):** Increase existing and provide new long-term opportunities for appropriate wildlife dependent activities by the public. • **Public-Use Goal 2 (PU-2):** Support and expanded public use of the Yolo Bypass Wildlife Area for environmental education and interpretation. • **Public-Use Goal 3 (PU-3):** Coordinate public access to and use of facilities including tour routes, parking areas, Putah Creek, the planned Pacific Flyway Center, and other areas to accommodate a variety of different user groups. • **Public-Use Goal 4 (PU-4):** Continue to foster community partnerships • **Public-Use Goal 5 (PU-5):** Continue and expand the volunteer program. • **Public Use Goal 6 (PU-6):** Minimize competition and conflicts among users and facilitate compatibility between public uses. • **Public-Use Goal 7 (PU-7):** Support use of the Yolo Bypass Wildlife Area by Native Americans for activities such as gathering native plant materials for cultural purposes. • **Public-Use Goal 8 (PU-8):** Facilitate safe use of the Yolo Bypass Wildlife Area by informing the public of potential risks, and also develop an emergency response plan. • **Unauthorized-Public-Use Goal 1 (UPU-1):** Prevent unauthorized use of the Yolo Bypass Wildlife Area. • **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. • **Facilities Goal 2 (F-2):** Construction, maintenance, and removal of facilities. • **Facilities Goal 3 (F-3):** Effectively manage existing facilities and/or structures for resource protection, safety, and prevention of unauthorized uses. • **Facilities Goal 4 (F-4):** Construct, operate and maintain the Pacific Flyway Center and other associated facilities. • **Facilities Goal 5 (F-5):** Maintain equipment necessary for future management of the Wildlife Area. • **Facilities Goal 6 (F-6):** Consider the construction and operation of an outdoor shooting range for bi-annual use by local game warden squad for periodic firearm use qualification process. • **Administration Goal 1 (A-1):** Maintain current data on the management and resources of the Yolo Bypass Wildlife Area. • **Fire Management Goal 1 (FM-1):** Develop and implement a wildfire plan for the Yolo Bypass Wildlife Area. • **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. • **Management Coordination Goal 2 (MC-2):** Coordinate with flood control agencies regarding flood control and management in the Yolo Bypass.

<table>
<tr><td></td><td colspan="3">

- **Management Coordination Goal 3 (MC-3):** Coordinate with other law enforcement agencies.
- **Management Coordination Goal 4 (MC-4):** Coordinate with local public-service agencies including the SYMVCD and the Yolo County Health Department.
- **Management Coordination Goal 5 (MC-5):** Maintain relationships with neighbors and tenants to address management issues.
- **Management Coordination Goal 6 (MC-6):** Coordinate activities associated with managing cholera, avian flu, and other disease outbreaks.

</td></tr>
<tr><td>Status:</td><td colspan="3">Completed June 2008</td></tr>
<tr><td rowspan="2">RCIS/LCP Species Covered:</td><td>Group 1</td><td>Group 2</td><td>Group 3</td></tr>
<tr><td>Alkali milk-vetch, baker’s navarretia, Heckard’s pepper-grass, western pond turtle, giant garter snake, swainson’s hawk, western burrowing owl, loggerhead shrike,tricolored blackbird, Sacramento splittail, Chinook salmon, Central Valley steelhead, San Joaquin spearscale, Colusa grass, brittlescale, Grasshopper sparrow, Vernal pool tadpole shrimp, conservancy fairy shrimp, vernal pool fairy shrimp, California linderiella, midvalley fairy shrimp, green sturgeon, white sturgeon, delta smelt, California tiger salamander, western spadefoot toad, Townsend’s big-eared bat, northern harrier, white-tailed kite, bank swallow, black tern, western yellow-billed cuckoo, yellow-breasted chat</td><td>Ferris’ milk-vetch, Palmate-bracted bird’s beak, heartscale, Rose-mallow, Mason’s lilaeopsis, pallid bat, bald eagle, golden eagle, American peregrine falcon, prairie falcon, short-eared owl, western snowy plover, mountain plover, California black rail, yellow-headed blackbird, bearded popcorn flower</td><td>Dwarf downingia, Northern California black walnut, delta tule pea, Cooper’s hawk, tule elk, mink, Delta woolly-marbles, Ferris’ goldfields, Coulter’s goldfields</td></tr>
<tr><td>Plan/Program Boundaries:</td><td colspan="3">Exhibit 2-1 (pg. 2-3) depicts the boundaries of the approximately 16,770-acre Yolo Bypass Wildlife Area. The northern boundary of the Yolo Bypass Wildlife Area is generally formed by the Union Pacific Railroad (UPRR) (formerly Southern Pacific Railroad) tracks that run parallel to and north of Interstate 80 (I-80). There is, however, a 182-acre portion of Yolo Bypass Wildlife Area that abuts the UPRR tracks on the north side. The eastern boundary is shaped largely by the East Toe Drain, which runs inside of the east levee of the Yolo Bypass (which is also the west levee of the Sacramento River Deep Water Ship Channel). This eastern boundary is the centerline of the open water in the East Toe Drain, except in an area approximately 3 miles due south of I-80 where the boundary turns west to avoid a small area of privately owned land. The western boundary of the Yolo Bypass Wildlife Area is generally defined by the west levee of the Yolo Bypass, except that the boundary also encompasses two properties outside of the Bypass levee. The southern boundary is approximately 8.7 miles south of I-80 on the east side and approximately 10 miles south of I-80 on the west side of the Wildlife Area.</td></tr>
<tr><td>Yolo County Conservation Target Locations:</td><td colspan="3">The Yolo Bypass Wildlife Area is composed of 17 separate management units: Causeway Ranch Unit (North)/Causeway Ranch Unit (Main); 1,000 Acres Unit; Causeway Unit; North Unit; Northwest Unit; West Unit; Northeast Unit; Central Unit; South Unit; Los Rios Unit; Los Rios WRP; Cowell Pond Unit; Pacific Flyway Center; Parker Unit; Field 29; Field 38; Tule Ranch Unit (Exhibit 2-1, pg. 2-3)</td></tr>
<tr><td>RCIS/LCP Natural Communities Covered:</td><td colspan="3">Cultivated lands seminatural community; Vernal pool complex natural community; Fresh emergent wetland natural community; Riparian natural community; California prairie natural community</td></tr>
</table>

Implementation Timeline:	The report recommends an exhaustive review of the achievement of the goals of the LMP should be prepared every five years following the date of adoption of the LMP or subsequent revisions. The Department has not completed an update, although much work has been done to accomplish the goals in this plan.
Governance:	The current management of the Yolo Bypass Wildlife Area operates under several legal constraints and existing agreements. These constraints and agreements include: Sacramento River Flood Control Project—Project Modification Agreement, Agreement under Section 8618 of the California Water Code, several agreements and commitments conveyed through the 2001 acquisition of the Glide Ranch and Los Rios Farms, memoranda of understanding regarding threatened and endangered species, memorandum of understanding between DFG and the Foundation, Fish And Game Code 1602 Streambed Alteration Agreement, coordination with the Sacramento-Yolo Mosquito And Vector Control District, management agreement with Dixon Resource Conservation District, programs through the Farm Service Agency, and coordination/cooperation associated with the Putah Creek Water Accord.
Costs and Funding:	The majority of the funding for the development of the land management plan consisted of Proposition 40 funding awarded by the Wildlife Conservation Board. The proposed staffing of the Yolo Bypass Wildlife Area required to fully implement this land management plan (e.g., salary [not including benefits]), is estimated to be approximately $801,000 in 2006 dollars. Table 6.1-1 (pg. 6-5 – 6-37) provides details the estimated hours and cost for staff members based on each Element/Goal/Task. The Department currently receives over $450,000 annually in agricultural lease revenue to help implement this plan. Current funding sources for operation and maintenance include: • Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act), • Agricultural lease revenues, • The Tobacco Tax and Health Initiative (Proposition 99), • The Environmental License Plate Fund, • Mitigation funds, • Funding under CALFED Bay-Delta Program, and • The Central Valley Project Improvement Act. Additionally, substantial in kind contributions are received from the Yolo Basin Foundation. On a project basis, funding sources for capital improvements / restoration and enhancement could include: • North American Wetlands Conservation Act (NAWCA) funding (approximately $8 million in NAWCA funding is currently available for restoration activities in the Yolo Bypass Wildlife Area); • California Endangered Species Tax Check-Off Fund; • U.S. Fish and Wildlife Service support under the Federal Endangered Species Act Section 6 provisions for cooperation with the states; • Wetlands Conservation Fund; • IRWMP-DWR Bond fund; • State Duck Stamp Program; • Upland Game Stamp Program; • U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Farm Bill Programs; • USFWS State Wildlife Grant Program, Federal Aid in Wildlife Restoration Program; • Central Valley Project, Wildlife Habitat Augmentation Plan; • Neotropical Migratory Bird Conservation Act Grants Program; • Riparian Habitat Joint Venture; • Ducks Unlimited, Wetland Restoration Program; • Department of Fish and Game Minor/Major Capital Outlay proposals; • DFG Comprehensive Wetlands Program; • Wildlife Conservation Board Inland Wetlands Conservation Program; • Other programs authorized under future bond acts; • DWR grants available for mitigation of water projects and levee maintenance activities;

	• Funding available through Yolo County Integrated Regional Water Management Plan; • Funding available through the Sacramento River Watershed Program; • Funding from grant programs administered by U.S. Environmental Protection Agency; • Funding from grant programs administered by National Oceanic and Atmospheric Administration; • Funding from grant programs administered by the National Fish and Wildlife Foundation; • Funding from grant programs administered by US Bureau of Reclamation; • Funding that becomes available as a result of programs to improve the Sacramento River Flood Control System by expanding the Yolo Bypass (including Sacramento Area Flood Control Agency); • Funding from the Yolo County NCCP; • Farm Service Agency payments to tenants; • AB 1982 : Funding to implement mosquito best management practices; and • DFG deferred maintenance fund.

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

<table>
<tr><td>Title:</td><td colspan="3">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="5">Yolo County
Yolo County</td></tr>
<tr><td>Goals & Purpose:</td><td colspan="5">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="5">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="3">Group 3</td></tr>
<tr><td>N/A</td><td>N/A</td><td colspan="3">N/A</td></tr>
<tr><td>Plan/Program Boundaries:</td><td colspan="5">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="5">N/A</td></tr>
<tr><td>RCIS/LCP Natural Communities Covered:</td><td colspan="5">None</td></tr>
<tr><td>Implementation Timeline:</td><td colspan="5">The CCRMP should be updated every ten years, at minimum; Yolo County finalized the CCIP August 1996.

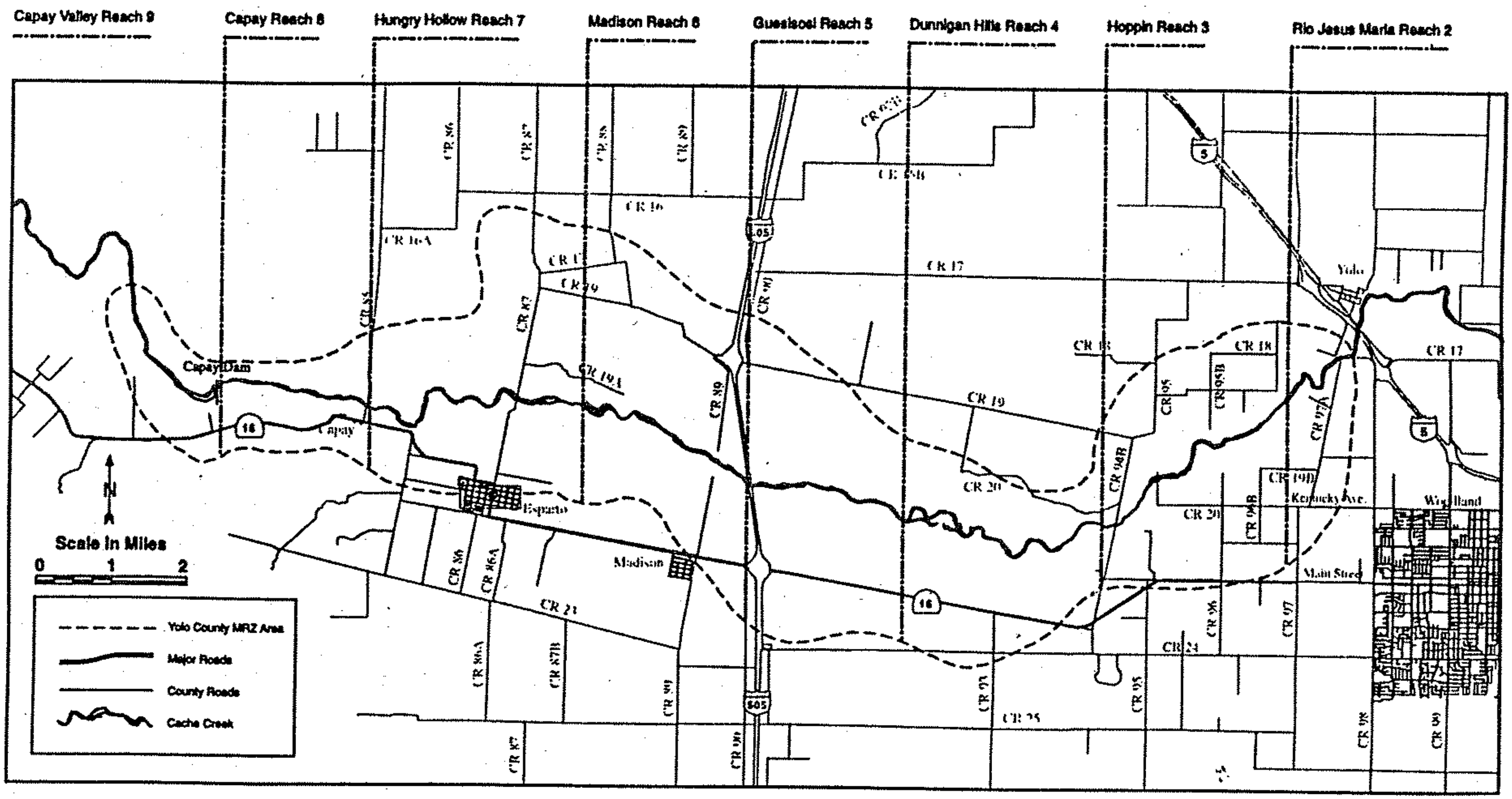
Draft CCRMP and CCIP are anticipated for completion in May 2017.</td></tr>
<tr><td>Governance:</td><td colspan="5">Yolo County manages modifications and maintenance of the Cache Creek channel, with input from the TAC, consistent with the review and guidance procedures described in the CCIP. The improvements 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



SOURCE: NHC, 1996

Reach Boundary

Plans & Data Sources

Regional Conservation Investment Strategy / Local Conservation Plan

<table>
<tr><td>Title:</td><td colspan="2">Delta Conservation Framework</td><td>Binder:</td><td>3</td></tr>
<tr><td>Lead Agency:
Date Completed:</td><td colspan="4">California Department of Fish and Wildlife
As of July 2017, public workshops held, but no draft released for comment</td></tr>
<tr><td>Goals & Purpose:</td><td colspan="4">Purpose: The Delta Conservation Framework will guide long-term implementation of strategies and related actions for Delta conservation and stakeholder integration and the protection, enhancement, restoration, and adaptive management of Delta ecosystems and their ecological functions to benefit human and natural communities.

The Delta Conservation Framework will:

Serve as the long-term continuation of the California Natural Resource Agency's California EcoRestore initiative;
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; and
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. Goals also include:

Ecosystem Function include expected changes and major associated uncertainties in the future require us to focus Delta conservation practices on the improvement or reestablishment of ecological processes. 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 contain 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.</td></tr>
<tr><td>Status:</td><td colspan="4">Scheduled for completion by the end of 2017 and will guide Delta conservation efforts to 2050</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></td><td colspan="2"></td></tr>
</table>

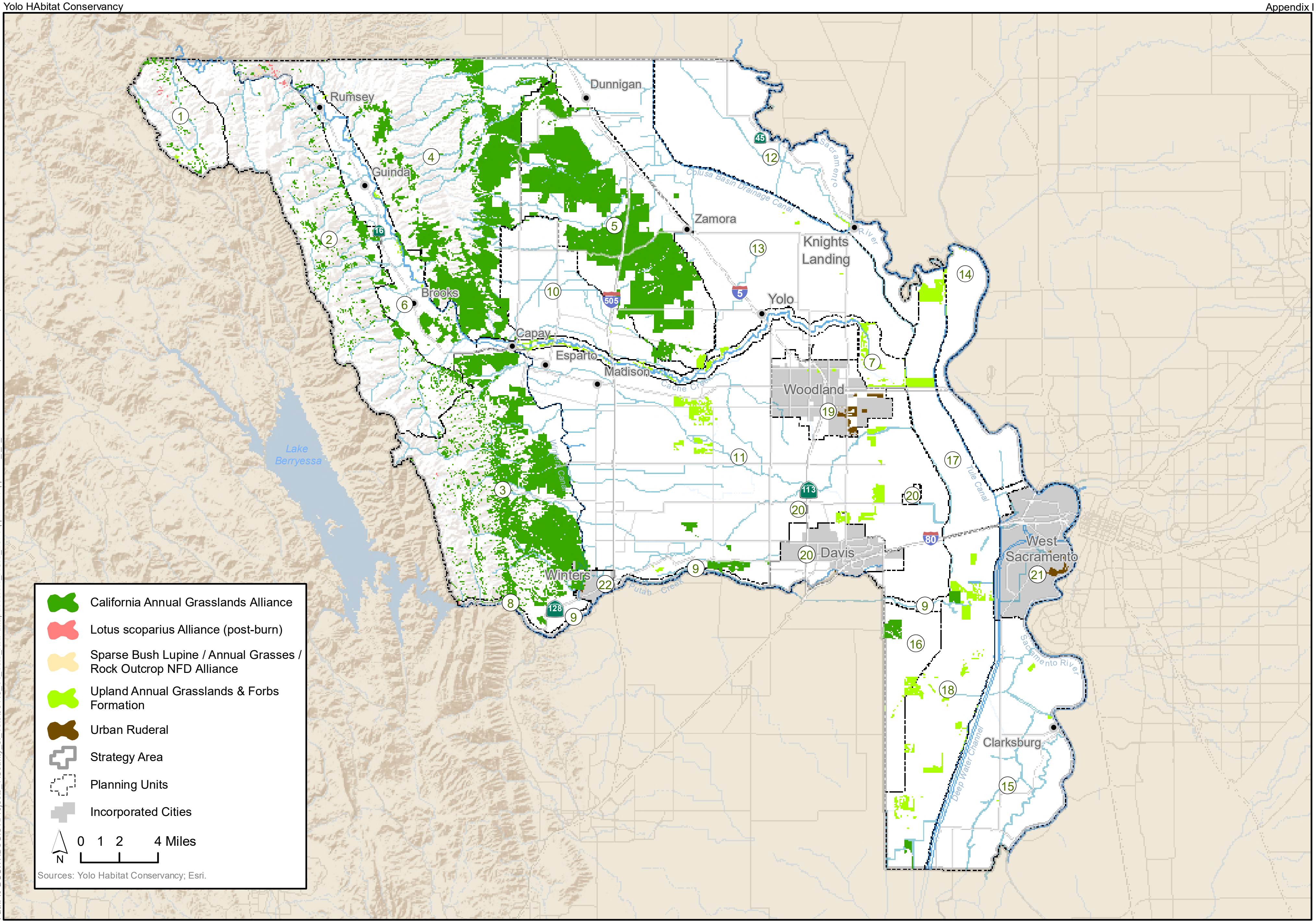
Plan/Program Boundaries:	Sacramento-San Joaquin Delta, Yolo Bypass and Suisun Marsh
Yolo County Conservation Target Locations:	Yolo Bypass
RCIS/LCP Natural Communities Covered:	UNKNOWN
Implementation Timeline:	CDFW plans to release and draft framework in 2017 for public comment. The framework will guide Delta conservation efforts to 2050.
Governance:	California Department of Fish and Wildlife
Costs and Funding:	UNKNOWN

Appendix G – Invasive Species Strategy

This Appendix was intended to consist of excerpts from the Invasive Plant Management Plan (Appendix E of the CVFPP Conservation Strategy [DWR 2016]), providing relevant information for meeting the Yolo RCIS/LCP Objective L3-1, *Invasive Species*. Since the excerpts are not compliant with Section 508 of the American Disabilities Act, they are not included in this document. The Invasive Species Strategy is available upon request from Shay.Humphrey@icf.com. Otherwise, the reader may refer to Appendix E of the CVFPP Conservation Strategy, located at this link: https://cawaterlibrary.net/document/cvfpp-conservation-strategy-appendix-e-invasive-plant-management-plan/

Appendix H

Natural Communities with Vegetation Type Detail



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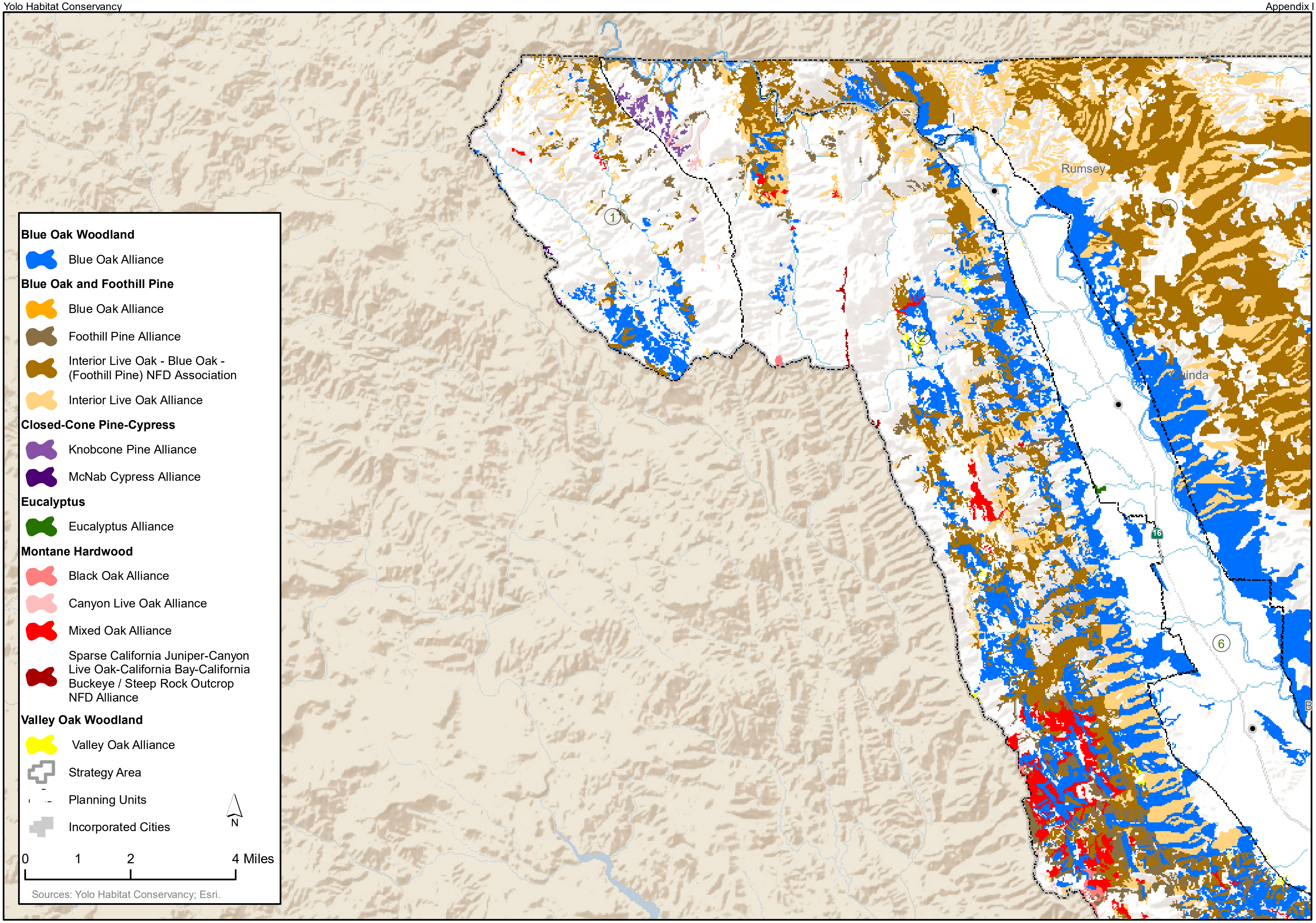
Appendix H-1

Vegetation Detail within California Prairie Natural Community



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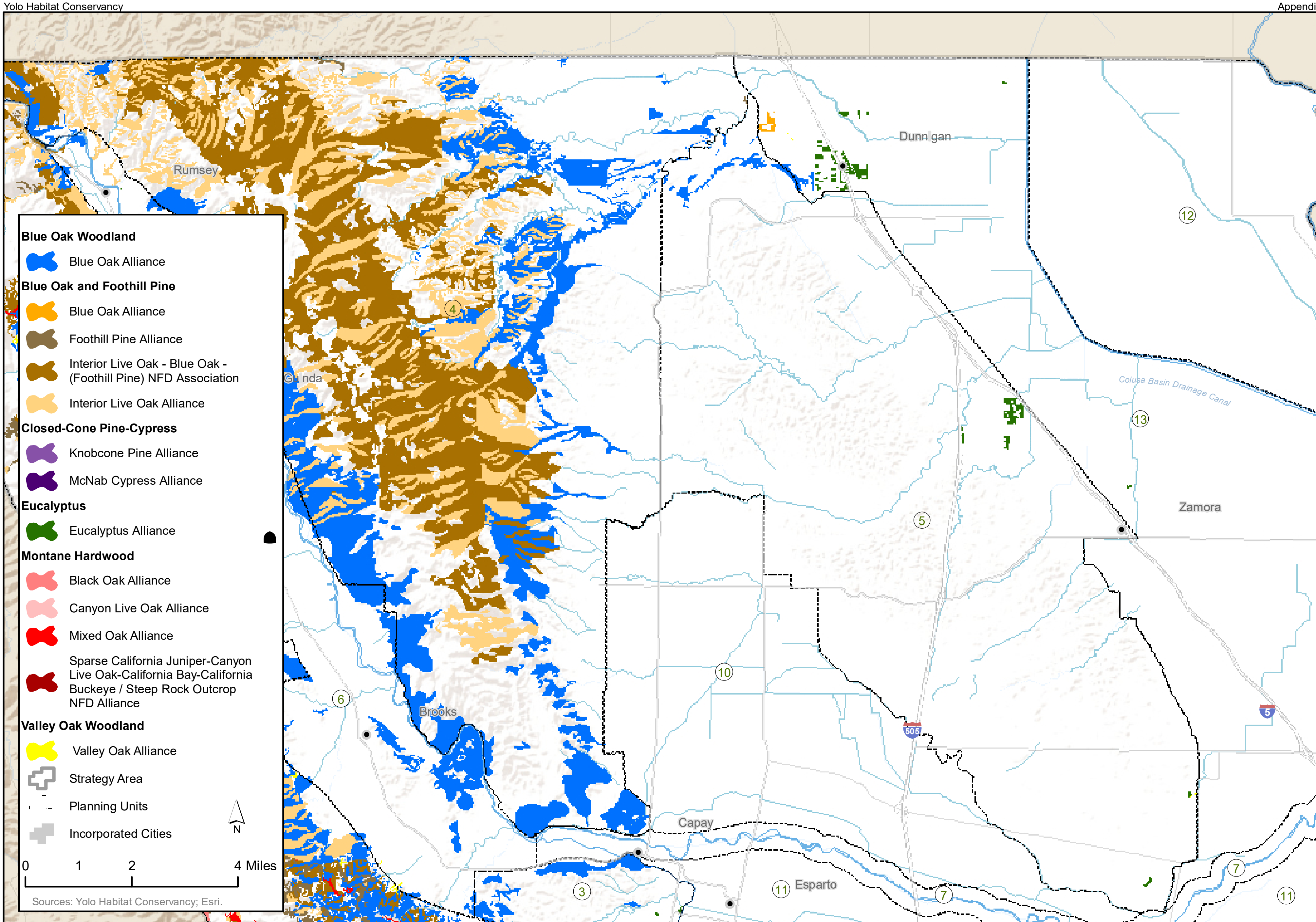
Appendix H-2a
Vegetation Detail within Woodland and Forest Natural Communities



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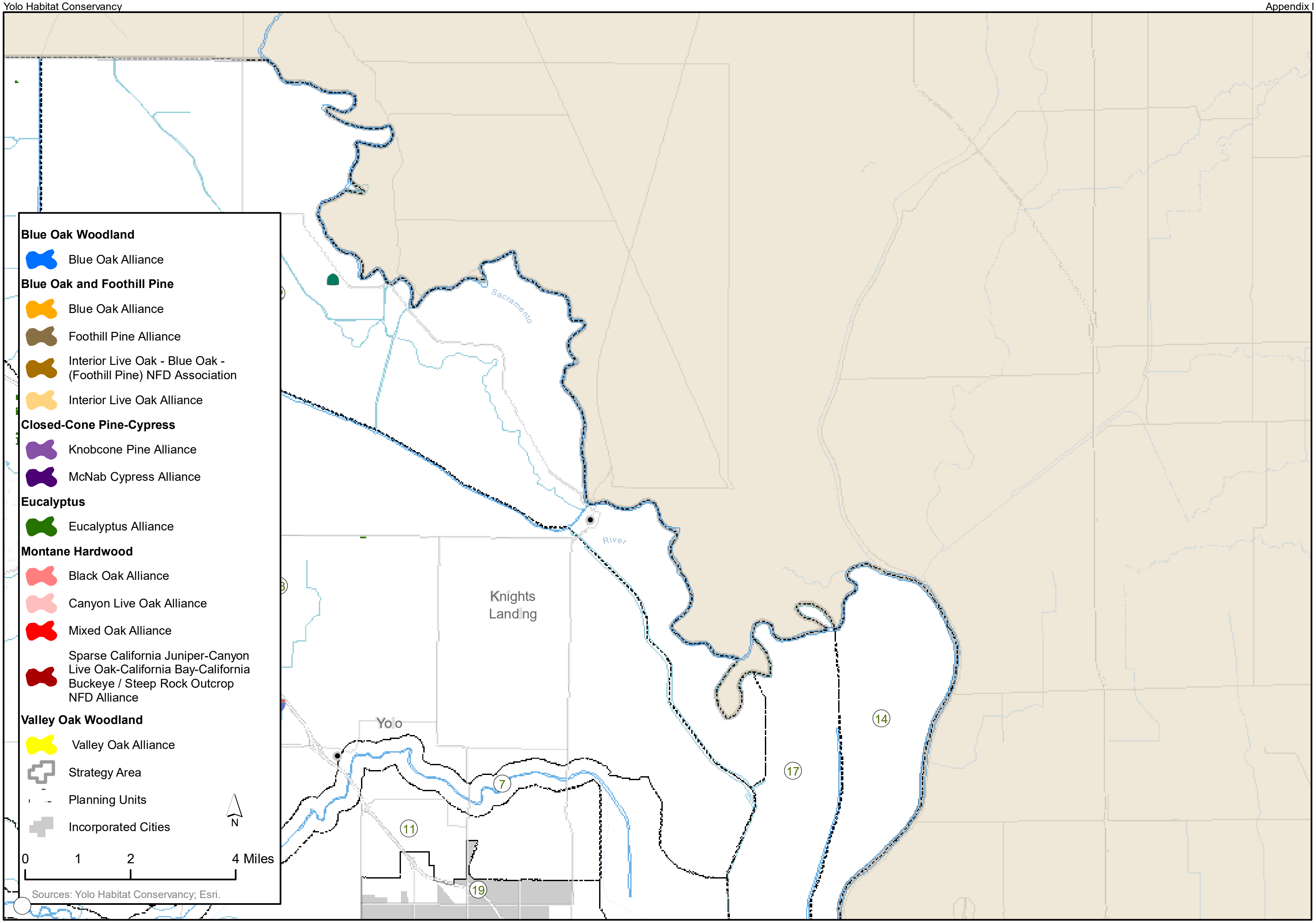
Appendix H-2b
Vegetation Detail within Woodland and Forest Natural Communities



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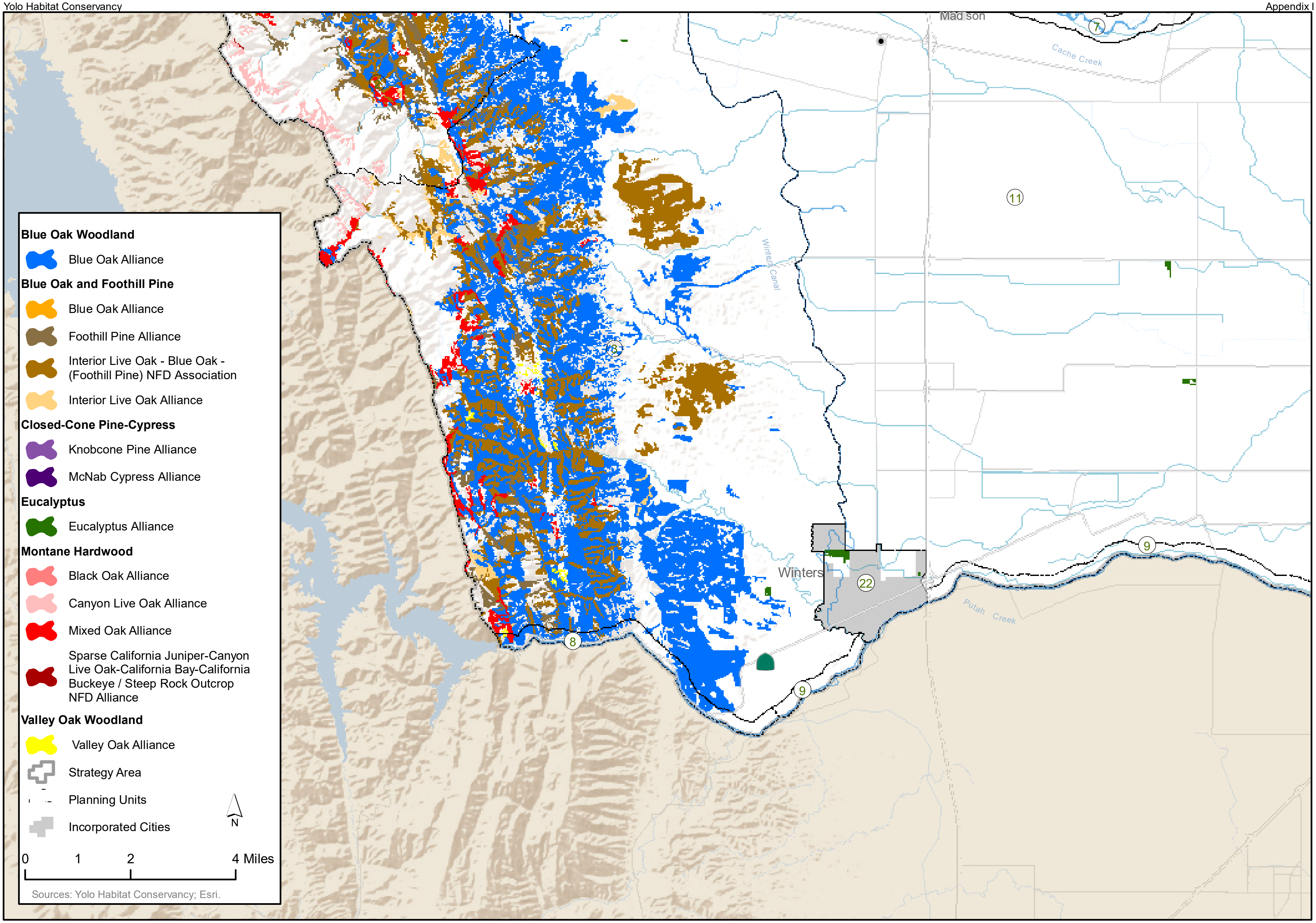
Appendix H-2c
Vegetation Detail within Woodland and Forest Natural Communities



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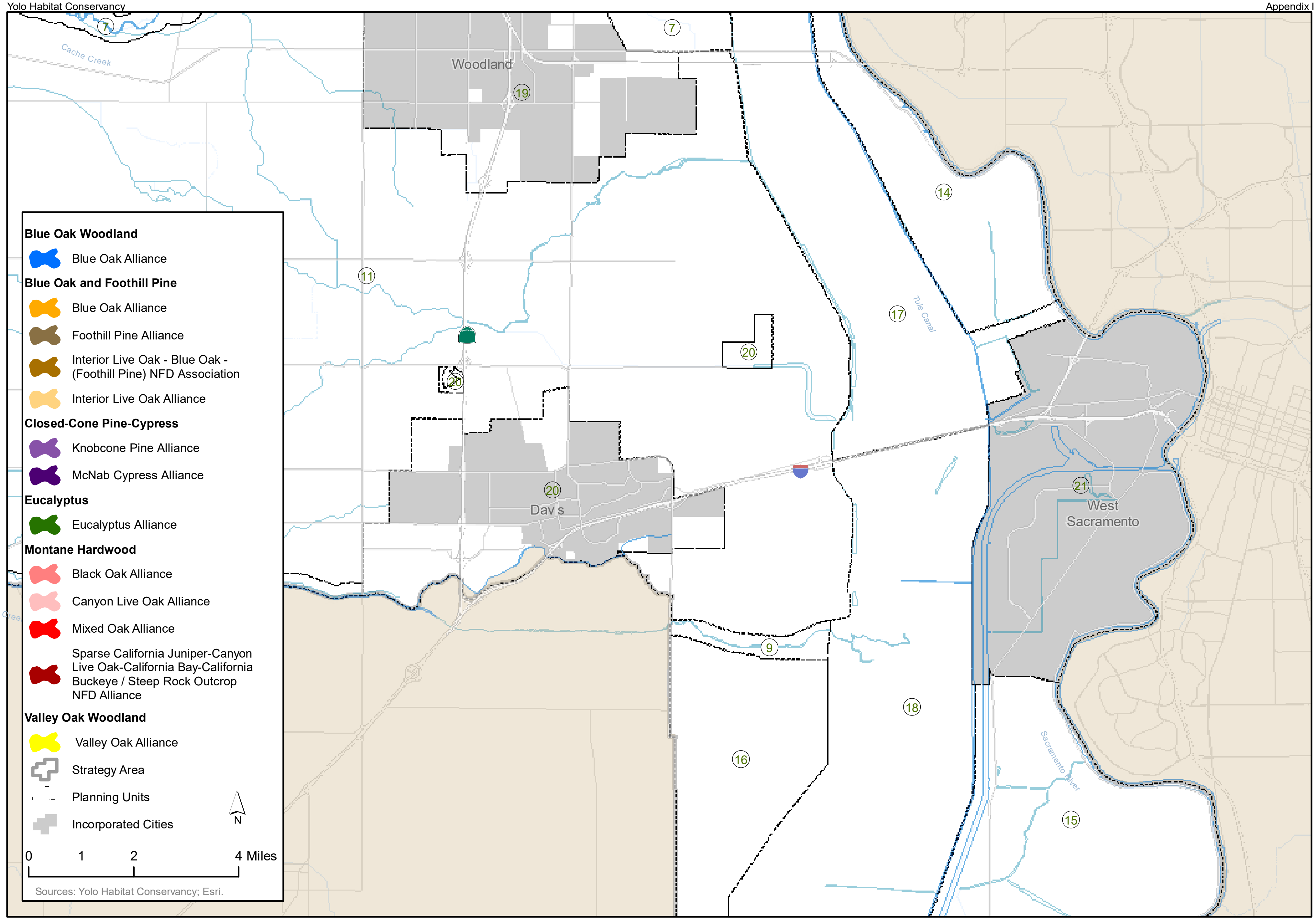
Appendix H-2d
Vegetation Detail within Woodland and Forest Natural Communities



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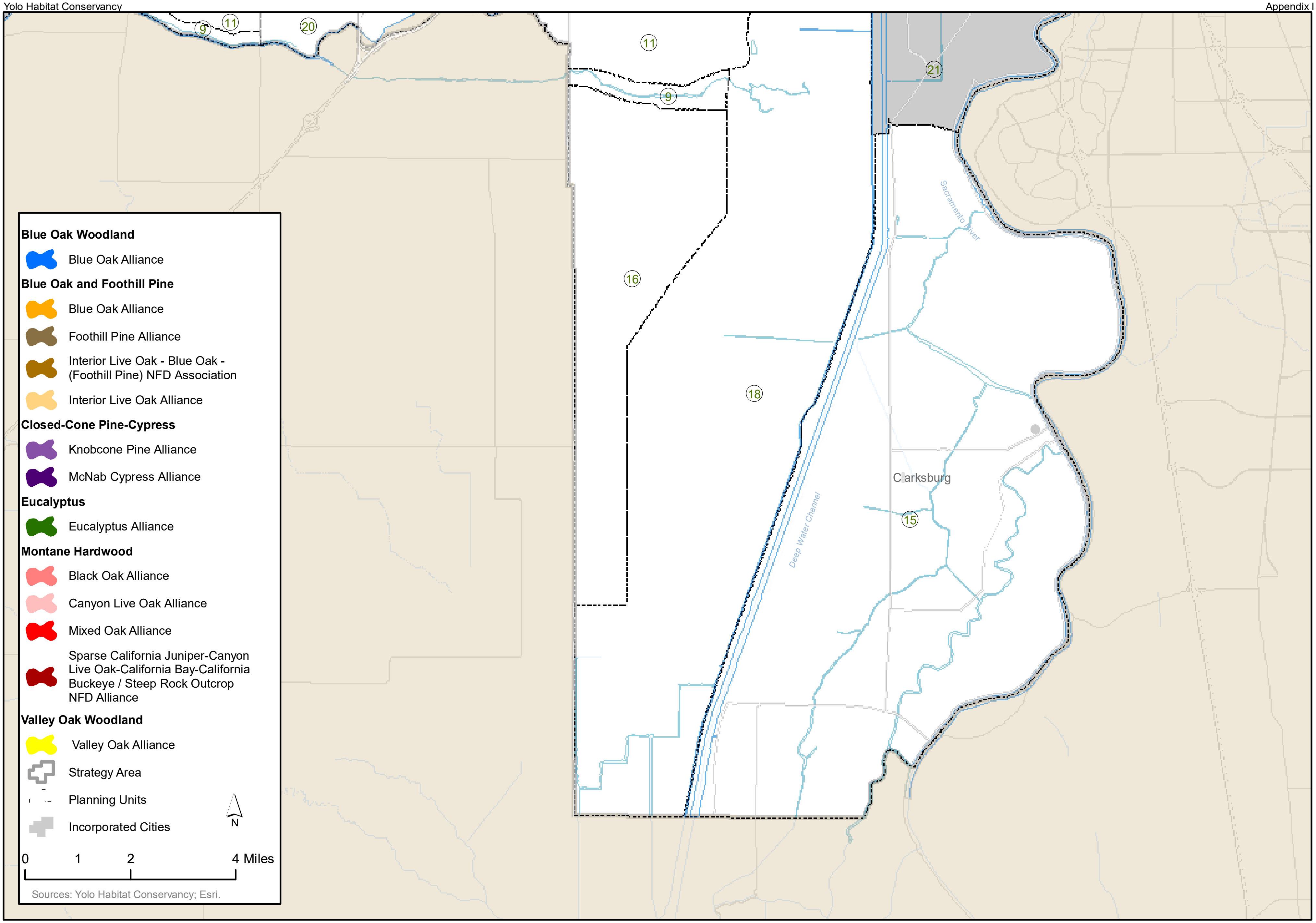
Appendix H-2e
Vegetation Detail within Woodland and Forest Natural Communities



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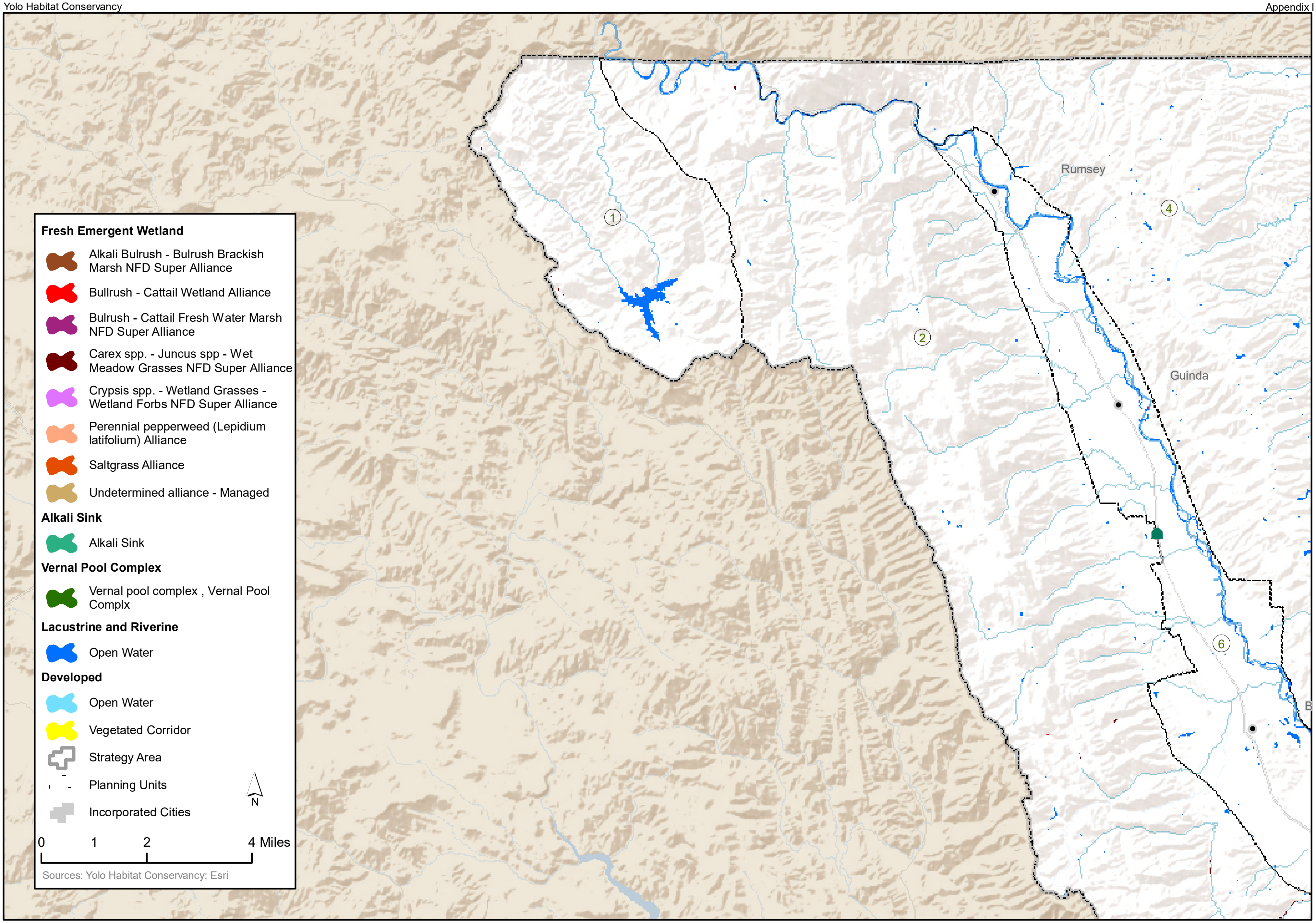
Appendix H-2f
Vegetation Detail within Woodland and Forest Natural Communities



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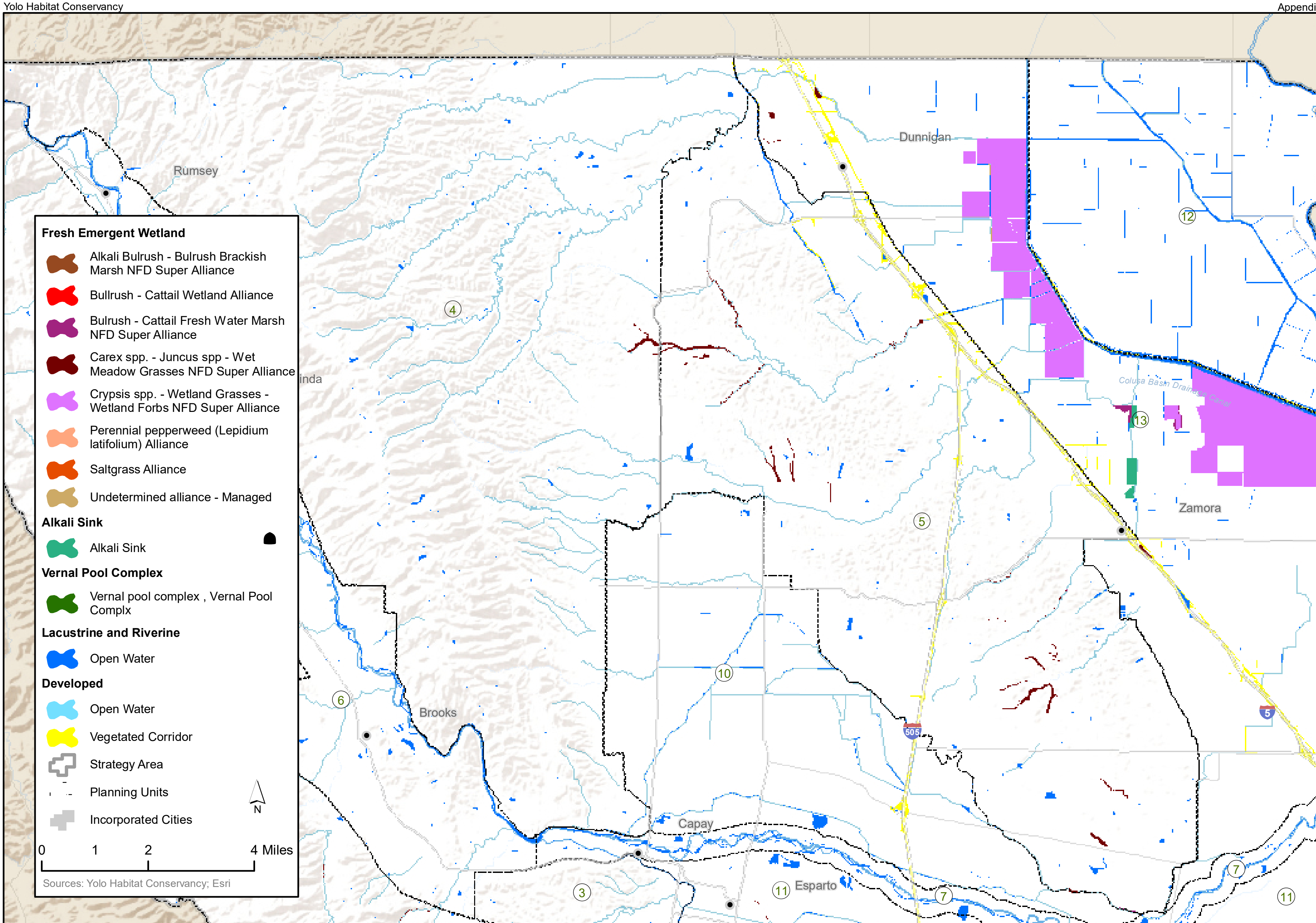
Appendix H-3a
Vegetation Detail within Wetland Natural Communities



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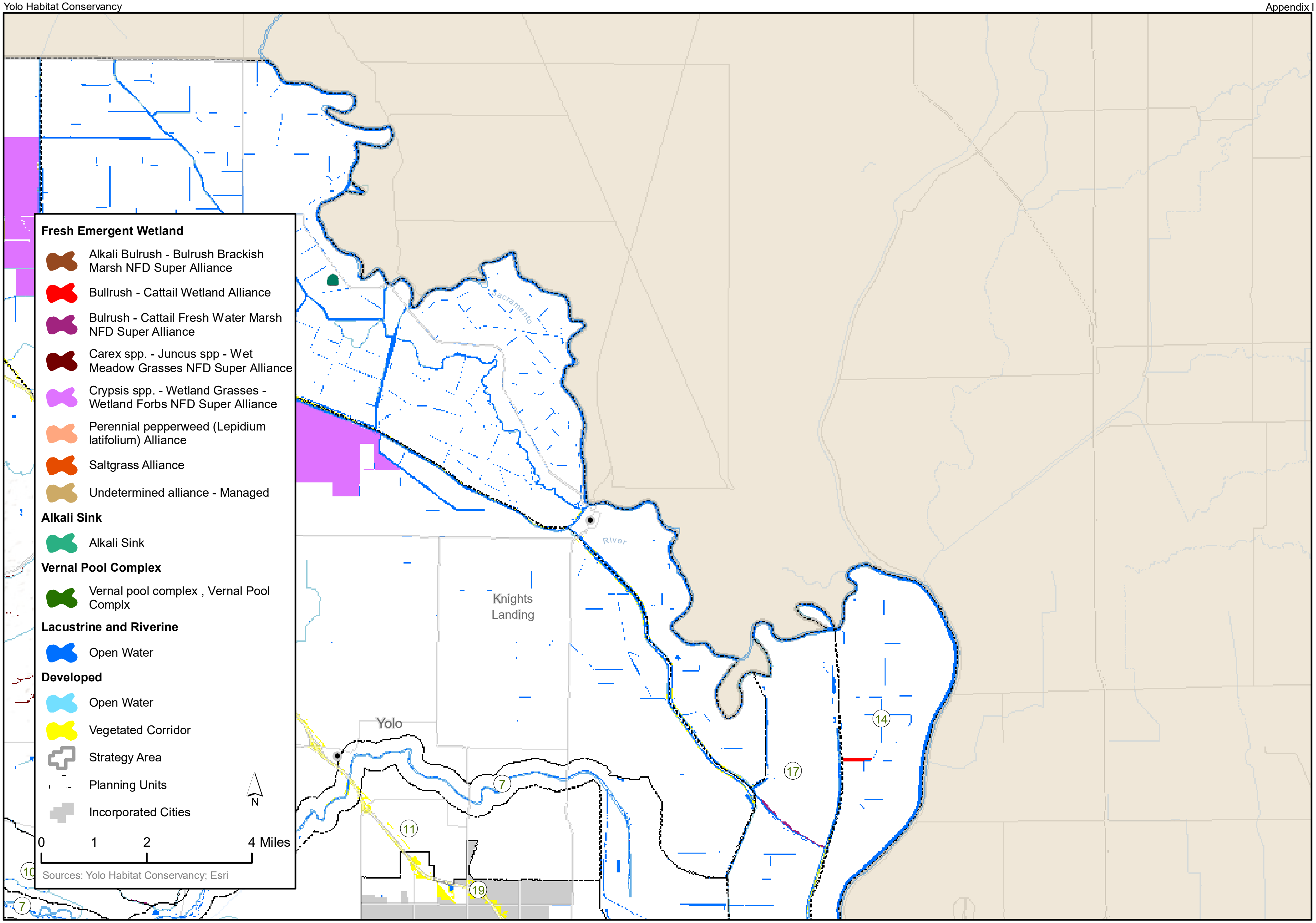
Appendix H-3b
Vegetation Detail within Wetland Natural Communities



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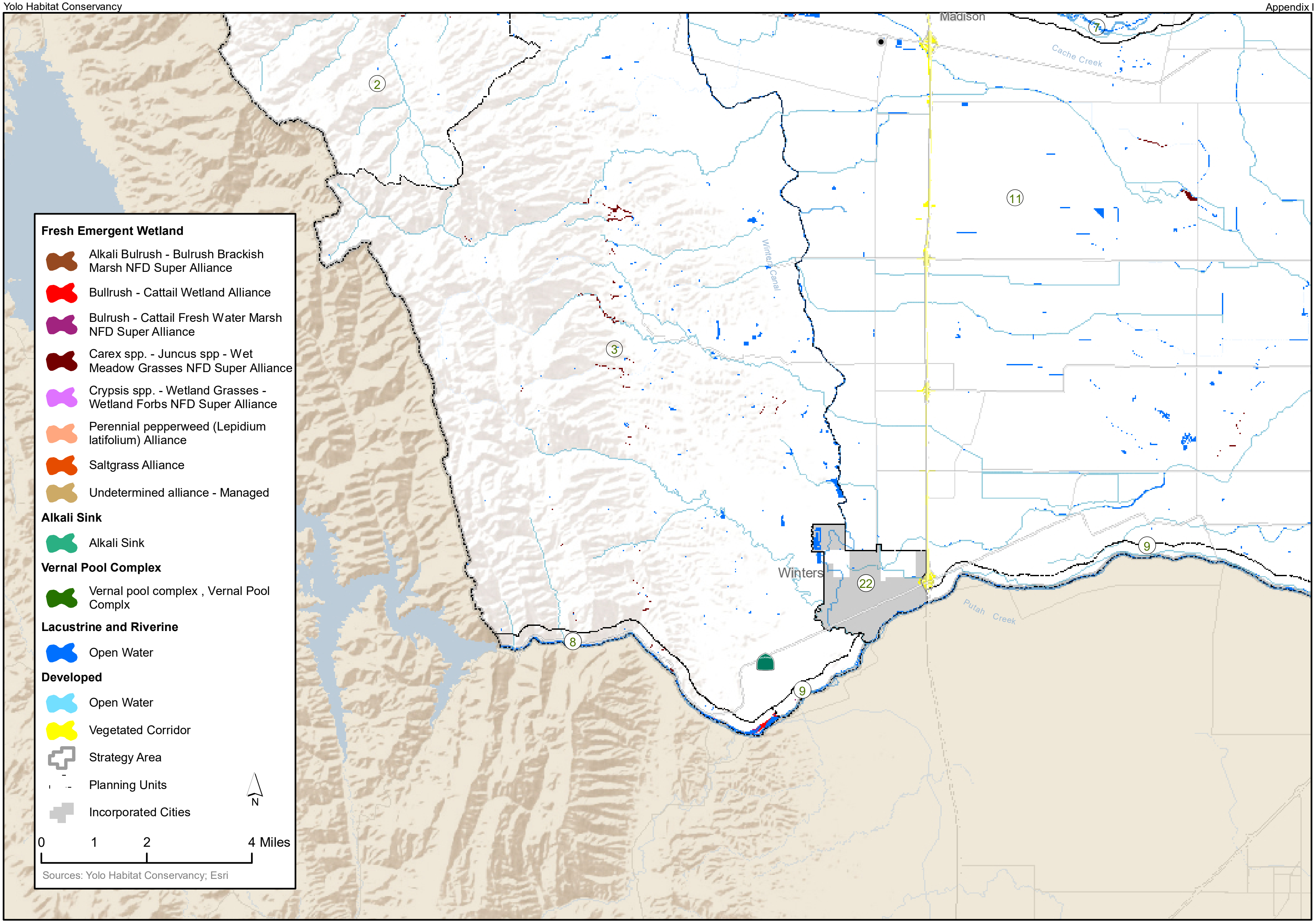
Appendix H-3c

Vegetation Detail within Wetland Natural Communities



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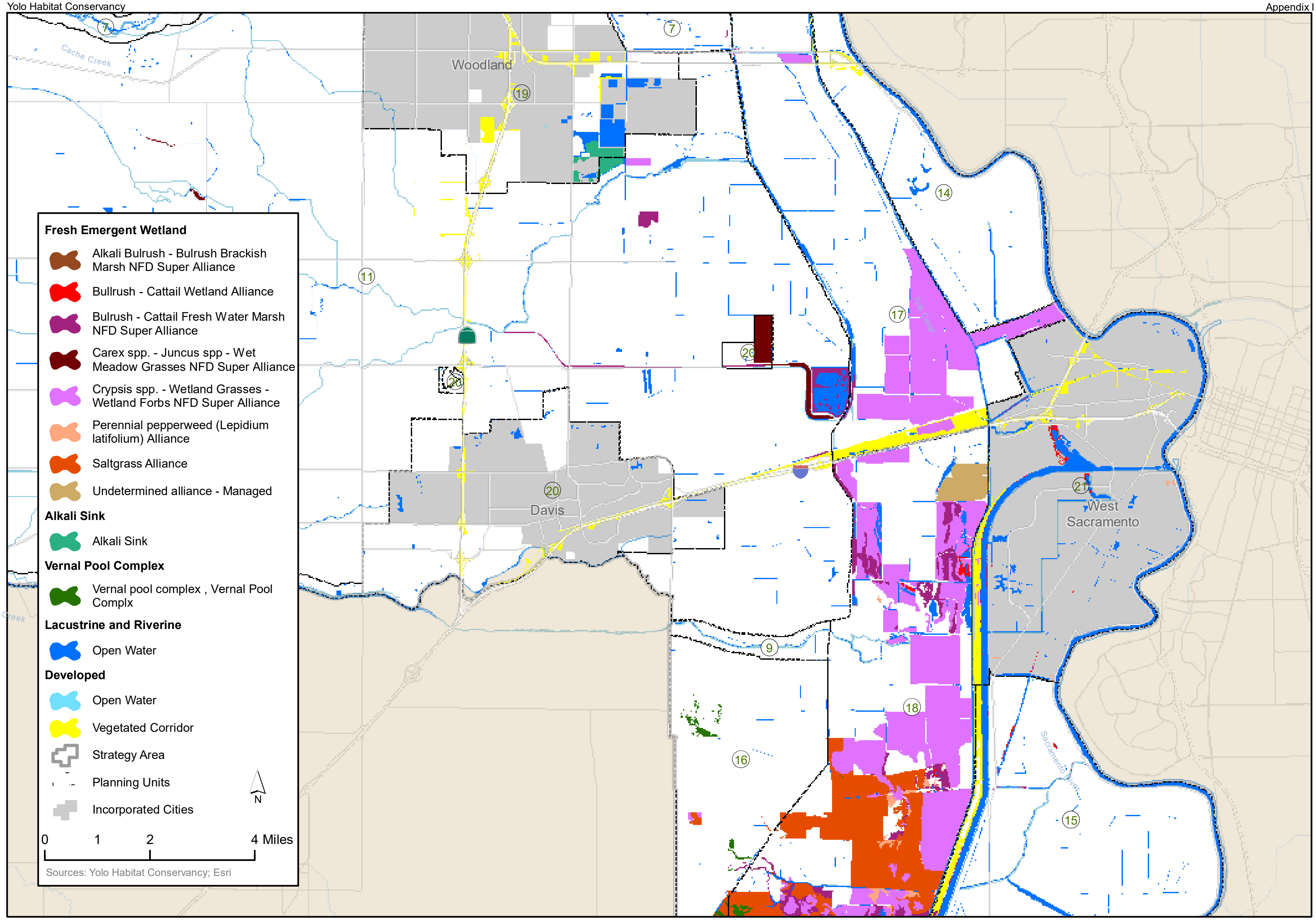
Appendix H-3d

Vegetation Detail within Wetland Natural Communities



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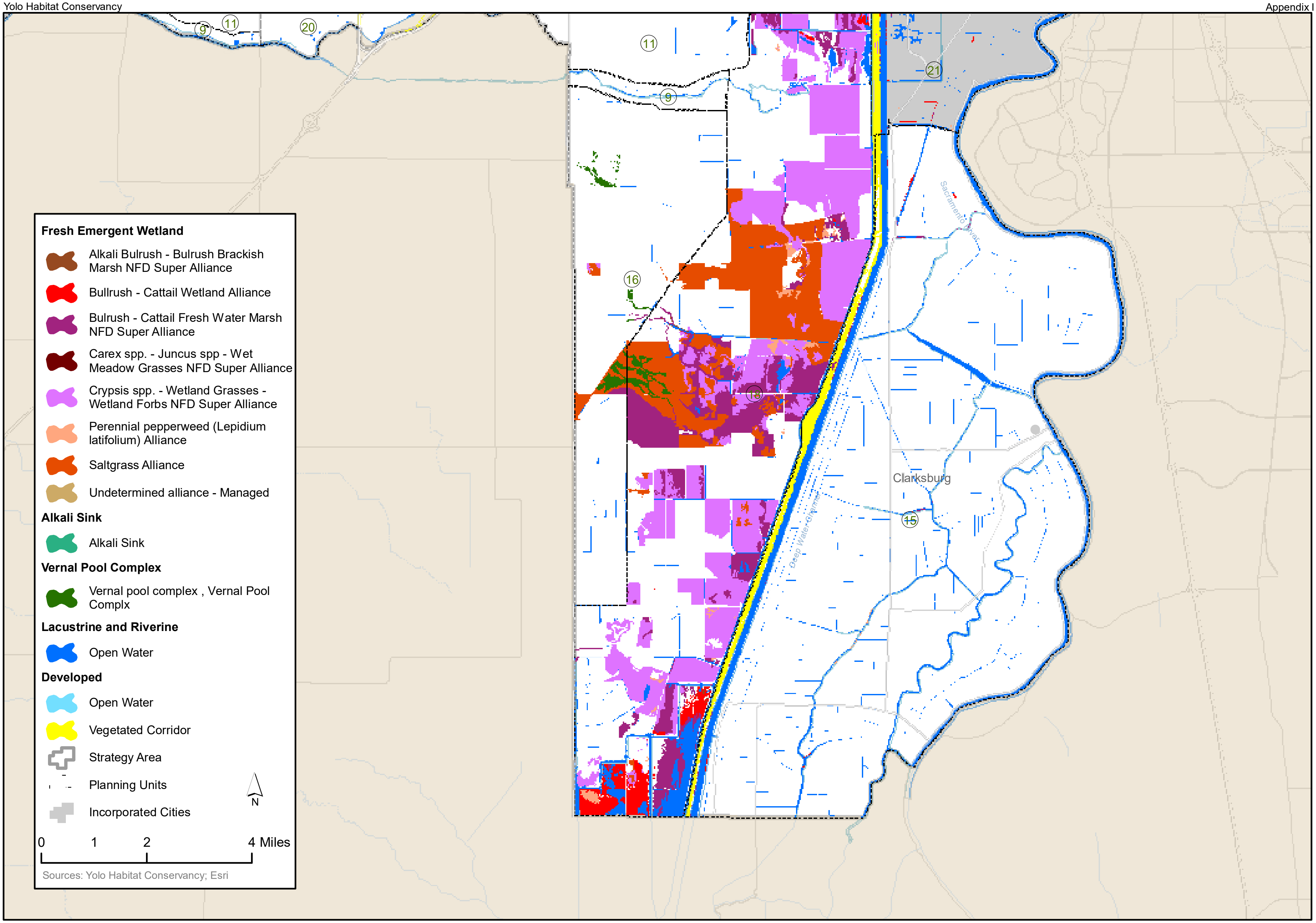
Appendix H-3e
Vegetation Detail within Wetland Natural Communities



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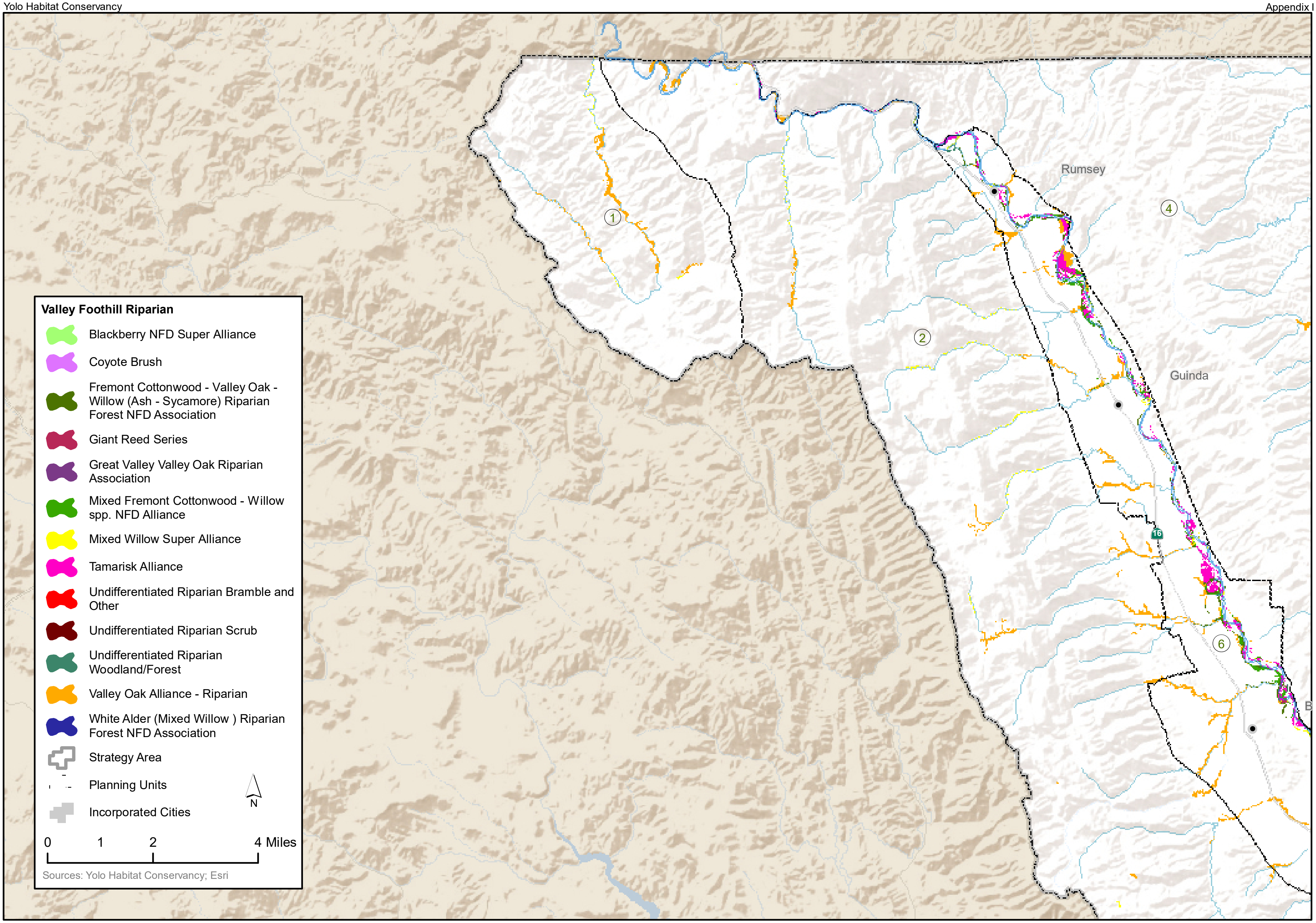
Appendix H-3f
Vegetation Detail within Wetland Natural Communities



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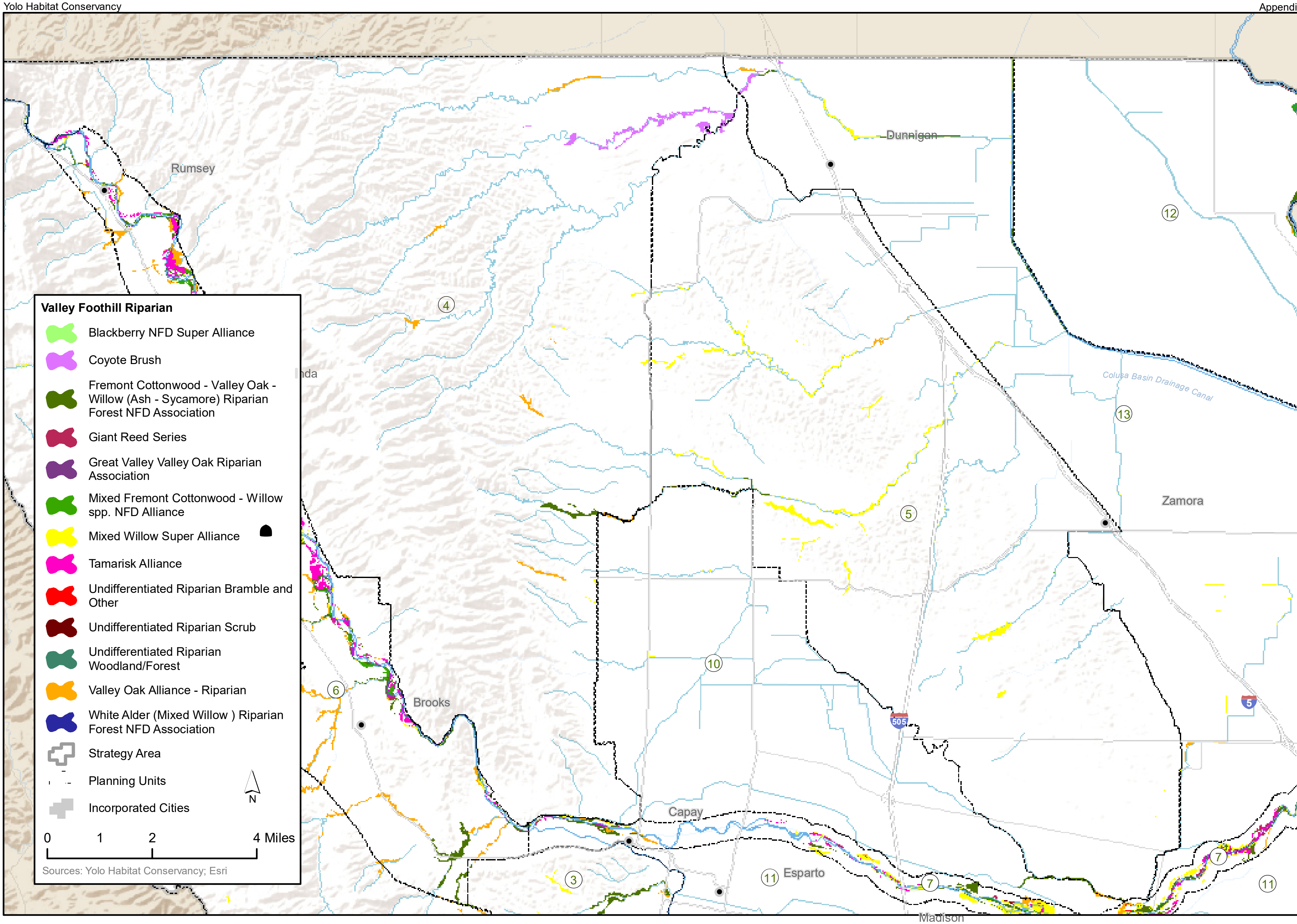
Appendix H-4a
Vegetation Detail within Riparian Natural Communities



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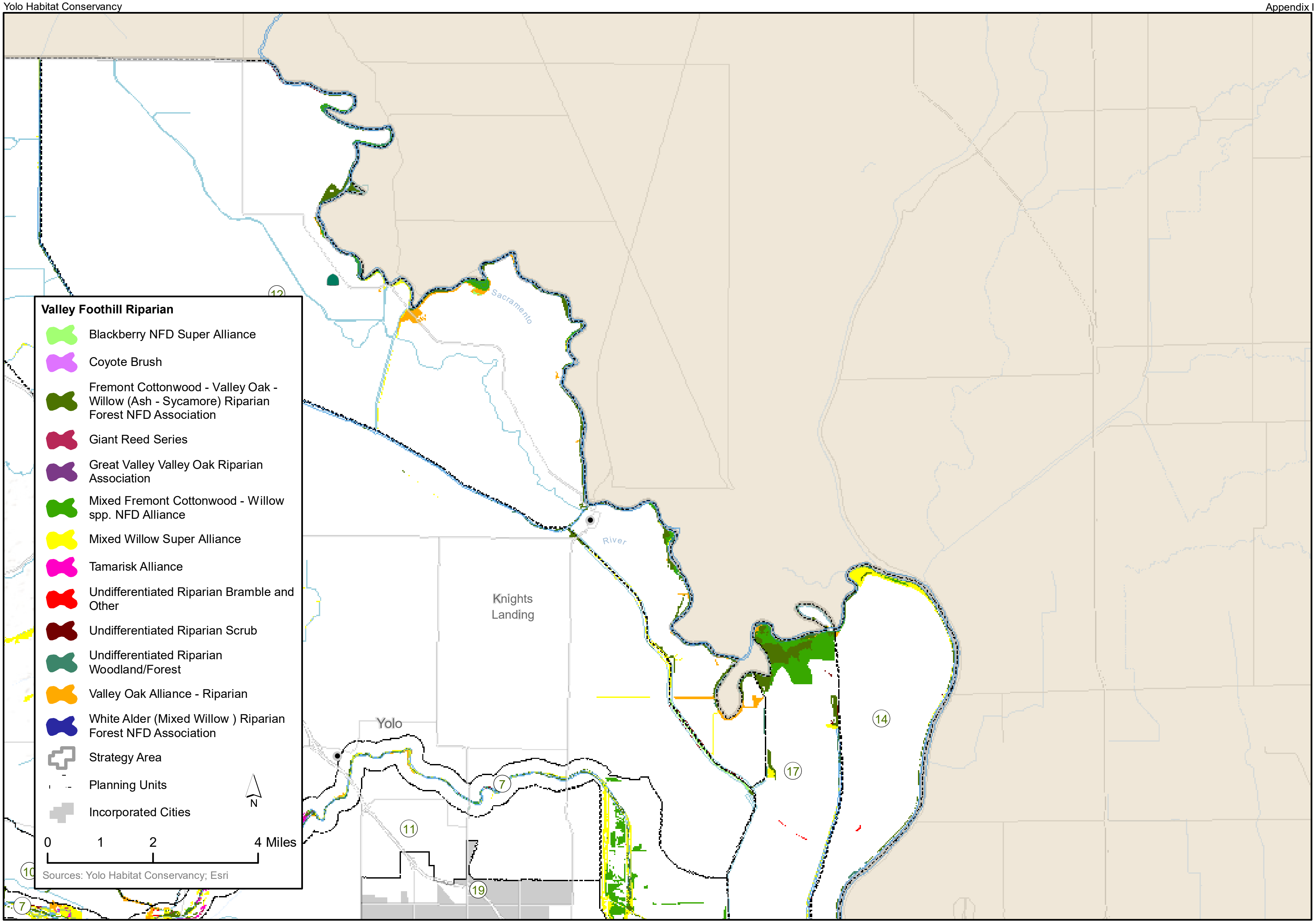
Appendix H-4b
Vegetation Detail within Riparian Natural Communities



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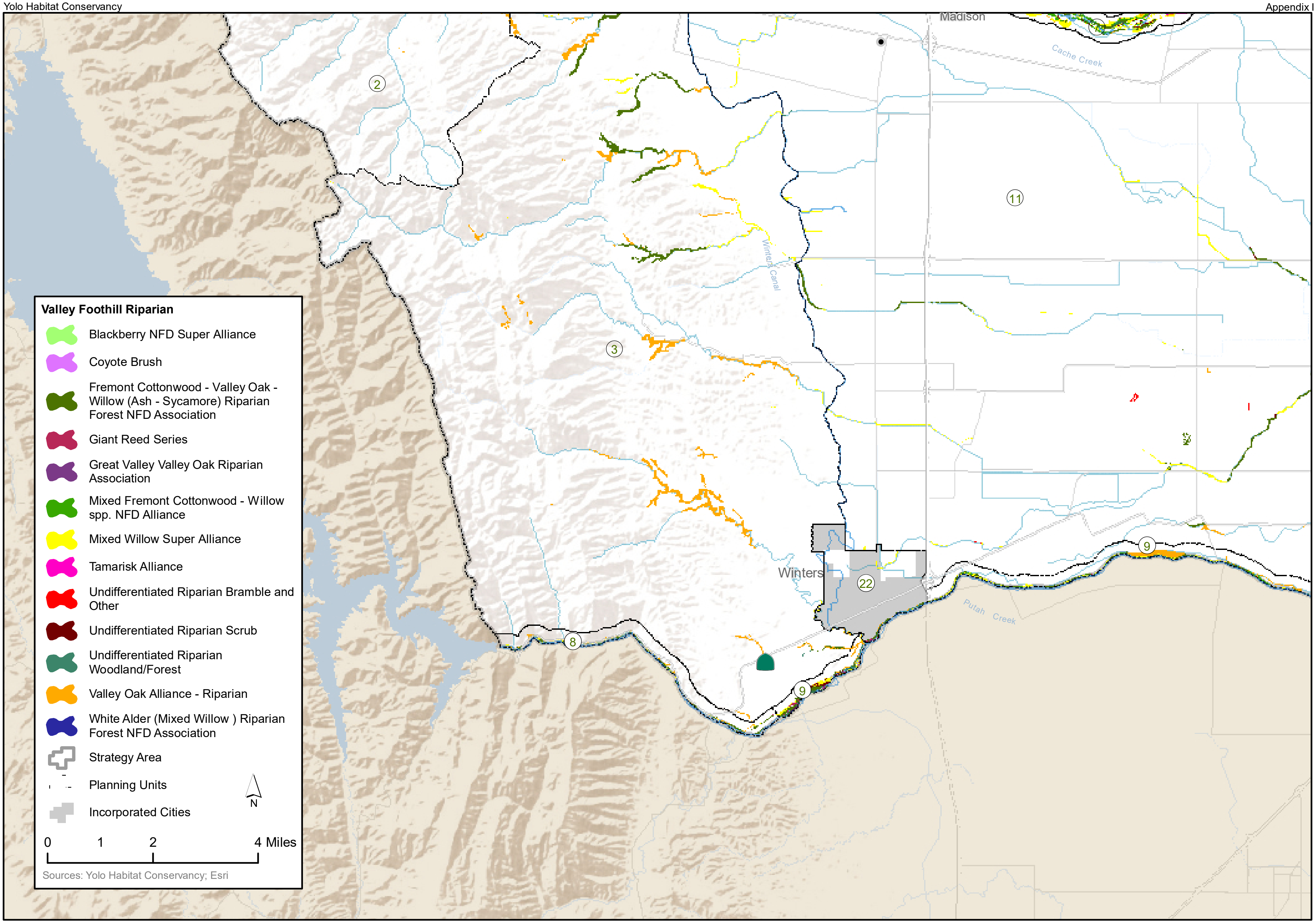
Appendix H-4c
Vegetation Detail within Riparian Natural Communities



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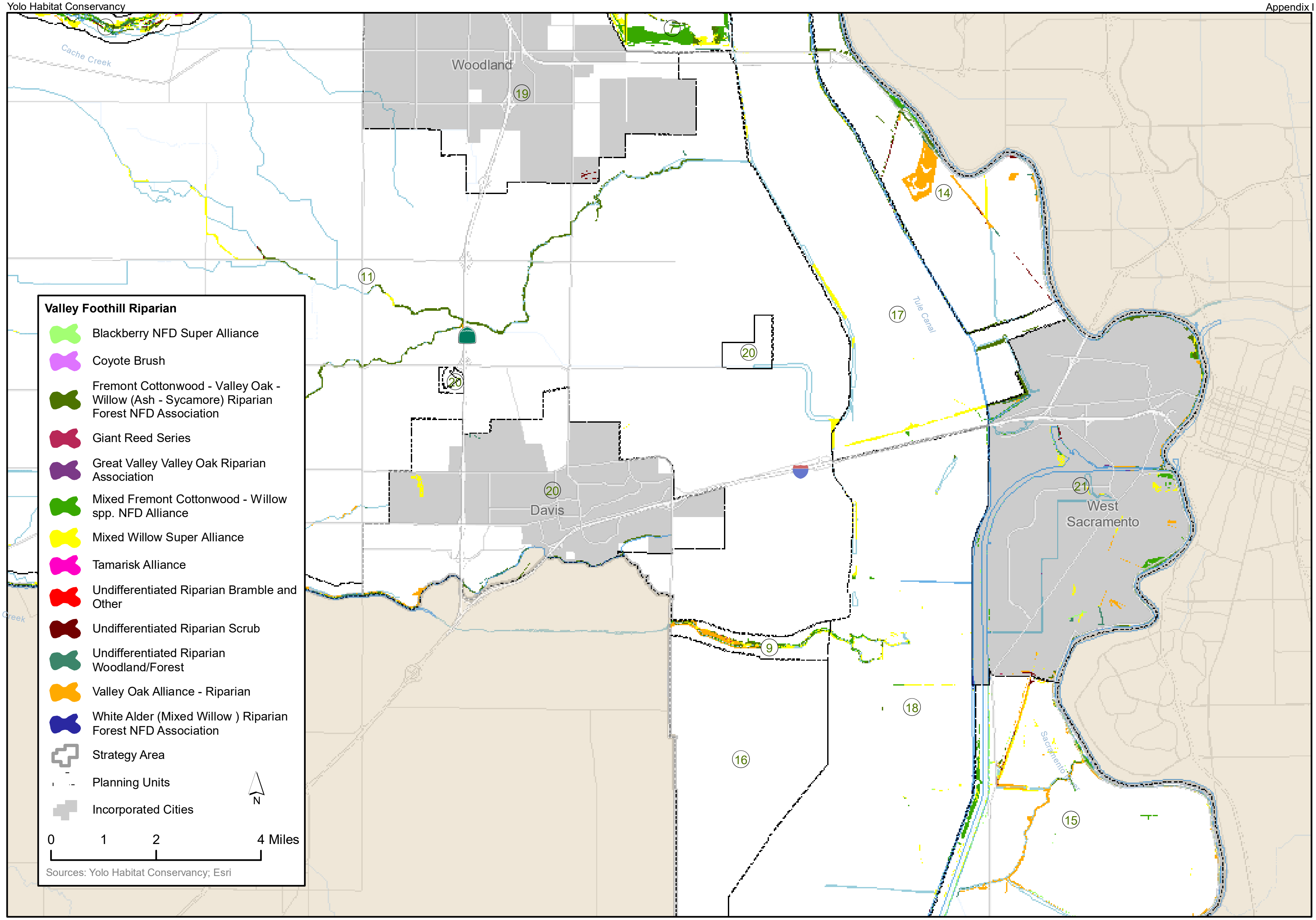
Appendix H-4d
Vegetation Detail within Riparian Natural Communities



Yolo Habitat Conservancy

Yolo RCIS/LCP

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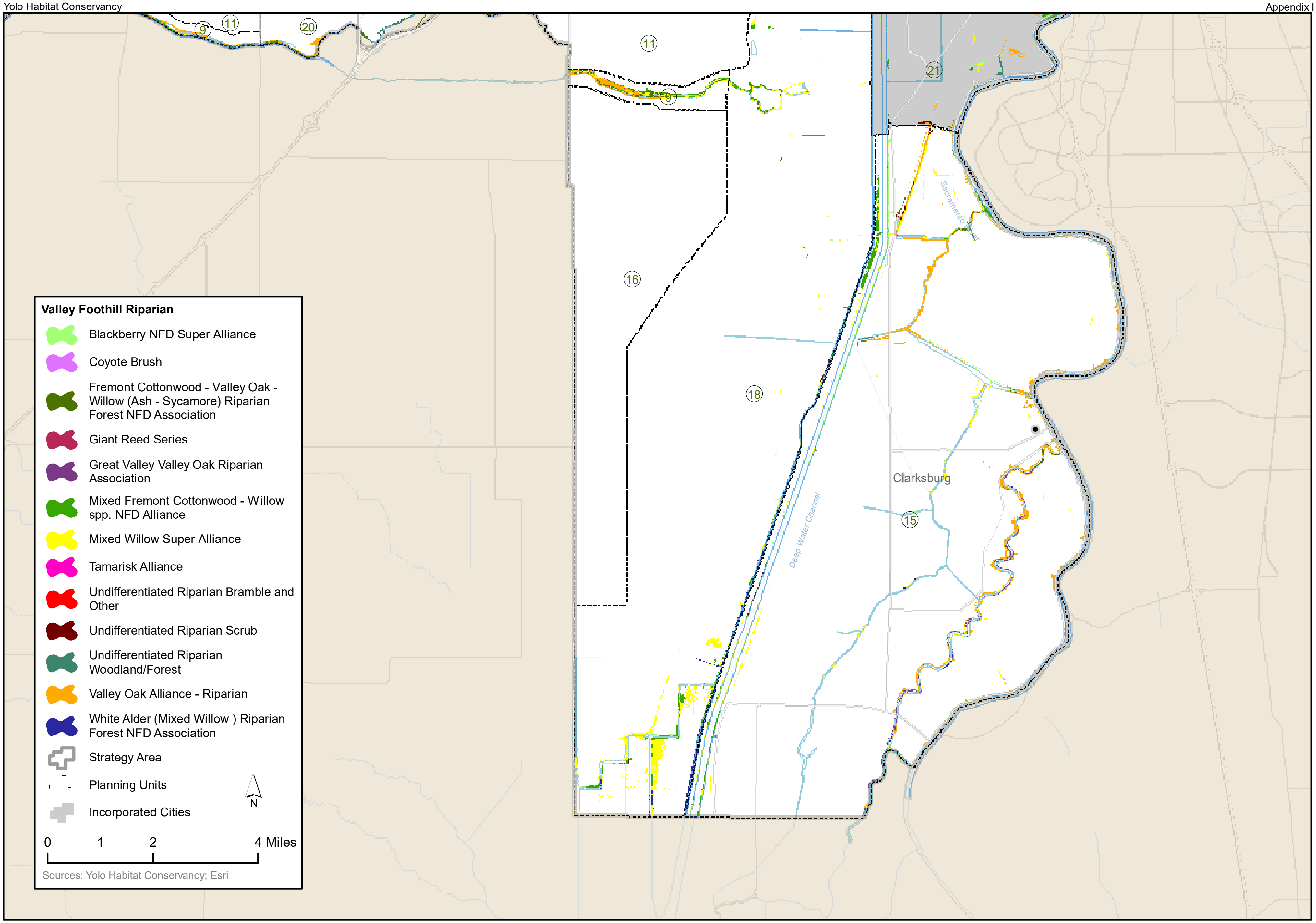
Appendix H-4e
Vegetation Detail within Riparian Natural Communities



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Appendix H-4f
Vegetation Detail within Riparian Natural Communities