STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

REPORT TO THE FISH AND GAME COMMISSION

A STATUS REVIEW OF THE
TRICOLORED BLACKBIRD
(*Agelaius tricolor*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
February 2018

Table of Contents

LIST OF FIGURES

Figure 1. Global range of the Tricolored Blackbird
Figure 2. Distribution of known breeding colony locations in California
Figure 3. Winter season aggregations of Tricolored Blackbirds
Figure 4. Number of Tricolored Blackbirds initiating breeding during 10-day intervals
Figure 5. Distribution of nesting substrates used by Tricolored Blackbirds
Figure 6. Predicted probability of Tricolored Blackbird colony occurrence and relative abundance
Figure 7. Number of young produced in Southern San Joaquin Valley colonies from 2005-2011
Figure 8. Percent of the Tricolored Blackbird in three regions of the state during statewide surveys
Figure 9. Distribution of active breeding colonies in southern California south of the Transverse Ranges
Figure 10. Locations surveyed during statewide surveys conducted since 2008
Figure 11. Number of birds observed per statewide survey conducted since 1994
Figure 12. Size of the largest and average of the five largest colonies observed during statewide surveys
Figure 13. Christmas Bird Count Circles used for winter population trend analysis
Figure 14. Number of Tricolored Blackbirds observed in regions of the state during statewide surveys
Figure 15. Estimated numbers of Tricolored Blackbirds in southern California
Figure 16. Land ownership in the range of the Tricolored Blackbird in California
Figure 17. Locations of HCPs and NCCPs for which Tricolored Blackbird is a covered species in California
Figure 18. Number of Breeding Birds in Harvested and Conserved Silage Colonies 2005–2009
Figure 19. Regional conversion of rangelands in California by type, 1984–2008
Figure 20. Increase in acreage of pistachio trees in California 1977–2012
Figure 21. Acreage of wine grapes and almonds in California from 1993 to 2012
Figure 22. Current and future housing densities projected by the U.S. EPA
Figure 23. Mapped climate exposure in 2100 under four climate projections
Figure 24. Projected climatically suitable range for grassland for the time period 2070–2099

LIST OF TABLES

Table 1. Number of colonies in major nesting substrate types
Table 2. Comparison of survey effort and results for seven statewide surveys
Table 3. Descriptions of 13 surveys that attempted to estimate the size of the Tricolored Blackbird
population between 1994 and 2017

LIST OF APPENDICES

EXECUTIVE SUMMARY

On August 19, 2015, the California Fish and Game Commission (Commission) received "A Petition to List the Tricolored Blackbird (*Agelaius tricolor*) as Endangered under the California Endangered Species Act and Request for Emergency Action to Protect the Species", as submitted by the Center for Biological Diversity. At its public meeting on December 10, 2015, in San Diego, California, the Commission considered the Petition, the California Department of Fish and Wildlife's (Department) petition evaluation and recommendation, and comments received. The Commission determined that sufficient information existed to indicate the petitioned action may be warranted and accepted the Petition for consideration. Upon publication of the Commission's notice of its findings, the Tricolored Blackbird was designated a candidate species on January 8, 2016.

This report contains the results of the Department's status review, including independent peer review of the report by scientists with expertise relevant to the Tricolored Blackbird. Additionally, it provides the Commission with the most current, scientifically-based information available on the status of the Tricolored Blackbird in California and serves as the basis for the Department's recommendation to the Commission.

The Tricolored Blackbird is designated as a Priority 1 Species of Special Concern by the Department and as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (USFWS). The species was previously petitioned for listing as endangered under the California Endangered Species Act (CESA) in 1991, 2004, and 2014. At its December 3, 2014 meeting in Van Nuys, California, the Commission voted to take emergency action to list the Tricolored Blackbird as an endangered species under CESA; the emergency regulation expired by operation of law in June 2015. The USFWS received petitions to list the Tricolored Blackbird as endangered under the federal Endangered Species Act in 2004 and 2015. The recent petition is currently under review by the USFWS. The Tricolored Blackbird is a covered species under several Habitat Conservation Plans and Natural Community Conservation Plans.

Species Description, Biology, and Ecology—Like other blackbirds in the family Icteridae, the Tricolored Blackbird is a medium-sized songbird with a slender, pointed bill and a relatively long tail. Tricolored Blackbirds are sexually dimorphic, with the breeding male plumage entirely black except for the bright red lesser wing coverts forming a conspicuous red patch ("shoulder" or "epaulets") on the wing and white median coverts forming a distinct border to the red. The female is mostly dark brown dorsally and heavily streaked in brown ventrally.

The Tricolored Blackbird is nearly endemic to the state of California. The species can be found throughout much of the lowlands west of the Sierra Nevada, extending west across the Central Valley to the coast from Sonoma County south to Santa Barbara County. The largest breeding colonies and the large majority of the breeding population occur in the Central Valley. The species is also found in the lowlands west of the deserts in southern California, extending south into northwestern Baja California. Small numbers of birds extend the range to the north into Oregon and Washington.

The Tricolored Blackbird forms by far the largest breeding colony aggregations of any extant North American landbird. Breeding colonies are seldom smaller than 100 nests, and in the past colonies have been composed of up to 300,000 breeding birds. Breeding within a colony is often highly synchronized, with all females in a colony typically initiating nest building within a few days. Nest density and territory size can vary among colonies with individual nests in the densest colonies built within one foot (0.3 m) or less of each other. Food resources for both the breeding adults and for the provisioning of young are mostly obtained from sites away from the colony location. Nestlings require animal matter (primarily insects) for the first nine days after hatching, and insect-rich foraging areas are required for successful reproduction. Adults will frequently travel up to 3 miles (4.8 km) from the colony location, and in some cases much further, to obtain insects for their young. Hence, the required foraging habitat for successful breeding has a much greater spatial extent than the nesting vegetation.

Tricolored Blackbirds often occupy and breed at two or more sites during the breeding season, a phenomenon known as itinerant breeding. Itinerant breeding is a rare trait among birds, and occurs exclusively in species that move between breeding attempts to locate or follow locally abundant food sources. Flocks of Tricolored Blackbirds roam widely within the breeding range in the weeks before breeding begins and between breeding attempts. In the Central Valley, there is a general pattern of a first nesting attempt in the San Joaquin Valley, with second nesting attempts often occurring to the north in the Sacramento Valley.

For successful breeding, Tricolored Blackbirds require three resources: 1) secure nesting substrate, 2) a source of water, and 3) foraging habitat that provides sufficient food resources. Historically, the nesting substrate (i.e., the vegetation in which nests are constructed) occurred primarily in freshwater wetlands dominated by cattails and tules. As the extent of freshwater wetlands decreased, Tricolored Blackbirds began using novel, nonnative vegetation types as nesting substrate. Other than wetlands, the primary nesting substrates used currently are Himalayan blackberry, thistles, stinging nettle, and agricultural grain fields. Foraging habitats during the breeding season include grasslands, low-density shrublands (e.g., alkali scrub), pastures, dry seasonal pools, and certain agricultural crops including alfalfa and rice, which provide for high production of insect prey for breeding Tricolored Blackbirds.

Status and Trends—The range of the Tricolored Blackbird has changed little since at least the mid-1930s. However, the distribution of the species within the range has shifted, and the species appears to be experiencing a range retraction in southern California and Baja California. In southern California, Tricolored Blackbirds no longer occur in most of the coastal portion of their former range, and 60–80% of the southern California population generally nests in a single region in western Riverside County. An apparent early nesting season shift in distribution from the Sacramento Valley to the southern San Joaquin Valley occurred at the end of the 20th century when Tricolored Blackbirds were discovered breeding in grain fields. This discovery corresponded to an increase in the number of dairies and the associated expansion of grain crops grown for silage in the San Joaquin Valley. Since the 1990s, the largest breeding colonies in the early nesting season have occurred on grain crops on or adjacent to dairies.

Early attempts to assess the Tricolored Blackbird population in the 1930s and 1970s suggested that the population size had declined by about 50% over 35 years. The most intensive efforts to estimate rangewide population abundance have occurred since 1994, with three statewide surveys conducted between 1994 and 2000, and an additional four statewide surveys conducted between 2008 and 2017. Although there has been limited effort to quantify uncertainty in the population estimates from any single statewide survey, the long-term trend shows a decline of 75%–90% over a 23-year period. The observed rates of decline of -5.8% to -10.5% per year indicates that the species has been in severe decline over the last two decades.

An Integrated Population Model (IPM) has recently been developed to jointly analyze banding, fecundity, and population data, which allows for evaluation of changes in population size and the demographic rates (e.g., survival or reproduction) responsible for the change. Data from more than 64,000 Tricolored Blackbirds banded from 2007 to 2016, fecundity data from 10 sites in 1992–2016, and population abundance data from eBird were used in development of the IPM. Over a 10-year period from 2007 to 2016, the Tricolored Blackbird population was estimated to have declined by 34% (95% credible interval = 71% decline to 7.5% growth). The estimated rate of population decline had a mean of -6.0% per year, indicating that the Tricolored Blackbird population has been in steep decline over the last 10 years. Results of the IPM indicated that adult female survival and fecundity were positively correlated with population growth rate. Because adult female survival is already relatively high and on par with other blackbird species, results from the IPM suggest that improvements in fecundity may be the best approach to increasing the Tricolored Blackbird population.

In the 1930s, the largest Tricolored Blackbird breeding colony consisted of more than 300,000 breeding birds. The average Tricolored Blackbird colony size declined significantly from 1935 to 1975, with the average colony size declining by more than 60%. During years when statewide surveys were conducted between 1994 and 2017, the size of the largest colony declined from more than 100,000 birds to less than 20,000 birds. The trend in size of the largest colonies follows a pattern similar to that of the total numbers of birds estimated during statewide surveys.

Christmas Bird Count (CBC) data were used to evaluate population changes in California during the nonbreeding season. CBC data analyses indicate a long-term decline in the Tricolored Blackbird population from 1974 to 2015, and a shorter term decline from 1995 to 2015.

Trends in the Tricolored Blackbird population from a variety of data sources and analyses are in agreement that the species has been in steep decline over the last several decades. Coupled with the earlier declines between the 1930s and 1970s, the recent declines have resulted in a population that is a small fraction of its historical abundance.

Threats—The Department has identified the following factors as potential threats to the continued existence of the Tricolored Blackbird in California: colonial breeding and small population size; habitat loss; overexploitation, including the harvest of breeding colonies; predation; contaminants; extreme weather events; and drought, water availability, and climate change. Although they have negative

effects on Tricolored Blackbirds, the following are not considered threats to the continued existence of the species at this time: interspecific competition, brood parasitism, disease, and invasive species.

Highly social and colonial breeding species are vulnerable to population declines, with an increased risk at small population sizes. In conjunction with a declining population abundance, the primary threats to the Tricolored Blackbird are habitat loss, especially loss of foraging habitat; low rates of reproductive success, in part due to losses of colonies to harvest on agricultural fields and to infrequent but intense predation events; and climate change, including increases in frequency and intensity of droughts. Although less certain in the level of impact on the Tricolored Blackbird, contaminants (primarily neonicotinoid insecticides) are an additional potentially important threat.

About 95% of the wetlands that occurred historically in the Central Valley have been lost. The loss of nesting substrates of all types continues, with specific nesting locations being lost in most years. 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. Nonnative vegetation types that are used for nesting are often considered undesirable and are frequently removed. Despite these ongoing losses, there appears to be suitable nesting substrate in some areas that goes unused in many years; therefore, nesting substrate availability does not appear to limit the Tricolored Blackbird population in these areas. However, there are other regions within the Tricolored Blackbird range where large areas of apparently suitable foraging habitat have little or no available nesting substrate.

The extent of foraging habitat required for successful breeding is much greater than the extent of nesting substrate, and once lost, large landscapes with suitable habitat are difficult to replace. Loss of foraging habitat has likely led to the extirpation of colonies from most of the coastal lowlands in southern California. 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. In recent years, the rate at which grasslands and compatible crops (e.g., alfalfa) have been converted to orchards has accelerated. Large-scale losses are projected to continue into the future as agricultural practices evolve, cities continue to expand, and a changing climate makes large areas unsuitable for grassland communities.

A large portion of the Tricolored Blackbird population nests annually on agricultural grain fields, mostly in grain grown for silage on dairies. In many cases the entire reproductive effort of silage colonies has been lost when the nesting substrate is harvested while the young or eggs are still in the nest. Efforts to protect colonies have had mixed success, with many colonies protected but with large colonies being lost in most years. The availability of well-funded colony protection programs, the emergency listing of the species prior to the 2015 breeding season, the continued protection under CESA as a candidate for listing, and the resulting response to colony harvest incidents by Department law enforcement resulted in an increased incentive for landowners to participate in colony protection programs. As a result, participation in colony protection programs has been very high in recent years. Without long-term secured funding and the incentives provided by protection under CESA, the future success of these programs is uncertain.

Although infrequent, predation has at times had large impacts on colonies, even leading to complete nesting failure. Because predation at Tricolored Blackbird colonies typically occurs on eggs, nestlings, and fledglings, predation can have a substantial effect on reproductive success when large colonies are affected.

Drought reduces water supply reliability and has far-reaching impacts on most habitat types in California. The recent multi-year drought resulted in reductions in surface water in the Central Valley, which likely reduced availability of wetlands for nesting. Several of the upland nesting substrates used by Tricolored Blackbirds are also reduced or eliminated in dry years. Extreme or prolonged drought negatively affects grasshopper and other insect prey populations through desiccation of eggs or through decreased biomass of primary producer food sources (e.g., grasses and forbs). Climate change is projected to bring longer and more severe droughts to California in the future.

The average temperature is expected to rise by approximately 2.7°F (1.5°C) by 2050, and the average number of extremely hot days (at least 105°F [41°C]) per year in Sacramento is expected to increase fivefold (up to 20 days) by the middle of the century. Rising temperatures may directly affect annual Tricolored Blackbird productivity by truncating the breeding season or causing colony failure. Two important Tricolored Blackbird communities, grassland and freshwater marsh, are projected to be among the natural communities most affected by climate change in California. The extent of freshwater marsh in California is projected to decrease by 71%–97% by year 2100 due to increasing temperatures, and the extent of grasslands are projected to decrease by 16%–48%.

Neonicotinoid insecticides have been implicated in the decline of invertebrate communities and, in a few cases, the decline of insectivorous birds. Several studies have revealed a negative relationship between insect populations and neonicotinoid use, and at higher concentrations they can have lethal and sublethal impacts to vertebrates. This relatively new group of insecticides may have caused declines of non-target insect species within the breeding range of the Tricolored Blackbird, resulting in a declining prey base, but no data have been collected that can directly support this. Studies to date have relied on observational data to find correlations between neonicotinoids and potential effects. There is a need for mechanistic research to investigate exposure rates of Tricolored Blackbirds to neonicotinoids, effect of exposure on body condition and fitness, and investigations into potential insect-based food-web impacts.

A number of recommended management actions are described in this report. These actions could be undertaken whether or not the Tricolored Blackbird is listed under CESA, by the Department as well as by other public agencies, non-governmental organizations, and private landowners in some cases. These include actions to address: habitat protection, restoration, and enhancement; breeding colony protection; monitoring and research; and education and outreach.

Recommendation—The Department provides this status review report, including its recommendation, to the Commission in an advisory capacity based on the best scientific information available. In addition to evaluating whether the petitioned action to list as endangered is warranted, the Department also considered whether listing as threatened under CESA is warranted. In consideration of the scientific

information contained herein, the Department has determined that listing the Tricolored Blackbird as threatened under CESA is warranted at this time.

REGULATORY FRAMEWORK

Petition Evaluation Process

A petition to list the Tricolored Blackbird (*Agelaius tricolor*) as endangered under the California Endangered Species Act (CESA) was submitted to the Fish and Game Commission (Commission) on August 19, 2015 by the Center for Biological Diversity. Commission staff transmitted the petition to the Department of Fish and Wildlife (Department) pursuant to Fish and Game Code section 2073 on August 20, 2015, and published a formal notice of receipt of the petition on September 4, 2015 (Cal. Reg. Notice Register 2015, No. 36-Z, p. 1514). The Department's charge and focus in its advisory capacity to the Commission is scientific. A petition to list or delist a species under the CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant" (Fish & G. Code, § 2072.3).

On October 2, 2015, the Department provided the Commission with its evaluation of the petition, "Evaluation of the Petition from the Center for Biological Diversity to List Tricolored Blackbird (*Agelaius tricolor*) as Endangered Under the California Endangered Species Act," to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)). Focusing on the information available to the Department relating to each of the relevant categories, the Department recommended to the Commission that the petition be accepted.

At its scheduled public meeting on December 10, 2015, in San Diego, California, the Commission considered the petition, the Department's petition evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the petition for consideration. Upon publication of the Commission's notice of its findings, the Tricolored Blackbird was designated a candidate species on January 8, 2016 (Cal. Reg. Notice Register 2016, No. 2-Z, p. 57).

Status Review Overview

The Commission's action designating the Tricolored Blackbird as a candidate species triggered the Department's process for conducting a status review to inform the Commission's decision on whether to list the species. At its scheduled public meeting on December 8, 2016, in San Diego, California, the Commission granted the Department a six-month extension to complete the status review and facilitate external peer review.

This status review report is not intended to be an exhaustive review of all published scientific literature relevant to the Tricolored Blackbird; rather, it is intended to summarize the key points from the best scientific information available relevant to the status of the species. The final report represents the Department's evaluation of the current and potential future status of the species and is informed by independent peer review of a draft report by scientists with expertise relevant to Tricolored Blackbird. It is intended to provide the Commission with the most current information on the Tricolored Blackbird and to serve as the basis for the Department's recommendation to the Commission on whether the petitioned action is warranted. The status review report also identifies habitat that may be essential to the continued existence of the species and provides management recommendations for recovery of the species (Fish & G. Code, § 2074.6). Receipt of this report is to be placed on the agenda for the next available meeting of the Commission after delivery. At that time, the report will be made available to the public for a 30-day public comment period prior to the Commission taking any action on the petition.

Existing Regulatory Status

California Endangered Species Act

The Tricolored Blackbird was the subject of three previous CESA listing petitions. In 1991, the Yolo chapter of the National Audubon Society submitted a petition to the Commission to list the species as endangered. After reviewing the document and other available information, the Department determined that the petitioned action might be warranted and recommended to the Commission that it accept and consider the petition. In March 1992, the Commission voted to accept the petition and designated the Tricolored Blackbird as a candidate for listing. During the 1992 breeding season, researchers discovered that the abundance of the species (number of individuals) was much greater than previously thought, and the Yolo Audubon Society withdrew the petition based on the new abundance data. The Commission allowed the petition to be withdrawn, but urged the Department to work with interested persons and groups to develop conservation measures for the Tricolored Blackbird. The species was again petitioned to be listed under CESA in 2004 (Cal. Reg. Notice Register 2004, No. 18-Z, p. 568). The petition evaluation report by the Department (Gustafson and Steele 2004) stated there was sufficient information to indicate the petitioned action may be warranted; however, the Commission voted to reject the petition (Fish and Game Commission meeting, Feb. 3, 2005). On October 8, 2014, the Center for Biological Diversity submitted a petition to list the Tricolored Blackbird as endangered (Cal. Reg. Notice Register 2014, No. 44-Z, p. 1861). The Commission referred the petition to the Department for an initial evaluation on October 15, 2014. At its December 3, 2014 meeting in Van Nuys, California, the Commission voted to take emergency action to add Tricolored Blackbird to the list of endangered species pursuant to Fish and Game Code section 2076.5, with the related regulation as approved by the Office of Administrative Law taking effect for an initial term of six months beginning on December 29, 2014 (Cal. Reg. Notice Register 2015, No. 2-Z, p. 91). At its meeting in Mammoth Lakes on June 11, 2015, the Commission voted to reject the 2014 petition and on June 30, 2015 the emergency regulation adopted in December 2014 expired by operation of law.

Federal Endangered Species Act

The Tricolored Blackbird also has a history of consideration for listing under the federal Endangered Species Act (ESA). In 1988, the United States Fish and Wildlife Service (USFWS) contracted for a compilation of all historical information on the distribution and abundance of the Tricolored Blackbird, resulting in the work of Beedy et al. (1991). In 1991, the USFWS identified the Tricolored Blackbird as a category 2 candidate for listing. However, in 1996, the USFWS eliminated category 2 species from the list of candidate species. In 2004, the USFWS received a petition to list the Tricolored Blackbird as a threatened or endangered species from the Center for Biological Diversity. In 2006, the USFWS issued a 90-day finding in response to the petition that listing the Tricolored Blackbird was not warranted (50 CFR Part 17, Dec 5, 2006). On February 3, 2015, the Center for Biological Diversity submitted a petition to the USFWS to list the Tricolored Blackbird as an endangered species under the ESA and to designate critical habitat concurrent with listing. The petition is currently under review by the USFWS (50 CFR Part 17, Sept 18, 2015).

California Species of Special Concern and USFWS Birds of Conservation Concern

The Tricolored Blackbird is listed as a Priority 1 Species of Special Concern (SSC) by the Department. The Department's SSC designation is administrative and is intended to alert biologists, land managers, and others to a species' declining or at-risk status, to encourage additional management of these species to ensure population viability, and to preclude the need for listing under CESA. SSCs are defined as species, subspecies, or distinct populations of animals native to California that currently satisfy one or more of the following criteria: extirpated from the state in the recent past; listed under ESA as threatened or endangered, but not under CESA; meets the state definition of threatened or endangered but has not been formally listed; experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (that have not been reversed), which if continued or resumed could qualify the species for threatened or endangered status under CESA; has naturally small populations or range size and exhibits high susceptibility to risk from any factor that, if realized, could lead to declines that would qualify it for threatened or endangered status (Shuford and Gardali 2008). In 2008, the USFWS updated its Birds of Conservation Concern report, identifying "species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973" (USFWS 2008). The Tricolored Blackbird was included on two Bird Conservation Region lists (Coastal California and Great Basin), the USFWS Region 8 (California and Nevada) list, and the national list. Neither the state nor the federal species of concern designations provides the species with formal regulatory status as does the CESA or ESA; however, negative impacts to SSC are generally considered potentially significant under the California Environmental Quality Act, and therefore mitigation for impacts may be provided (see Existing Management section).

Migratory Bird Treaty Act

The Tricolored Blackbird is included on the list of species protected under the Migratory Bird Treaty Act (MBTA). It is unlawful to take, possess, transport, sell, or purchase any bird listed in the Act, or its nest or eggs, without a permit issued by the USFWS.

A recent reinterpretation (December 22, 2017) of the MBTA by the U.S. Department of the Interior solicitor regarding implementation of the law suggests that incidental take will no longer be prohibited. Rather, the solicitor argued that the "MBTA's prohibition on pursuing, hunting, taking, capturing, killing, or attempting to do the same applies only to direct and affirmative purposeful actions that reduce migratory birds, their eggs, or their nests, by killing or capturing, to human control." The effect of this interpretation on the conservation of Tricolored Blackbirds is not clear.

California Fish and Game Code

The Fish and Game Code includes certain protections for birds, including nongame birds. Sections applicable to the Tricolored Blackbird include the following:

> Section 3503 – It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

> Section 3513 – It is unlawful to take or possess any migratory nongame bird as designated in the Migratory Bird Treaty Act or any part of such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

> Section 3800(a) – All birds occurring naturally in California that are not resident game birds, migratory game birds, or fully protected birds are nongame birds. It is unlawful to take any nongame bird except as provided in this code or in accordance with regulations of the commission.

The Fish and Game Code defines take as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (Fish & G. Code, § 86).

BIOLOGY AND ECOLOGY

Species Description

The Tricolored Blackbird was first collected by Thomas Nuttall in 1836 near Santa Barbara, California (Nuttall 1840, Baird et al. 1874). A male specimen was sent to John James Audubon who described it as a unique form of blackbird in his well-known *Ornithological Biography* (Audubon 1839).

The Tricolored Blackbird is sexually dimorphic, with the breeding male plumage entirely black except for the bright red lesser wing coverts forming a conspicuous red patch ("shoulder" or "epaulets") on the wing and white median coverts forming a distinct border to the red. The black body plumage is glossed bluish when viewed in sunlight. The female is mostly dark brown dorsally and heavily streaked ventrally

with dark brown streaks merging to form a largely solid dark brown belly. The head of the female is indistinctly patterned with a whitish supercilium, malar, chin, and throat (Beedy et al. 2017).

Although similar in appearance to the related Red-winged Blackbird (*A. phoeniceus*), several features can be used to distinguish the two species in breeding plumage (described by Nuttall 1840, Cooper 1870, Baird et al. 1874). The black plumage of the Tricolored Blackbird male has a soft bluish luster that is lacking in the Red-winged Blackbird. The lesser wing coverts (the red "shoulder") on the breeding male Tricolored Blackbird are a much deeper red (described as crimson, carmine, or the color of venous blood) compared to the brighter red with a tinge of orange (vermilion or scarlet) in the Red-winged Blackbird. The median coverts in the Tricolored Blackbird are white (pale-yellowish when fresh) and create a stark contrast between the black and red feathers on the wing, whereas in the Red-winged Blackbird they are generally yellowish (or black in the subspecies that breeds in much of the Central Valley). The bill of the Tricolored Blackbird averages thinner and can appear more sharply pointed. In flight, the wings of the Tricolored Blackbird appear to have a more pointed shape (vs. rounded in the Red-winged Blackbird) due to differences in length of the primary flight feathers. Female Tricolored Blackbirds have darker plumage than most female Red-winged Blackbirds, although this difference is less pronounced in the Central Valley where the subspecies of Red-winged Blackbird is relatively dark (Beedy et al. 2017).

Taxonomy

The Tricolored Blackbird is a member of the avian family Icteridae, which is restricted to the Americas in the Western Hemisphere and includes blackbirds, orioles, cowbirds, grackles, and meadowlarks (Skutch 1996). The blackbirds are medium-sized songbirds with slender, pointed bills and relatively long tails. There are about 100 species in the family, most of which occur in the tropics. Following recent taxonomic changes that removed several South American species from the genus *Agelaius*, there are currently five species in the genus worldwide (Remsen 2017). The only other species that occurs on the North America mainland is the much more widespread and diverse Red-winged Blackbird. The other three species in the genus occur in the Greater Antilles: *A. assimilis* (the Red-shouldered Blackbird of western Cuba), *A. humeralis* (the Tawny-shouldered Blackbird of Hispaniola and Cuba), and *A. xanthomus* (the Yellow-shouldered Blackbird of Puerto Rico) (Beedy et al. 2017). There are no recognized subspecies of Tricolored Blackbird (AOU 1957).

Geographic Range and Distribution

The Tricolored Blackbird is nearly endemic to the state of California, with small numbers of birds extending the species' range into neighboring states of Oregon, Washington, and Nevada, and into Baja California.

Breeding Range

The majority of the Tricolored Blackbird's breeding range is composed of two disjunct regions of California and Baja California, separated by the Transverse Ranges of southern California (Figure 1). The larger of the two areas includes the lowlands west of the Sierra Nevada, extending west across the

Central Valley to the coast from Sonoma County south to Santa Barbara County. The second area includes the lowlands west of the deserts in southern California, extending south into northwestern Baja California. Throughout this report, references to the southern California portion of the species' range are to this area south of the Transverse Ranges, unless otherwise stated.
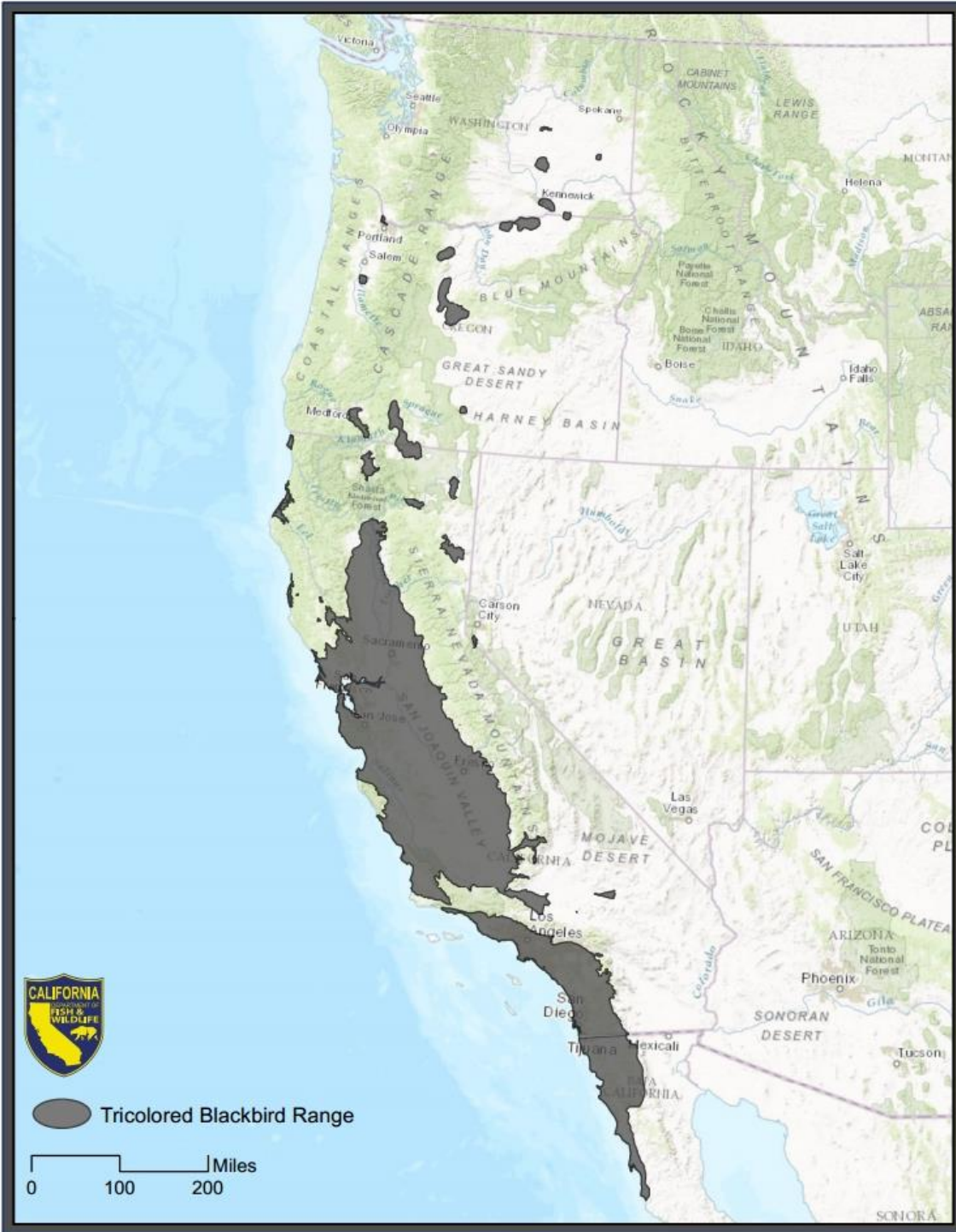
Figure 1. Global range of the Tricolored Blackbird.

Small numbers of birds extend the range to the north in isolated low-lying areas on the northern California coast and to isolated areas in northeastern California, Oregon, and eastern Washington. Similarly, the range extends east from the southern Central Valley to small areas in the Mojave Desert. The species is currently known to occupy a single area in Douglas County, Nevada (Skutch 1996, Ammon and Woods 2008, Beedy et al. 2017).

Winter Range

In winter, Tricolored Blackbirds mostly withdraw from the portion of their breeding range north of the Central Valley (northeastern California, Oregon, and Washington) and from Nevada to the lowlands of central and coastal California (Wahl et al. 2005, Ammon and Woods 2008, Beedy et al. 2017), although a small number of birds are occasionally documented throughout the northern breeding range during winter (Gilligan et al. 1994, Spencer 2003, eBird Dataset 2016). The species can be found in most of the remainder of its range year-round, with shifts in distribution as described below.

Distribution of Breeding Colonies

Within the breeding range, the largest breeding colonies and the large majority of the breeding population occur in the Central Valley of California (Figure 2b). In all California statewide surveys (breeding season surveys conducted on a mostly triennial schedule since 1994), most (≥90% in all years but 1997) of the observed birds were detected in the Central Valley counties during the early breeding season (Hamilton et al. 1995, Beedy and Hamilton 1997, Hamilton 2000, Kelsey 2008, Kyle and Kelsey 2011, Meese 2014a).

Although the overall distribution and breeding locations vary from year to year, Tricolored Blackbirds at the species level exhibit some fidelity to traditional use areas. These areas likely provide all of the critical resources needed by breeding colonies, while the specific nesting sites used in the area can change from year to year (Beedy et al. 1991). In the Central Valley, there are distinct regions that frequently support multiple colonies and a large proportion of the breeding population. In the southern San Joaquin Valley, the largest colonies are typically detected in an area centered at the junction of Kern, Kings, and Tulare counties (Figure 2), although the numbers in Kings and Tulare counties have declined in recent years (Meese 2017). In the northern San Joaquin Valley, Merced County regularly supports multiple large colonies. Further north in the Central Valley and Sierra Nevada foothills, breeding colonies are regularly distributed more broadly from Sacramento County north through the Sacramento Valley to Butte, Colusa, and Glenn counties. In southern California, breeding colonies are located mainly in the western portions of Riverside and San Bernardino Counties, south through the interior of San Diego County (Figure 2; Feenstra 2009). Colonies are patchily distributed throughout the rest of the species' range in California, particularly in the Coast Ranges and on the coastal slope.

The limited range of the species in Oregon, Washington, and Nevada is believed to be maintained by irregular occurrences of relatively small numbers of birds (Gilligan et al. 1994, Spencer 2003, Wahl et al. 2005, Ammon and Woods 2008). These states have historically supported less than 1% of the species' global population (Beedy et al. 1991). Although previously more widespread, breeding in Baja California now appears to occur at only a few isolated locations (Erickson et al. 2007, Erickson and de la Cueva

a)

b)
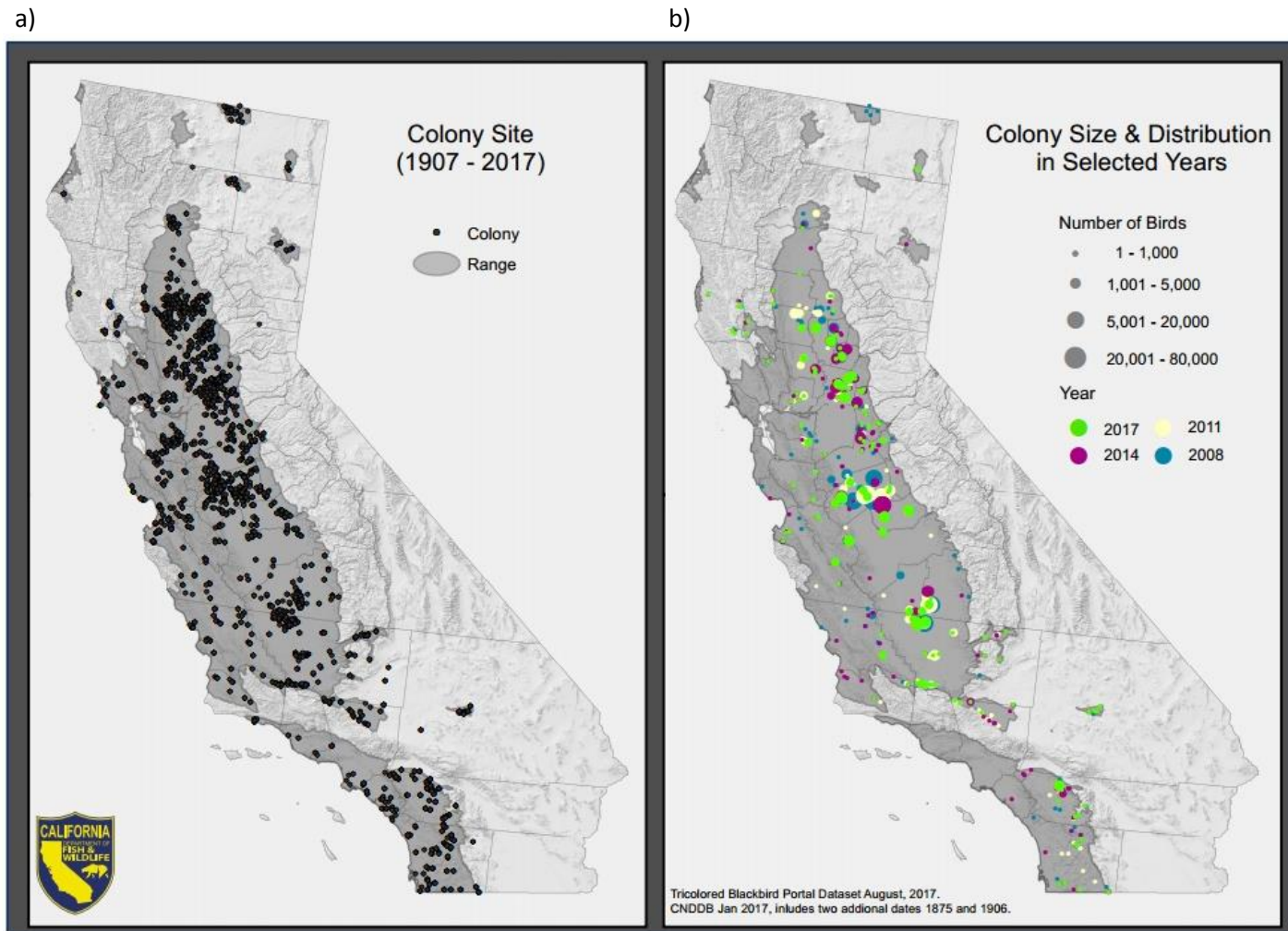
Figure 2. Distribution of known breeding colony locations in California. a) All known breeding locations 1907-2017. b) Distribution and size of breeding colonies in selected years. Recent statewide survey years were selected for mapping the distribution and size of breeding colonies due to the more thorough searches conducted in those years; the map includes colonies from throughout the breeding season (i.e., it is not limited to the April survey period when the population is concentrated in the southern half of the state).

2008, Feenstra 2013, Erickson et al. 2016). Currently, no more than about 1% of the species' population is believed to breed outside of California.

Breeding colonies typically occur in valleys or low-lying areas with nesting habitat and extensive grassland, certain agricultural crops, or other suitable foraging habitat. However, the elevation of colony locations varies greatly across the range. The majority of birds breed below an elevation of about 300 feet (91 m) in the Central Valley. In the central Sierra foothills, colonies occur up to 1,720 feet (524 m), although most have been detected near the valley floor at or below about 300 feet elevation (Airola et al. 2015a). In the southern Sierra Nevada they breed up to 2,500 (762 m) feet near Lake Isabella in eastern Kern County (eBird Dataset 2016). In southern California, most colonies occur below about 1,500 feet (457 m), although colonies at more inland locations are at higher elevations, with a small colony in San Diego County occurring at about 4,400 feet (1,341 m). Further inland, such as in the Mojave Desert and to the northeast in the Modoc Plateau, colonies occur at elevations up to several thousand feet. Grinnell and Miller (1944) included a record of 4,400 feet on the "South Fork of the Pit River" in Modoc County. The single known breeding location in Nevada is at 4,730 feet (1,442 m) elevation (Ammon and Woods 2008).

Winter Distribution

Although Tricolored Blackbirds can be found throughout much of the California breeding range year-round, most birds withdraw from the southern San Joaquin Valley and the northern Sacramento Valley in the winter (Grinnell and Miller 1944, Beedy et al. 2017). Band recoveries and observational studies have documented movement of birds away from these portions of the range toward the central part of the valley surrounding and including the Sacramento-San Joaquin Delta region (Neff 1942, DeHaven and Neff 1973, DeHaven et al. 1975a). Birds are generally concentrated in this region, the northern San Joaquin Valley in Merced County, and in coastal areas north and south of the San Francisco Bay area in winter (Orians 1961a, Payne 1969, Stallcup 2004) (Figure 3). Evidence from banded birds recovered outside the Central Valley is limited, but birds from throughout the northern range are thought to follow the general pattern of winter movement to central and coastal California (DeHaven et al. 1975a, Beedy 2008). Although a relatively large portion of the population winters in this region, wintering flocks have been detected at widely scattered locations throughout the species' range north of the Transverse Ranges (DeHaven et al. 1975a).

South of the Transverse Ranges, birds from Santa Barbara County south to Baja California appear to occupy the region year-round (Unitt 2004, Beedy 2008), although distribution in the southern portion of the range is patchy in all seasons. Recoveries of birds banded in southern California have revealed movements over much shorter distances compared to birds from the Central Valley (Neff 1942, DeHaven and Neff 1973).

Genetics and Population Structure

Hamilton (2004a) documented differences in apparent patterns of movement between Central Valley and southern California populations of Tricolored Blackbirds, and suggested that a lack of gene flow may have led to genetically distinct populations. While banding studies indicate extensive movement of

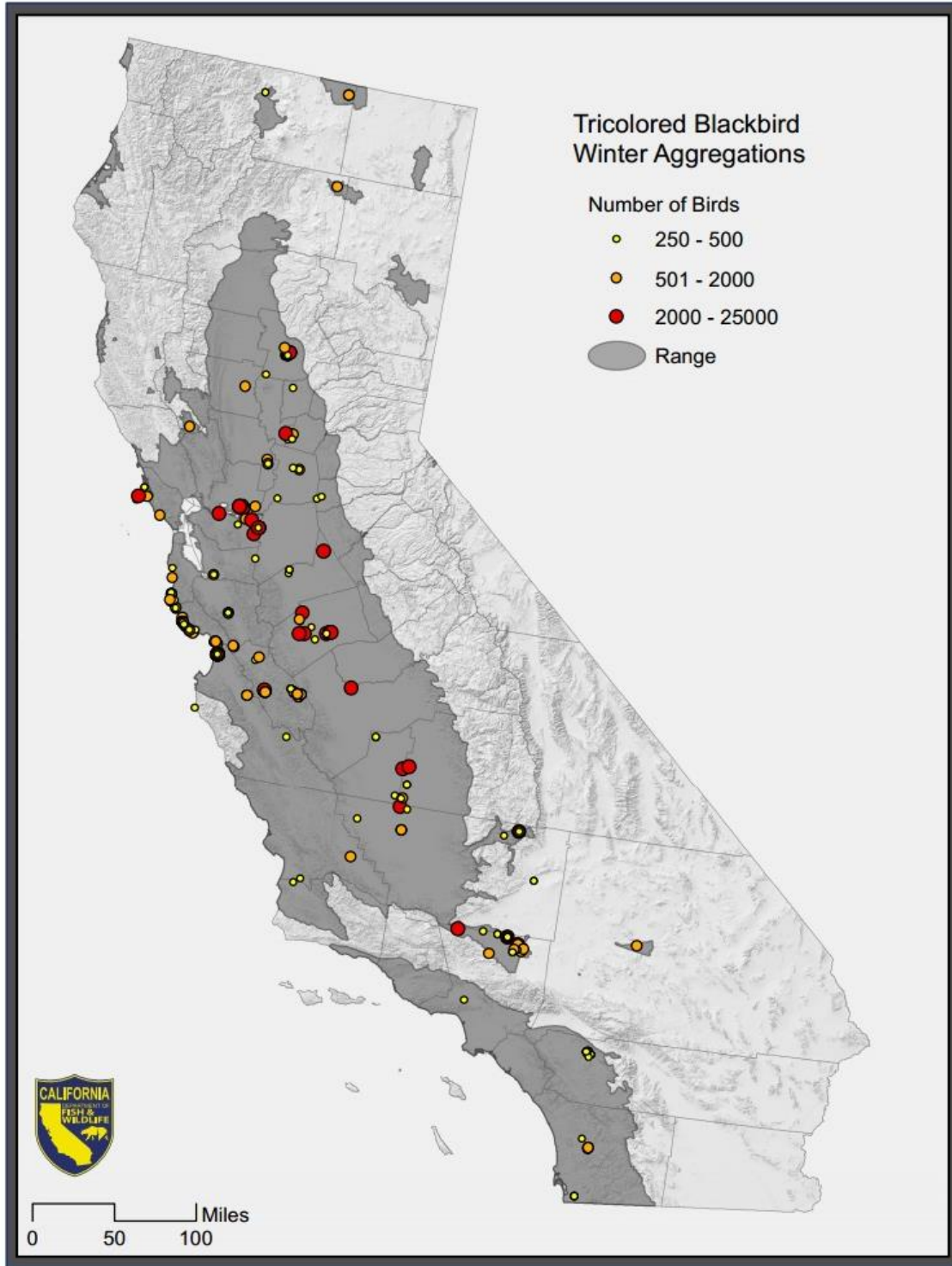**Figure 3**. Winter season aggregations of Tricolored Blackbirds. Data is from eBird and was selected to represent November through January distribution for groups of at least 250 birds.

Tricolored Blackbirds throughout the entire length of the Central Valley (DeHaven et al. 1975a), DeHaven and Neff (1973) reported on recoveries of banded birds from the Central Valley and southern

California and suggested that little or no exchange occurs between populations north and south of the Transverse Ranges. The observation of a single banded bird in the Mojave Desert of northern Los Angeles County was the first datum documenting movement of the species from the Central Valley to the desert (Feenstra 2009), although there is a report from the late 1800s documenting a flock of Tricolored Blackbirds moving in the opposite direction (Belding 1890). In 2014 and 2016, the second and third Tricolored Blackbirds that had been banded in the Central Valley were photographed in San Bernardino County, providing further evidence of movement from the valley to the Mojave Desert (Meese 2014b, Aug 2017 email from R. Meese to N. Clipperton; unreferenced). No movement across the Transverse Ranges (i.e., between the Central Valley/Mojave Desert and the southern California portion of the species' range) has been documented based on banding data.

A microsatellite and mitochondrial DNA analysis (Berg et al. 2010) on the Tricolored Blackbird did not find evidence of substantial genetic differentiation between the Central Valley and a southern population composed of birds from the Mojave Desert and southern California. The birds sampled in the southern population had higher allelic diversity, suggesting that the southern population may be an important reservoir of genetic variation for the species. There was statistically significant evidence of inbreeding (F_{IS}) in both putative populations, and F_{IS} was about 33% greater in southern than in central California. A greater percentage of birds appeared to move from southern to Central California than vice versa. The historical effective population size (Ne) was estimated to be three to eight times greater in southern California than in central California, and reductions in Ne appeared to be considerably greater in southern California (Berg et al. 2010). A caveat to these results is that samples were obtained at only two colonies south of the Transverse Ranges and at two colonies in the desert, sample sizes were small at some colony locations, and the study used a relatively small number of genetic markers. In addition, it may be inappropriate to combine birds from the Mojave Desert with birds from south of the Transverse Ranges to represent a single southern population, as was done in Berg et al. (2010). This is especially true if the birds in the Mojave Desert are connected through gene flow with birds in the Central Valley. Researchers at UCLA are currently conducting a study with more advanced genomic techniques to characterize genetic variation, population structure, and spatial and temporal patterns of movement throughout the range of the Tricolored Blackbird (Feb 2017 email from K. Barr to N. Clipperton; unreferenced).

Movements

Most Tricolored Blackbirds are resident in California, with seasonal movements leading to shifts in distribution within the state over the course of a year. Grinnell and Miller (1944) wrote that the Tricolored Blackbird is "resident within State [California], but partly migratory within the Sacramento-San Joaquin drainage system; all populations are in some degree nomadic and in fall and winter normally leave the immediate vicinity of the nesting colonies." Banding studies (Neff 1942, DeHaven and Neff 1973, DeHaven et al. 1975a) and observations of unbanded birds (Payne 1969) demonstrated that most Tricolored Blackbirds reside throughout the Central Valley from March through September, and then move into the Sacramento-San Joaquin Delta and northern San Joaquin Valley (primarily Merced County) and coastal locations during winter. More extensive migratory movements are made by small numbers of birds that breed north of the Central Valley as far north as Washington (Wahl et al. 2005);

most of these migratory individuals apparently return to California in winter. In southern California south of the Transverse Ranges, birds seem to undergo much more localized seasonal movements compared to those from the Central Valley (Neff 1942, DeHaven and Neff 1973).

Itinerant Breeding

Individual Tricolored Blackbirds often occupy and breed at two or more sites during the breeding season, a phenomenon known as itinerant breeding (Hamilton 1998). Itinerant breeding is a very rare trait among birds, and occurs exclusively in species that move between breeding attempts to locate or follow locally abundant food sources (Jaeger et al. 1986). Although early observers suspected that Tricolored Blackbirds nested more than once in a season at multiple locations (e.g., Neff 1937), the movements of Tricolored Blackbirds have been described as "sheerly and illogically erratic" (Neff 1942), "wanderings" (Payne 1969), and "highly nomadic" (Beedy et al. 1991). Recoveries of banded Tricolored Blackbirds documented interannual breeding at widely separated locations, but within-year movements during the breeding season were not documented prior to the 1990s (Neff 1942, DeHaven and Neff 1973). The movements of Tricolored Blackbirds continue to be somewhat unpredictable from year to year, but Hamilton et al. (1995) suggested, based on a large-scale shift in the distribution of the population between early and late-season nesting attempts, that most of the adults in the Central Valley breed more than once and often at different locations. This itinerant breeding follows a pattern of initial breeding in the south, mostly San Joaquin Valley and southern foothills to Sacramento County, with a shift north for a second breeding attempt, primarily in the Sacramento Valley and adjacent foothills. The timing and degree to which this shift occurs vary from year to year (Hamilton 1998). The timing of breeding in Sacramento County was intermediate to that of the San Joaquin and Sacramento Valleys, with initiation of breeding in Sacramento County approximately 10 days later than in the San Joaquin Valley, but over a month before most breeding in the northern Sacramento Valley (Figure 4). On the Central California Coast in Monterey County, 25% of radio-tagged birds moved between study colonies during a breeding season, suggesting itinerant breeding on a smaller scale (Wilson et al. 2016).

The following discussion of seasonal movements is largely from Beedy and Hamilton (1997) and Beedy et al. (2017).

Spring Movements from Wintering Areas

The species vacates wintering areas concentrated around the Sacramento-San Joaquin River Delta and along coastal California in mid-February. Birds arrive at breeding locations and establish colonies in Sacramento County and throughout the San Joaquin Valley from early March to early April (DeHaven et al. 1975a). Colonies at foothill locations adjacent to the San Joaquin and Sacramento valleys may be established by late March, but many are not established until May. In southern California and Baja California, the species typically nests in April and May but may nest anytime throughout March–June.

Flocks of Tricolored Blackbirds roam widely within the breeding range in the weeks before breeding begins and between breeding attempts. These flocks prospect the landscape for abundant insect food resources near which breeding colonies are established (Payne 1969). Similar behaviors have been

documented in nomadic flocking species of semiarid habitats in Asia, Africa, and Australia, where colonial breeding occurs opportunistically in areas of high prey abundance (Payne 1969).
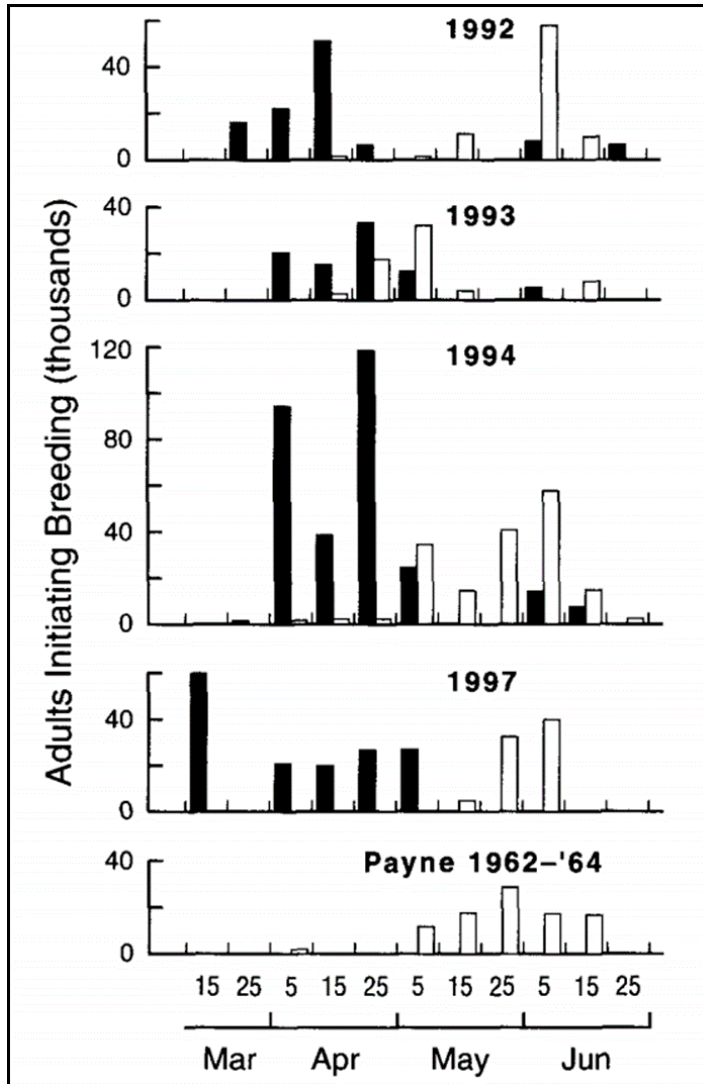
Figure 4. Number of Tricolored Blackbirds initiating breeding during 10-day intervals in the San Joaquin Valley (plus Sacramento County) and in the Sacramento Valley. Black bars represent San Joaquin Valley plus Sacramento County. White bars represent the northern Sacramento Valley. Figure from Hamilton et al. (1998).

Breeding Season Movements

During the breeding season, Central Valley birds often move north to the Sacramento Valley after first nesting efforts (March–April) in the San Joaquin Valley and Sacramento County, with small numbers apparently moving further north to northeastern California and southern Oregon (Beedy and Hamilton 1997, Hamilton 1998). On the floor of the Sacramento Valley north of Sacramento County, the largest colonies are typically not settled until May or early June. Recent banding results suggest a degree of

colony cohesion, where many birds at a colony may move and breed together again in a new location, but banding results also suggest a high degree of mixing between breeding attempts. Although later nesting is typical in northern portions of the range, small colonies may form throughout the breeding season anywhere in the geographic distribution (Hamilton 1998). Radio telemetry studies have shown that birds move from one breeding colony location to another while both are active, due presumably to reproductive failures at the first colony, but data linking movements to breeding failure are lacking (Wilson et al. 2016). Apparent shifts in location following nest failure have been observed in other portions of the range, including southern California (WRC-MSHCP 2016) and the San Joaquin Valley (Weintraub et al. 2016).

Post-breeding Movements

Most Central Valley birds occur in the Sacramento Valley at the end of the breeding season and remain there until mid-September or later, apparently attracted to ripening and recently harvested rice (DeHaven et al. 1975a). From mid-September through mid-November, most move south into the Sacramento-San Joaquin Delta, Merced County, and coastal locations.

Winter Movements

In winter, numbers decline in the Sacramento Valley and increase in the Sacramento-San Joaquin Delta and northern San Joaquin Valley (Neff 1942, Orians 1961a, Payne 1969, DeHaven et al. 1975a). Large foraging flocks have traditionally occurred in pasturelands in southern Solano County by late October and often joined large flocks of several blackbird species to roost on islands in the eastern part of Suisun Marsh. Wintering flocks formerly numbering more than 10,000 birds assembled near dairies on the Point Reyes Peninsula, Marin County, by mid-October in the 1980s, but these numbers have been reduced to 3,000 or less in recent years (eBird Dataset 2016). Highly variable numbers of birds also winter in the central and southern San Joaquin Valley, with flocks of hundreds or thousands seen in most years in the general area where large colonies occur in the early spring (Kern and Tulare counties; eBird Dataset 2016). Winter flocks consist at times of only Tricolored Blackbirds, either mixed-sex or single-sex, and at other times Tricolored Blackbirds occur in mixed-species blackbird flocks. Birds from one large winter roost in Sacramento County foraged over an area 32 km in diameter (Neff 1937). Winter distribution and movements are not well understood.

Home Range and Territoriality

Unlike most species of songbirds that defend a territory in which they nest and acquire most of their necessary resources, the Tricolored Blackbird breeds in dense colonies in which adult males defend only a small area surrounding the nest site, and this only until nests are established and eggs are laid (Lack and Emlen 1939, Payne 1969). Nest density and male territory size can vary among colonies with individual nests in the densest colonies built within one foot (0.3 m) or less of each other (Hosea 1986, Beedy et al. 1991). In some cases two nests may even share interwoven strands of nest material (Lack and Emlen 1939). Male territories have been measured from 1.8 m^2 to 3.25 m^2 (Lack and Emlen 1939, Orians 1961b) and nest densities have been observed at up to six nests per square meter (Beedy et al. 2017). The greatest nesting density reported occurred in a rare nesting substrate, giant cane (*Arundo*

sp.), with 2,500 adults nesting in an area 42 x 13 feet (13 x 4 m) (equivalent to 4.5 birds per square foot) (DeHaven et al. 1975b).

The small territories in dense breeding colonies cannot supply sufficient food for the adults and for the growing young, therefore most foraging occurs away from the colony site. While breeding, most foraging occurs within 2–3 miles (3.2–4.8 km) of colony sites (Orians 1961b, Hamilton et al. 1992), although longer foraging flights have been documented (up to 8 miles [13 km] or more). Typically, only a portion of the landscape surround a breeding colony is suitable for foraging and the range used by individual birds in colonies is variable depending on the extent and quality of the foraging landscape.

Colonial Breeding and Social Behavior

> "To one in search of something utterly different I can heartily recommend an hour, or a day, in a Tricolor swamp… *Agelaius tricolor* is intensely gregarious, more so than perhaps any other American bird. Every major act of its life is performed in close association with its fellows… the very day of its nesting is agreed upon in concert. In continuous procession the individuals of a colony repair to a field agreed upon in quest of building material; and when the babies are clamoring the loudest for food, the deploying foragers join their nearest fellows and return to the swamps by platoons and volleys, rather than as individuals." – Dawson (1923).

Coloniality in birds is typically defined as the breeding by a contiguous group of individuals at a more or less centralized place from which colony residents regularly depart from to search for food. This breeding strategy is most common among seabirds, in which more than 95% of species nest colonially (Danchin and Wagner 1997), but it is uncommon among North American landbirds.

The Tricolored Blackbird forms by far the largest breeding colony aggregations of any extant North American landbird (Neff 1937, Lack and Emlen 1939, Orians 1961a, Skutch 1996). Bent (1958) found that the Tricolored Blackbird "nests in enormous, most densely populated colonies, the nests being placed more closely together than in any other colonies of marsh-nesting blackbirds." Grinnell and Miller (1944) stated, "one essential would seem to be provision at the site of the colony for a large number of individuals. Nests apparently must be close together and pairs usually [must be] in excess of 50 in order to meet the instinctive requirements of the species." Breeding colonies are seldom smaller than 100 nests, and in the past have been as large as 100,000 to 200,000 nests (Neff 1937, Orians 1961a). Each male breeds, on average, with two females resulting in a skewed sex ratio at many breeding colonies (Lack and Emlen 1939, Orians 1961b, Payne 1969, Hamilton 1998, Beedy et al. 2017). Although Payne (1969) observed breeding colonies consisting of as little as four nests, of the 21 colonies monitored, no colonies containing less than 100 nests were successful in fledging young.

While the great concentration of birds in a small area is the most conspicuous feature of Tricolored Blackbird colonies, the degree of synchrony among members of the colony is no less unique (Orians 1960). Breeding within a colony is often highly synchronized, with all females in a colony typically initiating nest building within a few days (Orians 1961b, Payne 1969). A flock of Tricolored Blackbirds can appear in an area in which it has been absent for months and begin nesting within days or even hours

(Orians 1961b). Food resources for both the breeding adults and for the provisioning of young are mostly obtained from sites away from the colony location. Insect-rich foraging areas appear to be identified and used by all or large portions of the breeding adults in a colony until the prey base is exhausted, at which time new areas are identified and breeding birds collectively shift to new foraging sites.

Occurrence dynamics—Tricolored Blackbird breeding colonies frequently shift locations from year to year, though sites used each year often occur in the same traditionally used areas. In some cases Tricolored Blackbirds exhibit high inter-annual site fidelity, perhaps driven by the continued availability of essential resources, including suitable nesting substrate, water, and foraging habitat (Beedy and Hamilton 1997). Of 72 occupied colony locations between 1992 and 1994, only 19 (26%) were active in all three years and an additional 11 (15%) were active in at least two years (Hamilton et al. 1995). In the central Sierra Nevada foothills, 58% (11 of 19) of occupied breeding colony sites in 2015 were also occupied in 2014 (Airola et al. 2015b). Of 44 sites surveyed during a three-year period in the central foothills, only eight (18%) were active in all three years and seven (16%) were active in two of three years (Airola et al. 2016). Of four colony locations monitored for three consecutive years in coastal Monterey County, all four were occupied in one year and only two were occupied in the other years (Wilson et al. 2016). From 2006 to 2011, annual occupancy rates varied across nesting substrate types, with wetland, thistle, and Himalayan blackberry (*Rubus armeniacus*) locations having similar rates of about 40% (Holyoak et al. 2014). Occupancy rates were lower for triticale and other grain sites and higher for nettle colony sites. Although any given site may be unoccupied in some years, birds often return to sites over longer time periods and some sites are used in almost every year. Hosea (1986) reported a colony location that had been occupied for more than 30 years in Sacramento County, and was able to locate several active colonies by visiting locations reported in the literature decades earlier. The result of these complex occupancy dynamics is an extremely variable rate of site fidelity over the short-term, but fidelity to breeding locations and general breeding areas are high over the longer term.

Beedy et al. (1991) compiled all available information on breeding colony locations and identified 696 historical breeding locations, although many of these lacked specific locality information. As of the 2016 breeding season, the number of known historical and current breeding colony locations had grown to 1,272, including all records since 1907 (Figure 2a). The large majority of these historical locations are not used in any given year, and many no longer meet the habitat requirements of the species and so have been abandoned as nesting sites. During recent thorough statewide surveys conducted between 2008 and 2014 the number of occupied breeding locations has averaged about 140 (Kelsey 2008, Kyle and Kelsey 2011, Meese 2014a). New locations are discovered each year, while other sites cease to be used. This turnover of breeding locations likely reflects shifting habitat conditions across the range and results in complex occupancy dynamics described above. Most sites are used repeatedly over the course of many years as long as local habitat conditions do not change.

Fluctuations in colony site selection and colony size have been attributed to a response of Tricolored Blackbirds to changes in local insect abundance within and across years (Orians 1961b, Payne 1969, DeHaven et al. 1975b). Their colonial breeding behavior requires that the foraging landscape surrounding the nest site provide abundant insect food sources. The colonial nesting, compressed

breeding cycle, and social structure of Tricolored Blackbirds are well suited for rapid exploitation of unpredictable resources when they become temporarily very abundant. Initiation of nesting may also be triggered by an abundant food source (Payne 1969).

Colony size has been shown to have a positive relationship with nest success in a wide variety of colonial species. In many cases, large Tricolored Blackbird breeding colonies have been observed to exhibit higher nest survival or reproductive success than smaller colonies (Orians 1961a, Payne 1969, Hamilton et al. 1992, Meese 2013, Weintraub et al. 2016), and in some years a few large colonies have been responsible for the majority of the reproductive output for the year (Hamilton 1993). However, there are many examples when a positive correlation between colony size and reproductive success was not observed, and a wide variation in reproductive success has been observed in both small and large colonies (Payne 1969, Meese 2013, Weintraub et al. 2016). It is possible that changes in environmental factors lead to density dependent reproductive success in some situations, while success may be density independent in other cases. The relationship between colony size and reproductive success is discussed in more detail in the Reproduction and Survival section.

Adaptive advantages of colonial breeding may be conferred by decreasing risk of predation or increasing foraging efficiency (Ward and Zahavi 1973, Beauchamp 1999), both of which could lead to increased success in production of young. The following mechanisms have been proposed as advantages to colonial breeding:

1. Predator avoidance
2. Joint anti-predator responses
3. Predator satiation
4. Social food-finding
5. Information sharing

Predator avoidance—Colonial breeding birds frequently occupy sites that are inaccessible to predators (Ward and Zahavi 1973), or in some cases that are naturally free of some groups of predators (e.g., seabirds nesting on isolated islands). Tricolored Blackbirds typically select breeding locations that provide a degree of protection from predators, either by selecting inaccessible sites (e.g., wetlands surrounded by or inundated by relatively deep water) or protective nesting substrates (e.g., dense, thorny, or spinous vegetation) that limit access by predators. Wetland sites may primarily limit access to terrestrial predators, whereas some dense or armored substrates may also limit access by predatory birds. In the case of a nomadic species like the Tricolored Blackbird, which does not necessarily use the same breeding location each year due to annual shifts in substrate suitability, social behavior may enhance the ability to locate these suitable locations.

Anti-predator responses—Social mobbing of predators or other aggressive behaviors are common among colonial nesting birds. However, Tricolored Blackbirds do not exhibit strong defensive responses against their predators. Unlike Red-winged Blackbirds that will fiercely defend territories from potential predators that approach the nest, Tricolored Blackbirds provide little in the way of defense to eggs or nestlings (Skutch 1996). For example, when a hawk is sighted the adults in a colony may stop vocalizing

and settle low within the nesting substrate, with the entire colony sometimes going silent (Orians and Christman 1968, Payne 1969). Adults may hover in the vicinity of a predator as nestlings are taken, but no pursuit of the predator is offered. Complete reproductive failure in colonies of thousands of birds can result from the efforts of relatively few predators (Beedy et al. 2017). Tricolored Blackbirds do not benefit from social anti-predator responses.

Predator satiation—The massive quantity of readily available prey in the form of eggs or nestlings at a Tricolored Blackbird breeding colony may reduce the chance of loss of any one nest by satiating territorial predators (e.g., raptors). Payne (1969) observed a single pair of Northern Harriers preying on a Tricolored Blackbird colony of 10,000 nests, with no negative impact on the large majority of the colony. Satiation of predators may be less likely in species that hunt in groups, such as many species of wading birds. In recent decades, Black-crowned Night-Herons, Cattle Egrets, and White-faced Ibis have caused complete failure of large breeding colonies (Meese 2012, 2016, Beedy et al. 2017). Predator satiation may provide a benefit to Tricolored Blackbird colonies, depending on the number and type of predators.

Food-finding and information sharing—Roosting and colonial birds may benefit from social behavior to more efficiently locate patches of concentrated food resources, and colony sites may serve as information centers where locations of good feeding sites can be shared among individuals (Ward and Zahavi 1973, Emlen and DeLong 1975, Brown 1988). Under this scenario, larger colonies may be more successful because there is a larger pool of information on the whereabouts of productive feeding places within the foraging area being exploited by the colony (Ward and Zahavi 1973). This increased foraging efficiency, along with the highly synchronized nesting and the compressed length of a nesting cycle in Tricolored Blackbirds, may increase the chance that temporarily abundant prey will remain available to the young in a colony for the duration of the breeding cycle. Coloniality may result from situations when suitable breeding sites are limited among areas of high food availability (Danchin and Wagner 1997).

Because of occasional destruction of entire Tricolored Blackbird breeding colonies by predators and observations of prey-following by adults, Orians (1961a) and Payne (1969) suggested that colonial nesting by Tricolored Blackbirds is more likely related to location and exploitation of a locally abundant food supply than to a strategy of predator avoidance or response. However, the choice of flooded or dense and armored vegetation for breeding suggests that suitable nesting locations provide some protection from predators, and predator satiation may be a successful strategy for confronting territorial predators. These benefits of colonial breeding are not necessarily mutually exclusive. Because predation at colonies and the ability of adults to locate and acquire food primarily effects the survival of eggs and young, these mechanisms may collectively serve to increase productivity.

Habitat Associations and Use

For successful breeding, Tricolored Blackbirds require three resources: 1) secure nesting substrate, 2) a source of water, and 3) foraging habitat that provides sufficient food resources.

Nesting Substrate

The nesting substrate for Tricolored Blackbird breeding colonies is defined as the vegetation in which nests are constructed. In most cases the nesting substrate is either flooded by water, as in wetland colony sites, or is composed of thorny or spiny vegetation that is impenetrable to many predators (Beedy and Hamilton 1997). In some cases, Tricolored Blackbird colonies occur in upland nesting substrates that lack these protective characteristics (e.g., silage grain, weedy mustard fields); in these cases the nesting substrate is usually extremely dense and therefore may provide similar protection.

The majority of Tricolored Blackbird breeding colonies have occurred in one of five nesting substrate types: 1) wetland vegetation (either cattail [*Typha* sp.] or bulrush [*Schoenoplectus* sp.]), 2) Himalayan blackberry, 3) thistle, usually milk thistle (*Silybum marianum*) or bull thistle (*Cirsium vulgare*), 4) stinging nettle (*Urtica* sp.), or 5) agricultural grain fields, especially triticale, a wheat-rye hybrid grain grown as silage for dairy cattle (Table 1). Several additional nesting substrates have been used to a lesser degree (less than 6% of colonies in total), with the more common being mustard (*Brassica* sp.), willows (*Salix* sp.), mallow (*Malva* sp.), wild rose (*Rosa* sp.), tamarisk (*Tamarix* sp.), and giant cane (*Arundo* sp.) (Beedy et al. 1991, Beedy and Hamilton 1997, Graves et al. 2013, Beedy et al. 2017, Tricolored Blackbird Portal 2017).

Table 1. Number of colonies in major nesting substrate types. Includes all colonies with known substrate type, 1907–2016.

Nesting substrate type	Number of colonies	Percent colonies
Wetland	621	52.4%
Himalayan blackberry	235	19.8%
Thistle	114	9.6%
Triticale or other grain	73	6.2%
Stinging Nettle	63	5.3%
All other	80	6.7%

The primary nesting substrates used by Tricolored Blackbirds have different distributions across the breeding range in California (Figure 5) (Cook and Toft 2005). Wetland sites with cattail or bulrush substrate are fairly evenly distributed across the range (Graves et al. 2013). Himalayan blackberry sites are mostly restricted to Merced County and north through the Sierra foothills to the Sacramento Valley. Triticale and other agricultural grain sites are found mainly in the southern San Joaquin Valley and Merced County, with a few additional sites in southern California. In recent years stinging nettle sites have mainly occurred in the southern San Joaquin Valley portion of Kern County including the surrounding foothill grasslands, although historically they were also common at the extreme northern portion of the California range in Siskiyou and Shasta counties. Thistle sites have been located throughout much of the range in California, and have been the primary nesting substrates used in the southern Sierra Nevada foothills (Airola et al. 2016). Thistle sites are typically only available to breeding Tricolored Blackbirds in years with weather patterns that support abundant thistle growth.
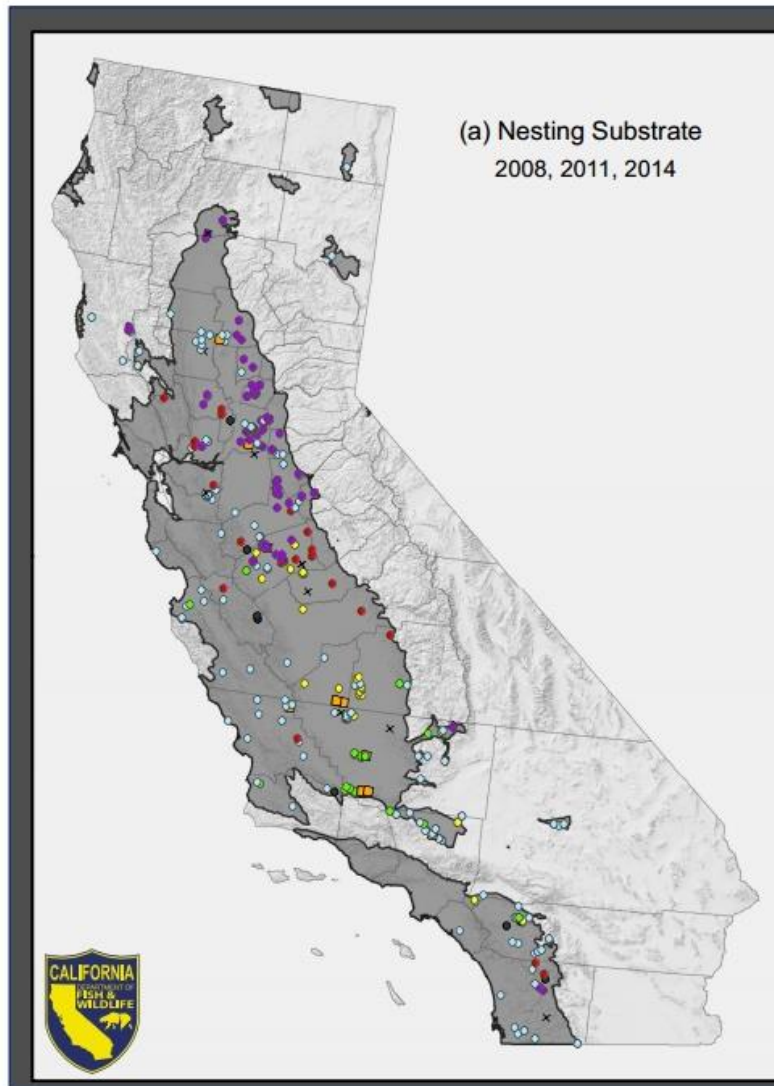
a)   b)
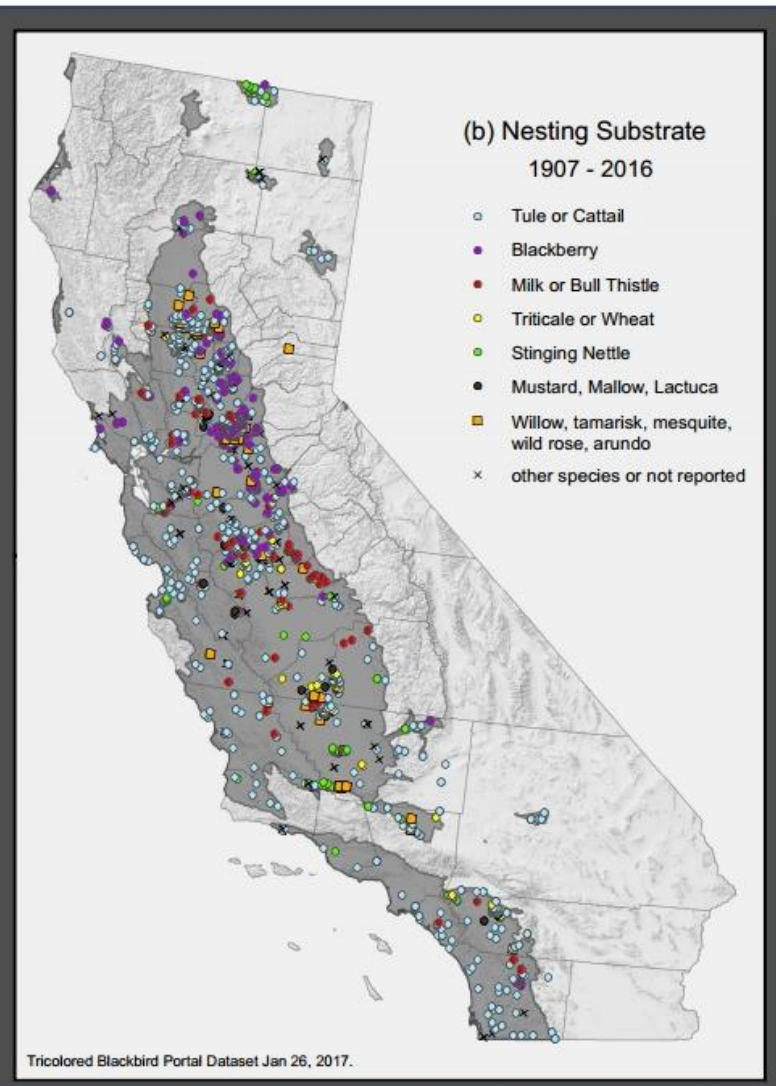
Figure 5. Distribution of nesting substrates used by Tricolored Blackbirds. a) Occupied breeding locations during 2008, 2011, and 2014. b) All known breeding locations 1907-2016.

Historically, most breeding colonies were in freshwater marshes dominated by cattails and tules (Beedy 2008). In the 1930s, 93% of breeding colonies were in freshwater marsh vegetation with the remaining colonies in willows, blackberries, thistles, and nettles (Neff 1937). The proportion of colonies in freshwater marshes had decreased to about 70% by the 1970s as Tricolored Blackbirds began using novel, nonnative vegetation types, especially Himalayan blackberry and thistles (DeHaven et al. 1975b). By 2008, the proportion of colonies established in freshwater marsh during the statewide survey had declined to 35% (Kelsey et al. 2008).

Tricolored Blackbirds are known to have bred in blackberry bushes from the early 1900s (Booth 1926, Neff 1934, 1937), but this was a very infrequent occurrence and the species of blackberry is not known. Sacramento County has a long history of breeding by Tricolored Blackbirds, with colonies in the 1930s found entirely in wetland substrates and colonies in the 1970s still mainly located in wetlands (Neff 1937, DeHaven et al. 1975b). In the 1980s and 1990s, an increasing percentage of breeding colonies were reported in nonnative Himalayan blackberry (Hosea 1986, Beedy and Hamilton 1997). Over 55,000 breeding Tricolored Blackbirds were located in Sacramento County in 1993, with the large majority of these in Himalayan blackberry and a small number in wetland substrates (Hamilton 1993). Himalayan blackberry is currently the dominant nesting substrate throughout the northern and central Sierra Nevada foothills. From 2014 to 2016, 65–80% of foothill colonies have occurred in Himalayan blackberry annually (Airola et al. 2016). Between 1994 and 2004, a large shift from cattail marsh colonies to Himalayan blackberry colonies occurred in the rice-growing region of Sacramento Valley (Hamilton 2004b). In 1994, Hamilton et al. (1995) found very few Tricolored Blackbird colonies using Himalayan blackberry in the Sacramento Valley, but by 2004 Himalayan blackberry was a commonly used nesting substrate adjacent to rice fields (Hamilton 2004b). This was in part due to the loss of specific cattail marsh sites, but was also likely due in part to an increase in distribution of Himalayan blackberry. Specific cattail marsh sites where 90,000 Tricolored Blackbirds nested in 1994 were either not maintained or were destroyed by 2004 (Hamilton 2004b).

Tricolored Blackbirds were discovered breeding in grain fields in the San Joaquin Valley in 1991 and 1992 (Hamilton et al. 1992). Prior to this, nesting in large cultivated grain fields was unknown and little work on the status of the species in the southern San Joaquin Valley had been conducted (Beedy et al. 1991, Hamilton et al. 1992). The only previous report of nesting in a cultivated grain field was from 1944, when a colony was observed in mustard-infested barley (Bent 1958). The discovery of breeding on grain fields in the 1990s corresponded to an increase in planting of triticale, which in the San Joaquin Valley is grown primarily as a silage crop for dairy cattle (colonies on agricultural grain fields associated with dairies are often referred to as "silage colonies"). This wheat-rye hybrid grain may be attractive to breeding Tricolored Blackbirds due to its robust structure that is well suited to support nests and it dense growth that is relatively impenetrable to terrestrial predators. Many of the recent grain colonies have occurred in weed-infested (usually mustard or mallow) triticale, although colonies also occur in pure stands of triticale and in other types of cultivated grains. Relatively little triticale had been planted for silage in the San Joaquin Valley by 1994, but by 2005 the planted acreage had grown to about 75,000 acres (304 km^2) (Aksland and Wright 2005). Of the nesting substrates used by Tricolored Blackbirds,

triticale and other grain fields are unique in that they are available in abundance each year in the San Joaquin Valley, and in recent years, many of the largest colonies have occurred on grain fields. Fifty percent of the breeding Tricolored Blackbirds detected in California during the 2008 statewide survey were observed nesting in triticale fields (Kelsey 2008).

During the April 2011 statewide survey, the majority of colonies (54%) in the San Joaquin Valley and Tulare Basin were located on agricultural grain crops, with an additional 22% in milk thistle. Conversely, 70% of colonies in the Sacramento Valley and Sierra Nevada foothills were in Himalayan blackberry. The majority of colonies in southern California, on the central coast, and in extreme northern California continued to occur in wetland habitats. Statewide, wetlands continued to support more colonies than any other substrate type (37%), although these wetland colonies supported only 5% of the total population reported in the statewide survey (Kyle and Kelsey 2011).

The areal extent of nesting substrate used by breeding Tricolored Blackbird colonies has ranged from a few square meters to more than 200 acres (81 ha) (Tricolored Blackbird Portal 2017). The smallest colonies have occurred in a variety of nesting substrate types, including cattail or bulrush marsh, Himalayan blackberry, and willows. The largest colonies of 100 acres (40 ha) or more have been located in triticale in recent years, although historically very large colonies occurred in wetland habitats (Neff 1937). The large majority of colonies occupy less than 10 acres (4 ha) of nesting substrate, with many being smaller than 1 acre (0.4 ha). DeHaven et al. (1975b) found that the area occupied by nests in all substrates types averaged less than 2 acres (0.8 ha) per colony, and the largest colonies observed from 1968 to 1972 occupied only 10 acres.

Nest densities vary widely across nesting substrates. DeHaven et al. (1975b) observed densities up to 66,670 nests per acre (100,000 breeding adults per acre) in Himalayan blackberry colonies, with the average density in blackberry colonies closer to 16,000 nests per acre. Densities in other common nesting substrates (cattails, bulrush, thistle, and willows) had densities of up to 13,340–20,000 nests per acres (20,000–30,000 breeding adults per acre), with average densities ranging from 3,300 to 4,800 nests per acre (DeHaven et al. 1975b).

Water

Breeding Tricolored Blackbirds require an open, accessible water source in the vicinity of the breeding location. Adults use the water for drinking and bathing, and will sometimes submerge insect prey items before provisioning young. Females will also submerge nesting material in water to, presumably, make it more pliable for use in nest construction (Beedy et al. 2017). The requirement for open water can be met by any of a number of sources, including wetlands, streams, ponds, reservoirs, and agricultural canals or ditches. Water must be available within a few hundred meters of the nesting substrate (Hamilton 1995). The loss of local water sources during the nesting cycle has caused entire colonies of birds to abandon their nests (Beedy et al. 1991).

Foraging Habitat

The Tricolored Blackbird breeds in dense colonies with the individual territories that are defended by each male consisting of a very small area. These dense congregations of large numbers of birds likely exert large pressures on the foraging landscape surrounding the nesting location. Unlike most other songbirds, Tricolored Blackbirds forage almost exclusively away from the small nesting territory, and colonies require suitable foraging habitat with abundant insect prey within a few miles of the colony site. Because provisioning success and the resulting rate of nestling starvation have been shown to influence reproductive success, the availability of high quality foraging habitat is at least as important to Tricolored Blackbird breeding as is the availability of suitable nesting substrate (Hamilton et al. 1992). The proximity to highly abundant insect food supplies is an important factor in the selection of breeding sites by Tricolored Blackbirds (Neff 1937, Orians 1961b, Payne 1969), and their nomadic and colonial behavior may have evolved as a strategy for maximizing the ability to locate and exploit unpredictable and temporarily abundant insect food sources. The required foraging habitat for successful breeding has a much greater spatial extent than nesting substrate. Although data are not available to define the minimum extent of foraging habitat, it has been reported that colonies with less than 200–300 acres (81–121 ha) of foraging habitat do not persist and that several thousand acres are usually necessary to maintain most large colonies (Hamilton 2004a).

Primary foraging habitats during the breeding season include grasslands, low-density shrublands (e.g., alkali scrub), pastures, dry seasonal pools, and certain agricultural crops including alfalfa and rice, which provide for high production of insect prey for breeding Tricolored Blackbirds. The landscape variables that best predict Tricolored Blackbird colony occurrence during the early breeding season are proportion of grassland and proportion of alfalfa. The likelihood of breeding colony occurrence increases when landscape composition reaches thresholds of 30% and 80% grassland cover and 15% alfalfa cover within 3 miles (4.8 km) of a colony location (NAS 2017). Relative size of breeding colonies also increases above approximately 15% alfalfa cover (Figure 6; NAS 2017). Adults will also sometimes exhibit aerial foraging above wetland colonies when aquatic insects are hatching (Beedy et al. 2017). Adult birds also frequently feed at cattle feedlots and dairies where they have access to abundant grain sources. Among grassland foraging habitats, Hamilton et al. (1995) reported that ungrazed grasslands were preferred over heavily grazed grasslands by foraging Tricolored Blackbirds, but this conclusion has not been reported in later studies of grassland foraging birds (Meese 2013, Airola et al. 2015a, 2016). Tricolored Blackbirds breeding in agricultural landscapes do not use most row crops, vineyards, or orchards (Hamilton et al. 1992, Hamilton 2004a). During the 2000 statewide survey, Hamilton (2000) found that over 90% of observed Tricolored Blackbird foraging activity occurred on private property.

In Sacramento County, Hamilton et al. (1992) reported that 96% of all foraging by breeding Tricolored Blackbirds occurred in grasslands. Large portions of eastern Sacramento County and the Sierra Nevada foothill region to the north and south are still dominated by annual grasslands, intermixed with agricultural lands, woodlands, and shrublands (Airola et al. 2015a). In 2014, Tricolored Blackbirds nesting in this region from Placer County in the north to Stanislaus County in the south continued to rely heavily on grasslands, with 70% of foraging observations occurring in grasslands (Airola et al. 2015a).

a)   b)
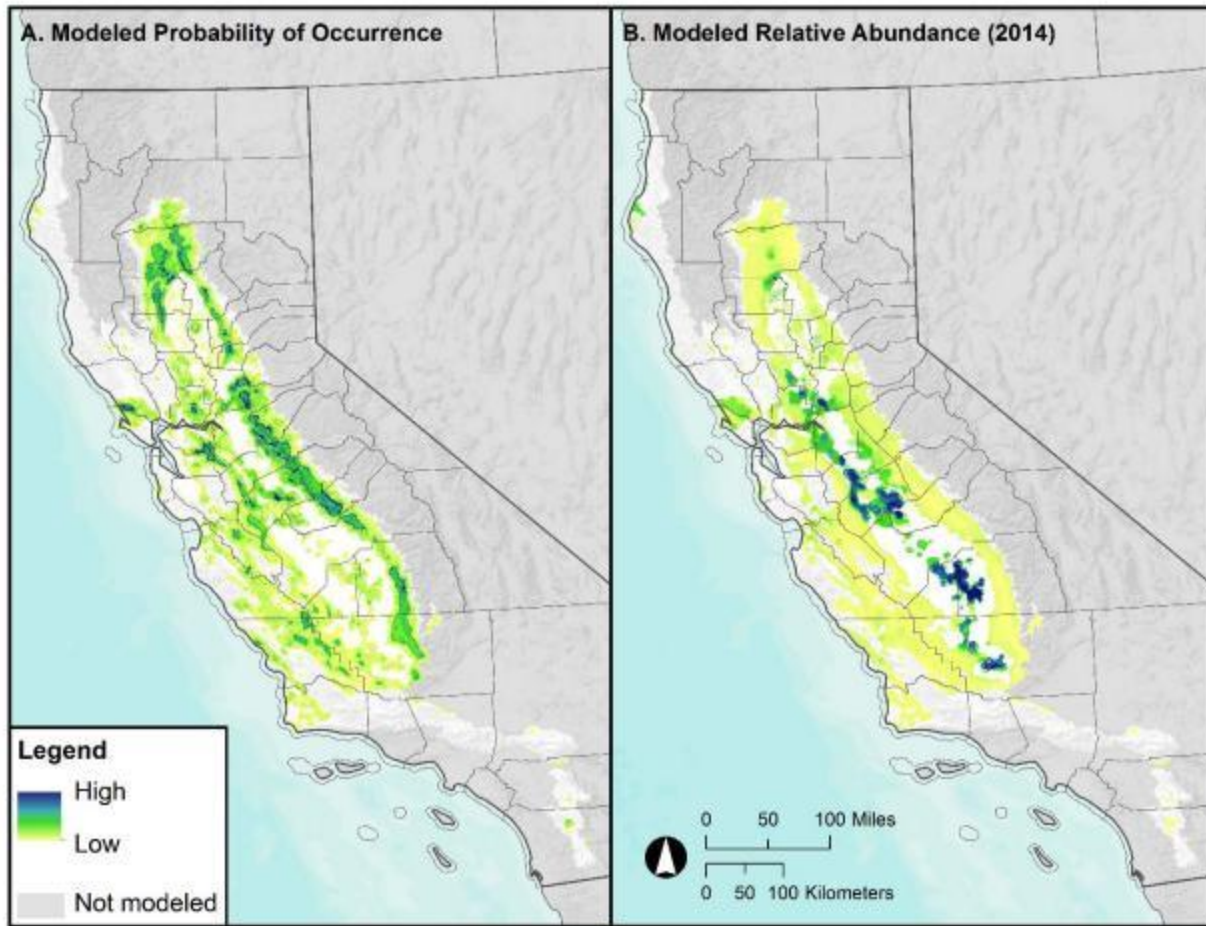
Figure 6. Predicted probability of Tricolored Blackbird breeding colony (a) occurrence and (b) relative abundance in 2014, based on foraging habitat and other covariate relationships determined in presence-absence and relative abundance models. The occurrence of colonies was best predicted by year, proportion grassland cover, and proportion alfalfa. The relative abundance at colonies was best predicted by proportion of alfalfa and number of dairies. Models focused on foraging landscape and did not consider nesting substrate. Figure from NAS (2017).

In many parts of the Central Valley and southern California where Tricolored Blackbird colonies occur on agricultural grain fields, alfalfa is often the most important foraging habitat for acquisition of insect prey (Cook and Toft 2005, Meese 2009a), and colonies in other nesting substrates in the Central Valley also frequently use alfalfa (Meese 2013). For colonies in the Mojave Desert area of San Bernardino County, alfalfa may be the only source of insects for provisioning young, except during rare occasions when the surrounding desert provides abundant insect prey. In some cases, alfalfa can be extremely productive and large colonies of up to 15,000 nesting birds have depended on less than 200 acres (81 ha) of alfalfa to meet most of their insect prey needs (Meese 2006).

Mailliard (1900) described the distinctive flight of Tricolored Blackbirds in the process of feeding nestlings as a "stream composed of birds going toward the tules with their bills full of bugs and of equal numbers returning to the fields for fresh supplies." Both prey abundance and proximity to the colony

site likely influence the reproductive success of a colony. When abundant insect prey are available adjacent to colony locations, adults will make only very short foraging flights to acquire prey, and shorter foraging distances may reduce the amount of time eggs and nestlings are exposed. For example, a colony in the nestling stage failed during a period of hot weather when adults needed to travel 3 miles (4.8 km) to forage (WRC-MSHCP 2017). In at least some cases, adults foraging near the colony site bring few prey items to their young, while adults foraging more distant return with many more prey items (Orians 1980, *cited in* Skutch 1996). This may be a mechanism to conserve energy by making fewer long-distance flights and shows the value of foraging habitats in close proximity to colony sites; however, the possibility that proximate food sources had been exhausted during observations cannot be ruled out. Most foraging occurs within about 3 miles (4.8 km) of the colony location, although Hamilton et al. (1992) reported maximum foraging flight distances by breeding birds of up to 8 miles (13 km). In the Central Valley from 2006 to 2011, Meese (2013) observed adult Tricolored Blackbirds foraging up to 5.6 miles (9 km) from the colony location.

Several authors have suggested that regional insect abundance plays a role in breeding colony site selection, and that a super-abundant insect population may stimulate nesting behavior (Lack 1954, Orians 1961b, Orians and Collier 1963, Payne 1969). This could explain the variation in general distribution of colonies between years (DeHaven et al. 1975a). The highly synchronized and colonial breeding system may have adapted to exploit an unpredictable environment where locations of nesting substrate and abundant insect food resources changed unpredictably from year to year (Orians and Collier 1963). Although Meese (2013) demonstrated that colony reproductive success was correlated with local availability of insect prey (usually within 3–5 miles of the nesting location), the role that insect abundance in foraging habitats has on colony site selection has not been investigated.

Diet and Food Habits

For most of the year, the majority of food items taken by Tricolored Blackbirds consist of plant material, especially seeds. However, during the breeding season, adult females require large amounts of high-protein insect prey for egg production and nestlings require a protein-rich diet for growth and development (Crase and DeHaven 1977). Nestlings are fed almost exclusively animal matter for the first nine days after hatching, at which point parents begin to introduce plant matter into the diet (Hamilton et al. 1995). Colonies consisting of many thousands of adult birds and growing nestlings require an immense amount of insect prey during short windows of time. The availability of insect prey in the foraging landscape likely influences the establishment of breeding colonies, and an abundant prey base is essential for successful breeding.

Nestlings have been provisioned with a wide variety of prey items, including grasshoppers and crickets (order Orthoptera), beetles, weevils, and water beetle larvae (order Coleoptera), moths and butterflies (including caterpillars; order Lepidoptera), and to a lesser degree spiders, flies, tadpoles, snails, and emergent dragonflies, damselflies, and midges (Payne 1969, Crase and DeHaven 1977, Skorupa et al. 1980). At three breeding colonies in Merced County where adults often foraged for prey in alfalfa and grain fields, animal matter made up 91% of food volume for nestlings and fledglings, with moth larvae, beetles, and weevils the primary food items (Skorupa et al. 1980). In foothill grasslands, grasshoppers

have often been the primary prey item fed to nestlings (Payne 1969, Airola et al. 2015a). In a diet study that included colonies from several regions of the Central Valley located among a variety of foraging substrates, animal matter made up more than 86% of the total volume of nestling food (Crase and DeHaven 1977). Ground beetles were the predominant food item when averaging across all colonies, followed by water beetle larvae, grasshoppers and crickets, and weevils. Colonies differed significantly in the primary food items provided to nestlings, with differences in foraging substrate responsible in some cases. For example, colonies with water beetle larvae as the predominant food source were located in rice-growing areas, and the greatest percent of grasshoppers were fed to nestlings at colonies bordered by grassland (Crase and DeHaven 1977).

Early observers noted that nestling and fledgling Tricolored Blackbirds were frequently fed grasshoppers, leading to descriptions of the species as a grasshopper-follower (Belding 1890, Bendire 1895, Mailliard 1914, Orians 1961b). Payne (1969) observed breeding adult Tricolored Blackbirds at colonies in the Sacramento Valley foraging primarily in grasslands and providing nestlings with a diet composed of 47% grasshoppers; crickets, beetles, and spiders were also acquired in grasslands and fed to young in smaller amounts. Payne (1969) suggested that the movements of Tricolored Blackbirds during the breeding season paralleled the nomadic movements of rangeland grasshoppers in California and compared the Tricolored Blackbird with "locust bird" species of Asia and Africa. Grasshoppers continue to provide a valuable food source to Tricolored Blackbird colonies, especially when adjacent to grasslands and pastures (Airola 2015a), but Tricolored Blackbirds have been shown to be more flexible in breeding season diet, as long as an abundant insect source is available.

In the spring and summer, the proportion of animal material consumed by adult Tricolored Blackbirds in the rice-growing region of the Sacramento Valley was 28% and 39%, respectively, with primary prey items including ground beetles, water beetle larvae, and orthopterans (Crase and DeHaven 1978). At four breeding colonies in agricultural areas of Merced County, animal matter made up 56% of food volume for adult females and 28% for adult males (Skorupa et al. 1980). The most consumed animal foods were beetles and weevils, moth larvae, and flies; the predominant plant foods consisted of oats (*Avena* sp.) and filaree (*Erodium* sp.), and to a lesser degree chickweed (*Stellaria* sp.) and pigweed (*Amaranthus* sp.). In the nonbreeding season, Tricolored Blackbirds are more strictly granivorous, although a variety of plant and animal matter is taken opportunistically. One study in the rice-growing region of the Sacramento Valley revealed that about 90% of the fall and winter diet consisted of plant material, primarily seeds of rice, other grains, and weed seeds (Crase and DeHaven 1978).

Reproduction and Survival

Breeding Phenology and Behavior

Breeding typically extends from mid-March through early August (Beedy et al. 2017). Autumnal breeding has been observed in the Central Valley (September–November; Orians 1960, Payne 1969) and in Marin County (July–September; Stallcup 2004), although not since 1964 and 2003 in the Central Valley and Marin County, respectively. From initiation of nest building to independence of fledged young, the nesting cycle of the Tricolored Blackbird is about 10 days shorter than that of the Red-winged Blackbird,

mostly due to rapid progression through the nest building and egg laying stages (Payne 1969). The condensed length of the nesting cycle may be a function of the synchronized colonial nesting and an adaptation to take advantage of unpredictable periods of abundant and temporary insect food sources (Payne 1969, Skutch 1996).

Nest building and incubation are performed exclusively by the female, but the male takes an active role in feeding the young (Lack and Emlen 1939, Orians 1960). Although female Tricolored Blackbirds breed in their first year, most males may defer breeding until they are at least two years old (Payne 1969). This contributes to a skewed sex ratio at many breeding colonies, with each male breeding on average with two females (Lack and Emlen 1939, Orians 1961b, Payne 1969). Although colonies with even sex ratios or with more skewed sex ratios (each male breeding with more than two females) have been observed (Hamilton et al. 1995), for monitoring purposes it is often assumed that each nest in a colony represents 1.5 breeding birds.

After fledging, Tricolored Blackbirds often leave the vicinity of the nest and congregate in groups of young birds from many different nests. These fledgling groups will often congregate near the edge of the nesting substrate nearest the foraging grounds being used by the adults, where they are fed when adults return to the colony site (Payne 1969). A group of fledgling Tricolored Blackbirds has been referred to as a crèche (Hamilton 1998, Beedy et al. 2017). The formation of crèches generally occurs among birds that breed in large colonies and whose eggs all hatch at about the same time (examples of other crèche-forming species include terns and penguins). Supervision of unrelated offspring by a small number of adult guardians is usually considered a characteristic of crèches, although it is unclear whether this is the case in Tricolored Blackbirds. A single large colony of Tricolored Blackbirds can produce many crèches, and a single crèche may include several thousand fledglings. Crèches can persist for up to one to two weeks, and have been observed as far as 3 miles (4.8 km) from a colony site (Payne 1969, Hamilton et al. 1995).

Reproductive Success

Successful breeding (i.e., production of any fledglings) was found to be positively correlated with colony size by Payne (1969); all colonies (n=7) that produced no fledglings contained 200 or fewer nests, while only one of seven successful colonies was smaller than 400 nests. Hamilton (1993) observed that the largest colonies in a single year of observation produced the highest estimates of reproductive success. Meese (2013) documented a weak positive correlation between reproductive success and colony size over a six-year period (r = 0.53, r^2 = 0.28). In wetland and silage colonies in the southern San Joaquin Valley, Weintraub et al. (2016) found reproductive success to vary with colony size, with more young fledged per nest in the largest and the smallest colonies, while intermediate sized colonies (1,000–5,000 birds) fledged fewer young.

Reproductive success, defined here as the average number of young fledged per nest, has been the generally accepted method for estimating productivity of Tricolored Blackbird colonies since the early 1990s (Hamilton et al. 1995, Meese 2013, Holyoak et al. 2014, Airola et al. 2015a). Reproductive success has been estimated in one of two ways: visual estimation of the number of fledglings or nest sampling

via walking transects through active colonies. When estimating reproductive success by visual counts of fledglings, colonies are visited at several-day intervals (often four days but in practice this has been variable) after fledglings have left the nests. The sum of fledgling counts on all site visits and the estimated number of nests in the colony are used to estimate the number of fledglings produced per nest. The fledglings observed at each visit are assumed to represent unique birds, which leads to some uncertainty in reproductive success estimates obtained using this method. When estimating reproductive success by nest transects, it has been common practice to count the number of young per nest during the portion of the nest cycle when nestlings are 7–9 days old, with a minimum target sample of 25 nests (Hamilton et al. 1995, Cook and Toft 2005, Meese 2013). Entering colonies when nestlings are less than seven days old inflates the reproductive success estimate by underestimating nestling mortality and entering colonies when greater than 9 days of age causes the nestlings to jump from the nests prematurely. As a result, reproductive success estimates obtained by the transect method represent the maximum number of young fledged per nest because several days may remain before nestlings fledge (Hamilton 2004b). Therefore, the two methods of estimating reproductive success measure two somewhat different indices of productivity.

Many Tricolored Blackbird colonies in the Central Valley exhibited relatively low reproductive success from 2006 to 2011. Meese (2013) estimated reproductive success at 47 colonies, representing most of the largest colonies each year, during this six-year period ranging in size from 800 to 138,000 breeding birds. Reproductive success was estimated using both the nest transect and the fledgling count methods. About half of the monitored colonies were in wetlands (n = 23), with the rest in thistle (n = 11), triticale (n = 9), and Himalayan blackberry (n = 4). The average reproductive success across all sites and years was 0.62. Colonies that were destroyed by harvest of the grain nesting substrate were not included in the study results. Low productivity during this time resulted in very few young Tricolored Blackbirds being produced in the southern San Joaquin Valley where a large portion of the population's first annual breeding attempts occur (Figure 7). Incidental observations in 2012 and 2013 suggested that the trend of low reproductive success continued.

Meese (2013) linked reproductive success at Central Valley colonies to relative abundance of insect prey at foraging sites, suggesting that many Tricolored Blackbird colonies may have been food-limited. High levels of predation plus destruction of colonies to harvest during this time also contributed to the low overall production of fledglings (Meese 2011, 2012). Parents reduce the size of broods at many colonies after the hatching of eggs (Hamilton et al. 1995). Often the majority of eggs in a clutch (usually three or four) will hatch but each nest typically fledges a reduced number of young, either due to parents not feeding all nestlings which leads to starvation, or by the active removal of nestlings from the nest by females (Payne 1969, Hamilton et al. 1995). This is likely because of a shortage of food supplies. When abundant food is available each nest produces more fledglings (Meese 2013), and although rare, as many as four young have been raised from some nests at productive colonies (Hamilton et al. 1995).

Few estimates of colony reproductive success are available after 2011, but observations of large numbers of fledglings at several colonies suggest that the species has had relatively high success at some colonies in recent years. In 2015, the estimated reproductive success at five colonies on agricultural grain fields averaged 0.6–1.9 fledglings produced per nest (Aug 2015 presentation from

NRCS to Tricolored Blackbird Working Group; unreferenced). In 2016, eight of nine known colonies on agricultural grain fields fledged at least some young, although efforts to estimate reproductive success were limited. Only one colony in silage was both accessible and uniform in nest density to allow for nest transects and resulted in an estimated reproductive success of 0.44 (Frazer 2016). At four colonies in Himalayan blackberry, cattail, and milk thistle that ranged in size from 5,000 to 12,000 birds, reproductive success estimates ranged from 0.4 to 0.67 (Meese 2016). In 2017, all known silage colonies at seven locations fledged at least some young. Some of these experienced very low reproductive success, but at least two had high success and produced several thousand fledglings. Several additional colonies in other nesting substrates were reported to have high (although unquantified) reproductive success in 2017, with four wetland colonies in the San Joaquin and Sacramento valleys producing at least several thousand young (Colibri 2017, Meese 2017). As in other years, many other colonies were observed to have low success. These limited quantitative estimates and additional qualitative assessments are difficult to compare directly to previous work due to the high variability in reproductive success across colonies and the inconsistent methods used to evaluate reproductive success.
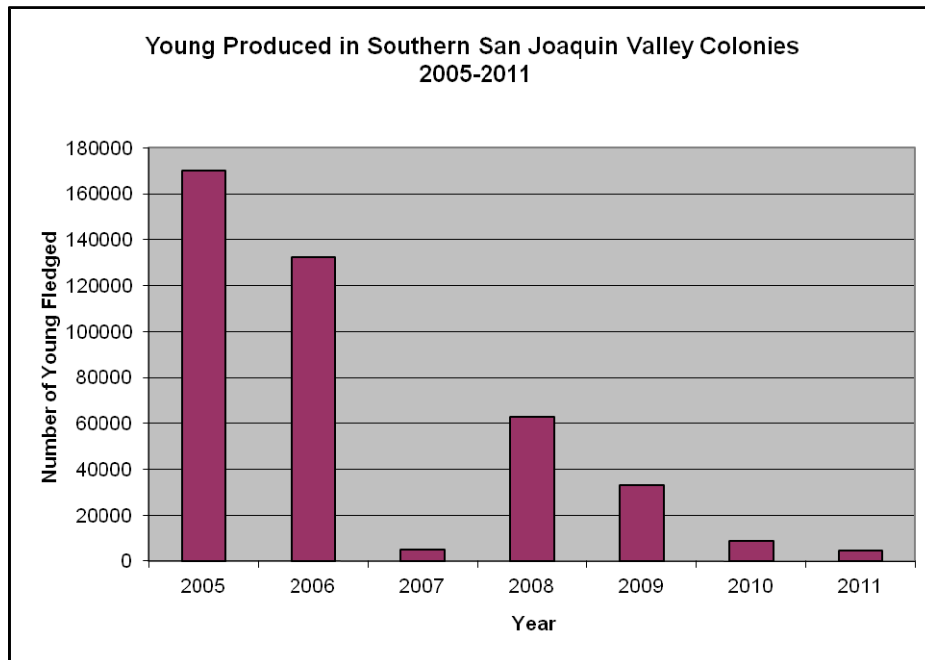
Figure 7. Number of young produced in Southern San Joaquin Valley colonies (Kern and Tulare counties) from 2005 to 2011. Figure from Meese (2011).

At times, reproductive output has been observed to vary across substrate types (Hamilton et al. 1992, Hamilton 2000, Holyoak et al. 2014). Holyoak et al. (2014) fitted statistical models to occupancy rates in the most common nesting habitat types in recent years (2006–2011) and considered data on abundance, reproductive success, and frequency of use for each nesting habitat type to determine the net reproductive output of different nesting habitats over time. Occupancy rates and other factors that influence reproductive output varied across habitat types, resulting in variation in the importance of habitats to Tricolored Blackbird productivity. Four nesting habitat types had sufficient sample size to make strong inferences about average reproductive output, including Himalayan blackberry, nettles,

wetlands, and grain fields. Himalayan blackberry and nettle colonies exhibited higher than average reproductive output. High overall reproductive output for nettle colonies is a little unexpected given that there are very few colonies, which are of average size, in this nesting substrate. However, high rates of occupancy and reproductive success result in high overall reproductive output for nettle colonies. Himalayan blackberry colonies exhibit average occupancy rates and size, but high reproductive success and the large number of colonies in this nesting substrate (the second most frequent colony type after wetlands) lead to high overall reproductive output. Grain field colonies exhibit average overall reproductive output, despite having low occupancy rates, low reproductive success, and a small number of colonies on grain fields each year; the very large size of grain field colonies increases the overall reproductive output. Of the four nesting habitat types assessed, wetlands remain the most common nesting habitat used by breeding Tricolored Blackbird colonies in recent years. Despite this, average levels of occupancy, reproductive success, and size of marsh colonies have led to the lowest overall contribution to reproductive output among the four nesting habitat types.

Between 1992 and 2003, average estimated reproductive success was significantly higher in nonnative Himalayan blackberry (RS = 2.0) than in native emergent cattail and bulrush marshes (RS = 0.5; Cook and Toft 2005). Excluding colonies that were lost to harvest, colonies on silage grain fields had an intermediate reproductive success (RS = 1.0). These rates of success on Himalayan blackberry and silage colonies over an 11-year period have rarely been reported at any individual colonies in more recent years. From 2006 to 2011, Meese (2013) observed a similar pattern of higher success in silage colonies compared to wetlands, although with lower overall values of reproductive success (unharvested triticale RS = 0.73; wetland RS = 0.31). However, in an intensive study of 12 colonies in the southern San Joaquin Valley, Weintraub et al. (2016) found no difference in reproductive success between colonies in agricultural silage fields and in wetlands. The reproductive success observed by Meese (2013) in Himalayan blackberry colonies was much lower (RS = 0.44) than that reported by Cook and Toft (2005), although only four Himalayan blackberry colonies were included in the 47 sampled colonies. In 2014, Airola et al. (2015a) estimated the average reproductive success at four Himalayan blackberry colonies in Sacramento County as 0.84 fledglings per nest, less than half that reported by Cook and Toft (2005) for the 1992–2003 time period. Although the methods used were slightly different, the estimate by Airola et al. (2015a) is within the range of reproductive success estimates observed in all nesting substrate types by Meese (2013) during six years of low reproductive success (average RS = 0.62; range 0.01–1.44), but the range of values observed by Airola et al. was much narrower (0.66–0.90). Although there has been much variation observed in reproductive success among substrate types, assessments that compiled data over multiple years are consistent in finding that Himalayan blackberry colonies experience relatively high success, while silage colonies are intermediate and wetland colonies have relatively low reproductive success, on average (Cook and Toft 2005, Meese 2013, Holyoak et al. 2014).

As a colonial breeding bird, Tricolored Blackbirds may benefit from occasional bouts of high productivity that recruit large numbers of birds into the population. Although reproductive success at many colonies has been relatively low in most years, estimates have been highly variable and in some years highly productive colonies have been observed. High rates of reproductive success at a few large colonies can produce large numbers of fledglings. For example, three colonies representing 50,000 nests accounted

for the production of an estimated 100,000 fledglings in 1993, while many smaller colonies produced no or few fledglings in the same year (Hamilton 1993). Meese (2013) observed high variability in reproductive success in both triticale and milk thistle colonies from 2006 to 2011 (range 0.01–1.44). The relatively high reproductive success at a small number of colonies was demonstrated to be a function of a high insect abundance in nearby foraging areas (Meese 2013). Low reproductive success has been implicated in Tricolored Blackbird population declines over the last two decades (Cook and Toft 2005, Meese 2013). Occasional high rates of reproductive success at a few large colonies may be a successful strategy for long-term population viability, but the degree to which infrequent bouts of high success can compensate for the low reproductive success that may be persistent and widespread across most colonies is unknown. Trends in the population size indicate that reproduction and survival rates have been insufficient over the last two decades to maintain the population (see Status and Trends section).

Survival

There are no published studies on the annual survival rate of Tricolored Blackbirds, but banding studies have shown that individuals can live up to 13 years (Neff 1942, DeHaven and Neff 1973). Meese (2014b) used recapture data to estimate the average annual adult survivorship of Tricolored Blackbirds as 60%. Estimates of annual survival rates for other temperate blackbirds have ranged from 42% to 60%, with rates for the closely-related Red-winged Blackbird ranging from 42% to 54% (Fankhauser 1971, Searcy and Yasukawa 1981).

An ongoing study has developed an Integrated Population Model (IPM) to jointly analyze banding, fecundity, and population data (from eBird). Banding data was analyzed in a Cormack-Jolly-Seber framework within the IPM, and preliminary results indicate that adult survival is higher in females than in males; however, there are far fewer banded males in the data than females, thus higher uncertainty around these estimates. The estimated average annual survival over the last 10 years was 0.68 for females and 0.53 for males (Robinson et al. 2018). The Integrated Population Model is discussed further in the Population Trend section.

STATUS AND TRENDS IN CALIFORNIA

Range

Nuttall (1840) observed the Tricolored Blackbird along the coast of California in the 1830s and, without offering any supporting evidence, suggested that the Tricolored Blackbird range extended into Oregon and Mexico. In the mid-1800s, Cooper (1870) reported the species to be common on the southern California coast from Santa Barbara to San Diego, with the range to the north passing "more into the interior, extending up as far as Klamath Lake and southern Oregon." Bendire (1895) reported the range as "[s]outhwestern Oregon, south through California, west of the Sierra Nevada, to northern Lower [Baja] California." Bendire knew of no reports of the species north of Klamath Lake in southwestern Oregon, and thought it to be uncommon there. The range of the species was confirmed to include northern Baja California in the late 1800s, with A. W. Anthony reporting them "[r]ather common along the northwest coast, breeding in all fresh-water marshes" (Bendire 1895).

Following a period of years with no reported sightings of Tricolored Blackbird in Oregon, Neff (1933) reported a number of observations of the species from 1931 to 1933, all within 30 miles (48 km) of Klamath Falls, and consisting collectively of fewer than 60 birds. Richardson (1961) reported up to several hundred Tricolored Blackbirds near Medford, Oregon in 1957 and documented breeding colonies of 1,500 and 1,800 birds in the region in 1958 and 1960, respectively. Inconsistent observations during the 1800s and early 1900s at the northern extent of the species range may represent shifts in distribution over time or are perhaps more likely the result of limited survey coverage. The species has continued to breed in small numbers in the vicinity of Klamath Falls to the present time, and small numbers of birds continue to occur near Medford during the breeding season. Small breeding colonies (30 or fewer birds) were observed in three northern Oregon counties (Multnomah, Umatilla, and Wheeler) in the 1980s (Beedy et al. 1991). Since the 1990s, several hundreds of birds have occurred regularly in central Oregon near the town of Prineville in Crook County, and breeding has been confirmed in the area. In recent decades, the species has been documented in several other isolated locations in western Oregon and eastern Washington, almost always in very low numbers but occasionally numbering in the hundreds of birds (Gilligan et al. 1994, Spencer 2003, eBird Dataset 2016). The degree to which these records represent recent range expansion to isolated areas, irregular use of the region, or increased survey coverage is unclear, but it appears that small numbers of birds may have recently expanded the species' range to at least some isolated areas in the north (Gilligan et al. 1994, Wahl et al. 2005).

Ammon and Woods (2008) describe the recent discovery and status of breeding Tricolored Blackbirds at a single location in western Nevada (Douglas County), and report that there was no confirmed breeding in Nevada prior to 1996. However, Wheelock (1904) described the distribution of the species in the early 1900s, and reported that in the vicinity of Lake Tahoe, "these birds stray across the crest, but not in the numbers in which they are found westward." The species was also reported to have bred in the vicinity of Lake Tahoe in the early 1900s (Dawson 1923) and Hosea (1986) reported a breeding colony in Carson City, Nevada in 1980.

In the early 1900s, the Tricolored Blackbird occurred in northwestern Baja California south to about the 30th parallel north (Grinnell 1928). This is consistent with recent breeding records from the southern extreme of the species range near El Rosario (Erickson et al. 2007, Feenstra 2013), although since at least 2016 there has been a retraction from the southernmost portion of the range.

The above historic accounts from the periphery of the range are largely consistent with the current range of the species, and overall, the range of the Tricolored Blackbird has changed little since at least the mid-1930s (Beedy et al. 2017). However, the species appears to be experiencing a range retraction in the southern California portion of the range and in Baja California, as discussed below.

Distribution

There are no descriptions of the distribution of the Tricolored Blackbird before the widespread conversion of native habitats across much of its range in California. However, accounts by early naturalists in California provide several records of the Tricolored Blackbird in the 1800s and early 1900s

that document the local abundance, and to some extent, the distribution of the species prior to any systematic study of the species across its range.

The early anecdotal reports from the 1800s and early 1900s, although typically not quantitative, informed the historical distribution of birds and demonstrated the occurrence of large numbers regionally. Most early observations of large numbers of birds were from the Central Valley and southern California, and only small numbers of birds have occurred north of the Central Valley, both historically and in recent years. Therefore, this report discusses changes in distribution for the Central Valley and for southern California, which have supported the majority of the population and for which adequate information is available to assess long-term changes in distribution.

Central Valley

In 1852, Heermann reported frequent encounters with winter flocks of Tricolored Blackbirds in the Suisun Valley that numbered "so many thousands as to darken the sky for some distance by their masses" (Baird et al. 1874). The Tricolored Blackbird was known to be an abundant breeder in the interior valleys of California in the late 1800s (Bendire 1895). Belding (1890) observed "an immense colony" near Stockton in 1879. Ray (1906) noted the species breeding at various points on an automobile trip down the San Joaquin Valley from Stockton to Porterville in 1905. Linton (1908) observed a breeding colony at Buena Vista Lake at the southern edge of the Central Valley in 1907. Lamb and Howell (1913) reported seeing "hordes" of Tricolored Blackbirds at Buena Vista Lake in 1912. Dawson (1923) reported the species as "locally abundant in the Great Interior [Central] Valley."

Neff (1937) was the first to attempt to document the rangewide status and distribution of Tricolored Blackbirds. Over a six-year period from 1931 to 1936, Neff located breeding colonies throughout the Central Valley and at a few additional locations in California and southern Oregon; however, Neff's surveys focused on the Sacramento Valley in most years. Based on his somewhat geographically limited efforts, Neff (1937) reported nesting birds in 26 California counties over the six-year study. During this period, the rice-growing areas of the Sacramento Valley appear to have been the heart of the Tricolored Blackbird's distribution, although this may be due to survey efforts being focused there and the limited effort applied further south in the San Joaquin Valley.

Bent (1958) reported that the center of abundance for the species seemed to be in the San Joaquin Valley. Orians and Christman (1968) reported that the largest colonies occurred in the rice-growing districts of the Central Valley (mainly the Sacramento Valley and northern San Joaquin Valley). Neither of these reports were based on systematic surveys of the valley and have limited utility in documenting species distribution, other than that the majority of the population continued to occur in the Central Valley.

The distribution of colonies encountered over a five-year period by DeHaven et al. (1975b) was similar to that observed 35 years earlier by Neff (1937). DeHaven et al. (1975b) reported that 78% of colonies located between 1968 and 1972 were in the Central Valley. Most colonies and breeding birds were found in the Sacramento and northern San Joaquin Valleys, including Butte, Colusa, Glenn, Yolo, Sacramento, Merced, and Stanislaus counties. In the 1980s, the largest colonies and the majority of the

known population continued to breed in the Sacramento and northern San Joaquin valleys (Hosea 1986, Beedy et al. 1991), although survey effort remained limited in the southern San Joaquin Valley.

An apparent early nesting season shift in distribution from the Sacramento Valley to the southern San Joaquin Valley occurred at the end of the 20th century. Although breeding had been documented in the San Joaquin Valley since the 1800s, this region had not been the focus of intense monitoring efforts prior to the 1990s. DeHaven et al. (1975b) reported that areas with suitable nesting substrates were scarce in the arid southern San Joaquin Valley in the 1970s. As described above, loss of native wetland breeding habitat had resulted in a shift to novel nonnative vegetation types beginning by the 1970s, and the distribution shift away from the Sacramento Valley is presumably in part due to these changes in nesting substrate availability. In the early 1990s, Tricolored Blackbirds were discovered breeding in grain fields in the San Joaquin Valley (Hamilton et al. 1992, Hamilton 1993). This discovery corresponded to an increase in the number of dairies and the associated expansion of triticale in the San Joaquin Valley as dairies began growing this new crop for silage. By 1994, most of the largest colonies and 40% of known breeding birds in the early part of the breeding season were found in the southern San Joaquin Valley associated with dairies and cattle feedlots (Hamilton et al. 1995). Relatively little triticale had been planted for silage in the San Joaquin Valley by 1994, but by 2005 the planted acreage had grown to about 75,000 acres (304 km^2) (Aksland and Wright 2005).

The shift in distribution to the San Joaquin Valley during the early breeding season has persisted, with very large proportions of the population nesting in a few large "mega-colonies" on or adjacent to dairies in the San Joaquin Valley (Kelsey 2008). In 1994, 68% of the estimated population in the early nesting season occurred in the San Joaquin Valley; this increased to 86% and 89% by 2008 and 2011, respectively (Hamilton et al. 1995, Kelsey 2008, Kyle and Kelsey 2011). In 2011, the 10 largest colonies were in the San Joaquin Valley during the early season survey (Kyle and Kelsey 2011). Breeding sites on triticale and other silage crops are also generally near other important habitat features, including irrigated pasture, grassland, or alfalfa crops for foraging, and available open water. The degree to which the apparent shift from the Sacramento Valley to the southern San Joaquin Valley is due to the loss of nesting habitat, the availability of a novel nesting substrate (i.e., triticale) and foraging habitat (i.e., alfalfa), or an increase in survey effort in the San Joaquin Valley is unknown (DeHaven 2000). Nevertheless, there has been a consistent use of the region by a majority of the Tricolored Blackbird population since the mid-1990s (Figure 8). The proportion of the population breeding in the San Joaquin Valley during the early part of the breeding season dropped to about 52% in 2014. This drop was in part due to increases in the number of birds in the Sacramento Valley, including the Sierra Nevada foothills, and southern California, but was primarily the result of a large rangewide decline, with most of the decline in number of birds occurring in the San Joaquin Valley (see the Regional Shifts in Abundance section). In 2017, the proportion of birds nesting in the San Joaquin Valley in the early breeding season returned to almost 70% (Meese 2017).

The grasslands and pastures of southeastern Sacramento County have seen consistent use by breeding Tricolored Blackbirds for at least the last 80 years (Neff 1937, DeHaven et al. 1975b, Hosea 1986, Beedy et al. 1991, Cook and Toft 2005, Airola et al. 2016), even as the dominant nesting substrate in the region has shifted from native wetlands to Himalayan blackberry (see Nesting Substrate section). DeHaven et

al. (1975b) described the pasturelands of southern Sacramento County as the most consistently used area during a five-year study. Until recently, little emphasis has been placed on monitoring Tricolored Blackbird colonies in the Sierra Nevada foothills and grasslands/pasturelands of the eastern Central Valley relative to population centers in the Central Valley and in southern California. Observations of colonies from this region during statewide surveys have usually been lumped with the Central Valley for reporting purposes. Starting in 2014, these grasslands in the low elevation foothills have received focused monitoring as a distinct breeding area (Airola et al. 2015a, 2015b, 2016), with regular use reported for not only Sacramento County, but also from Butte County in the north to Stanislaus County in the south. In 2016, precipitation patterns supported growth of milk thistle patches across extensive areas in the foothills further south as far as Fresno County, resulting in breeding by more than 22,000 birds that had not been observed in the region in the two previous years (Airola et al. 2016). When milk thistle is available for nesting by Tricolored Blackbirds, this nonnative plant may extend the distribution of the species into the southern Sierra Nevada foothills.
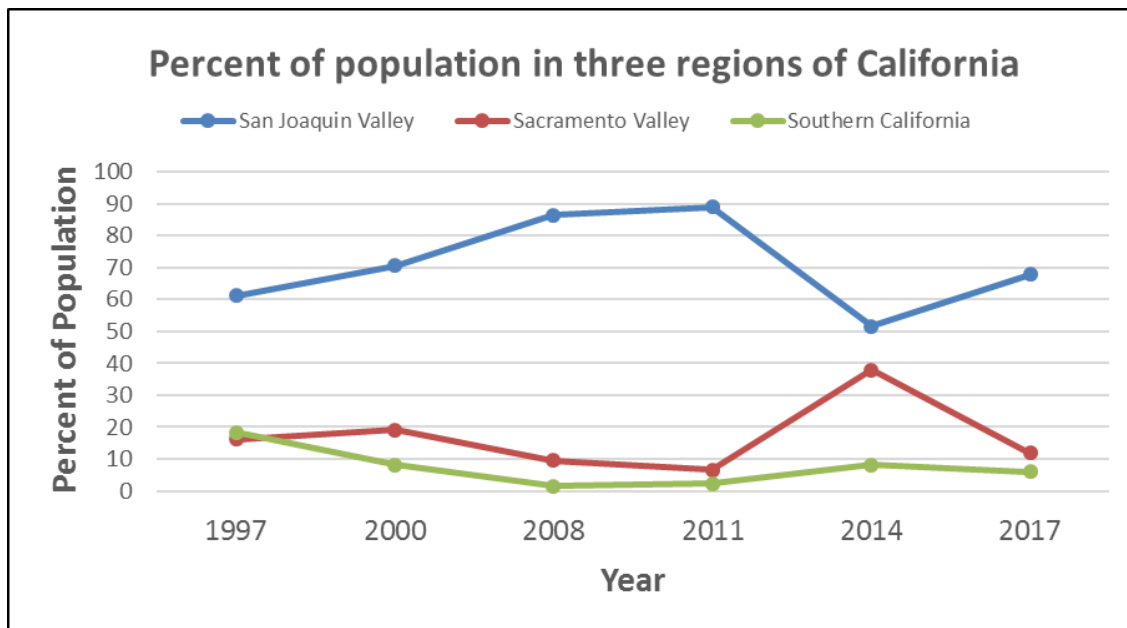
Figure 8. Percent of the Tricolored Blackbird population in three regions of the state during statewide surveys. Regions are defined as in Kelsey (2008): Southern California includes the Mojave Desert and the region south of the Transverse Ranges. Sierra Nevada foothill colonies are lumped with either the Sacramento Valley or the San Joaquin Valley, depending on latitude.

Distributional shifts may have occurred within the Central Valley, and some areas of the valley that once supported large numbers of birds now support few or no breeding colonies, while other areas appear to have become much more important. Changes in distribution may be due in part to shifting of birds to new areas, but may also be due to a declining population and associated loss from some areas. Despite these changes, the Central Valley and surrounding foothills as a whole have supported the majority of the Tricolored Blackbird population both historically and in recent years. Additional information on use of the Central Valley is presented in the Regional Shifts in Abundance section.

Southern California and Baja California

The first Tricolored Blackbird specimen was collected by Nuttall near Santa Barbara in 1836 (Baird et al. 1874, Bent 1958). Although he did not observe breeding colonies, Nuttall reported that the Tricolored Blackbird was very common around Santa Barbara and Monterey in the month of April (Nuttall 1840). In the mid-1800s, Cooper (1870) found the Tricolored Blackbird to be the most abundant species near San Diego and Los Angeles, and they were not rare near Santa Barbara. In the late 1800s, the species was described as an abundant winter resident in Los Angeles and Orange counties, occurring in very large flocks, with several colonies known to breed in tule marshes up to 1,500 feet (457 m) in elevation (Bendire 1895). Grinnell (1898) reported the species to occur in "considerable numbers" throughout the lowlands of the Pacific slope of Los Angeles County, and Willett (1912) considered the species a common resident throughout the lowlands of coastal southern California. Dawson (1923) reported the species as "locally abundant…in the San Diegan district."

There is evidence that the Tricolored Blackbird had experienced declines in a large portion of its range in southern California, even by the 1930s. In a revision of his former description of the species' status in coastal southern California, Willett (1933) described the species as a "formerly common resident…Now rare throughout former range in southern California, excepting in some sections of San Diego County." Grinnell and Miller (1944) described the status of the Tricolored Blackbird as "common to abundant locally" but noted a general decrease in southern California.

In 1980, the Tricolored Blackbird was characterized as a fairly common resident in the southern California coastal district that bred locally in all coastal counties (Garrett and Dunn 1981). The species no longer occurs at many historical sites in coastal southern California. Small numbers of breeding birds were documented at a few locations in coastal Santa Barbara County through the 1970s, with the last known colony of 200 birds in 1979 (Lehman 1994, Tricolored Blackbird Portal 2017). The last known colony in Ventura County, of 53 birds, occurred in 1994. About 200 birds persisted as breeders in the portion of Los Angeles County south of the Transverse Ranges through the 1990s, with the last known breeding attempt in 1999 (Allen et al. 2016, Tricolored Blackbird Portal 2017). Several hundred breeding birds occupied multiple sites in Orange County through the 1990s, but only a single colony of 14 birds has been observed breeding in the county in two years since 2000. The highly urbanized coastal portion of San Diego County, which supported thousands of breeding birds through at least the 1970s, has supported less than a thousand breeding birds at only three locations since 2000 (Tricolored Blackbird Portal 2017). Very few Tricolored Blackbirds now breed in the coastal lowlands of southern California where they were once abundant (Garrett et al. 2012).

Approximately 60–80% of the southern California population (south of the Transverse Ranges) nests in the San Jacinto Valley of western Riverside County in most years (Cook 2010). This area supports the Department's San Jacinto Wildlife Area and one of the last remaining agricultural communities in southern California. The numerous dairies in the valley along with the wetlands and grasslands of the Wildlife Area constitute the last stronghold for breeding Tricolored Blackbirds in southern California. Currently, nearly all farmland in the valley is slated for large scale residential and commercial development.

The status of the Tricolored Blackbird population in Baja California has followed a similar pattern to that for southern California. In the late 1800s, the species was described as "rather common along the northwest coast [of Baja California], breeding in all fresh water marshes" (Bryant 1889). Grinnell (1928) described the species as a "Fairly common resident locally in the northwestern section of the territory, north from about 30 degrees." In the 1980s, the species was described as a "local resident in northwestern Baja California south to El Rosario" (Wilbur 1987). A search of the entire Baja California range turned up a single breeding colony of 80 birds in 2007 (Erickson et al. 2007) and four breeding colonies totaling 240 birds in 2008 (Erickson and de la Cueva 2008). A follow-up survey several years later located three breeding colonies supporting an estimated total of 240–340 birds (Feenstra 2013). In recent years, most breeding in Baja California has occurred in the north within about 70 miles (113 km) of the U.S. border. Breeding continued at a disjunct area at the historical southern extent of the species' range (about 100 miles [160 km] farther south than the next nearest breeding location) near El Rosario through at least 2013 (Erickson and de la Cueva 2008, Feenstra 2013). By 2016 all known breeding colonies occurred within about 12 miles (19 km) of the U.S. border (Erickson et al. 2016). In 2017, the only known breeding colonies occurred within 5 miles (8 km) of the U.S. border and eight nonbreeding Tricolored Blackbirds were observed at a historic breeding site about 70 miles (113 km) south of the U.S. border. No birds were observed south of this point, leaving the southernmost 100 miles (160 km) of the species range in Baja California apparently unoccupied (April 2017 email from R. Erickson to N. Clipperton; unreferenced).

Where previously abundant and widespread south of the Transverse Ranges, the distribution of breeding colonies is now mostly restricted to inland sites in western Riverside and San Bernardino counties, and in the interior of San Diego County (Feenstra 2009). This represents a long-term decline in southern California and Baja California, with remnant colonies disappearing in recent decades throughout much of the southern range (Figure 9), including much of coastal southern California and the majority of the historical range in Baja California (Erickson et al. 2016). This may represent a permanent breeding range retraction from portions of the range where the species was previously abundant, and is likely the result of ongoing urban development and declines in population numbers.

Allen et al. (2016) reported that nesting commenced late in the 20th century in the Mojave Desert portion of northern Los Angeles County, and attributed this to manmade reservoirs and other impoundments, but breeding by small numbers of birds was known for the area since at least the 1970s (DeHaven et al. 1975b, Beedy et al. 1991). The species was known to occur in the Mojave Desert since at least 1890, but breeding was not documented (Belding 1890). The region has not supported more than a few thousand breeding birds in any year.

Population Trend

Breeding Population

Assessments of the rangewide population abundance of the Tricolored Blackbird prior to the 1990s are restricted to published literature describing research by a limited number of individuals in the 1930s (Neff 1937) and an additional rangewide assessment using similar methods in the 1970s (DeHaven et al.

a)
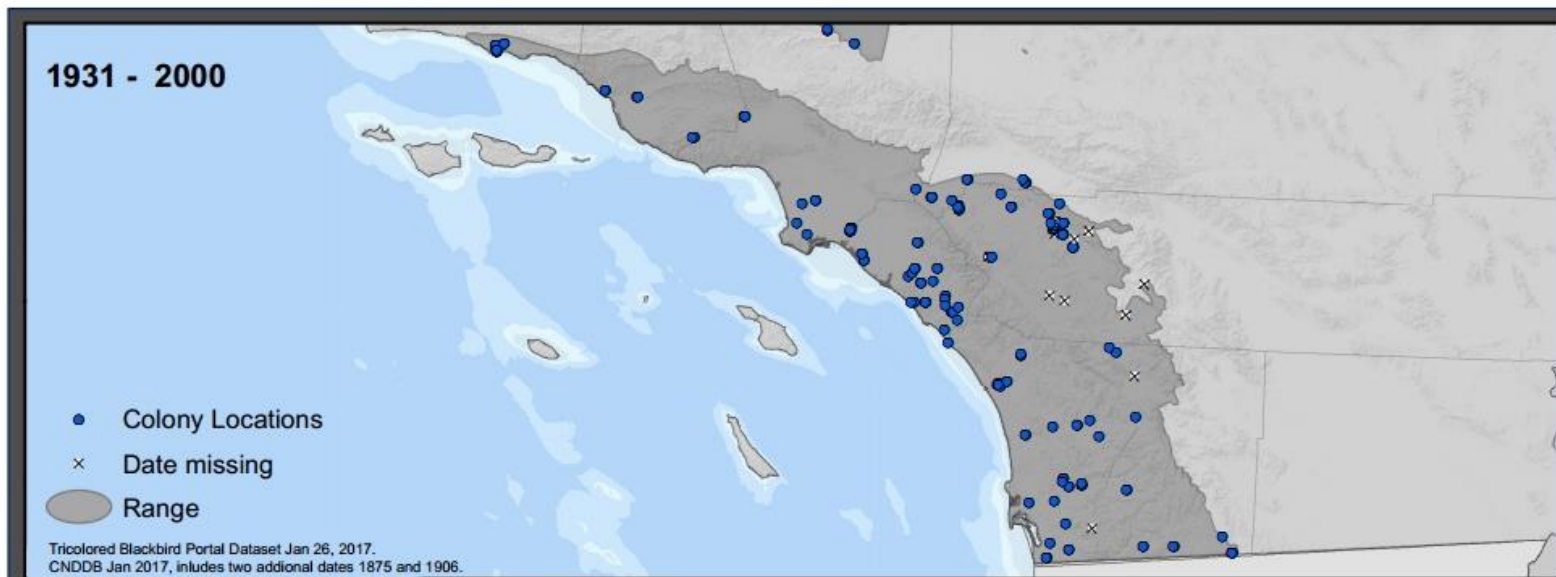
b)
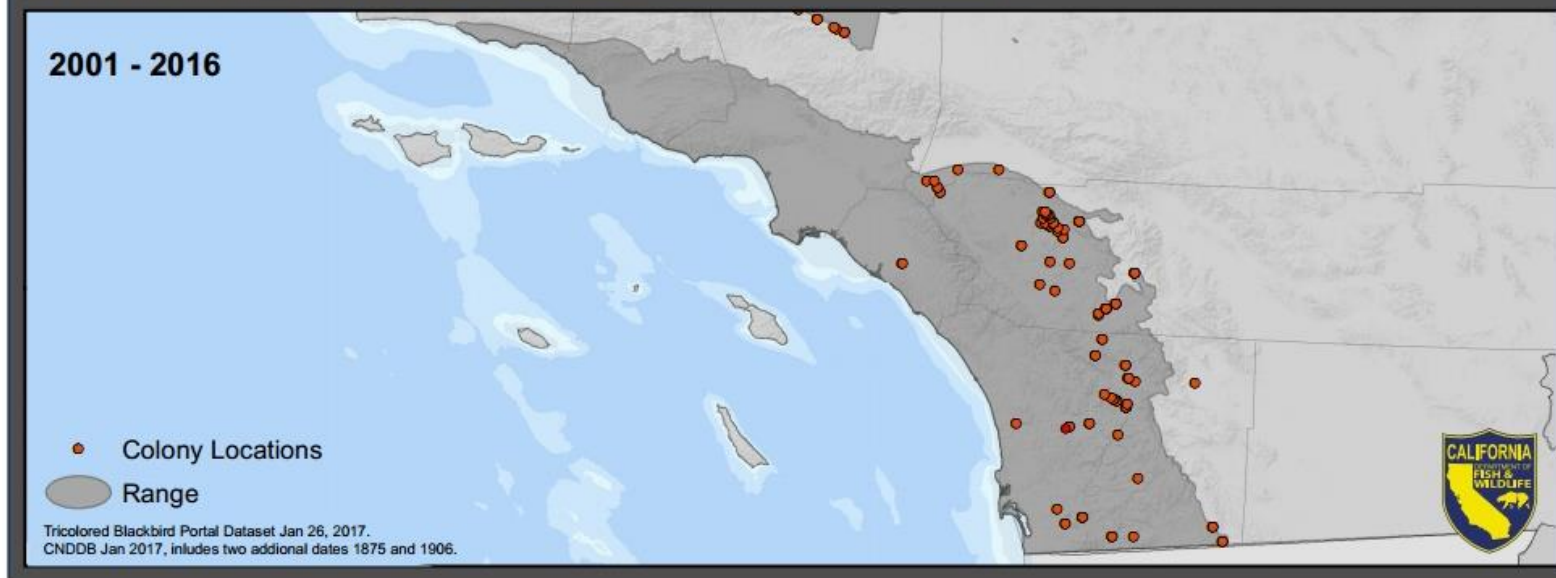
Figure 9. Distribution of active breeding colonies in southern California south of the Transverse Ranges. a) 1931–2000. b) 2001–2016.

1975b). An additional recent published study used all available breeding colony data collected over more than 100 years (1907–2009) to evaluate changes in average colony size (Graves et al. 2013). The most intensive efforts to estimate rangewide population abundance have occurred since 1994, with results presented in reports prepared by academic researchers, Audubon California biologists, and in contractor reports prepared for the USFWS and the Department. These represent the best available information for assessing trends in the rangewide population over the last two decades. The North American Breeding Bird Survey (BBS) provides one of the primary sources of data for evaluating relative abundance and population trends for North American landbirds (Hudson et al. 2017). Unfortunately, a species that breeds in large colonies and shifts in location on the landscape from year to year is not expected to be well-represented in BBS data. The data for Tricolored Blackbird have been identified to have deficiencies (Sauer et al. 2017a) and therefore are not a good source of information on abundance or population trends.

Over a period of six years (1931–1936), Neff (1937) surveyed Tricolored Blackbird colonies across California. Neff located several breeding colonies of more than 100,000 nests in the Sacramento Valley, with the largest composed of greater than 200,000 nests (corresponding to approximately 300,000 adult Tricolored Blackbirds). Breeding colonies were located throughout the Central Valley and in a few additional locations in California and southern Oregon; however, Neff's surveys focused on the Sacramento Valley in most years. An effort to cover the entire known range of the species was attempted by Neff in only one year (1932). Most areas outside the Sacramento Valley were covered only incidentally as "cooperators drove up or down the State in the performance of routine duties," and in the regions of the state that were most thoroughly surveyed, it was impossible to make complete surveys of all possible locations (Neff 1937). Neff concluded that obtaining an estimate of the statewide population was not possible. Working alone in 1934, Neff observed an estimated 491,250 nests (about 737,000 breeding birds), almost all of which were in the Sacramento Valley. The presence of birds in the San Joaquin Valley and southern California was noted in the same year, but no effort was made to estimate numbers. Several authors have cited Neff (1937) in statements about the Tricolored Blackbird population in the 1930s, sometimes suggesting that the population numbered in the millions (e.g., Beedy et al. 1991, Hamilton et al. 1995, Kyle and Kelsey 2011). Neff himself did not attempt to extrapolate his results to a region-wide estimate, although the roughly 737,000 breeding birds observed in a single year is likely an underestimate of the population at the time.

No attempts were made to describe the Tricolored Blackbird distribution or abundance during the 1940s, 1950s, or most of the 1960s. From 1969 to 1972, DeHaven et al. (1975b) attempted to survey the entire range of the Tricolored Blackbird to document the distribution of the species and to compare estimates of abundance to those provided by Neff (1937). The surveys were carried out by a few individuals surveying vast areas by road, and in most areas were limited to one or two drives through each county where Tricolored Blackbirds were known to occur in California and southern Oregon. Still, the search effort was at least as extensive as that carried out by Neff in the 1930s, and included the benefit of improved transportation and an increased number of roads. In many counties the survey consisted of driving county roads with little knowledge of historical colony sites, but this was an improvement over much of the effort of the 1930s, when counties were considered covered if visited

incidental to other activities. Despite a greater search effort, all measures of abundance indicated a decline: the number of active colonies detected per year declined from 43 to 41; nonbreeding birds encountered declined from >50,000 in a single year to <15,000 over four years; maximum colony size declined from hundreds of thousands to tens of thousands of birds; and number of birds observed per year within the study period declined from about 375,000 per year to about 133,000 per year (DeHaven et al. 1975b). Although no population estimate was provided, the authors suggested that the Tricolored Blackbird population declined by more than 50% in 35 years. Like Neff three decades before, DeHaven et al. (1975b) were unable to cover the entire range of the species thoroughly, including large portions of the southern San Joaquin Valley.

Following more than a decade with no survey to assess the statewide population, Beedy et al. (1991) compiled all historical records of Tricolored Blackbird breeding colonies and conducted limited field surveys from 1986 to 1990 to evaluate long-term population trends. Bill Hamilton and others (Hamilton et al. 1992, Hamilton 1993) conducted ecological investigations in 1992 and 1993 that included documentation of colony locations and sizes, the discovery of large breeding colonies on grain fields in the San Joaquin Valley, and the initial observations that suggested Tricolored Blackbirds are itinerant breeders (Hamilton et al. 1995). Based on the increased understanding of the species' biology and distribution, a new approach to estimating the statewide population of Tricolored Blackbirds was proposed by Ted Beedy and Bill Hamilton (Hamilton 1998, Meese 2015a). The discovery of itinerant breeding with broad movements between nesting attempts made it clear that a survey of the statewide population should occur during a narrow window in order to maximize the likelihood of detecting nesting colonies and to avoid double-counting birds (Hamilton et al. 1995, Beedy and Hamilton 1997). A survey conducted in a minor portion of the range or carried out over a long time period would either miss breeding colonies or double count birds over multiple breeding attempts. An improved understanding of colony occupancy dynamics suggested a need for early season colony-detection efforts to locate active colonies (Hamilton et al. 1995), while also considering the compiled information on all historical breeding locations in order to visit as many potential breeding locations as possible.

The new approach to surveying the statewide population was first implemented during the 1994 breeding season. The survey was conducted on a single day in the early part of the season (April 23). The choice of a survey date is an effort to select a time period when most birds have initiated a first nesting attempt and can be detected and counted at breeding colony sites, but before the first breeding cycle is completed and birds have moved to the north (usually) for the second breeding attempt. The goal of the survey was to conduct as complete a population census as possible by visiting as many known breeding locations (historical and recent) as possible, documenting occupancy status, and estimating colony size at all occupied locations. This was also the first survey to be largely volunteer-based and to enlist a large number of observers over a narrow time period. Compared to the surveys of the 1930s and 1970s, these surveys employed many more surveyors to more thoroughly cover as much of the state and known colonies as possible. The discovery of breeding by a large proportion of the population on silage fields near dairies had recently been documented (Hamilton et al. 1992, 1995), and therefore unlike previous statewide survey efforts, the 1994 survey focused heavily on the San Joaquin Valley.

After the establishment of the new approach to conduct a statewide survey, attempts to census the population were carried out in 13 years between 1994 and 2017. Despite a consistent approach in many of the early years of this time period, methods varied considerably for many of these surveys. The years 1994, 1997, and 2000 produced a set of three triennial surveys that were considered to have been comparable in effort by the survey organizers (Beedy and Hamilton 1997, Hamilton 2000, Cook and Toft 2005). After a period of years with surveys that followed inconsistent and variable approaches, another set of four triennial surveys were conducted using similar methods in 2008, 2011, 2014, and 2017 (Kelsey 2008, Kyle and Kelsey 2011, Meese 2014a, Meese 2017). The effort and results of these seven surveys are summarized in Table 2. Although the other six survey years (1995, 1996, 1999, 2001, 2004, and 2005) are not discussed further here, they are briefly summarized in Table 3 and in a larger discussion of Tricolored Blackbird surveys included in Appendix 1.

Due to small changes in methods over time and the inherent difficulties in estimating population abundance of a colonial, itinerant breeding bird species, there are several potential sources of uncertainty in the population estimates from statewide surveys. Attempts to quantify this uncertainty have been limited and inconsistent across survey years. Traditional survey sampling designs would likely produce biased estimates of population size due to the colonial breeding and the unpredictable distribution of Tricolored Blackbird colonies from year to year, and new approaches to surveying the population are being explored. Comments on the approach used to estimate the size of the population during recent statewide surveys, along with a discussion of uncertainty, are provided in Appendix 2.

Table 2. Comparison of survey effort and results for seven statewide surveys.

Year	Duration	Number of observers	Number of counties surveyed (occupied)	Number of sites surveyed (breeding sites)	Occupied breeding locations	Estimated number of birds
1994	1 day (3 days)[1]	60[2]	− (32)	−	100	369,400
1997	1 day (3 days)[1]	55[2]	− (33)	−	71[3]	232,960
2000	4 days	81[2]	33 (25)	231 (181)	72	162,000
2008	3 days	155	38 (32)	361 (284)	135	395,000
2011	3 days	100	38 (29)	608	138	259,000
2014	3 days	143	41 (37)	802	143	145,000
2017	3 days	181	44 (37)	884	168	177,700

[1] Observations of birds not associated with colonies from one day before and after the survey day were accepted, effectively expanding the survey window to three days.
[2] Number includes participants who submitted written reports. A larger number of volunteers may have searched for birds.
[3] As reported by Hamilton (2000).
"—" = data not reported

The statewide survey efforts in 1994, 1997, and 2000 followed similar methods to locate and survey as many colonies as possible. Although the duration of the survey and the survey effort varied across these years, the organizers of the surveys reported these three surveys had used the most consistent methods

to date and could be compared to assess the population trend (Beedy and Hamilton 1997, Hamilton 2000). However, inconsistencies in effort still occurred with the 1994 survey conducting only a limited survey of southern California, and the 2000 survey using more observers to visit more sites than the other two survey years. Therefore there was a general increase in survey effort and geographic coverage each year. Despite this, Hamilton (2000) reported that the San Joaquin Valley, with its potentially large silage colonies, was not surveyed completely. However, he concluded that "…the method of the Census and the survey, to reinvestigate all known breeding places and to search for new ones, has become an increasingly complete assessment of Tricolored Blackbird distribution and abundance. The 2000 Census probably located a greater proportion of the entire population than did censuses in previous years." The estimated number of birds declined 56% from 369,400 birds in 1994 to about 162,000 birds in 2000 (Hamilton 2000, Cook and Toft 2005). In addition to the results of the surveys showing declines in the 1990s, Hamilton (2000) stated that personal observations over long intervals by many regional experts had also suggested declines during this time period.

Table 3. Brief descriptions of 13 surveys that attempted to estimate the size of all or a portion of the Tricolored Blackbird population between 1994 and 2017.

Survey year	Description of survey	Sources
1994	The first year a statewide survey was conducted in a narrow time period, was informed by knowledge of historical breeding locations and by pre-survey colony detection work, and enlisted the help of a large number of volunteers.	Hamilton et al. (1995) Beedy and Hamilton (1997)
1995 and 1996	Limited pre-survey effort. Incomplete county coverage. Large colonies may have been overlooked. Results are not considered representative of the total population.	Beedy and Hamilton (1997)
1997	Used the same coverage, methods, and personnel as did the 1994 survey. Participation was greater than in 1994.	Beedy and Hamilton (1997)
1999	Participation in the survey was low. Results considered an underestimate of population size by the survey organizer.	Hamilton et al. (1999, 2000) Hamilton (2000)
2000	Used the same methods applied in 1994 and 1997, although a greater number of observers were used to visit more locations. Training was provided to participants. Surveys from 1994, 1997, and 2000 were considered comparable.	Hamilton (2000)
2001	Followed a very different approach compared to standardized methods used since 1994. A limited number of sites were visited and estimates were compiled from observations made throughout the breeding season.	Humple and Churchwell (2002)
2004	Not intended to provide an estimate of the statewide population size that was comparable to previous surveys. Surveys limited to colony sites that had historically supported more than 2,000 birds. Focused on sites in the Central Valley.	Green and Edson (2004)
2005	No report was produced and no record is available describing the survey effort.	Meese (2015a)
2008	Used similar methods as in the 2000 survey, although estimates not adjusted using nest density. Also, county coordinators were used for the first time to ensure each county was well surveyed by volunteers. Maps with all survey locations were provided for the first time, and a website improved communication and data management. Number of survey participants and number of sites surveyed greatly increased relative to earlier surveys.	Kelsey (2008)
2011	Methods followed those used in 2008, although county coordinators were not used to lead surveys in individual counties.	Kyle and Kelsey (2011)
2014	Used the same methods as in 2008 and 2011, and again used county coordinators to ensure each county was thoroughly covered. The number of counties and number of sites visited exceeded all other surveys to date.	Meese (2014a)
2017	Used the same methods as in 2008–2014, with the addition of a mobile map application that assisted in location of sites. The number of survey participants and the number of counties and sites visited exceeded all other surveys to date. Surveys conducted 2008–2017 are considered comparable, although interpretation must account for increase in effort over time.	Meese (2017)

As during the early set of survey years, the survey effort increased each year from 2008 to 2017. More counties were surveyed in 2014 than on any previous survey and the number of observers participating on the 2014 survey (n = 143) was exceeded on only one previous survey (n = 155 in 2008). There was a large increase in the number of sites visited in each survey year between 2008 and 2014, and the number of colony sites visited in 2017 exceeded that of any other survey (Figure 10). The 2017 survey was the most extensive survey conducted to date based on all available metrics of effort (Table 2). The number of birds estimated on statewide surveys declined 63% from 395,000 birds in 2008 to an all-time low of about 145,000 birds in 2014 (Kelsey 2008, Meese 2014a) (Table 2). From 2014 to 2017, the estimated number of birds increased 22% to about 177,700. The number of birds observed in 2017 represents a 55% decline in the population over the nine years since 2008. The observed decline occurred despite large increases in the number of confirmed colony locations surveyed in each successive survey.

Although the conclusion following each of the two groups of survey years (1994–2000 and 2008–2017) was that a population decline had occurred, differences in survey methods and effort make it difficult to combine the two groups of surveys to make longer-term conclusions (Meese 2015a). Does the estimated number of birds in 2008 represent an increase in population size following the decline of the 1990s, or do increased survey effort and other changes to survey methodology preclude comparison of results from the two survey periods? In addition to differences in duration of the survey, geographic scope, and effort shown in Table 2, there were important differences in methods used between the two groups of surveys (see Appendix 1). Methods unique to the earlier 1994–2000 surveys include: 1) birds counted at colonies before the survey were included in the results if the colony remained active after the survey period (although not counted on the survey day); 2) birds observed and counted at colonies after the survey were included if nest phenology led to a conclusion that the colony was active on the survey date (although not observed); and 3) visual colony size estimates were often adjusted using observed nest densities, as determined by walking transects through colony sites after the survey, which resulted in final colony size estimates that in some cases differed substantially from those reported by survey participants (Hamilton et al. 1995). Unfortunately, the overall impact (both the magnitude and direction) of these methodological differences on the population estimates is unknown, and therefore a direct comparison of results from the two time periods is not appropriate. However, Hamilton et al. (1995) reported that the adjustment of estimates using nest densities at large colonies resulted in less than a 15% change in any colony size estimate. At a minimum, the large step change in survey effort between the two time periods must be taken into account if the data are to be used to inform a longer-term population trend.

As shown in Table 2, the individual metrics of survey effort were not consistently reported across survey years. The number of sites surveyed has been used to describe survey effort in recent years (Meese 2014a, 2015, 2017), but this number is not known for the surveys conducted in the 1990s. The number of counties surveyed was also not reported for surveys conducted in the 1990s. The number of participants and the number of occupied breeding locations were reported for all survey years. It is not known whether an increase in effort as measured by any of these metrics results in a proportional increase in the number of birds observed, but Graves et al. (2013) reported that total counts of breeding

Tricolored Blackbird Colony Site Surveys (2008, 2011, 2014 & 2017)

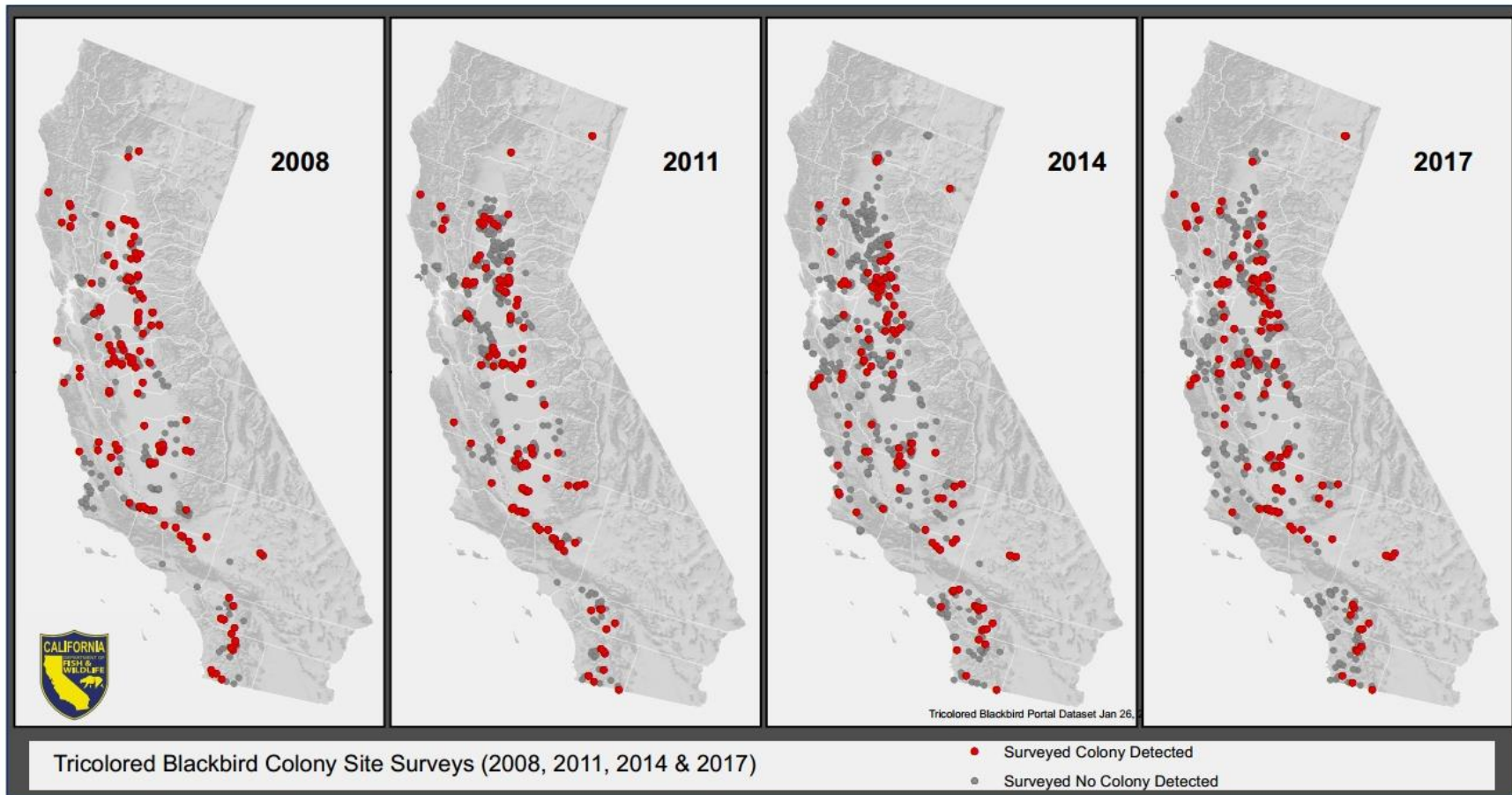● Surveyed Colony Detected
● Surveyed No Colony Detected

Figure 10. Locations surveyed during statewide surveys conducted since 2008. Red circles indicate occupied breeding locations. Gray circles indicate surveyed locations that were not occupied.

birds are correlated with the number of sites sampled. The number of sites sampled is also related to the proportion of the landscape searched by survey participants (Figure 10) and therefore might be the most appropriate metric of effort with which to standardize survey results.

In order to make use of as many survey years as possible to evaluate population trend over time, survey results were adjusted for effort when available (Figure 11a-c). Viewed as a whole, when adjusting for survey effort the results suggest a consistent pattern in the Tricolored Blackbird population since 1994. Regardless of the metric used to adjust population estimates for survey effort, the trend shows a long-term decline over the 23-year period with a partial recovery between 2000 and 2008[1]. Depending on the metric used to correct for effort, either 2014 or 2017 represents the all-time low for effort-adjusted number of birds observed.

As the number of locations visited has increased with each successive statewide survey, so too has the number of locations with some uncertainty regarding the exact location. These are historical breeding locations for which the exact coordinates were often not reported, and therefore the level of confidence is recorded as "uncertain" in the Tricolored Blackbird Portal database (2017). As a result, surveyors have visited an increasing number of locations that have not necessarily supported Tricolored Blackbird breeding in the past (Table 4). This is not wasted effort, as the visits to uncertain locations increase the size of the landscape area searched for colonies during the survey (Figure 10), and the locations are likely near historical colony sites. Nevertheless, for the 2017 survey, participants were directed to focus on sites with known coordinates, resulting in a large decline in the number of "uncertain" sites surveyed. To be conservative in interpreting changes in survey effort over time, the uncertain locations were removed from the count of sites visited during the 2000, 2008, 2011, 2014, and 2017 surveys to adjust the effort for those survey years (Table 4). The adjusted number of sites surveyed each year continues to show an increase in survey effort over time. A graph prepared using the revised number of sites surveyed (Figure 11d) revealed little effect on the pattern of birds observed per site shown in Figure 11b.

Table 4. Number of sites surveyed during recent statewide surveys, adjusted to remove uncertain locations.

Survey year	Number of sites surveyed	Number of uncertain sites	Revised number of sites surveyed
2000	231	4	227
2008	361	8	353
2011	608	54	554
2014	802	127	675
2017	884	25	859

---

[1] One peer reviewer questioned whether an increase in population size occurred between 2000 and 2008. Based on participation in surveys of the southern San Joaquin Valley from the early 1990s to 2005, and again in 2008, the reviewer made the following statement: "The changes [declines] were remarkable. I surveyed the whole of the breeding range of Tulare, Kings, Fresno, and Kern in 2004 and again in 2008, and could not believe the magnitude of change that had occurred in those years."

a)

Birds per survey participant

$y = -763.41x + 5843.6$
$R^2 = 0.7933$

b)

Birds per site surveyed

$y = -191.4x + 1095$
$R^2 = 0.6229$

Birds per occupied breeding location

$y = -457.67x + 4130.9$
$R^2 = 0.8786$

Birds per site with known location

$y = -191.78x + 1119.8$
$R^2 = 0.6264$

c)

d)
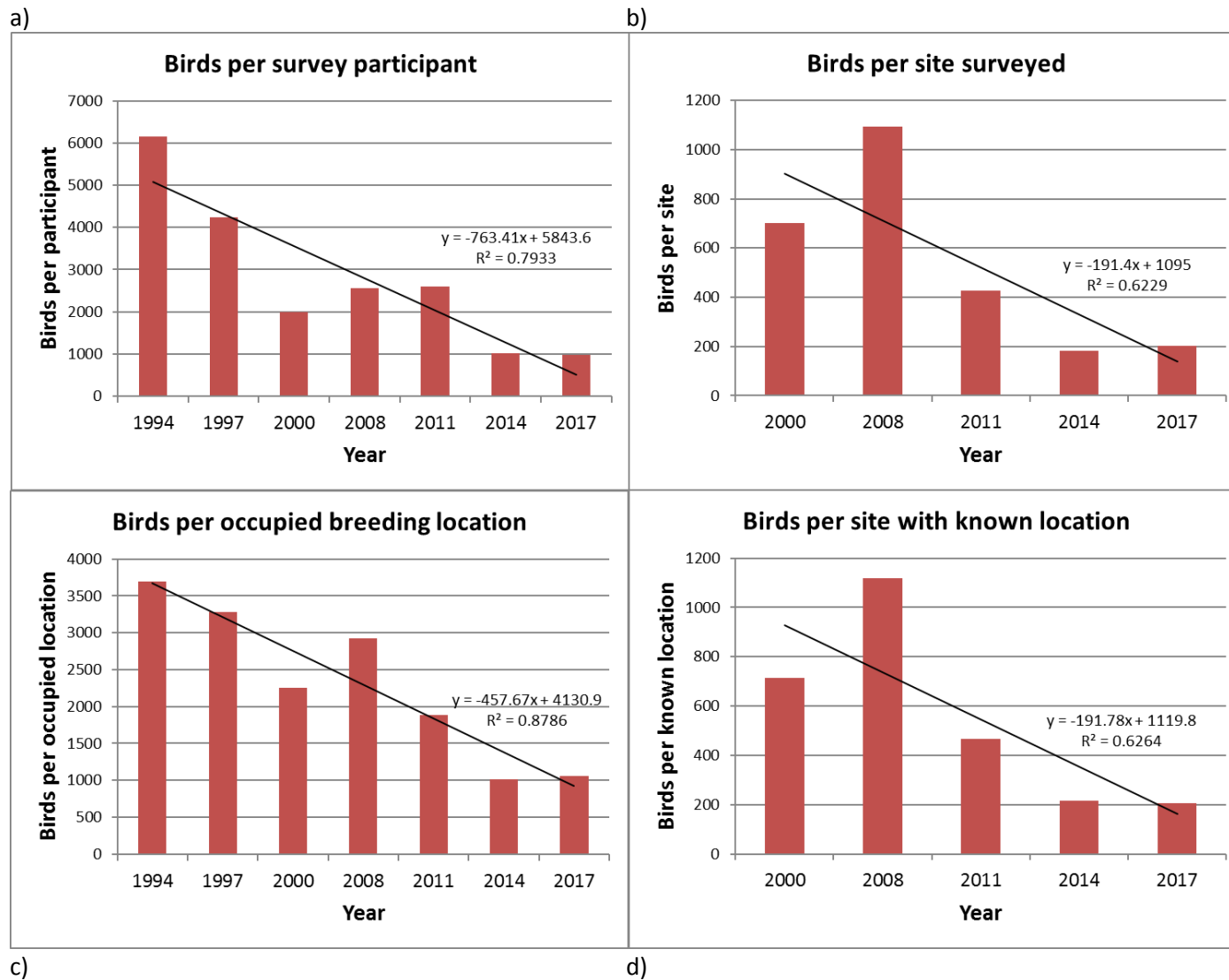
Figure 11. Number of birds observed per statewide survey conducted since 1994, corrected for level of survey effort.
a) <u>Birds per participant</u>: 90% decline over 23 years (**-9.6% per year**). b) <u>Birds per site</u>: 85% decline over 17 years (**-10.5% per year**).
c) <u>Birds per occupied location</u>: 75% decline over 23 years (**-5.8% per year**). d) <u>Birds per known location</u>: 83% decline over 17 years (**-9.8% per year**).

The linear regression trendlines for each of the effort-corrected survey results indicate that the Tricolored Blackbird population has declined by 75%–90% in the last 23 years (Figure 11). The observed rates of decline of 5.8% to 10.5% per year indicate that this species has been in severe decline over the last two decades. These rates of decline are in the range of the steepest declines observed across all North American landbird species based on Breeding Bird Survey data (Sauer et al. 2017b). Results of the most recent 2017 statewide survey suggest that the Tricolored Blackbird population decline may have slowed or reversed since 2014, but the population remains at or near its smallest size ever recorded. Coupled with the earlier declines between the 1930s and 1970s, the recent declines have resulted in a population that is a small fraction of its historical abundance.

Colony Size

In recent statewide survey years, the size of the largest colonies (including the single largest colony and the average of the several largest colonies per year) has been reported as an alternative metric to total counts of birds for tracking trends over time. Use of the size of large colonies to evaluate trends is only appropriate if the survey effort is sufficient to detect most of the largest colonies. Although the survey effort required to detect most of the largest colonies is unknown, Graves et al. (2013) reported that average colony size observed, based on colony data from 1907 to 2009, was not strongly correlated to the total number of sites sampled annually, suggesting that survey effort may have generally been sufficient to detect the largest colonies. Larger colonies may be more likely to be detected and therefore survey effort may have less effect on size of largest colonies observed compared to total counts of birds.

Neff (1937) located several breeding colonies of more than 100,000 nests in the Sacramento Valley, with the largest composed of greater than 200,000 nests (about 300,000 adult birds). Orians (1961a) reported that, in 1959 and 1960, 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. The largest reported colonies in the 1970s were in Colusa and Yolo counties and comprised about 30,000 adults (DeHaven et al. 1975b, Beedy and Hayworth 1992). All but one of the colonies observed by DeHaven et al. (1975b) that were larger than 20,000 birds were located in the Sacramento Valley. In the 1980s, the largest reported colony was in the northern San Joaquin Valley at Kesterson Reservoir (Merced County) in 1986, with an estimated 47,000 adults (Beedy and Hayworth 1992).

After the discovery of Tricolored Blackbird breeding colonies on grain fields in the San Joaquin Valley in the early 1990s (Hamilton et al. 1995), the size of the largest colonies in several subsequent years once again grew to more than 100,000 birds (so-called "mega-colonies"). Beedy and Hamilton (1997) reported that 1994 and 1997 were the only two survey years to date with sufficient survey effort to detect "virtually all large colonies." In 1994, Hamilton et al. (1995) found that the largest colony, at San Luis National Wildlife Refuge, numbered about 105,000 adult Tricolored Blackbirds. In 1997, Beedy and Hamilton (1997) reported the largest colony to contain about 80,000 adults. The documentation of large colonies during this time period is likely due in part to the formation of mega-colonies on grain fields, but may also be a result of increased survey effort in the San Joaquin Valley.

Colonies of at least 80,000 breeding birds continued to occur through 2010 (Meese 2009a, Meese 2010). From 2008 to 2017, maximum colony size declined from 80,000 to fewer than 20,000 birds (Kelsey 2008, Kyle and Kelsey 2011, Meese 2017). In 2014, only a single colony consisted of more than 20,000 birds and only three colonies consisted of 10,000 birds or more (Meese 2014a). The proportion of birds observed in the 10 largest colonies during the years 2008, 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. This reflects a downward trend in the sizes of the largest colonies, without a large increase in the number of occupied breeding locations (Figure 12). The trend in the largest colonies from 1994 to 2017 is similar to those in Figure 11 for effort-corrected statewide survey results: a long-term decline over the 23-year period with a partial recovery between 2000 and 2008.
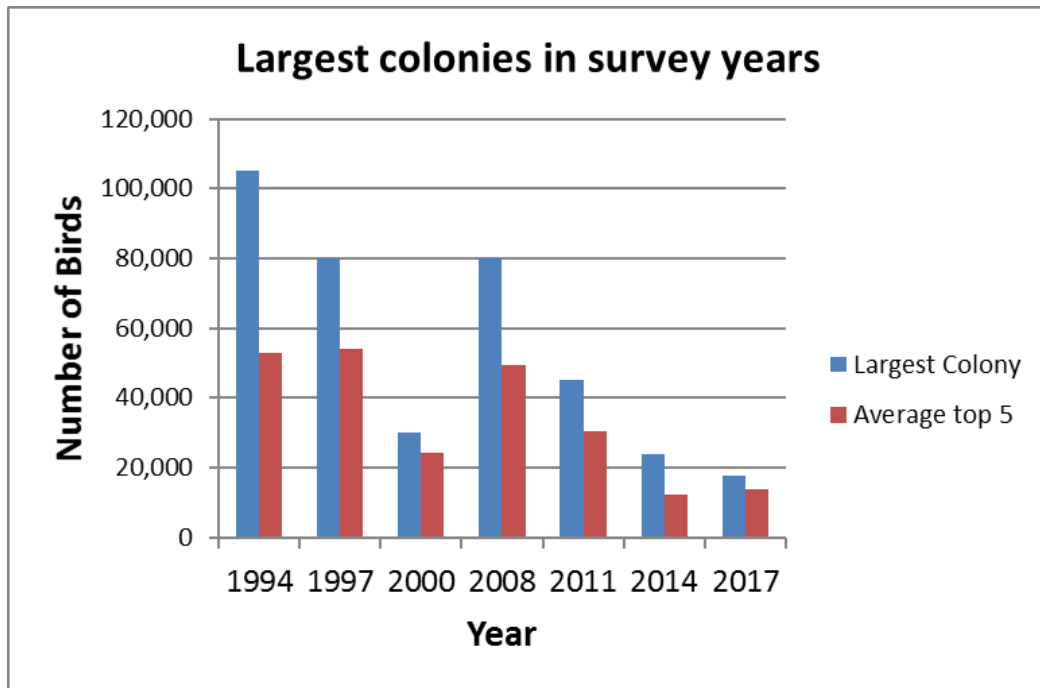
Figure 12. Size of the largest and average of the five largest colonies observed during statewide surveys conducted since 1994.

Graves et al. (2013) performed an evaluation of trends in the average size of Tricolored Blackbird colonies over a more than 100-year period (1907–2009) using data compiled from a variety of sources. Average colony size, rather than total abundance, was used as the metric to evaluate trends to account for the effects of variable sampling effort across years. Graves et al. (2013) found a significant decline in the average colony size from 1935 to 1975, with the average colony size declining by more than 60%. This corresponds to the period over which DeHaven et al. (1975b) concluded that the population size had declined by about 50%. Despite large amounts of data on colony sizes from the 1980s onward, no significant decline was detected in average colony size from 1980 to 2009. This finding is counter to reports of population declines for portions of the 1980–2009 period (e.g., Beedy et al. 1991, Hamilton 2000). However, the statistical evaluation conducted by Graves et al. (2013) used data only through 2009, so it does not include much of the time period during which the recent population decline was

observed (2008–2014). In addition, it is unlikely that survey effort was sufficient in all years since 1907 to detect most of the largest Tricolored Blackbird colonies, which may have influenced the estimates of average colony size.

The degree to which size of the largest or average colonies correlates to total population size in any given year is unknown. However, during statewide survey years since 1994, the sizes of the largest colonies follow a pattern similar to that of the total numbers of birds observed. Given that in many years the majority of the birds occur in a small number of the largest colonies and the number of occupied colonies per year has not increased dramatically with increased survey effort (Table 2), it is likely that short-term declines in colony size often reflect real changes in the population size. Over longer periods, the correlation between colony size and population might be expected to break down due to shifts in breeding distribution and selection of novel nesting substrates. For example, when the population began using agricultural grain crops in the early 1990s and experienced an apparent shift in early breeding season distribution to the San Joaquin Valley, very large colonies were reported for the first time in many years. These changes in nesting substrate availability and distribution could have influenced the size of the largest colonies (and average colony size) by concentrating the population at a small number of breeding locations without necessarily reflecting a change in population size. In fact, Graves et al. (2013) reported that colonies in triticale and other grain crops were 40 times larger than colonies in other habitats during the last 20 years. This may explain in part why they did not find a reduction in average colony size from 1980 to 2009, a time when breeding surveys revealed declines in total number of birds observed.

Winter Population

The Christmas Bird Count (CBC) is a volunteer-based survey conducted each winter at designated 15-mile (24 km) diameter circles across North America. CBC data consist of counts of all birds encountered during a single day at each circle for which a count is conducted. There are more than 2,400 count circles across North America, some of which have been run since the early 1900s (Soykan et al. 2016). The number of count circles increased dramatically through the 1950s and 1960s, especially in the western region of the U.S. (Niven et al. 2004), and long-term trend assessments have often used a start date in the late 1960s to avoid any influence of increased survey coverage on apparent trends (Butcher et al. 2006). This is also the time period when the Breeding Bird Survey was initiated, which allows for comparisons between breeding and wintering populations (Butcher et al. 2006). Counts are not necessarily conducted for every circle each year, and some circles are run more consistently than others. The number of volunteer observers and the duration of the count can vary from year to year, and yearly differences in effort can have substantial influence on the results of the counts. Therefore, the number of party-hours is often used as a measure of effort to standardize count results. Count circle locations are also not randomly selected, so data cannot be extrapolated to provide population estimates across the range of a species, but if corrected for effort can provide an index that can inform population change in areas covered by count circles.

Soykan et al. (2016) used a hierarchical model to evaluate population change from 1966 to 2013 for several hundred species sampled by the CBC, including Tricolored Blackbird. The analysis assessed

change in each U.S. state and in each Bird Conservation Region (BCR; a map of BCRs is available at http://nabci-us.org/resources/bird-conservation-regions-map/), with the Coastal California BCR being the primary BCR in which Tricolored Blackbird occurs. Trends for Tricolored Blackbird were non-significant at both the California and the BCR scales. Hierarchical models are more efficient than linear regression approaches when assessing population change for a large number of species across multiple geographic scales, and can control for variation in survey effort among circles and across years. However, the use of large spatial scales for analysis may introduce variability in the quality of information that may not be accounted for in the models. Although the Coastal California BCR captures the majority of the Tricolored Blackbird range in California, it is neither geologically nor biologically uniform. Also, the addition of count circles over time has not been evenly distributed across the BCR or the state. Due to the variability in habitat and species distribution at these broad scales, any apparent population trend, or lack thereof, can be an artifact of the years in which count circles were added or removed, or the years in which particular circles were surveyed across a heterogeneous landscape. A finer-scale approach that considers the impacts of this variability on a single species is warranted.

In California, count circles increased through the 1960s as has been documented in other areas, but the number of circles continued to increase through the early 1990s. The number of circles in California detecting Tricolored Blackbird doubled from 1974 (25 circles) to 1986 (50 circles) and the number of circles with Tricolored Blackbird detections did not stabilize until the 1990s. Since 1992 the number of circles with Tricolored Blackbird detections has been fairly stable and has fluctuated between 54 and 66. Because of the continued increase in the number of count circles through the 1990s, and the inconsistent running of counts at some circles over time, the sampling intensity has varied across the range of the Tricolored Blackbird in California. Based on the number of count circles surveyed in California over time, and by establishing criteria for consistency of effort, the Department assessed trends based on CBC data for two time periods: 1974–2015 and 1995–2015. These two periods capture a longer-term extending back to the 1970s when the breeding-season surveys of DeHaven et al. (1975b) were conducted, and a shorter term covering the time since the first statewide surveys of the 1990s and when CBC data quality was highest and most consistent. The distribution of count circles that met a set of criteria and that were therefore included in the analyses provides fairly good coverage of the core of the winter distribution of the species (Figure 13; Appendix 3). Population trends were estimated from the slope of the regression of the log-transformed counts on year (see Butcher et al. 1990). Results of the CBC data analyses indicate declines in the Tricolored Blackbird population over both the longer term 1974–2015 period and the shorter term 1995–2015 period (Appendix 3).

Improvement in bird identification skills by volunteer observers has been apparent within the past 20 years, and poses a significant challenge in the interpretation of trends based on CBC data. This may be especially true for species with potential identification problems and for flocking species such as the Tricolored Blackbird (Butcher et al. 1990). As a result, counts that are adjusted by party-hour may be positively biased in recent years, which would tend to result in a positive bias in observed trends.

A number of historical winter observations of large numbers of Tricolored Blackbirds corroborate the observed decline in CBC data. For example, wintering flocks numbering 12,000–14,000 once assembled near dairies on the Point Reyes Peninsula, Marin County, which was one of the most reliable locations to

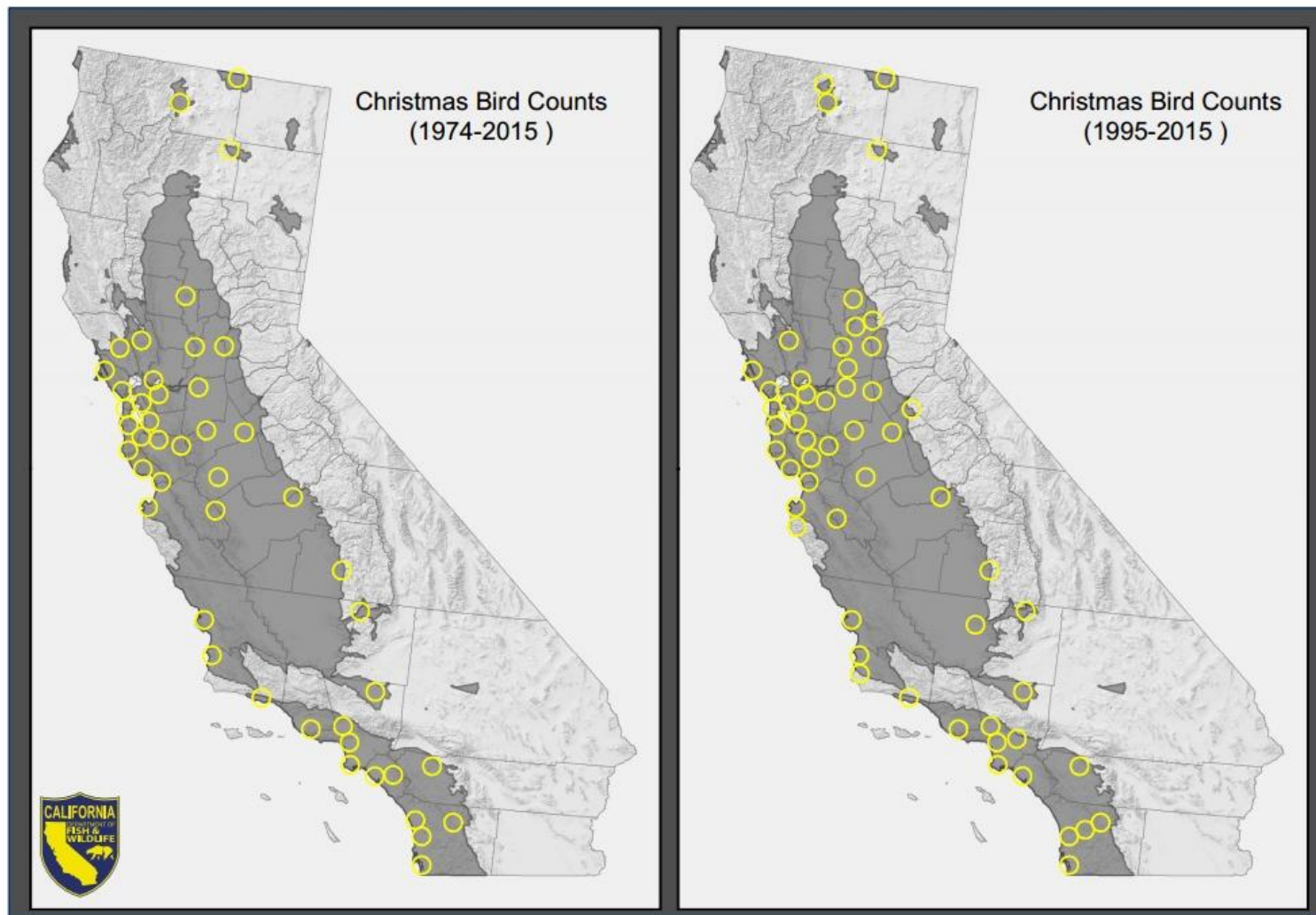a)   b)

Figure 13. Christmas Bird Count Circles used for winter population trend analysis. a) Circles for which data were analyzed over a long-term period (1974–2015). b) Circles for which data were analyzed for a shorter-term analysis during which better data was available. See Appendix 3 for details of the analyses.

observe large numbers of wintering Tricolored Blackbirds. In recent years, these flocks have been in the range of 2,000–3,000 birds (eBird Dataset 2016, Beedy et al. 2017). There have been no known habitat changes in this region over the time period with declining bird numbers.

Integrated Population Model

An ongoing study has developed an Integrated Population Model (IPM) to jointly analyze banding, fecundity, and population data, which allows for evaluation of changes in population size and the demographic parameters responsible for the change. Data from more than 64,000 Tricolored Blackbirds banded from 2007 to 2016, fecundity data from 10 sites in 1992–2016, and population abundance data from eBird were used in development of the IPM (Robinson et al. 2018).

Over a 10-year period from 2007 to 2016, trends using eBird population data alone suggested a 52% decline, which is similar to the magnitude of decline observed in statewide breeding surveys conducted from 2008 to 2017 (55% decline). Incorporation of survival and fecundity data in the IPM resulted in an estimated population decline of 34% over 10 years (95% credible interval = 71% decline to 7.5% growth). The growth rate of the population was negative with a mean of -6.0% per year, although the credible interval slightly overlapped zero (CI = -14%–1.6% per year). This is highly suggestive of a decline, as 94% of the IPM iterations resulted in an estimated growth rate below zero (Robinson et al. 2018). The estimated rate of decline indicates that the Tricolored Blackbird population has been in steep decline over the last 10 years, and is consistent with rates observed in the statewide survey data over the last 23 years.

Results of the IPM indicated that adult female survival and fecundity were positively correlated with population growth rate, and the years of highest population abundance followed intervals when fecundity and female survival were highest. Because adult female survival is already relatively high and on par with other blackbird species, there may not be room to improve it via conservation measures. Therefore, the results of the IPM suggest that improvements in fecundity may be the best approach to increase the Tricolored Blackbird population (Robinson et al. 2018).

Regional Shifts in Abundance

Because of the Tricolored Blackbird's large-scale seasonal movements and the potential for large interannual shifts in breeding distribution, year-to-year changes in regional abundance are common. Tricolored Blackbird surveys have regularly revealed large annual changes in local abundance that would not be expected due to productivity or mortality rates alone (Hamilton 1998). During statewide surveys, large declines in one region are often coupled with large increases in other regions, and therefore caution is warranted when interpreting year-to-year changes in local abundance. That said, persistent long-term changes in distribution and regional abundance likely represent shifts in regional habitat suitability or population size.

Central Valley

Based on incidental observations on the regional abundance of Tricolored Blackbirds in the 1800s and early 1900s, the Central Valley was described as the center of abundance for the species. The first systematic attempt to assess the species' rangewide distribution and abundance confirmed this, with most birds observed in the Sacramento Valley (Neff 1937). Additional observations and study of breeding colonies occurred through the 1960s before a second attempt at quantifying rangewide abundance in the early 1970s, with the majority of birds again found in the Sacramento Valley and northern San Joaquin Valley (DeHaven et al. 1975b).

Within the Central Valley, shifts in regional abundance over relatively short time periods have been a regular occurrence. Over a period of five years in the 1930s, Neff (1937) observed regular shifts in the annual centers of abundance between the rice-growing regions of the Sacramento Valley (Butte and Glenn counties) and regions to the south in Sacramento and Merced counties. DeHaven et al. (1975b) noted substantial yearly variation in centers of breeding abundance, even in their limited study area consisting of the Sacramento and northern San Joaquin valleys. For example, they observed 57,000 Tricolored Blackbirds nesting in Colusa County in 1969, but only 2,000 the following year. This pattern was mirrored in Yolo County where the number of breeding birds observed declined from 25,000 to 5,000. At the same time, other counties in the Sacramento Valley experienced increases in the number of breeding birds, with Glenn County increasing from 2,000 to 18,500 birds, and Yuba County increasing from 1,000 to 5,250 birds. A larger region comprising the major rice-growing region of the Sacramento Valley (Butte, Colusa, Glenn, Yolo, and Yuba counties) also varied considerably in the proportion of the known population it supported, with the proportion of known breeding birds in the region ranging from 29% to 59% during a four-year study period (DeHaven et al. 1975b). In the year when the smallest proportion of birds were located in this rice-growing region, the largest known congregation of birds occurred to the south in the pasturelands of southeastern Sacramento County. These regional shifts in abundance demonstrate the species' ability to undergo large interannual shifts in breeding distribution, likely in response to an unpredictable food supply, the availability of nesting substrates, or other habitat components.

In addition to short-term shifts in regional abundance, the Central Valley has experienced longer-term changes, with some regions of the valley experiencing long-term declines in number of breeding colonies or breeding birds. For example, Kings County supported tens of thousands of breeding birds per year through the 1990s, with 65,000 birds breeding in the county in 1992. In recent years, the county has hosted only a few hundred to a few thousand breeding birds. Glenn County, which once supported hundreds of thousands of birds per year and continued to support at least 10,000 birds into the 1990s, has not hosted more than 1,400 birds in any year since 2000 (eBird Dataset 2016, Meese 2017). San Joaquin County regularly supported up to about 10,000 birds per year through the 1990s, but has hosted only a few small colonies since then, with the largest recent colony of 1,800 birds in 2015. As described above, the Tricolored Blackbird appears to have experienced a population increase in the 1990s in the San Joaquin Valley as a whole, with a corresponding decrease in the Sacramento Valley. Following this increase, the population in the San Joaquin Valley experienced a severe decline of 78% from 2008 to 2014 (Meese 2015a). This is a time period during which the species declined by 63%

rangewide, and the majority of this decrease was due to declines in the San Joaquin Valley. The total number of birds lost from the San Joaquin Valley portion of the range during this period (~267,000 birds) exceeded the rangewide decline (250,000 birds), with a small portion of the loss compensated by increases in the breeding population elsewhere (Figure 14) (Meese 2015a). The number of birds breeding in the San Joaquin Valley rebounded somewhat by 2017, but declines in this region remain the primary contributor to rangewide population declines since 2008.
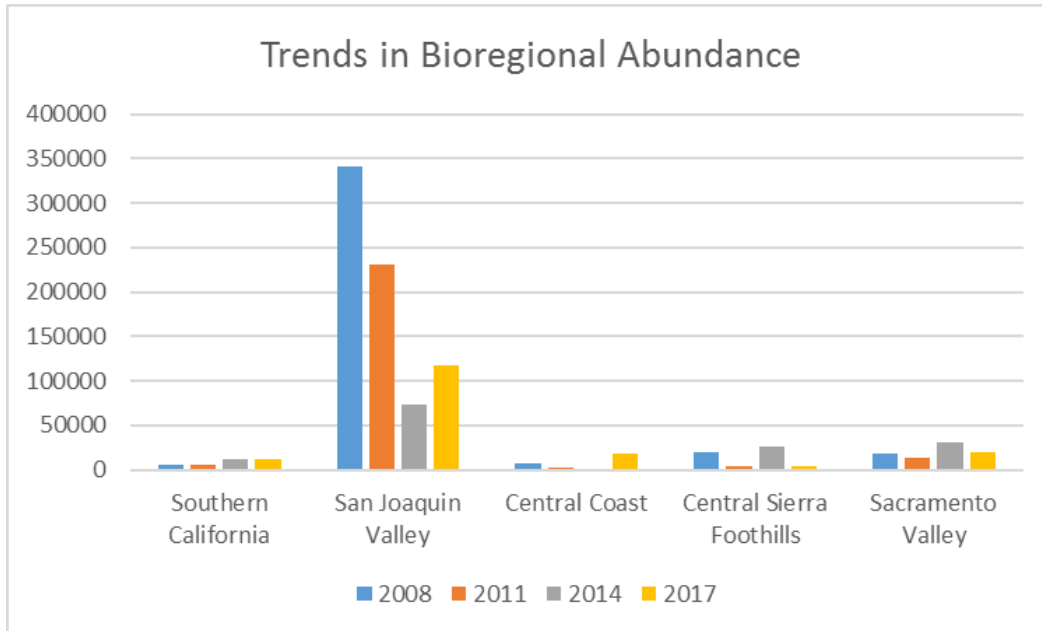
Figure 14. Number of Tricolored Blackbirds observed in regions of the state during statewide surveys conducted since 2008. Figure from Meese (2017).

Southern California and Baja California

As described above under Distribution, the Tricolored Blackbird was once abundant on the coastal slope of the southern California portion of the range, from Santa Barbara County to San Diego and into Baja California. Although the early reports of species abundance were not quantitative, they serve as a comparison to numbers of birds in the region in recent decades. Neff (1937) provided the first quantitative estimates for southern California, although San Diego and Santa Barbara counties were the only counties his collaborators spent a significant amount of time surveying; thousands of birds were documented in both of these counties. DeHaven et al. (1975b) reported colonies of up to 10,000 birds in southern California (Riverside County), with thousands of birds documented in all counties south of the Transverse Ranges, except Orange County.

The first statewide survey to include all counties in southern California was conducted in 1997 (Beedy and Hamilton 1997). That year, more than 40,000 Tricolored Blackbirds bred in the southern California portion of the range, with more than 90% occurring in western Riverside County (Feenstra 2009, Cook 2010). Since this time, the largest proportion of the southern California breeding population has continued to occur in western Riverside County (Cook 2010). The 2005 statewide survey located about

12,500 breeding birds south of the Transverse Ranges. A thorough search of historical breeding locations in southern California in 2008, 2009, and 2011 revealed a population south of the Transverse Ranges of consistently less than 5,000 breeding birds (Figure 15) (Kelsey 2008, Feenstra 2009, Kyle and Kelsey 2011). By 2009 the coastal slope portion of the region had declined to only 750 Tricolored Blackbirds breeding at a single site in San Diego County (Feenstra 2009). The 2014 survey located a slightly larger population in southern California of about 6,400 breeding birds (Meese 2014a). In 2017, the number of birds observed increased again to about 8,800, although the large majority of these (>80%) were located in the San Jacinto Valley region of western Riverside County. San Diego was the only other county with breeding birds in 2017, with seven small colonies totaling fewer than 700 birds. Most breeding colonies of the Tricolored Blackbird in Southern California have tended to be small in recent years, averaging a few hundred birds (Feenstra 2009). The exception has been the larger colonies consisting of thousands of birds in recent years that have nested at the San Jacinto Wildlife Area or the dairies nearby (Cook 2016, WRC-MSHCP 2017).
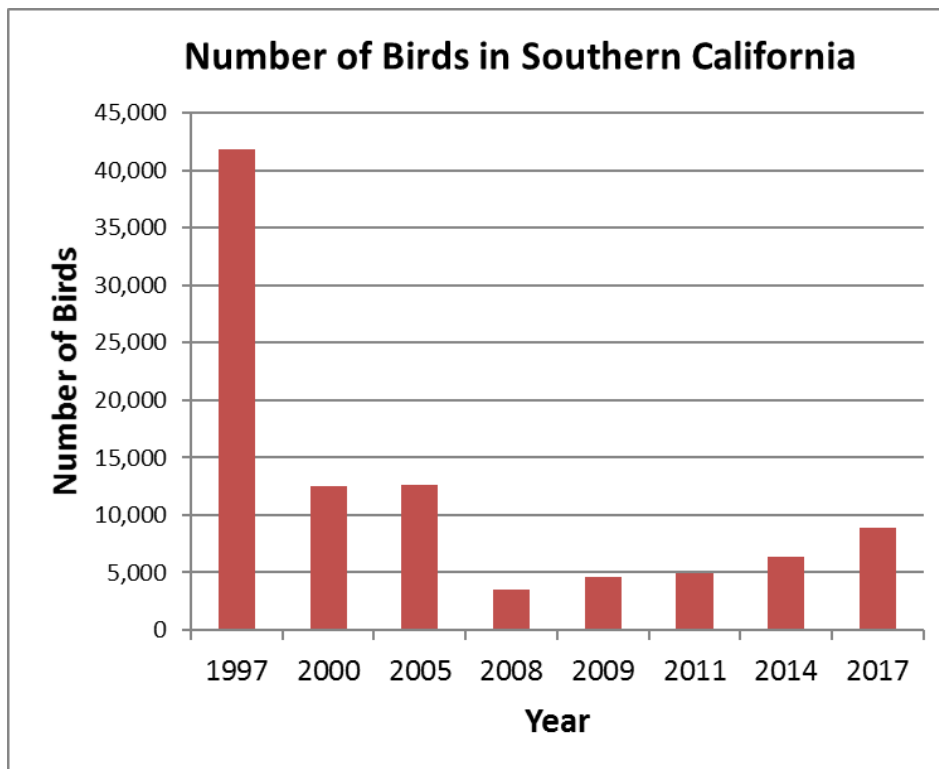
Figure 15. Estimated numbers of Tricolored Blackbirds in southern California (south of the Transverse Ranges) since the first thorough survey of the region in 1997.

In the last decade the breeding population in the Mojave Desert portion of the range in San Bernardino and northern Los Angeles counties appears to have grown somewhat, from just over 1,000 breeding birds located during surveys in 2008–2011, to more than 5,000 breeding birds in 2014, the majority of which were at a single breeding location (Meese 2014a). It is unclear whether the Mojave Desert birds are more closely associated with the southern California population or to the birds in the Central Valley, although observations of three banded birds since 2009 and observations of a flying flock in the 1800s

have documented birds moving between the desert and the Central Valley. Ongoing genomic studies will address the population structure and patterns of movement throughout California.

Originally considered common in northwestern Baja California, numbers appear to have declined by the late 1900s. Recent surveys have shown that the northwestern Baja California population has declined to only several hundred individuals (Erickson et al. 2007, Erickson and de la Cueva 2008, Feenstra 2013, Erickson et al. 2016, Meese 2017).

In summary, the Tricolored Blackbird, once described as the most abundant bird species in southern California, had declined dramatically by the time statewide surveys were established in the 1990s. Tens of thousands of breeding birds continued to occupy the region during the first complete survey of 1997. The most recent intensive searches of the southern California portion of the range located only thousands of breeding birds at a small number of locations. Following the first comprehensive survey of southern California counties in 1997, the Tricolored Blackbird population declined by nearly 90%, to lows of fewer than 5,000 birds from 2008 to 2011. The southern California population (as defined in the 2014 survey report to include the Mojave Desert) increased somewhat by 2014, but most of the increase can be attributed to birds at a single location in the Mojave Desert. This decline coincides with the disappearance of the species from much of the southern California portion of the range and is mirrored by declines in abundance and distribution in the Baja California portion of the species' range. If recent trends continue, the species may decline to extirpation in the southern portion of its range in the near future.

Northern and Central Coasts

Small numbers of birds bred annually during the late nesting season (July–September; thought to represent second breeding attempts by birds that previously nested elsewhere) in western Marin County until 2003 (Stallcup 2004). There has been no documented breeding in Marin County since then.

EXISTING MANAGEMENT

Land Ownership within the California Range

There is a paucity of public lands in the Central Valley, with the region that regularly supports more than 90% of the breeding population composed primarily of privately-owned lands (Figure 16). The total area in the range of the Tricolored Blackbird in California is more than 34 million acres (137,600 km^2). Privately-owned lands compose 84% of this area, with state and federal lands totaling about 12%. Much of the area under federal ownership is composed of forested areas that are not suitable for the species. The USFWS National Wildlife Refuges and Department Wildlife Areas comprise about 250,000 acres (1,012 km^2) and 254,000 acres (1,028 km^2), respectively (1.5% of the range, combined).

Of the 1,045 historical breeding locations with known coordinates in the Tricolored Blackbird Portal database (as of January 2017), 191 (18%) have been located on public lands. A minority of breeding colonies continue to occur on public lands each year. For example, during the 2011 statewide survey, colonies were found on a county park, a Department Ecological Reserve in San Diego County and an

Ecological Reserve in Kern County, and on three National Wildlife Refuges in the Central Valley (Kyle and Kelsey 2011). These colonies totaled 66,325 breeding birds (about 25% of the estimated statewide population in that year), the large majority of which were from a single colony on a USFWS National Wildlife Refuge.
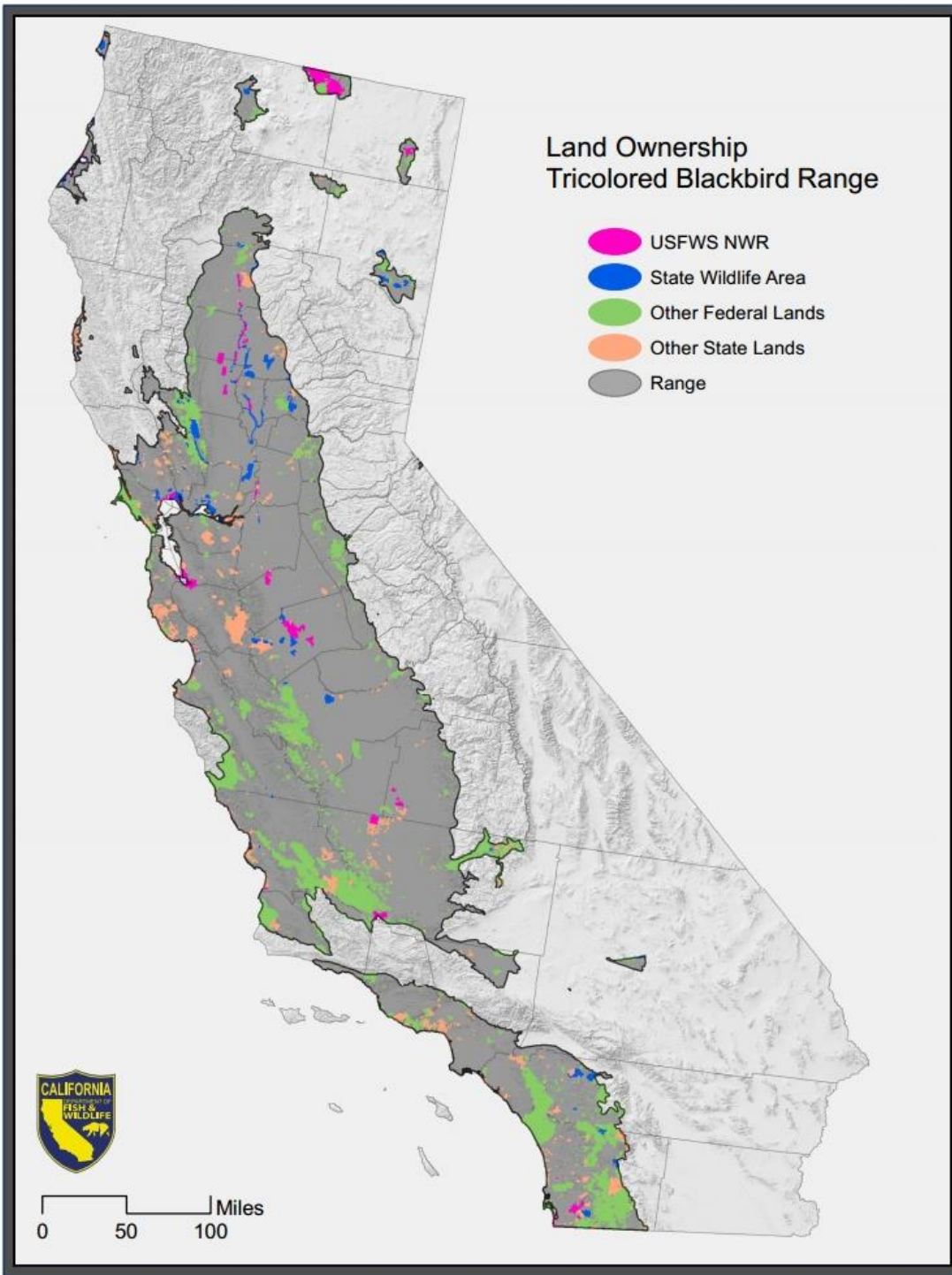

Figure 16. Land ownership in the range of the Tricolored Blackbird in California.

Habitat Conservation Plans

Habitat Conservation Plans (HCPs) provide the basis for regulatory compliance with the ESA by nonfederal entities. HCPs provide a mechanism to authorize incidental take of federally threatened and endangered species under section 10(a) of the ESA, while also describing how negative impacts to covered species will be minimized or mitigated in the plan area. An HCP must minimize and mitigate the impacts of take to the maximum extent practicable. HCPs can accommodate a range of projects that vary greatly in size and scope, and are a mechanism by which long-term landscape-level plans can receive take permits under the ESA.

There are five approved (permits issued) HCPs in California that include the Tricolored Blackbird as a covered species and two additional HCPs that are in the planning stage (Figure 17; Table 5).

The goals, objectives, and conservation measures for Tricolored Blackbird included in approved HCPs are summarized below.

Natomas Basin HCP

The Natomas Basin Habitat Conservation Plan (NBHCP) covers 53,342 acres (216 km^2) in the northwestern part of Sacramento County and southern Sutter County. The City of Sacramento and County of Sutter are participants. The 50-year term expires June 2053.

Tricolored Blackbirds nest and forage in the Natomas Basin. At the time of the planning effort, one active nesting colony was known from the eastern edge of the plan area (Betts Kismat-Silva Reserve) and three recent colony occurrences are located in the Sutter County portion of the area. Based on habitat preferences of Tricolored Blackbirds, the Natomas Basin supported about 1,998 acres (8 km^2) of potential nesting habitat and 41,310 acres (167 km^2) of potential foraging habitat (NBHCP 2003). A total of 449 acres (182 ha) (22%) of potential nesting habitat will be lost to urban development under the plan. A loss of 15,311 acres (62 km^2) (37%) of potential foraging habitat will result from the planned development (USFWS June 24, 2003).

Under the plan, 2,138 acres (865 ha) of managed marsh habitat will be preserved in a reserve system. Wetland reserves are intended to focus on the needs of giant garter snake (*Thamnophis gigas*) while also benefitting other covered species, but as described in the Habitat Loss section, many managed wetlands are unsuitable for Tricolored Blackbird colonies. The managed marsh reserves will provide potential nesting habitat for Tricolored Blackbirds in close proximity to foraging habitat, which is expected to maintain suitable nesting opportunities for this species. Additionally, 4,375 acres (1,770 ha) of rice and 2,188 acres (885 ha) of upland habitats will be protected in the reserve system. Generally, acquisition of upland habitat is prioritized first for the conservation of Swainson's Hawk (*Buteo swainsoni*) then secondarily for other upland-associated covered species including Tricolored Blackbird (USFWS June 24, 2003).
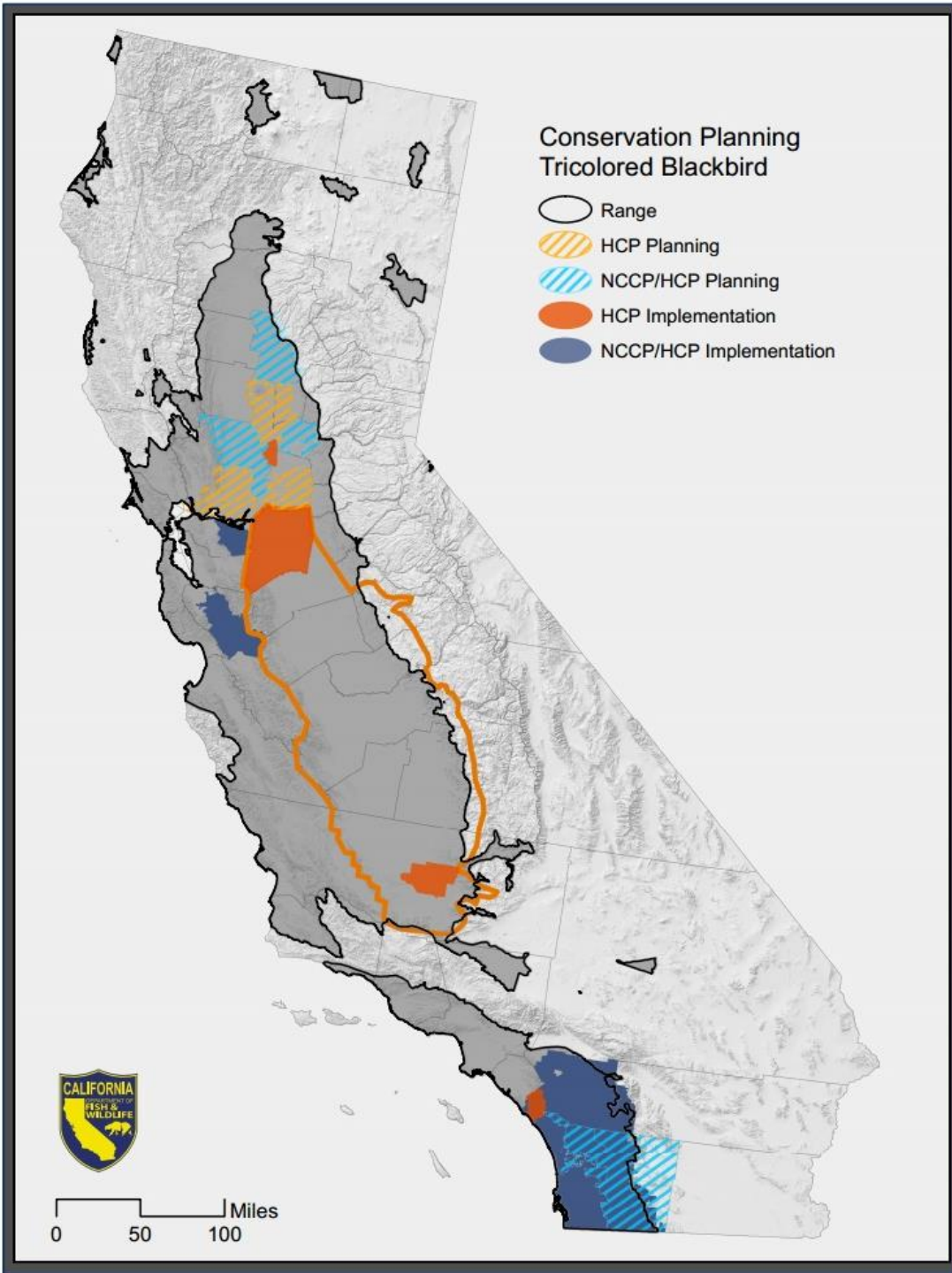
Figure 17. Locations of HCPs and NCCPs for which Tricolored Blackbird is a covered species in California. Solid orange and blue represent approved plans. Lighter hatching colors are plans that are in the planning stage and have not been approved.

Table 5. Current and Planned HCPs/NCCPs in California that include Tricolored Blackbird as a covered species.

Plan title	Counties	Plan acreage	Date permit issued	Term
Natomas Basin (HCP)	Sacramento, Sutter	53,342	June 2003	50 years
San Joaquin County Multi-species Conservation Plan (HCP)	San Joaquin	896,000	May 2001	50 years
PG&E San Joaquin Valley Operations & Maintenance (HCP)	Portions of nine counties: San Joaquin, Stanislaus, Merced, Fresno, Kings, Kern, Mariposa, Madera, Tulare	276,350	December 2007	30 years
Kern Water Bank (HCP)	Kern	19,900	October 1997	75 years
Orange County Southern Subregion (HCP)	Orange	132,000	January 2007	75 years
South Sacramento (HCP)	Sacramento	317,656	Planning stage	TBD
Solano Multi-species (HCP)	Solano, Yolo (edge)	580,000	Planning stage	TBD
East Contra Costa County (NCCP)	Contra Costa	175,435	July 2007	30 years
Santa Clara Valley Habitat Plan (NCCP)	Santa Clara	460,205	July 2013	50 years
Western Riverside County Multiple Species Habitat Conservation Plan (NCCP)	Riverside	1,300,000	June 2004	75 years
San Diego County Multiple Species Conservation Program (NCCP)	San Diego	511,878	August 1998	50 years
San Diego Gas & Electric Subregional (NCCP)	San Diego, Orange, Riverside	Linear projects[1]	December 1995	55 years
San Diego County Water Authority (NCCP)	San Diego, Riverside	Linear projects[1]	December 2011	55 years
Butte Regional Conservation Plan (NCCP)	Butte	564,270	Planning stage	TBD
Yuba-Sutter Regional Conservation Plan (NCCP)	Yuba, Sutter	468,552	Planning stage	TBD
Placer County Conservation Plan Phase I (NCCP)	Placer	201,000	Planning stage	TBD
Yolo Habitat Conservancy (NCCP)	Yolo	653,663	Planning stage	TBD
San Diego East County Multiple Species Conservation Plan (NCCP)	San Diego	1,600,000	Planning stage	TBD
San Diego North County Multiple Species Conservation Plan (NCCP)	San Diego	311,800	Planning stage	TBD

[1] These NCCPs cover discrete linear or energy projects but have larger plan areas that overlap with other NCCPs.
Primary Sources:
USFWS endangered species page for Tricolored Blackbird under conservation plans:
https://ecos.fws.gov/ecp0/profile/speciesProfile?spcode=B06P#conservationPlans
Summary of Natural Community Conservation Plans (NCCPs) September 2016
https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=15329&inline

San Joaquin County Multi-Species Conservation Plan HCP

The San Joaquin County Multi-Species Conservation Plan HCP (SJMSCP) spans 896,000 acres (3,626 km^2) in San Joaquin County. Participating entities include seven cities and the County of San Joaquin. The 50-year term expires May 2051.

The SJMSCP identified 9,374 acres (3,794 ha) of "occupied" habitat for the Tricolored Blackbird in the plan area and an additional 47,193 acres (191 km^2) of potential habitat including foraging and wintering areas. It is expected that 1,614 acres (653 ha) of Tricolored Blackbird habitat will be lost under full build-out. Mitigating impacts to covered species will largely be accomplished through the protection of habitat through the creation and management of preserves. Tricolored Blackbirds are associated with five planned preserves.

Pacific Gas & Electric San Joaquin Valley Operations & Maintenance HCP

The PG&E San Joaquin Valley Operations & Maintenance HCP (PG&E HCP) plan area includes 276,350 acres (1,118 km^2) in portions of nine counties in the San Joaquin Valley, as follows: San Joaquin, Stanislaus, Merced, Fresno, Kings, Kern, Mariposa, Madera, and Tulare. The 30-year term expires in 2037.

Tricolored Blackbirds occupied approximately 1,443 acres (584 ha) of existing PG&E right-of-way in the plan area (52 occurrences in CNDDB as of 2007).

Over the 30-year permit term, the PG&E HCP estimated that covered activities would directly disturb approximately 120 acres (49 ha) of suitable nesting or foraging habitat, with most of this disturbance occurring in foraging habitat. Less than 3 acres (1.2 ha) of nesting habitat is expected to be permanently lost. Covered activities that may cause disturbance to birds will affect 1,020 acres (413 ha) of suitable Tricolored Blackbird habitat. These impacts are expected to be individually small and widely dispersed. Permanent loss of suitable foraging or nesting habitat will be compensated at a 3:1 ratio and temporary disturbance to suitable habitat will be compensated at a 0.5:1 ratio. Overall, PG&E will provide approximately 69 acres (28 ha) of Tricolored Blackbird compensation (USFWS 2007a).

Kern Water Bank HCP

The Kern Water Bank HCP covers 19,900 acres (81 km^2) of central Kern County. The 75-year term expires in 2072. Planning documents list no known Tricolored Blackbird colonies from the Kern Water Bank area; however, it was acknowledged that the species might move into the HCP area in the future. Impacts were described as "negligible; high mobility of the species [nonbreeding birds] allows easy escape from project-related impacts" (Kern Water Bank Authority 1997). Monitoring has revealed several breeding colonies totaling several thousand birds in the area since the plan was approved (Tricolored Blackbird Portal 2017). Most recently, a monitoring effort conducted in 2011 documented five small colonies numbering about 400 individuals within the plan area and a large colony numbering several thousand individuals that settled but then abandoned (Hardt 2011).

Orange County Southern Subregion HCP

The Orange County Southern Subregion HCP comprises 132,000 acres (534 km^2) in the plan area, including the Cleveland National Forest (40,000 acres [162 km^2]). Excluding certain urbanized areas and the National Forest property, the planning area totals 86,000 acres (348 km^2) within southern Orange County. The County of Orange and Rancho Mission Viejo are signatory to the implementing agreement. The 75-year term expires in 2082.

Six general Tricolored Blackbird breeding locations have been documented in the planning area historically. Not all sites have been used consistently or recently and only a single colony of 14 birds has occurred in the area since the plan was approved. A total of 18,759 acres (7,591 ha) of potential foraging habitat was identified in the planning area. One of the known historic breeding sites will be directly impacted by the proposed covered activities and an estimated 3,769 acres (1,525 ha) of foraging habitat will be developed or otherwise made unsuitable for Tricolored Blackbirds (USFWS 2007b).

The plan conserves four of the breeding colony sites within a planned habitat reserve. Adequate foraging habitat within a 4-mile (6 km) radius of these sites also would be conserved. Planners assumed that "at least 1,000 acres [405 ha] of foraging habitat within 4 miles of a nest site would be more than adequate to sustain the relatively small nesting colonies that occur in the study area" (Dudek and Associates 2006).

Natural Community Conservation Plans

Like HCPs, Natural Community Conservation Plans (NCCPs) are long-term landscape-level conservation plans. Under California state law, the Natural Community Conservation Planning Act (Fish & G. Code, §§ 2800-2835) provides a mechanism to obtain authorization for incidental take of CESA-listed and other species. An NCCP provides for the protection of habitat, natural communities, and species diversity on a landscape or ecosystem level, while allowing compatible and appropriate economic activity. An NCCP is broader in its objectives than the take authorization provided under the California and Federal ESAs, and may require conservation measures that go beyond mitigation of impacts to meet the recovery needs of covered species. All approved NCCPs are also HCPs and so provide authorization for take of federally-listed species through section 10 of the ESA.

There are six approved NCCPs in California that include the Tricolored Blackbird as a covered species and six additional NCCPs that are in the planning stage (Figure 17; Table 5). The goals, objectives, and conservation measures for Tricolored Blackbird included in approved NCCPs are summarized below.

East Contra Costa County NCCP

The East Contra Costa County NCCP (ECCC) spans 174,018 acres (704 km^2) in eastern Contra Costa County. The signatories to the implementing agreement include four cities and the County of Contra Costa. The 30-year term will expire August 2037.

During the project planning phase, Tricolored Blackbirds were described as sporadic in the plan area; two breeding colonies were noted and several additional small colonies were detected during fieldwork

for the county bird atlas project (ECCC 2006). The Contra Costa County Bird Atlas project found the Tricolored Blackbird to be a "fairly common permanent but highly local resident of freshwater marshes and weedy fields, particularly in East County but also locally elsewhere." (Glover 2009). The largest colony detected numbered several hundred pairs.

Under the agreement, up to 204 acres (83 ha) of core habitat and 9,621 acres (3,893 ha) of primary foraging habitat may be impacted as a result of covered activities. A planned preserve system will protect 126–164 acres (51–66 ha) of suitable core habitat and 16,747–20,138 acres (6,777–8,150 ha) of primary foraging habitat. The preserve system will also protect at least seven of 13 ponds, all of which may provide potential breeding habitat. Additional pond and wetland creation (an estimated 85 acres [34 ha] of perennial wetland plus an estimated 16 acres [6 ha] of pond habitat) will be created or restored. Conservation easements will be acquired on 250–400 acres (101–162 ha) of cropland or pasture; landowners will be required to enhance habitat for Tricolored Blackbird and other covered species (CDFG 2007). Two recent land acquisitions with value for Tricolored Blackbirds have occurred, totaling 895 acres (362 ha) (ECCHC 2011, ECCHC 2013). No progress towards pond creation was reported in the latest available annual report of activities (ECCHC 2016).

Santa Clara Valley Habitat Plan NCCP

The Santa Clara Valley Habitat Plan NCCP (SCVHP) includes the three cities and the County of Santa Clara. The permit covering Tricolored Blackbird encompasses 460,205 acres (1,862 km^2). The term of the permit is for 50 years and will expire July 2063.

Tricolored Blackbirds are relatively uncommon in Santa Clara County. Breeding colonies are few and fairly small. During the Santa Clara County Breeding Bird Atlas project, Tricolored Blackbirds were confirmed breeding in 19 survey blocks. In total, hundreds to several thousand individuals were documented (Bousman 2007).

Conservation goals for Tricolored Blackbirds include protection of at least four sites that support, historically supported, or could support nesting colonies. Each protected site will have at least 2 acres (0.8 ha) of breeding marsh habitat and will have at least 200 acres (81 ha) of foraging habitat within 2 miles (3.2 km) (ICF 2012). Impacts to this species are limited to loss of habitat. Acquisitions will focus on the four breeding sites and at least 22,840 acres (9,243 ha) of modeled habitat, as well as the creation of new wetlands that may provide breeding habitat for the species (CDFW 2013).

Western Riverside County Multiple Species Habitat Conservation Plan NCCP

The Western Riverside County Multiple Species Habitat Conservation Plan NCCP (WRC-MSHCP) covers approximately 1,300,000 acres (5,261 km^2) in western Riverside County. All unincorporated county land west of the crest of the San Jacinto Mountains, as well as 14 cities are included in the plan area. The 75-year term will expire 2079.

Tricolored Blackbirds were described as "widely scattered" throughout the lowlands of Riverside County and few current or historical breeding locations were documented within the planning area (Dudek and

Associates 2003). A total of 480 acres (194 ha) of primary habitat (potential marsh breeding habitat) and 259,695 acres (1,051 km^2) of secondary habitat (potential foraging habitat) was identified as occurring within the planning area. A loss of 60 acres (12.5%) of primary habitat and 193,180 acres (74%) of secondary habitat was projected under the plan. Secondary habitat losses are primarily agricultural land and grassland (Dudek and Associates 2003). Mitigation identified in the plan includes the protection of 420 acres (170 ha) of suitable primary habitat (marsh) and protection of 66,510 acres (269 km^2) of secondary habitat (playa and vernal pool, grasslands, agriculture land, and riparian scrub, woodland, and forest).

Several breeding colonies have occurred in the area each year since plan approval, although not necessarily within protected conservation areas. Most colonies have numbered in the hundreds of birds, with the total number breeding in western Riverside County ranging from about 1,300 to 5,000 since 2010 (WRC-MSHCP 2013, 2017). The largest colonies have frequently occurred on private grain fields and in some years have been lost to harvest (WRCRCA 2015). In other years, the majority of birds have nested on the San Jacinto Wildlife Area.

According to recent biological monitoring reports, three of the five Core Areas identified for Tricolored Blackbird conservation purposes do not provide suitable or sufficient breeding habitat for the species (WRC-MSHCP 2013). Other sites were recommended as additional Core Areas based on recent Tricolored Blackbird activity. Further, a recommendation was made that the plan "be modified to recognize loss of foraging habitat in the vicinity of breeding sites as a significant threat to the survival of the species" (WRC-MSHCP 2011, 2013, WRCRCA 2015).

San Diego County Multiple Species Conservation Program

The San Diego County Multiple Species Conservation Program NCCP (SDCMSCP) covers approximately 511,878 acres (2,071 km^2) in San Diego County. SDCMSCP participants include the County of San Diego and several cities. The 50-year term expires 2048.

Under the plan, 23% of breeding habitat (1,400 acres [567 ha]) may be lost to development or other impacts. The Plan identified the following rationale for including Tricolored Blackbirds as a covered species: "…77% of potential habitat, including 59% of mapped localities, will be conserved. Breeding colonies move from season to season, and with a goal of no net loss of wetlands, most of the suitable breeding sites will continue to be available… Foraging habitat near the known nesting colonies will be conserved at 70–100%" (Ogden Environmental 1998).

San Diego Gas & Electric Company Subregional NCCP

The San Diego Gas & Electric Company (SDG&E) Subregional NCCP covers discrete linear or energy projects but has a larger plan area that overlaps with other NCCPs. The plan area traverses 2,000,000 acres (8,094 km^2) of SDG&E service territory in San Diego, Orange, and Riverside counties. Its 55-year term will expire December 2050.

In total, the SDG&E plan will result in a combined permanent loss of no greater than 400 acres (162 ha) with 50 miles (80 km) of electric transmission and/or new gas transmission lines. Impacts to Tricolored Blackbirds were considered to be generally very small and minimized or mitigated when potential impacts occur to the species' habitats (SDG&E 1995).

San Diego County Water Authority NCCP

The San Diego County Water Authority NCCP covers discrete linear projects but has a larger plan area that overlaps with other NCCPs. The plan area traverses 992,000 acres (4,014 km^2) in western San Diego and southwestern Riverside counties. Covered Activities will occur within 1,000 feet (305 m) on either side of the pipelines or facilities, or approximately 64,600 acres (261 km^2) along the pipeline rights-of-way, and other facilities. The 55-year term of the agreement will expire December 2066.

One Tricolored Blackbird colony was documented near a water authority reservoir during the planning process; no colonies were noted within the planned impact zone (CNDDB in SDCWA and RECON 2010). Approximately 16 acres (6 ha) of potential Tricolored Blackbird breeding habitat could be impacted by permitted activities. Twenty-one acres (8.5 ha) of potentially suitable breeding habitat in the existing preserve area may be used to mitigate impacts to Tricolored Blackbird. Suitable foraging habitat is conserved in the 1,186 acre (480 ha) San Miguel Habitat Management Area within the San Diego National Wildlife Refuge (Merkel and Associates 1997 in SDCWA and RECON 2010); however, no nesting has been documented there.

Conservation Plan for the Tricolored Blackbird

Following the 1991 petition to list the Tricolored Blackbird under CESA, a multi-stakeholder working group was formed to plan for and implement conservation actions. This resulted in the first of many statewide surveys, the first silage buyout to protect a breeding colony, and ongoing research. However, the working group made limited progress in developing comprehensive conservation measures for the Tricolored Blackbird and eventually dissolved in the mid-1990s. In 1997, a status update and management guidelines for the Tricolored Blackbird was completed (Beedy and Hamilton 1997). The species was again petitioned to be listed under CESA in 2004. After this petition was rejected by the Fish and Game Commission, a new multi-stakeholder Tricolored Blackbird Working Group was formed in 2005 and the group released a conservation plan in 2007 detailing the conservation and management, research and monitoring, data management, and education and outreach goals for the species (TBWG 2007). Working group members, including the Department, signed a Memorandum of Understanding agreeing to implement the actions in the conservation plan. Most of the goals and objectives in the plan are still relevant today and portions of the plan are currently being updated by the Tricolored Blackbird Working Group. Progress toward meeting objectives by the Department, USFWS, and partners on the working group has focused on protecting large breeding colonies threatened by harvest of agricultural grain fields and increasing knowledge through monitoring and research. New information is being used to update goals and objectives in the conservation plan.

Protection of Agriculture Colonies from Losses to Harvest

As described above, a large portion of the Tricolored Blackbird population has nested annually on agricultural grain fields since the 1990s, mostly in grain grown for silage on dairies. Although dairies often provide nesting substrate (the grain grown to feed cattle), a water source (e.g., drainage ditches or wastewater ponds), and food for adult birds (stored grains), colonies located on or adjacent to dairies often have low productivity. Where foraging habitat is available in the form of insect-rich alfalfa fields, grasslands, or other productive land cover types, these so-called silage colonies can be relatively productive (Meese 2013). However, in many cases the entire reproductive effort of silage colonies has been lost when the nesting substrate is harvested while the young or eggs are still in the nest (Cook and Toft 2005, Meese 2009b). The timing of grain harvest typically coincides with the Tricolored Blackbird breeding season, resulting in the destruction of nests, eggs, and nestlings, and mortality of some adult Tricolored Blackbirds. The Tricolored Blackbird colonies that form on agricultural grain fields early in the breeding season are often the largest colonies formed each year, and the complete destruction of these colonies due to harvest can be especially damaging to annual blackbird productivity (Arthur 2015).

The protection of large colonies that occur on agricultural grain fields has been the primary conservation action implemented for Tricolored Blackbird since the species was discovered breeding in this substrate type in the early 1990s. Shortly after the discovery of grain colonies in the San Joaquin Valley, the USFWS intervened to encourage harvest delays and protect the largest known breeding colony (Hamilton 1993). In 1994, a crop was bought to protect a 28,000-bird colony (Kelsey 2008). Hamilton et al. (1995) calculated that interventions in 1992, 1993, and 1994 may have been responsible "for the presence of over 75,000 adult Tricolored Blackbirds in 1995 [which had been nestlings in the three previous years], about 25% of the known population." In 1999, the Department and USFWS protected a colony that was composed of one-third of the known population at the time, which otherwise would have been destroyed by routine harvesting activities (Hamilton et al. 1999). In 2004, silage purchases by the Department and USFWS protected portions of three colonies that consisted of more than 100,000 adult Tricolored Blackbirds. In the 1990s and early 2000s, it was common to target only the largest colonies for protection and to protect only a portion of the field occupied by a colony (the most densely occupied area) due to funding limitations. In 2006, the two largest known colonies, totaling more than 200,000 breeding birds, were protected through silage buyouts (Meese 2006). Meese (2009b) estimated that payments to landowners for harvest delays resulted in the protection of 364,000 nests and about 396,000 Tricolored Blackbird fledglings in the five years from 2005 to 2009. Despite these efforts to protect birds breeding on agricultural fields, losses to harvest have continued to occur in almost all years, and in several years the majority of silage colonies have been lost (Figure 18). The Harvest of Breeding Colonies section details some of the losses.

The Natural Resources Conservation Service (NRCS) established a fund in 2012 that was used for three breeding seasons to protect colonies on agricultural lands and to enhance habitat for the Tricolored Blackbird. Landowner participation in the program varied from year to year, with many thousands of nests protected each year while many colonies continued to be lost to harvest. For example, in 2012 only 3 of 8 colonies on silage fields were protected and in 2013 only 6 of 11 were protected (Aug 2013 presentation from NRCS to Tricolored Blackbird Working Group; unreferenced).
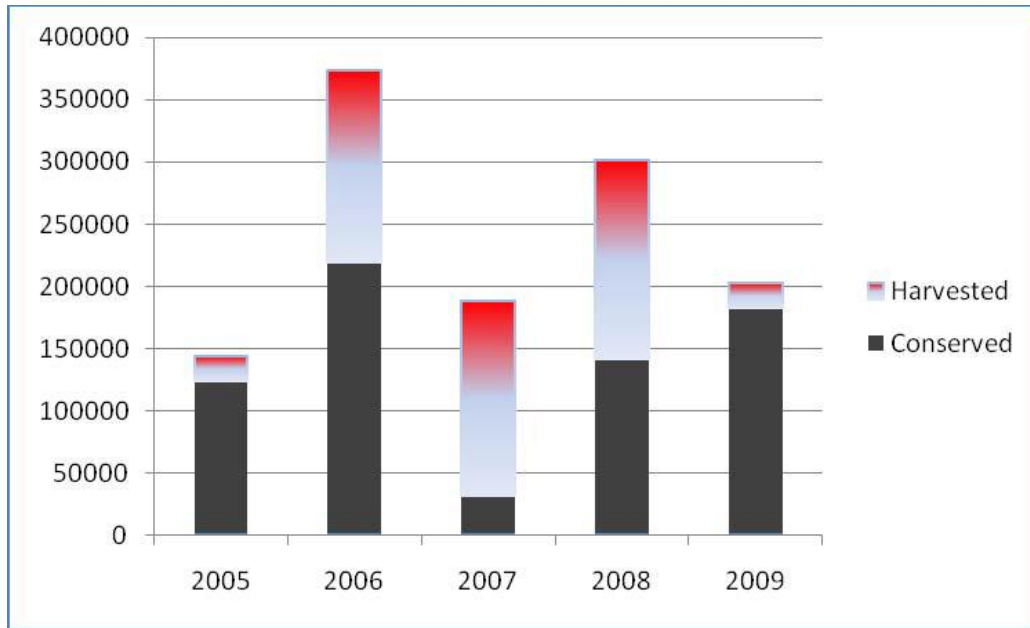
Figure 18. Number of Breeding Birds in Harvested and Conserved Silage Colonies 2005–2009.
Figure from Meese (2009b).

Regional Conservation Partnership Program

In 2015, the NRCS awarded a Regional Conservation Partnership Program (RCPP) grant to a group of conservation and dairy organizations (Arthur 2015). The grant provided five years of funding to protect, restore, and enhance Tricolored Blackbird habitat on agricultural lands, with the primary objective being to prevent loss of breeding colonies to harvest. During the first year of implementation in the 2016 breeding season, the program succeeded in enrolling all landowners with Tricolored Blackbird colonies identified on their property, and 100% of known agricultural colonies representing more than 60,000 breeding birds were protected through delay of harvest. In 2017, a single colony, which was large by today's standards (estimated at up to 12,500 breeding birds), was lost to harvest at a location that had not been enrolled in the NRCS program (Colibri 2017).

Because a large proportion of the Tricolored Blackbird population nests on silage grain fields in the spring, successful reproduction in the early nesting season has depended to a large degree on the willingness of farmers to delay harvest and potentially lose portions of their crops (Cook and Toft 2005). Programs that compensate farmers for these losses have had variable success, but have been very successful in the two most recent breeding seasons. The recent success has resulted from: 1) consistent and adequate funding sources for locating and monitoring colonies, conducting outreach efforts to farmers, and compensating landowners for the cost associated with harvest delays; 2) a coordinated effort by members of the Tricolored Blackbird Working Group to develop and implement colony protection programs; and 3) the protections provided by CESA and law enforcement activities conducted by the Department since 2015, which have incentivized participation in colony protection programs. The protection of all known colonies on agricultural fields in the 2016 breeding season is encouraging progress, but given the multiple requirements for success, the future of colony protection programs and

therefore the success of a large proportion of the annual breeding effort, is uncertain. Without the programs, which to date have been funded by the state and federal governments, colonies associated with silage fields will likely return to being population sinks (Cook and Toft 2005). See the section on Harvest of Breeding Colonies below for further discussion of this ongoing threat to the species.

Habitat Restoration and Enhancement

USFWS National Wildlife Refuges

The USFWS manages several National Wildlife Refuges (NWR) in the breeding range of the Tricolored Blackbird. In northeastern California, the Lower Klamath and Tule Lake NWRs have supported breeding colonies at several locations, although colony size has been relatively small as is typical for this portion of the range. The Sacramento National Wildlife Refuge Complex in the Sacramento Valley, the San Luis National Wildlife Refuge Complex in the northern San Joaquin Valley, and Kern and Pixley NWRs in the southern San Joaquin Valley have all supported breeding Tricolored Blackbird colonies.

The Sacramento National Wildlife Refuge Complex has actively managed selected wetlands to maintain suitable Tricolored Blackbird habitat for some time, and they have been frequently successful in attracting large breeding colonies to Delevan NWR. Recent restoration at Colusa NWR has resulted in a return of breeding birds after many years of absence. Portions of the Merced NWR have been managed to provide breeding substrate for Tricolored Blackbirds in recent years, and the refuge has been successful in attracting multiple colonies of several thousand breeding birds. The Kern NWR has supported suitable habitat, and for many years hosted breeding colonies. Despite continued efforts to provide flooded spring wetlands, in recent years use of the refuge by breeding colonies has been limited, although a colony of 3,000 birds nested on the refuge in 2017. The Pixley NWR has not supported breeding colonies in recent years, but the USFWS is implementing management to attract breeding birds.

NRCS Easements and Incentive Programs

Through a combination of easements on privately owned lands and 3-year incentive programs, the NRCS has enrolled about 500 acres (202 ha) of land (as of January 2017) in programs that will provide wetland habitat for Tricolored Blackbird nesting. These programs focus on providing dense cattail habitat using water management practices compatible with Tricolored Blackbird nesting. The majority of current NRCS habitat projects are in the Grasslands District of Merced County, with a smaller acreage in the southern San Joaquin Valley in Kern and Tulare Counties. Existing habitat projects have proven successful, with Tricolored Blackbirds breeding on three NRCS easement properties in 2016 (report to the Tricolored Blackbird Working Group, January 31, 2017; unreferenced).

One wetland restoration site in Tulare County, Atwell Island, has been particularly successful. This is a site owned by the Bureau of Land Management and managed for Tricolored Blackbird nesting habitat under a conservation easement held by NRCS. The Atwell Island location has hosted Tricolored Blackbird breeding colonies in most years since 2013, ranging in size from 250 to more than 10,000 birds (Tricolored Blackbird Portal 2017). This site is located in the southern San Joaquin Valley within 10 miles

(16 km) of several grain colony locations, and can serve as a model for other restoration efforts. However, like many restoration sites, no source of funding has been identified to provide long-term management or a consistent water supply for the benefit of Tricolored Blackbird.

California Department of Fish and Wildlife Lands

On many of the Department wildlife areas and ecological reserves located in the breeding range of the Tricolored Blackbird, management practices include spring or permanent wetland habitats that can support suitable nesting substrate for breeding colonies. In some cases, these wetlands have been managed specifically for Tricolored Blackbirds by setting back wetland succession through burning or mechanical methods, and in other cases the wetlands are typically managed for a broader suite of species. Use of Department wildlife areas and ecological reserves by breeding colonies includes (Tricolored Blackbird Portal 2017):

> Northeastern California – The Honey Lake Wildlife Area has supported breeding colonies at two wetland locations. The number of breeding birds has been small, with the most recent observation of 200 breeding birds in 1996.

> Sacramento Valley – Four wildlife areas in the Sacramento Valley have supported breeding colonies. Three of these wildlife areas are in Butte County (Oroville, Gray Lodge, and Upper Butte Basin), each of which has supported colonies at a single location, with the most recent observations including 1,600 birds on a wetland at Gray Lodge Wildlife Area in 2011 and 2,000 birds in willows at Oroville Wildlife Area in 2015. Oroville Wildlife Area also regularly supports foraging birds in the post-breeding season (B. Stone pers. comm.). The Yolo Bypass Wildlife Area in Yolo County has hosted small breeding colonies at three separate locations in wetlands and button willow shrubs.

> San Joaquin Valley – Four wildlife areas in the San Joaquin Valley have supported breeding colonies. Three of these are in Merced County, with North Grasslands Wildlife Area supporting three colony locations in milk thistle and mustard, Los Banos Wildlife Area supporting five colony locations in wetlands, and O'Neill Forebay Wildlife Area supporting four colony locations in Himalayan blackberry. The most recent use includes a 9,000 bird colony on a wetland at Los Banos Wildlife Area in 2008 and a 3,500 bird colony in Himalayan blackberry at O'Neill Forebay Wildlife Area in 2005. The fourth wildlife area in the San Joaquin Valley, Mendota Wildlife Area, is located in Fresno County. This wildlife area has supported breeding colonies at three separate wetland locations, with the last reported breeding by 1,000 birds in 1995.

> Southern California – The Rancho Jamul Ecological Reserve in San Diego County has hosted a small breeding colony on a wetland in most years since 2007. This colony is usually fewer than 200 breeding birds. In Riverside County, the San Jacinto Wildlife Area has supported breeding colonies at 12 different locations. Most of the colonies have occurred in wetland habitats, with a few locations in other vegetation types including stinging nettle, thistles, and mallow. This wildlife area is located in the most important region for breeding Tricolored Blackbirds in southern California. The wildlife area regularly hosts several thousand breeding birds, with a single location supporting 10,000 birds

in 2005. During the 2017 statewide survey, 6,300 birds were observed at a single location on the wildlife area.

The Department has also worked with private landowners to create nesting habitat using a variety of incentive programs. The goals of the programs have included management of water to create spring wetland habitat with emergent cattail vegetation. Several of these projects were successful in attracting Tricolored Blackbird colonies, with colonies of up to several thousand birds breeding on private wetlands created through these programs from at least 2005 through 2011. Funding has been limited in recent years, resulting in declining participation and the loss of most of the wetland nesting habitat created under the incentive programs. Tricolored Blackbird wetland nesting habitat was provided only as long as funds were available, which may ultimately be the case with habitat provided under current short-term incentive programs, such as those implemented by NRCS.

California Environmental Quality Act

The California Environmental Quality Act (CEQA; Public Resources Code Section 21000 et seq.) requires state and local agencies to publicly disclose, analyze, and potentially mitigate environmental impacts from projects over which they have discretionary approval power. In particular, CEQA requires that actions that may substantially reduce the habitat, decrease the number, or restrict the range of any species that can be considered rare, threatened, or endangered must be identified, disclosed, considered, and mitigated or justified (Cal. Code Regs., tit. 14, §§ 15065(a)(1), 15380).

The environmental review process required by CEQA can be costly and time consuming, and compliance is not always thorough. Agencies may also make the determination that projects are exempt (i.e., they do not need to go through the impact analysis, public disclosure, and mitigation process). Mitigation is required if a project is not CEQA-exempt and impacts would be potentially "significant." Mitigation must reduce negative impacts to below a level of significance or minimize unavoidable significant impacts, where feasible. The CEQA process generally incentivizes agencies and project applicants to implement mitigation, thereby avoiding significant impacts.

Due to its SSC designation, negative impacts to Tricolored Blackbirds are generally considered potentially significant if agencies determine on a project-specific basis that the species meets the CEQA criteria for rare, threatened, or endangered. However, agencies are not required to make this determination for Tricolored Blackbirds and other species that are not listed under CESA or ESA.

FACTORS AFFECTING ABILITY TO SURVIVE AND REPRODUCE

Colonial Breeding and Small Population Size

Social species might experience increased risk of population declines and extinction, and obligate colonial nesting birds may be especially vulnerable. In these species, there is generally a positive relationship between individual fitness (i.e., reproduction or survival) and population size or density, a concept which is broadly referred to as the Allee effect (Stephens and Sutherland 1999). In modern

times, three colonial and highly social bird species have gone extinct in North America north of Mexico, including the Passenger Pigeon (*Ectopistes migratorius*), the Carolina Parakeet (*Conuropsis carolinensis*), and the Great Auk (*Pinguinus impennis*) (Cook and Toft 2005). The Passenger Pigeon declined to extinction as a result of its highly social and nomadic breeding, combined with multiple population pressures including loss of foraging habitat and commercial hunting (Bucher 1992, Stephens and Sutherland 1999). In addition to the well-known effect of market hunting in the decline of the Passenger Pigeon, habitat alteration and a lack of social facilitation in food finding due to reduced population size have been implicated in the extinction of the species (Bucher 1992). The species seemed to have an inability to survive and reproduce at low population numbers. The Tricolored Blackbird is similar to the Passenger Pigeon in that they are both highly social, colonial breeders with nomadic tendencies that likely evolved for locating highly localized and abundant food sources and other breeding requirements. The Tricolored Blackbird has experienced, or continues to experience, many of the population pressures that led to extinction of the Passenger Pigeon. However, unlike the Passenger Pigeon, the Tricolored Blackbird has responded to the wide-scale loss of native nesting and foraging habitat by using a variety of novel upland and agricultural vegetation types. As habitat provided by these vegetation types continues to decline, a key question is whether the colonially breeding Tricolored Blackbird can maintain a viable population at some reduced population abundance that is comprised of only small colonies or concentrates the majority of the population into very few colonies. That is, what is the population size and distribution necessary in order to support a well-distributed breeding population with colonies that are productive and resilient to the dynamic breeding and foraging landscape within their range?

The degree of sociality of a species might reflect the degree to which it experiences Allee effects. Highly social species may require a minimum group size for successful reproduction, or may experience reduced reproduction or survival at low population densities (Stephens and Sutherland 1999). As described in the section on Biology and Ecology, Tricolored Blackbirds may benefit from social and colonial behaviors by reducing mortality due to predation during the nesting cycle and by facilitating food finding and information sharing. Smaller groups of birds would likely retain the ability to locate and use secure nesting substrates, but small colonies might lose the potential benefits of predator satiation and of social food finding and information sharing. The location and exploitation of abundant food sources could affect small groups of birds both in the selection of productive breeding locations and in acquiring sufficient prey with which to provision young after a site is selected.

Some bird species are known to nest in colonies when conditions are suitable, but can also nest in smaller groups or as single pairs. For example, the White-winged Dove (*Zenaida asiatica*) once nested in extremely large colonies in Mexico. In 1978, 22 breeding colonies contained a collective population size of more than eight million birds (Sanchez Johnson et al. 2009). Individual birds were shown to have very high site fidelity to breeding areas, sometimes returning to nest in the same tree across years (Schwertner et al. 2002). Habitat changes driven by urbanization and intensification of agricultural practices caused the loss and fragmentation of nesting habitat, and now the White-winged Dove nests singly or in smaller colonies at more dispersed locations in Mexico and appears to have adapted to use urban areas (Schwertner et al. 2002, Sanchez Johnson et al. 2009). Unlike the Tricolored Blackbird, the White-winged Dove does not appear to have a high degree of sociality in seasonal movements, breeding

site selection, and food-finding (Schwertner et al. 2002), which may allow it to occur and breed in smaller numbers.

Although the Tricolored Blackbird has been observed to nest in very small colonies (as few as 4 nests), the species has not been observed to nest as single pairs. Very small colonies (<100 birds) are quite rare, and although nesting success varies greatly across colonies of all sizes, there is evidence that small colonies are not as successful as larger colonies (Payne 1969), and that larger colonies produce more young per female (Hamilton 1993, Meese 2013, Weintraub et al. 2016). Reductions in population size may make the Tricolored Blackbird more vulnerable to additional declines due to inherent natural history factors, but the degree to which a small population would limit the species' ability to survive and reproduce is not known.

The fact that half or more of the total Tricolored Blackbird population will often occur in a small number of large colonies in silage fields during the first nesting attempt makes the species vulnerable to losses of productivity (Cook and Toft 2005, Meese 2012, Beedy et al. 2017). In 2011, 65% of the total known population was located at only six colony sites in Merced, Kern, and Tulare counties (Kyle and Kelsey 2011). This concentration of large portions of the population makes the species vulnerable to a number of potential threats, especially colony destruction through harvest, predation, or extreme weather events (Weintraub et al. 2016).

Habitat Loss

Loss of Nesting Habitat

The conversion of wetland nesting habitat to agricultural and urban uses has been implicated in the long-term decline of the species. Neff (1937) observed, "[t]he destruction of [Tricolored Blackbird] nesting habitats by man is of most importance," and cited reclamation and drainage as key factors in the loss of many favorable sites, along with "dredging or cleaning of reservoirs, marshes, and canals in order to destroy the growths of cattails and tules." Only about 15% of the four million acres (16,187 km^2) of wetlands that existed in the Central Valley in the 1850s remained when Neff conducted his work in the 1930s, and about 40% of those remaining wetlands were lost between 1939 and the 1980s (Frayer et al. 1989). Of the freshwater emergent wetlands most likely to be used by breeding Tricolored Blackbirds in the Central Valley, 50% were lost between 1939 and the 1980s, with an average loss of 5,200 acres (2,104 ha) per year (Frayer et al. 1989). These losses were primarily due to conversion of wetlands to agriculture.

DeHaven et al. (1975b) found no nesting substrate at several locations in Los Angeles, Kern, Sacramento, and Yolo counties where earlier researchers had studied the species. Subsequent investigators have continued to document habitat loss at known prior breeding colony locations through the present. For example, Beedy et al. (1991) found that 9.3% (n = 17) of the 183 known colony locations used in the 1980s were extirpated by 1990 through permanent removal of nesting habitat. Hamilton et al. (1999) observed the removal of a wetland that had supported a productive breeding colony in 1998. DeHaven (2000) noted the loss of several breeding colonies in Sacramento County to urban development and the expansion of vineyards. Humple and Churchwell (2002) reported on the draining of a wetland and the

removal of Himalayan blackberry that had previously supported breeding colonies. Hamilton (2004b) documented the loss or destruction of cattail nesting substrates that had supported up to 90,000 breeding birds between 1994 and 2004. During the 2017 statewide survey, local experts and survey participants were asked to score the suitability of nesting substrate for all sites visited. Of the 636 sites for which scores were reported during the survey or during pre-survey site visits, 70 sites (11%) were scored as permanently unsuitable, usually due to development or conversion to permanent crops like orchards or vineyards (Table 6). An additional 80 sites had no nesting substrate present during the survey and 101 sites had vegetation present, but were considered unsuitable by the survey participant. Based on this habitat assessment, about 60% of known historical breeding sites supported suitable nesting substrate during the 2017 season.

Table 6. Nesting substrate suitability for 636 sites scored before and during the 2017 statewide survey.

Score	Number of sites (percent of total)	Notes on suitability scores
Suitable	385 (60%)	Nesting substrate present and considered suitable for nesting.
Unsuitable	101 (16%)	Nesting substrate present but appears to be unsuitable for nesting (e.g., it is immature, too short, lacks sufficient foliage, too sparse, or has recently been burned).
Substrate absent	80 (13%)	Nesting substrate absent because it has been removed or died (e.g., former grain field planted to alfalfa, milk thistle stand or Himalayan blackberry that has been mowed, wetland that has dried up).
Permanently unsuitable	70 (11%)	Nesting substrate is absent and cannot be replaced (e.g., has been converted to urban development, orchard, or vineyard).

Following a low point in the extent of wetlands in the 1980s, aggressive restoration actions resulted in an increase of 65,000 acres (263 km^2) of managed wetlands between 1990 and 2005 (CVJV 2006). The majority of the wetlands in the Central Valley are managed lands that are maintained by application of water, and many areas undergo occasional land recontouring or vegetation control to maintain desired conditions. As of 2006, there were about 205,000 acres (830 km^2) of managed wetlands in the Central Valley (CVJV 2006). Most managed wetlands (~90%) are flooded primarily in the fall and winter for wintering waterfowl (i.e., seasonal wetlands) and are unlikely to provide suitable nesting substrate for Tricolored Blackbirds. A small proportion are managed as semi-permanent or permanent wetlands that hold water during the spring and summer (Iglecia and Kelsey 2012) and are often managed to support brood habitat for waterfowl. The small proportion of semi-permanent and permanent wetlands may provide suitable nesting substrate for breeding Tricolored Blackbirds, depending on management practices.

The availability of novel, nonnative upland nesting substrates may have lessened the impact of the decline in Central Valley wetlands to the Tricolored Blackbird population (Cook and Toft 2005). However, these nonnative vegetation types are often considered undesirable and are frequently removed. Himalayan blackberry habitat with a history of use by breeding colonies has been removed on many occasions by burning, treatment with herbicide, or mechanical removal (Meese 2011, Airola et al. 2015a, 2015b). Milk thistle colonies have been destroyed when landowners have removed or sprayed

the invasive weed while Tricolored Blackbirds are actively nesting (Airola et al. 2016). In 2015 and 2016, large colonies in mustard were destroyed by grazing cattle, and vegetation has been sprayed with herbicide to prevent reestablishment (Meese 2016). The active removal of Himalayan blackberry and other weeds utilized by breeding Tricolored Blackbirds has been widespread but is generally localized in any given year, and therefore may not have a large overall effect on the population. However, there are cases where removal of nesting substrate has resulted in permanently unsuitable conditions, such as the loss of the largest colony sites and about two-thirds of the breeding population in Sacramento County between 1994 and 2002 (Cook and Toft 2005). Many of these losses were in the southwest portion of the county, which experienced urbanization and agricultural intensification (Tricolored Blackbird Portal 2017), and reductions or degradation of foraging habitat likely contributed to these large-scale declines. The number of birds breeding in Sacramento County appears to have rebounded since this decline in the 1990s and early 2000s, at least in part due to a shift in distribution to areas with adequate foraging habitat and Himalayan blackberry nesting substrate. However, in the central Sierra Nevada foothills that include many colonies in Sacramento County, 32% of colonies active in 2014 occurred in areas zoned for development or that were proposed for rezoning for development (Airola et al. 2015a). In 2017, a group of Himalayan blackberry sites that had supported 13,000 breeding Tricolored Blackbirds were removed or degraded by aggregate mining activities (Oct 2017 email from D. Airola to N. Clipperton; unreferenced). The Department is unaware of any available information to evaluate distribution or trends of these nonnative nesting substrates across the range of the Tricolored Blackbird in California.

Although the loss of wetlands in California's Central Valley is well documented and there are many examples of nesting substrate being removed or degraded at historical Tricolored Blackbird colony locations, there also appears to be suitable nesting substrate in some areas that goes unused in many years. In some areas, nesting substrates are abundant (e.g., silage grain fields in parts of the San Joaquin Valley, Himalayan blackberry in parts of the central Sierra Nevada foothills), and only a fraction of available substrates is used each year; therefore, Tricolored Blackbirds do not seem to be nest substrate-limited in these areas. However, there are other regions where large areas of apparently suitable foraging habitat have no available nesting substrate, or where nesting substrate is only available during years when rainfall patterns support vigorous growth of upland nesting substrates (Airola et al. 2016). Most managed wetlands in the Central Valley are not suitable as nesting substrate for the Tricolored Blackbird, but wetlands remain the substrate type most frequently used by breeding colonies, and upland nesting substrates provide additional habitat. The dynamic occupancy patterns at breeding locations from year to year and the need for abundant insect prey in surrounding foraging habitat makes it difficult to reach conclusions about nesting substrate suitability based on occupancy in a single year. It is likely that loss of nesting substrate has caused local declines and shifts in distribution, but the overall effect on the population is difficult to assess, especially without considering other breeding requirements. Losses of nesting substrate at historically large or productive colony locations, or in areas surrounded by high quality foraging habitat, would have the largest impact on the population.

Loss of Foraging Habitat

The extent of foraging habitat required for successful breeding is much greater than the extent of nesting substrate. The abundance of insect prey in foraging habitat has been linked to reproductive

success, and Tricolored Blackbirds may choose breeding locations in part based on the local prey populations. Because insect populations are variable and unpredictable from year to year, the Tricolored Blackbird population likely requires much more foraging habitat on the landscape than is used in any given year, and once lost, large landscapes with suitable habitat are difficult to replace. For these reasons, loss of foraging habitat is likely as important, or more so, than the documented losses of nesting substrate to the long-term viability of Tricolored Blackbirds.

The loss of foraging habitat has been suggested as a likely cause of decline in southern California (Hamilton et al. 1995, Cook 2010). The extirpation of colonies from most of the coastal lowlands in southern California, despite the presence of more numerous marsh habitats relative to inland areas, suggests that foraging habitat sufficient to support breeding colonies is the population's limiting factor (Unitt 2004). Loss of habitat, particularly foraging habitat, has been suggested as the greatest threat to the survival of the species in southern California. In western Riverside County, where the majority of the southern California population occurs, large residential and commercial developments are planned for much of the San Jacinto Valley. This will likely result in substantial loss of dairy lands and the alfalfa fields used by Tricolored Blackbirds that nest both on and off the San Jacinto Wildlife Area (R. Cook pers. comm.).

Hamilton et al. (1992) reported on the pervasive loss of foraging habitat near breeding colony sites due to expansion of cultivated agriculture and the conversion of existing agriculture to incompatible crops in the Central Valley, and considered this the primary threat to population abundance. DeHaven (2000) observed widespread habitat loss due to urban expansion and agricultural conversions to vineyards and orchards relative to the 1970s when he and others conducted Tricolored Blackbird research across the state, and suggested that habitat loss was a primary driver of continued population declines. Conversion of pastures and crops suitable for foraging by Tricolored Blackbirds was observed in Placer, Sacramento, Stanislaus, and Tulare counties. DeHaven (2000) noted especially extensive losses in Sacramento County, where urban development and expansion of vineyards had removed thousands of acres of high-quality habitat. More than 5,000 acres (20 km^2) of habitat had been converted to vineyards in just a two-year period from 1996 to 1998, resulting in the loss of known breeding colony locations.

Grasslands have been identified as one of the most vulnerable habitats across North America, and many grassland species have experienced steep population declines in recent decades (NABCI 2016). A great deal of effort has been expended on conserving the grasslands in the central part of North America from the Great Plains to northern Mexico (Knopf and Skagen 2012). The grasslands of California have not received the same level of conservation attention, although losses of grasslands in California have been extensive.

Soulard and Wilson (2015) used Landsat (satellite) data to analyze land-use and land-cover change in the Central Valley from 2000 to 2010, and compared this to changes in the valley since 1973. The largest land-cover trend from 2000 to 2010 occurred in grassland/shrubland habitats. During this 10-year period, an estimated 79,200 acres (321 km^2) of grasslands and shrublands were lost, representing a 5% decrease in the Central Valley over 10 years. Over the longer period from 1973 to 2010, grasslands and shrublands declined by 22% (a loss of 476,900 acres [1,930 km^2]), due mainly to conversions to more

intensive agriculture and urban development. Although many of the grassland losses were due to agricultural intensification, losses of agriculture to urban development resulted in relatively little net change in area of agriculture in the Central Valley from 1973 to 2010.

Cameron et al. (2014) analyzed time series land cover data from the California Farmlands Mapping and Monitoring Program collected between 1984 and 2008 to evaluate rangeland habitat (grassland, shrubland, and woodland) conversion in California. The area evaluated covers much of the breeding range of the Tricolored Blackbird except for southern California. About 483,000 acres (1,955 km^2) of rangelands were converted during this 20+ year period, with urban and rural development and conversion to more intensive agricultural uses accounting for most (~90%) of the rangeland loss. Agricultural intensification was primarily due to increases in vineyards and orchards, but smaller amounts of other agricultural crops that may provide foraging habitat for Tricolored Blackbirds were also responsible for grassland loss. The San Joaquin Valley region, which in recent decades has been the center of abundance for breeding Tricolored Blackbirds during the early nesting season, experienced the largest amount of rangeland conversion (Figure 19).
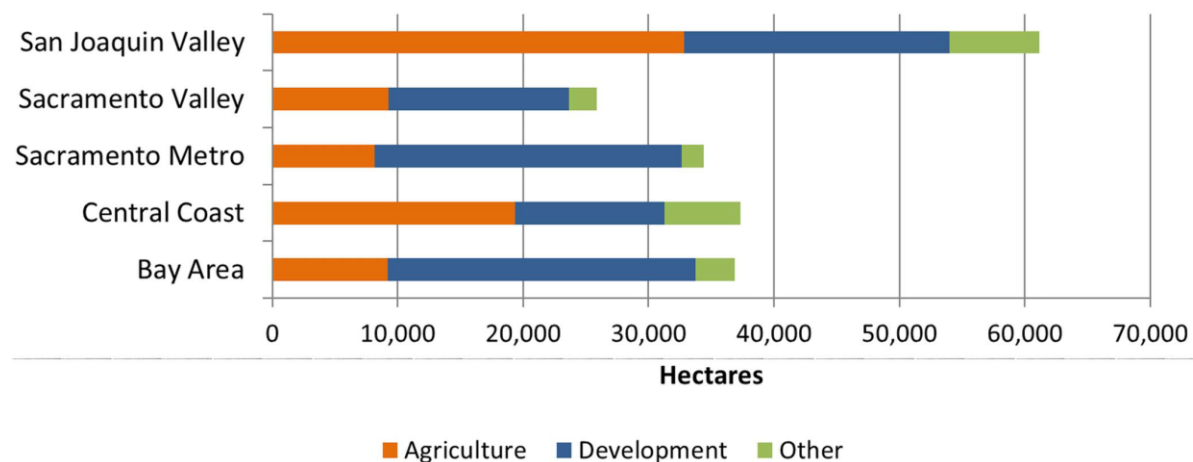
Figure 19. Regional conversion of rangelands in California by type, 1984–2008. Figure from Cameron et al. (2014).

Land cover types suitable for Tricolored Blackbird foraging in the Central Valley continue to be converted to incompatible land cover types such as orchards, vineyards, and urban development as agricultural practices evolve and cities continue to expand. Due to the continued expansion of nut trees and vineyards that replace grasslands, shrublands, or agricultural crops that provide insects required for breeding (e.g., alfalfa), regions that were previously occupied by thousands of birds have now become permanently unsuitable for breeding because of insufficient foraging habitat (Meese 2016). For example, the acreage of pistachio orchards in the Central Valley has grown exponentially in recent years and the acreage of almonds continues to increase (Figures 20 and 21). The five leading pistachio producing counties in California have also supported a large proportion of the Tricolored Blackbird breeding population in recent years (Kern, Tulare, Kings, Fresno, and Madera counties), with Kern County alone supporting 42% of pistachio production in 2012 (Geisseler and Horwath 2016). These regions of habitat loss in the San Joaquin Valley have also experienced the largest regional declines in

the Tricolored Blackbird breeding population. In the central Sierran foothills, many colony sites and the surrounding foraging landscape are zoned for development, and several development projects that may affect Tricolored Blackbird habitat have moved forward in recent years (Airola et al. 2015a, 2016). Statewide, the proportion of grasslands within 3 miles (4.8 km) of occupied breeding colony locations declined significantly from 2008 to 2014 (from about 30% to 25%; NAS 2017).
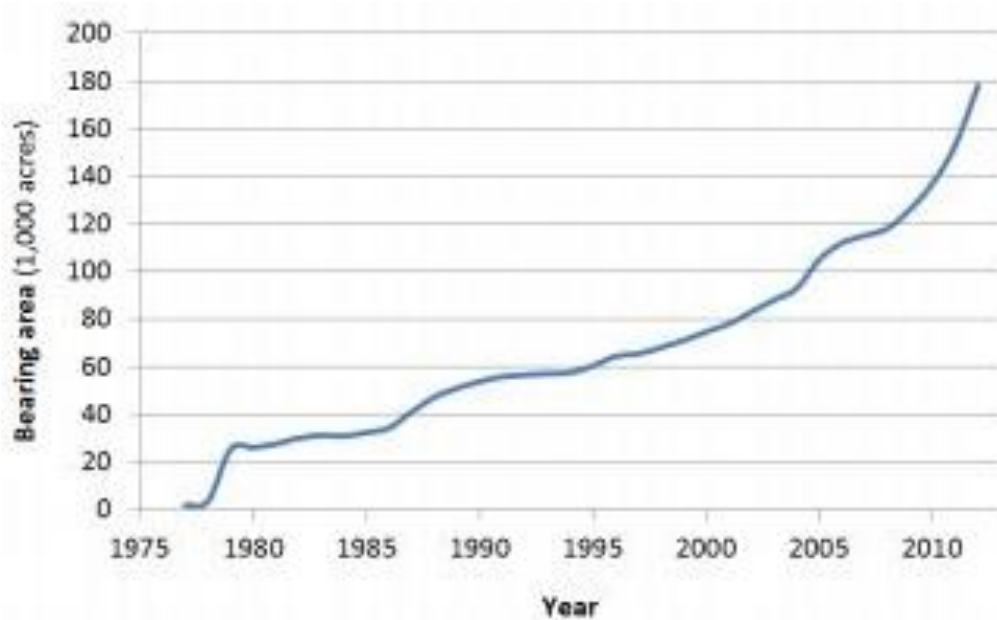

Figure 20. Increase in acreage of pistachio trees in California 1977–2012. Figure from Geisseler and Horwath (2016).
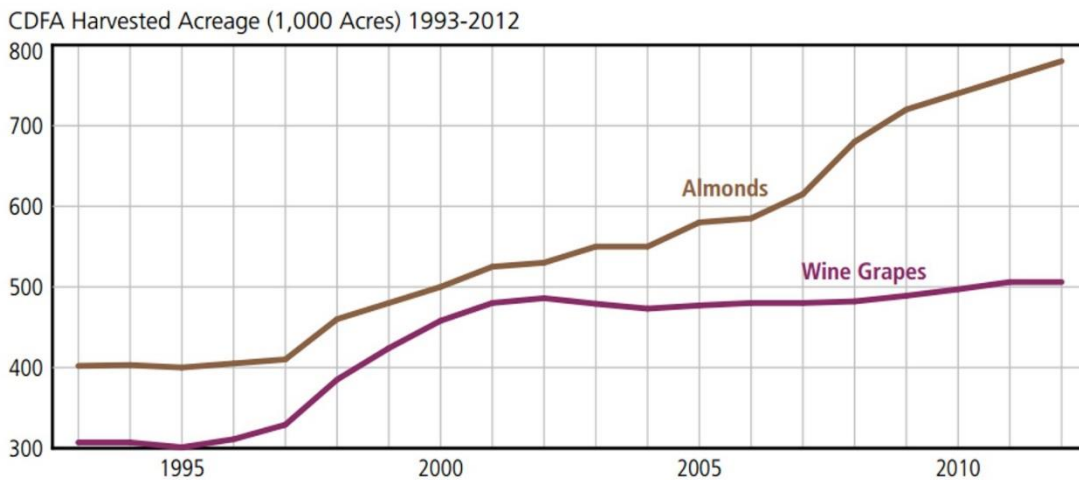

Figure 21. Acreage of wine grapes and almonds in California from 1993 to 2012. Figure from DWR (2015).

The California Rangeland Trust has conserved more than 300,000 acres (1,214 km^2) of rangeland in 24 California counties through conservation easements (https://www.rangelandtrust.org/ranch/). Although data are not available on the distribution of conserved lands within the range of the Tricolored Blackbird, some of the conserved ranches are in counties that receive regular use by breeding Tricolored Blackbirds, including Kern, Merced, Madera, and Placer counties. Many of the easements are in the Coast Ranges, where Tricolored Blackbird colonies are typically small, but a large number of easements also occur in the central and southern Sierra Nevada foothills. Data on the proximity of conserved rangelands to Tricolored Blackbird breeding colony locations is not available, but these easements may provide protection of important foraging habitat for birds that breed in the foothills and grasslands on the periphery of the Central Valley.

Multiple studies using a variety of data sources have consistently shown large losses of rangeland and suitable crop foraging habitat over the last several decades. Conversion of suitable foraging habitat continues and has accelerated in portions of the Tricolored Blackbird's range. Although large acreages of rangeland habitat have been conserved through conservation easements, these have not necessarily focused on areas of highest value to Tricolored Blackbird and are small relative to the extent of grassland in the state and the observed rate of loss over the past several decades. Future development in California is projected to be concentrated in several core areas of the Tricolored Blackbird range, including the Central Valley, the foothills of the Sierra Nevada, and on both sides of the Transverse Ranges in southern California (Jongsomjit et al. 2013; Figure 22), which would further reduce or degrade the available foraging landscape for breeding colonies. Loss of suitable rangeland foraging habitat is projected to continue into the future (see Drought, Water Availability, and Climate Change section). The proportion of grasslands in the landscape surrounding potential breeding sites has been shown to be the most important land cover type in predicting the occurrence of breeding Tricolored Blackbirds, and the proportion of alfalfa in the foraging landscape is highly correlated with colony size during the early nesting season (NAS 2017). Combined with regular loss of nesting substrate, the ongoing loss of foraging habitat makes it less likely that these essential breeding habitat requirements will co-occur on the landscape, with the result being a reduced number of locations suitable for successful breeding and foraging by Tricolored Blackbird colonies.
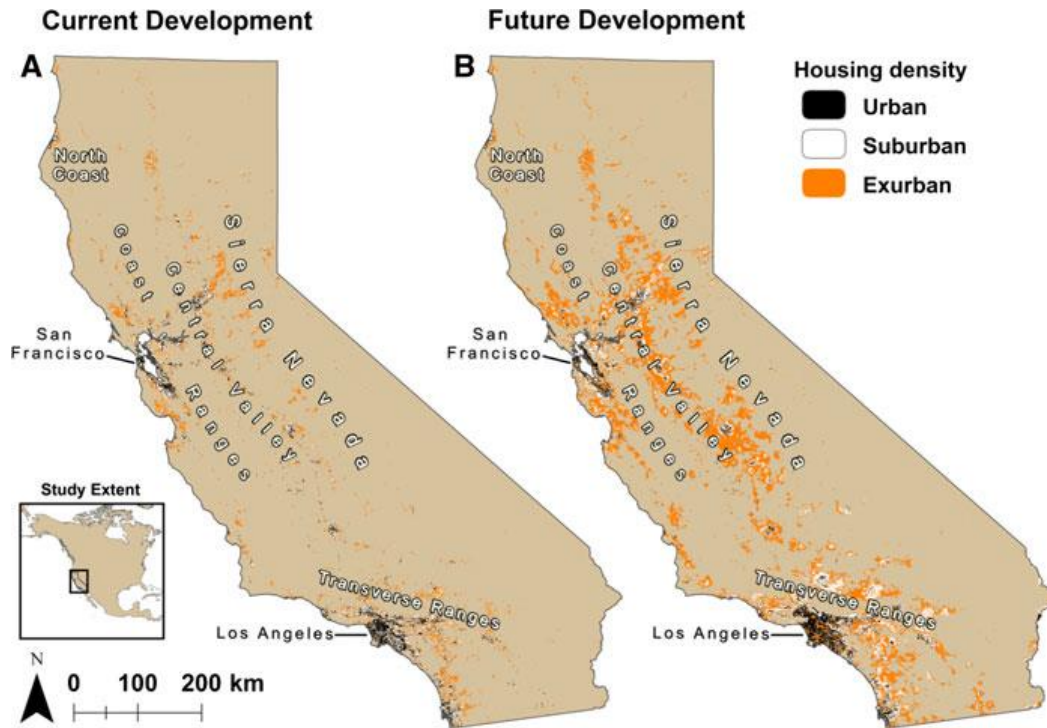
Figure 22. Current and future housing densities projected by the U.S. EPA. a) Current development. b) Future development. Figure from Jongsomjit et al. (2013).

Overexploitation

Market Hunting and Depredation Killing

Neff (1937, 1942) reported hundreds of thousands of blackbirds sold on the Sacramento market, many of which were Tricolored Blackbirds. Market hunting of blackbirds in the Central Valley became a thriving business in about 1928 or 1929 and continued through the mid-1930s. Tricolored Blackbirds banded for research activities throughout the 1930s were often recovered by market hunters with whom Neff collaborated (1942).

McCabe (1932) described the deliberate strychnine poisoning of 30,000 breeding Tricolored Blackbirds as part of an agricultural experiment. In the early 1930s active poisoning and shooting programs were enacted to control populations of blackbirds (McCabe 1932, Neff 1937). Tricolored Blackbirds and other blackbird species were killed by poisoned baits used as a means of blackbird control in rice fields in the Sacramento Valley, and numerous blackbirds were shot by farmers or by hired bird herders in attempts to drive the flocks away from rice and other crops (Neff 1942). During the period from 1935 to 1940 blackbird depredations in rice fields were of lesser intensity, and control operations by means of poisoned baits were almost entirely discontinued (Neff 1942).

Because the Tricolored Blackbird forages in mixed-species flocks with the European Starling and other species of blackbirds in the nonbreeding season, and because these flocks forage at feedlots and on

ripening rice, the Tricolored Blackbird may be exposed to avicides intended to control nuisance and depredating flocks of blackbirds. The number of Tricolored Blackbirds killed by avicides is unknown.

A depredation order under the federal Migratory Bird Treaty Act allows for the control of several species of blackbirds and corvids in agricultural situations without a permit from the USFWS (when birds are causing serious depredation of agricultural or horticultural crops or to livestock feed; 50 CFR 21.43). In 1988, the USFWS modified the long-standing depredation order to remove the Tricolored Blackbird and prohibit killing the species without a federal permit (Beedy et al. 1991). Although Tricolored Blackbird is no longer covered by the depredation order, it is possible that misidentification of Tricolored Blackbirds when they occur in mixed flocks in the fall and winter leads to unintentional mortality of the species. Landowners are required to report on activities and on the number of birds captured or killed under the depredation order, including non-target species such as the Tricolored Blackbird (50 CFR 21.43, Nov 5, 2014). Based on reports provided to the USFWS, annual reporting appears to be inconsistent and the number of birds killed under the depredation order may be underreported. The number of Tricolored Blackbirds killed annually is unknown and therefore the killing of blackbirds to protect ripening rice in the Sacramento Valley is a known but unquantified source of Tricolored Blackbird mortality. The U.S. Department of the Interior solicitor recently argued that interpreting the MBTA to prohibit incidental take is incorrect (see the Existing Regulatory Status section). If the taking of Tricolored Blackbirds during otherwise lawful activities such as the shooting of birds covered under a USFWS depredation order is no longer considered a violation of MBTA, this could result in increased mortality due to shooting or other forms of control.

There has been limited documentation of the shooting of Tricolored Blackbirds in the Sacramento Valley. Two birds that had previously been banded were reported to have been shot by a rice farmer in Butte County in 2009 (Meese 2009a). These birds were reported because they were banded and it seems likely that additional, unbanded birds were also shot.

Historical killing of blackbirds to protect crops and for the food market may have contributed to a long-term decline of the species, but the intentional killing of Tricolored Blackbirds has declined since the 1930s. The effect of mortality due to shooting or poisoning on annual Tricolored Blackbird survival rates is currently unknown.

Harvest of Breeding Colonies

The Tricolored Blackbird colonies that form on agricultural grain fields early in the breeding season are often the largest colonies formed each year, and the complete destruction of these colonies due to harvest can be especially damaging to annual blackbird productivity (Arthur 2015). Normal harvesting activities typically coincide with the breeding season and the harvest of fields that contain nesting colonies results in nest destruction and the loss of eggs or nestlings. The cutting of grain has also killed adult Tricolored Blackbirds but most adults appear to survive harvest operations.

Shortly after the discovery of grain colonies in the San Joaquin Valley, Hamilton et al. (1992) observed the loss of a 15,000-bird colony to harvest. As early as 1993, the USFWS intervened to encourage harvest delays and protect the largest known breeding colony (Hamilton 1993). Since then, colony

protection through crop purchase or delayed harvest has been the primary conservation action implemented for the species (see Existing Management section), with mixed success. Despite annual attempts to locate and protect large colonies since the early 1990s, losses to harvest have occurred in most years (Figure 18), with 2010 and 2016 being the only years with no known losses to harvest. For context, a brief list of some of the known large losses follows. Two large colonies representing more than 60,000 breeding birds were lost due to harvest in 1994 (Hamilton et al. 1995). The two largest breeding colonies in 1995 were destroyed during harvest of the grain nesting substrate (Beedy and Hamilton 1997). At least one colony of 14,000 birds was harvested in 1999 and four colonies were lost to harvest operations in 2000 (Hamilton et al. 1999, Hamilton 2000). Two colonies totaling approximately 80,000 breeding birds were lost to harvest operations in 2003 (Cook and Toft 2005). Especially large losses occurred in 2004, 2006, 2007, and 2008, when the largest colonies or the majority of grain colonies were lost (Meese 2009b). In 2008, several of the largest known colonies were destroyed, with six colonies being cut that hosted 140,000 breeding birds (Meese 2008). At least three colonies were lost to harvest in 2011, including the largest known colony, which supported 17% of the total known population (Kyle and Kelsey 2011, Meese 2011). The largest colony in southern California in 2013, which contained most of the southern California population, suffered complete reproductive failure when the field was cut (WRC-MSHCP 2014). At least two colonies in grain fields were destroyed in 2014 during the harvest of nesting substrate and at least three colonies were partially or totally destroyed due to harvest in 2015 (Meese 2014a, 2015b). After a breeding season with no known harvest losses in 2016, a large colony (estimated at up to 12,500 birds) was mostly lost in 2017 when the grain nesting substrate was cut in preparation for harvest (Colibri 2017).

No colonies are known to have been destroyed by harvest in 2010; a settlement on a dairy in Merced County was lost when the grain was harvested, but the harvest occurred during nest building before eggs were laid (Meese 2010). Beginning in 2016, a new partnership was created through a grant from NRCS, with Audubon California, dairy trade organizations, and agencies working together to conduct outreach to dairy owners and to detect and protect breeding colonies. The program succeeded in enrolling all landowners with Tricolored Blackbird colonies identified on their property in 2016, and 100% of known agricultural colonies were protected through delay of harvest. In 2017, most colonies on grain fields at dairies were again protected, but at least one large colony in Madera County was destroyed when the grain was cut (Colibri 2017).

The value of protecting colonies that breed on silage fields has been questioned because adult birds are not necessarily killed by harvesting operations and Tricolored Blackbirds are known to breed more than once in a season. DeHaven (2000) and Hamilton (2004a, 2004b) suggested that habitat losses might be more important in population declines than nesting mortality, and resources spent protecting colonies on silage fields might be better spent protecting or restoring habitat. However, clutch size has been observed to decline in second nesting attempts (Beedy et al. 2017). The only study to evaluate reproductive success over the course of a breeding season, which was carried out on silage and wetland colonies in the San Joaquin Valley, showed that reproductive success declined as the season progressed (Weintraub et al. 2016). The elimination of a first breeding attempt may cause breeding colonies to miss the period of peak prey abundance, thereby reducing seasonal reproductive success, as has been

observed in other species (Martin 1987). Colony destruction through harvest typically occurs well after females have laid eggs and often after eggs have hatched, so the lost energetic input to a failed breeding attempt and the delay before a second attempt likely reduce total annual productivity, even if birds attempt to nest a second time (Meese 2008). Most adult Tricolored Blackbirds appear to nest at least twice during the breeding season, and destruction of colonies late in the nesting cycle could eliminate one of these attempts. In addition to the loss of eggs and nestlings, adult birds are known to have been killed when colonies are harvested. Because nest survival and reproductive success rates were similar in silage and wetland colonies in the San Joaquin Valley, Weintraub et al. (2016) suggested that payments to farmers who delay harvest is a viable conservation action for increasing productivity.

The Tricolored Blackbird was shown to have experienced low reproductive success from at least 2006 to 2011 (Meese 2013). Reproductive success appears to have always been quite variable across colonies in any given year, and occasional success at large colonies may be important in maintaining the population over time (see Reproduction and Survival section). A number of factors have been shown to influence reproductive success, including predation and shortage of food, but reproductive failures caused by harvest at breeding Tricolored Blackbird colonies on agricultural fields of the San Joaquin Valley may have contributed to population declines through loss of much of the annual reproductive potential of the species in several years.

In summary, the direct killing of Tricolored Blackbirds was once a large source of adult mortality, but the number of birds killed declined dramatically after blackbird depredations in rice fields declined in the 1930s. Killing of Tricolored Blackbirds that may be depredating crops during the post-breeding period is likely a continuing source of mortality, but the limited available data do not indicate this to be a large source of mortality; additional data would be required to determine the degree to which this factor effects the population. Destruction of colonies in agricultural fields has been occurring since Tricolored Blackbirds were discovered nesting in this substrate type in the early 1990s. In recent years (2015–2017), the protections provided to the Tricolored Blackbird as a candidate under CESA, the availability of funds to implement colony protection programs, law enforcement actions conducted by the Department, and a coordinated effort by agencies, the dairy and farming industries, and nonprofit groups, have led to a dramatic decline in this source of mortality. These protections, and a resulting increase in productivity, may have contributed to population stability observed between 2014 and 2017. However, losses of large colonies to grain harvest have continued. The future success of breeding colonies on agricultural crops will depend on the availability of funds to continue programs that locate and monitor breeding colonies on grain fields early in the nesting season and compensate farmers for delaying harvest. If the recent reinterpretation of the MBTA by the U.S. Department of the Interior solicitor removes the prohibition on incidental take, protection under CESA may be necessary in order to ensure continued participation in colony protection programs.

Predation

A large number of predators have been observed preying on Tricolored Blackbirds (Table 7), including their eggs or nestlings. Most observations of predation have occurred at breeding colonies when the

birds are congregated in dense groups, and most predation has occurred on the eggs, nestlings, or fledglings of Tricolored Blackbirds.

Table 7. Predators of Tricolored Blackbirds.

Taxonomic Group	Predators	Sources
Birds	Black-crowned Night-Heron (*Nycticorax nycticorax*), Cattle Egret (*Bubulcus ibis*), White-faced Ibis (*Plegadis chihi*), Great Blue Heron (*Ardea herodias*), Cooper's Hawk (*Accipiter cooperii*), Swainson's Hawk (*Buteo swainsoni*), Red-tailed Hawk (*Buteo jamaicensis*), Peregrine Falcon (*Falco peregrinus*), Prairie Falcon (*Falco mexicanus*), Merlin (*Falco columbarius*), Northern Harrier (*Circus hudsonius*), Barn Owl (*Tyto alba*), Burrowing Owl (*Athene cunicularia*), Short-eared Owl (*Asio flammeus*), Yellow-billed Magpie (*Pica nuttalli*), American Crow (*Corvus brachyrhynchos*), Common Raven (*Corvus corax*), Great-tailed Grackle (*Quiscalus mexicanus*)	Mailliard (1900), Neff (1937), Payne (1969), Hamilton et al. (1995), Beedy and Hamilton (1997), Hamilton (2000), Kelsey (2008), Meese (2010), Meese (2012), Airola et al. (2015a), Meese (2016), Beedy et al. (2017)
Mammals	coyote (*Canis latrans*), wolf (*Canis lupus*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*), feral domestic cat (*Felis catus*), mink (*Mustela vison*)	Evermann (1919), Neff (1937), Payne (1969), Hamilton et al. (1995), Beedy and Hamilton (1997), Wilson et al. (2016), Beedy et al. (2017)
Snakes	gopher snake (*Pituophis catenifer*), king snake (*Lampropeltis* sp.), garter snake (*Thamnophis* sp.), and possibly western rattlesnake (*Crotalus oreganus*)	Neff (1937), Payne (1969), Hamilton et al. (1995)

Small areas of native vegetation may be especially vulnerable to predation, especially if they are near sites at which predator populations are artificially high due to the availability of augmented food sources from human activities. In the early 1990s, Hamilton and others found that many breeding colonies in emergent wetland nesting substrates suffered partial or complete destruction by predation (primarily by Black-crowned Night-Herons; Hamilton et al. 1992, 1995, Hamilton 1993), resulting in consistently lower reproductive success in wetlands compared to other nesting substrates. Beedy and Hamilton (1997) reported that more recently, Black-crowned Night-Herons eliminated all or most nests at several freshwater marsh breeding colonies. Hamilton (2000) later reported that wetland colonies with no Black-crowned Night-Heron predation were highly successful. DeHaven (2000) reported that he also observed high rates of colony failure due to predation in the 1970s, a time when the majority of the population still bred in wetland substrates. Whether recent rates of loss to predation are similar to historical rates of loss is unknown.

In recent decades, complete nesting failures have been caused by novel predators on agricultural grain fields, and the increasing concentration of birds in mega-colonies may have increased their susceptibility to nest predation (Kelsey 2008). Cattle Egrets from a single rookery caused complete or near-complete failure of large breeding colonies in Tulare County from 2006 to 2011 (Meese 2012). White-faced Ibis prey on the eggs of the Tricolored Blackbird, and in 2016 caused the complete failure of a large breeding colony on a silage field in Tulare County (Meese 2016, Beedy et al. 2017).

Kelsey (2008) reported a steady increase in population sizes of several avian predators in California, including Black-crowned Night-Heron, Cattle Egret, American Crow, and Common Raven. However, the most recent Breeding Bird Survey data show an increase for only one of these species, the Common Raven, and the data for Cattle Egret have important deficiencies that preclude trend assessment (Sauer et al. 2017a). White-faced Ibis have experienced a large population increase in California since the 1980s (Shuford et al. 1996), but BBS data are inadequate for trend assessment (Sauer et al. 2017a).

Although many species have been documented as predators of Tricolored Blackbirds, most have not had severe effects on the population or on the breeding success at nesting colonies. However, a few species have caused the complete failure of entire breeding colonies through heavy predation on eggs and nestlings. In recent decades, the predators that have destroyed entire colonies have usually been wading birds that hunt in large groups (i.e., Black-crowned Night-Heron, Cattle Egret, and White-faced Ibis). These species have had significant negative impacts on the overall productivity rate of Tricolored Blackbirds in several years over the last three decades (Hamilton et al. 1995, Cook and Toft 2005, Meese 2012). A few other species, including Common Raven, raccoon, and coyote have had large effects on breeding success, but these predators have typically not caused complete colony failure or have had less widespread effects.

Interspecific Competition

Red-winged Blackbirds and, less frequently, Yellow-headed Blackbirds, will often nest in the same locations as Tricolored Blackbird colonies, although they may occupy the less-dense portions of a marsh. Where territorial conflicts occur, Tricolored Blackbirds ignore the territorial displays of these other species and overwhelm them with their sheer numbers, displacing them to the fringes of the substrate or pushing them out entirely (Payne 1969). There is no evidence that competition with these species is limiting the Tricolored Blackbird population (Hamilton et al. 1995).

Beedy et al. (2017) reported that Great-tailed Grackles may be aggressive toward nesting Tricolored Blackbirds but did not consider the impacts severe. White-faced Ibis may destroy Tricolored Blackbird nests when in the process of constructing their own nests in the same wetland or grain field, causing large-scale nest failure, but this occurs infrequently (Weintraub et al. 2016). The Marsh Wren (*Cistothorus palustris*) may destroy eggs in Tricolored Blackbird nests that are in proximity to its own nest (Beedy et al. 2017). Competition with other species does not appear to be a large factor in the survival or reproduction of the Tricolored Blackbird.

Brood Parasitism

The Brown-headed Cowbird (*Molothrus ater*) is known to rarely parasitize nests of Tricolored Blackbirds (Hamilton et al. 1995, Beedy et al. 2017), but brood parasitism is not a major threat to the species.

Disease

Beedy et al. (2017) stated that no diseases have been reported for the Tricolored Blackbird but that in some years many nestlings have mites. Avian pox is prevalent in Tricolored Blackbirds in the Sacramento

Valley, and much less so in the San Joaquin Valley (Beedy et al. 2017). West Nile virus (WNV) has been detected in dead Tricolored Blackbirds, as well as in many other species of blackbirds, orioles, and grackles nationwide (www.cdc.gov/westnile/resources/pdfs/Bird%20Species%201999-2012.pdf). Adult Tricolored Blackbirds tested positive for WNV antibodies in 2009 but did not show symptoms of the disease and were assigned a relatively low risk score (Wheeler et al. 2009, Beedy et al. 2017). Although the highly social nature of the species could place the Tricolored Blackbird at greater risk to disease transmission, the impact of disease and parasites on the species is unknown but is not thought to be a major threat to the species.

Contaminants

Feeding in agricultural environments creates numerous opportunities for exposure to contaminants. Mortality of Tricolored Blackbird eggs and nestlings due to chemical contaminants has been suggested in a number of cases. Hosea (1986) reported that two colonies in Colusa and Sacramento counties near rice fields were over-sprayed during aerial application of herbicides resulting in the poisoning of almost all of the nestlings. Beedy and Hayworth (1992) described the effects of possible selenium toxicosis on a Tricolored Blackbird colony by comparing the reproductive success of a colony at Kesterson Reservoir in Merced County, which had a history of selenium contamination, with the success at four other colonies. Nesting failures were documented and deformities in Tricolored Blackbird nestlings were observed at the colony at Kesterson, and livers from dead nestlings collected at Kesterson had elevated levels of selenium. The area was cleaned up and the use of selenium-laden agricultural drain water to maintain the wetlands at Kesterson was discontinued. There have been no apparent selenium impacts on Tricolored Blackbird nesting success since. Hamilton et al. (1995) reported evidence of chemical-induced egg mortality from mosquito abatement operations in Kern County.

In 1995, Hamilton et al. concluded that, "Despite the limited evidence that Tricolored Blackbirds are suffering some mortality as a result of patterns of chemical use in agricultural areas, poisons do not appear to be inducing a serious population problem for Tricolored Blackbirds." Hamilton (2000) knew of no evidence that toxic contaminants had adversely affected the Tricolored Blackbird since the early 1990s.

Feeding in residential areas can also expose birds to contaminants. In 2012, several adults at a colony in Riverside County were found dead. Seventeen dead Tricolored Blackbirds were tested and found positive for strychnine. The likely source was misapplied gopher poison that was applied on the ground rather than in a gopher burrow as required by the label (Jan 2018 email from K. Rogers to N. Clipperton; unreferenced). A similar case of suspected strychnine poisoning occurred in Sacramento County in 2012.

Neonicotinoid Insecticides

A relatively new class of insecticides, neonicotinoids, has been implicated in the decline of invertebrate communities and, in a few cases, the decline of insectivorous birds. The application of neonicotinoids has increased dramatically in California, especially since the early to mid-2000s (https://water.usgs.gov/nawqa/pnsp/usage/maps/). Neonicotinoids are relatively stable, and are water soluble so can be incorporated into the tissues of plants. They are commonly applied to crops as seed

treatments, with the insecticide taken up systemically by the growing plant (Godfray et al. 2014). In the two decades since their introduction, neonicotinoid insecticides have become the most widely used insecticides in the world (Goulson 2013). They are highly effective at killing insects and have relatively low mammal and bird toxicity. However, at higher concentrations they can have lethal and sublethal impacts to vertebrates (Mineau and Palmer 2013).

Acute toxicity of neonicotinoids has been assessed for only a few bird species, with wide variation in results. Bobwhite and Mallard are the species typically used in acute toxicity testing for regulatory purposes, but where smaller species have been tested, including songbirds, the body weight-corrected dosage resulting in mortality is much lower (Mineau and Palmer 2013). A potential acute impact mechanism for species that are partly granivorous, like the Tricolored Blackbird, is sublethal or lethal effects through the ingestion of neonicotinoid-coated seeds. Ingestion of only a few neonicotinoid-coated seeds (a single seed in the case of corn) might be sufficient to kill a songbird, but there has been little work conducted on the availability and consumption of treated seeds by vertebrates (Goulson 2013, Mineau and Palmer 2013). Although not limited to neonicotinoids, a study that evaluated the effect of multiple potential factors found that acute toxicity of pesticides was the strongest correlate to declines of grassland bird species in the U.S., followed by habitat loss caused by agricultural intensification (Mineau and Whiteside 2013). No data are available on the acute toxicity of any neonicotinoid insecticide specifically to Tricolored Blackbirds, but seeds treated with imidacloprid, a widely used neonicotinoid insecticide, caused ataxia and retching in captive Red-winged Blackbirds and Brown-headed Cowbirds (Avery et al. 1993). These effects were transitory and birds learned to avoid consumption of treated seeds when alternative grains were available. Neonicotinoids may also have chronic toxicity effects (exposure over longer time periods) on reproductive success, but chronic effects are even less studied than acute effects (Mineau and Palmer 2013).

Neonicotinoids may also indirectly affect Tricolored Blackbirds through suppression of insect prey populations. They have been shown to have adverse effects on a number of non-target invertebrate species, with most studies focusing on bees (Hopwood et al. 2012, Godfray et al. 2014). In California, long-term observational data have revealed declines in the number of butterfly species and declines in abundance for many butterfly species in the Central Valley, both of which were negatively associated with annual application rates of neonicotinoid insecticides (Forister et al. 2016). Imidacloprid was shown to have a negative association with a wide variety of insectivorous bird populations in the Netherlands, suggesting that the pesticide may have led to food deprivation in birds (Hallmann et al. 2014). The evidence linking imidacloprid concentrations to bird population declines was circumstantial, but the authors ruled out confounding effects from other land use changes and showed that the timing of observed declines in bird populations corresponds to the introduction of neonicotinoid insecticides (Goulson 2014, Hallmann et al. 2014).

Depending on environmental conditions, neonicotinoids can persist and accumulate in soils and in waterways, and levels measured in soils, waterways, and field margin plants have sometimes overlapped substantially with concentrations sufficient to control pests in crops (Goulson 2013). Neonicotinoids degrade through photolysis when exposed to sunlight and so would not be expected to occur at high levels in clear water (Goulson 2013). However, Starner and Goh (2012) detected

imidacloprid in 89% of water samples taken from rivers, creeks, and drains in agricultural regions of California, with 19% of samples exceeding the US Environmental Protection Agency guideline concentration of 1.05 µg/L; this suggests that the insecticide moves off of treatment areas and may impact non-target aquatic insects. Little is known about the uptake of neonicotinoids from soil and water by non-target plants, and the downstream effect on non-target invertebrates (Goulson 2013).

Several studies have revealed a negative relationship between insect populations and neonicotinoid use. These results, along with the large increase in application of neonicotinoids, suggest a potential mechanism leading to observed reductions in reproductive success in Tricolored Blackbirds (Meese 2013). It is possible that this relatively new group of insecticides has resulted in declines of non-target insect species within the breeding range of the Tricolored Blackbird resulting in a declining prey base, but no data have been collected that can directly support this. It is also possible that acute effects resulting from ingestion of neonicotinoid-coated seeds has had a negative impact on the population, but the number of Tricolored Blackbirds suffering sublethal or lethal effects due to exposure to neonicotinoids is unknown. In addition to Tricolored Blackbirds, population declines in insectivorous birds have been documented across North America, with specific examples from California's Central Valley (Nebel et al. 2010, Airola et al. 2014). Neonicotinoids may be playing a role in driving these declines, but more study is needed. There is a need for mechanistic research to complement results from observational data; these should include testing exposure rates of Tricolored Blackbirds to neonicotinoids, effect of exposure on body condition and fitness (direct effects), and investigations into potential insect-based food-web impacts (indirect effects).

Invasive Species

With the exception of occasional impacts due to nonnative predators (e.g., Cattle Egret, Great-tailed Grackle), invasive species have not been reported to have a large negative impact on the ability of the Tricolored Blackbird to survive and reproduce. The availability of many nonnative plant species as nesting substrates have allowed the Tricolored Blackbird to breed in locations that would otherwise be unavailable. Invasive species are not considered a major threat to the species, and in large parts of the species' range invasive plants may be considered a benefit. The birds nest in several non-native plants (e.g., Himalayan blackberry, milk thistle, mustard, and mallow), some of which are considered to be invasive. Some nonnative plants in weedy fields, such as curly dock (*Rumex crispus*), can provide a food source (Cook 2016).

Extreme Weather Events

Hamilton et al. (1995) stated that high mortality of Tricolored Blackbird nestlings can result from severe or prolonged storms and that some observed reproductive failure may be the result of chilling of adult and nestling birds. Also, some adult female mortality at nests appears to have been induced by cold and rainy weather (Hamilton et al. 1995). Heavy winds or precipitation (rain or hail) have been documented to knock down nesting substrates and to knock nests out of the vegetation, often in triticale or other grain colonies but also in milk thistle colonies (Meese 2010, 2016), eliminating the reproductive effort for all or a part of breeding colonies. Weintraub et al. (2016) observed the blowdown of triticale fields at

two colonies, resulting in the loss of thousands of nests. Extremely high temperatures have also been documented to cause colony failure (WRC-MSHCP 2017). Weather events may have widespread impacts on reproductive success in some years, but impacts are usually isolated and the overall effect on the population's ability to reproduce is limited in most years. However, this depends on the size of the colonies affected, the nesting stage at which colonies are impacted, and the severity and distribution of storms (Airola et al. 2016). In some years, weather has likely reduced the annual recruitment due to widespread and severe impacts.

Drought, Water Availability, and Climate Change

Drought reduces water supply reliability and has far-reaching impacts on most habitat types in California (DWR 2014, 2015a). Several significant statewide droughts have occurred in California over the last century (1928–1934, 1976–1977, 1987–1992, and 2007–2009) (DWR 2015a), and California recently experienced the three driest consecutive years of statewide precipitation in the historical record between 2012 and 2014. The winter of 2015 produced a record low statewide mountain snowpack of only 5% of average.

Drought effects on availability of nesting substrate

Tricolored Blackbirds have adapted to use a variety of novel vegetation types as nesting substrate, but wetlands continue to support the largest number of breeding colonies each year. Because of the need for wetlands that are flooded during the spring and summer breeding season, the various approaches to wetland management, and the dependence on water deliveries to maintain wetland habitats in most of the Tricolored Blackbird's range, assessing the availability of suitable wetland nesting substrate in a given year is difficult. A recent method applied reflectance to satellite imagery to identify areas of open surface water in the Central Valley (Reiter et al. 2015). Although not an ideal approach to quantifying and assessing distribution of wetlands, the method would identify wetlands with large amounts of open water. In addition, identification of open water on the landscape during the Tricolored Blackbird breeding season is likely a good proxy for the availability of water for wetland management. Reiter et al. (2015) showed that open surface water declined across the Central Valley between 2000 and 2011. Drought had a significant negative effect on open surface water in the late summer and early fall. Cumulative years of drought resulted in a noticeable reduction in surface water. Although not a direct measure of Tricolored Blackbird breeding habitat, declines in surface water during the drought likely resulted in reduced availability of wetlands with sufficient water to provide high quality nesting substrates.

Although more resilient to dry conditions than wetland vegetation, plants species that provide upland nesting substrate for Tricolored Blackbird colonies also experience negative effects due to drought. After several years of dry conditions during California's most recent drought, many Himalayan blackberry copses that have historically supported Tricolored Blackbird colonies were observed to be dry and mostly barren of leaves. In a few cases, extremely dry blackberry bushes continued to be used by breeding colonies, but many were unoccupied. Milk thistle, which provides high-quality nesting substrate across much of the Tricolored Blackbird range when annual precipitation patterns support

vigorous growth, was largely absent from historically used areas until California experienced an average water year in the winter of 2015–2016 (Airola et al. 2016). The wetter weather created nesting substrate in areas that had not been used by Tricolored Blackbirds in several years, and breeding colonies once again occupied these areas.

Drought effects on prey populations

The availability of large insect prey is an important factor in Tricolored Blackbird reproductive success, and may influence colony site selection. Large landscapes with suitable foraging habitat are strong drivers of colony site occupancy and abundance (NAS 2017).

Insect abundance is strongly related to biomass of herbaceous vegetation, including important Tricolored Blackbird prey items like grasshoppers in grasslands (Falcone 2010). Climate, especially drought, is thought to play a key role in abundance of grasshoppers and other insect species in grasslands (Vose et al. 2016). The response of insect populations can differ depending on drought severity. For example, non-severe drought and warm temperatures can have a positive effect on grasshopper populations through increased survival and faster population growth (Kemp and Cigliano 1994). However, extreme or prolonged drought can negatively affect grasshopper populations through desiccation of eggs or through decreased biomass of primary producer food sources (i.e., grasses and forbs) (Vose et al. 2016). Reductions in precipitation not only lead to reductions in the abundance of insects in grasslands, but may also make insect prey less accessible through changes in behavior (e.g., moving underground) (Barnett and Facey 2016). Severe droughts likely have strong negative effects on grasshoppers and insect prey in general (Kemp and Cigliano 1994, Vose et al. 2016).

The established impacts of precipitation on insect populations in grasslands, especially grasshoppers, suggests a mechanism for drought impacts on Tricolored Blackbird productivity. Research is needed that measures grasshopper and other prey abundance relative to precipitation and primary productivity around occupied Tricolored Blackbird colonies, and evaluates the effect on Tricolored Blackbird reproductive success.

Climate Change

Average annual temperatures have been rising in California in recent decades, and climate models are in broad agreement that temperatures in California will rise significantly over the next century (DWR 2015b). The average temperature is expected to rise by approximately 2.7°F (1.5°C) by 2050, and depending on the emissions scenario, average temperatures could increase by 4.1–8.6°F (2.3–4.8°C) by the year 2100 (Moser et al. 2012). Summer temperatures will rise more than winter temperatures, and the increases will be greater in inland California. As a result, the average number of extremely hot days (at least 105°F [41°C]) per year in Sacramento is expected to increase fivefold (up to 20 days) by the middle of the century, and may increase to as many as 50 days per year by 2100 (Moser et al. 2012). Tricolored Blackbirds have been observed to cease initiation of breeding when temperatures exceeded 90°F (32°C), although care of existing nests continued in temperatures over 100°F (38°C) (Hamilton et al. 1995). Extremely high temperatures have also caused colony failure. Rising temperatures may directly affect annual Tricolored Blackbird productivity by truncating or interrupting the breeding season,

although more work is needed on the effect of temperature on initiation and success of nesting attempts. Tricolored Blackbirds have begun nesting earlier in the year, perhaps in response to climate change (e.g., see Tottrup et al. 2010, Mazerolle et al. 2011). Between 1939 and 2009, the mean date of first breeding date has shifted to occur about 22 days earlier (M. Holyoak pers. comm.).

Along with projected negative impacts to Tricolored Blackbird foraging habitat due to housing and agricultural development discussed above, the areas of California with the largest climate-projected effects on a variety of bird species are largely concentrated within the Tricolored Blackbird range in the Central Valley (Jongsomjit et al. 2013). A suite of analyses integrating the effects of climate change and land use changes in California's rangelands concluded that grassland habitat loss in California could reach 37% by the year 2100 (Byrd et al. 2015). Thorne et al. (2016) estimated the vulnerability of California's natural communities to climate change by examining how a range of climate change scenarios would change the spatial distribution of those communities. Two important Tricolored Blackbird communities, grassland and freshwater marsh, were projected to be among the most affected natural communities in California, with freshwater marsh being one of only four communities receiving the highest vulnerability rank. Under multiple emission scenarios, the regions modeled as being most highly stressed by future climate change include much of the Tricolored Blackbird's core range in the Central Valley and surrounding foothills (Figure 23). The extent of freshwater marsh was projected to decrease by 71%–97% by year 2100. Of the area currently occupied by grassland in California, 16%–48% is expected to no longer be suitable, depending on the climate change scenario (Figure 24). The current level of emissions is on track with the higher-impact scenarios (Thorne et al. 2016).

The recent severe drought in California was at least partially due to, and made more severe by, climate change (Diffenbaugh et al. 2015). Climate change is projected to bring longer and more severe droughts to California in the future (Diffenbaugh et al. 2015, Williams et al. 2015), exacerbating the impacts to Tricolored Blackbird habitat described above. The Central Valley may be particularly vulnerable to warming-driven drought increases in the future (Williams et al. 2015), and water deliveries are projected to be reduced by 5.6% from 2013 to 2033 due to climate change effects on reliability (DWR 2014). Climate change effects on water supplies and stream flows are expected to increase competition among urban and agricultural water users and environmental needs (Moser et al. 2012). This competition may lead to decreases in available wetland nesting substrate provided by private and public land managers. Declines in the availability of water for agriculture may also reduce prey populations provided by high quality crops like alfalfa and rice.
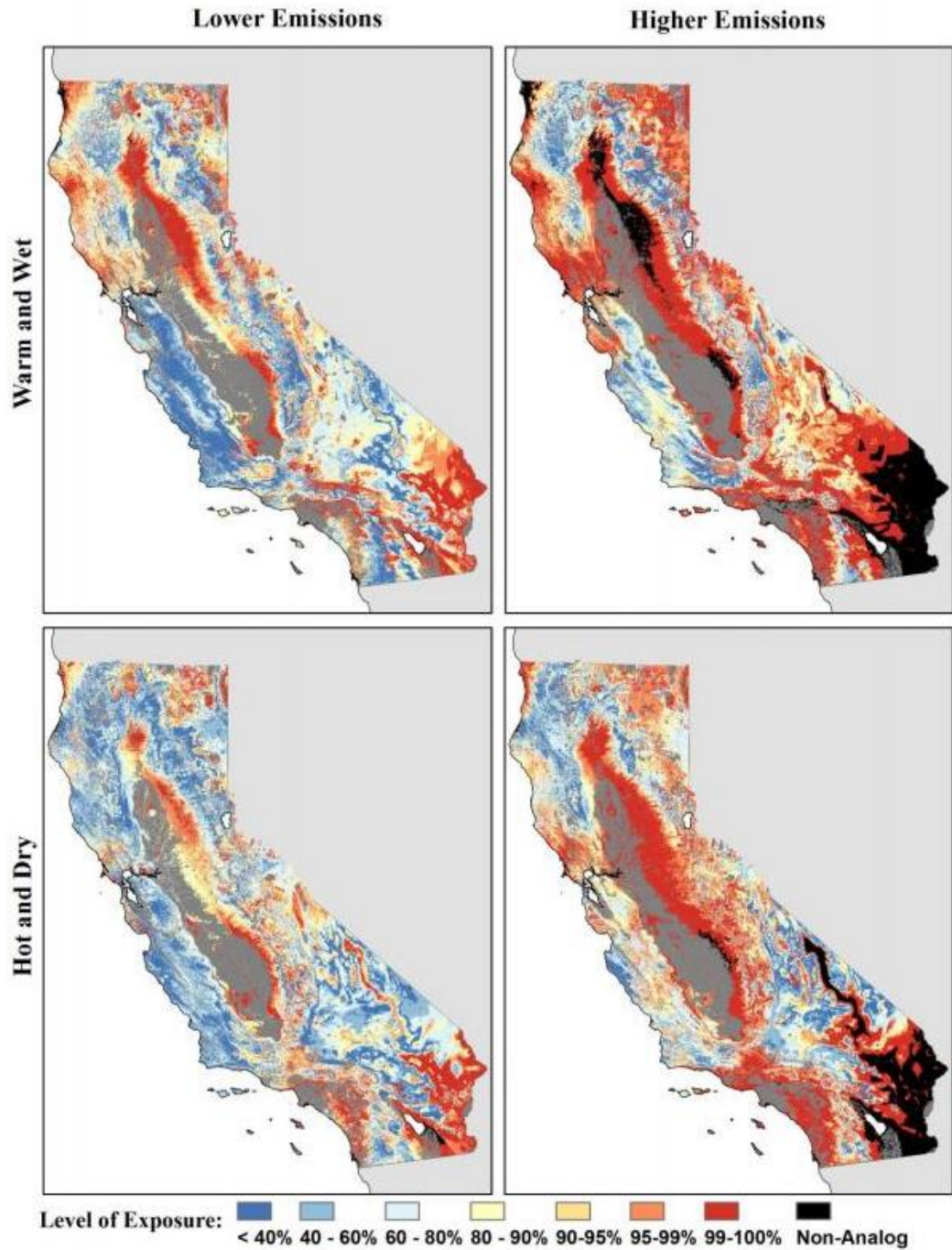
Figure 23. Mapped climate exposure in 2100 under four climate projections. Areas considered to be highly stressed are in the 95-99%, 99-100% and Non-Analog categories. Grey areas on the map represent urban and agricultural areas and were not evaluated. Figure from Thorne et al. (2016).

Lower Emissions　　　　**Higher Emissions**

Warm and Wet

Hot and Dry

■ Newly Suitable　■ No Longer Suitable　□ Remaining Suitable

Figure 24. Projected climatically suitable range for grassland for the time period 2070–2099 under four climate projections. Figure from Thorne et al. (2016).

SUMMARY OF LISTING FACTORS

CESA's implementing regulations identify key factors that are relevant to the Department's analyses and the Fish and Game Commission's decision on whether to list species as threatened or endangered. Specifically, a "species shall be listed as endangered or threatened…if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) com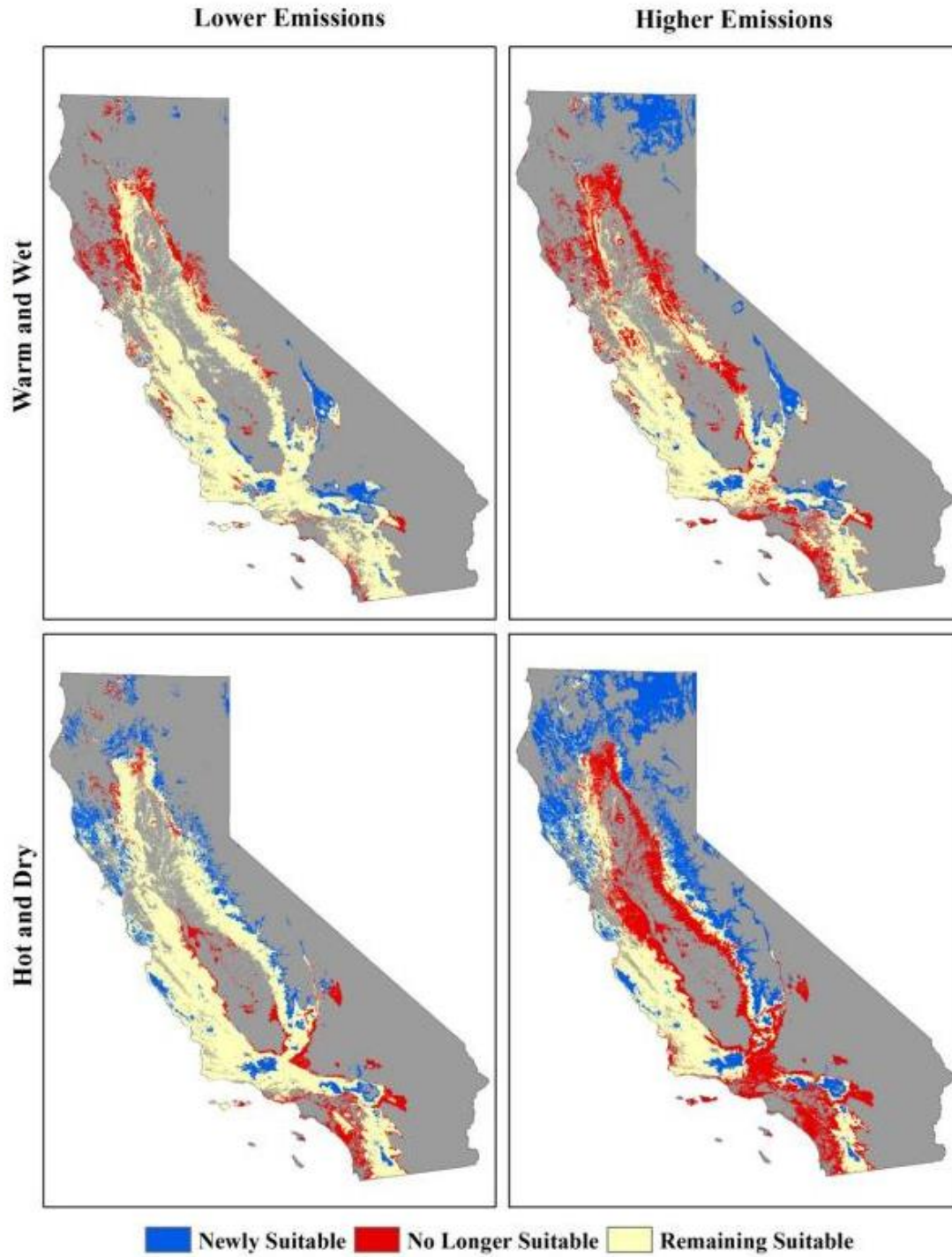petition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., Tit. 14, § 670.1).

This section provides summaries of information from the foregoing sections of this status review, arranged under each of the factors to be considered by the Commission in making a determination as to whether listing is warranted.

Present or Threatened Modification or Destruction of Habitat

Of the estimated four million acres (16,187 km2) of wetlands that existed in the Central Valley in the 1850s that could have been available to Tricolored Blackbirds as nesting substrate, only about 5% remain. Most of the loss of wetlands occurred in the late 1800s and early 1900s, but there was a continued decline of 50% between 1939 and the 1980s, with an average loss of 5,200 acres (2,104 ha) per year. Restoration actions beginning in the 1980s have resulted in an increase of 65,000 acres (263 km2) of managed wetlands between 1990 and 2005. Although many of these managed wetlands may provide nesting habitat for Tricolored Blackbird, the majority are managed as seasonal wetlands for wintering waterfowl and are not suitable. Wetlands remain the most frequently-used nesting substrate, but as the extent of wetlands declined, Tricolored Blackbirds began using novel, nonnative vegetation types and agricultural grain fields.

The loss of nesting substrates of all types continues, with specific nesting locations being lost in most years. Wetlands continue to be lost as lands are converted to agriculture or urban uses, or water availability limits the ability to maintain habitat through the breeding season. Nonnative vegetation types are often considered undesirable and are frequently removed. Despite these ongoing losses, there appears to be suitable nesting substrate in some areas that goes unused in many years; therefore, Tricolored Blackbirds do not seem to be nest substrate-limited in these areas. However, there are other regions within the Tricolored Blackbird range where large areas of apparently suitable foraging habitat have little or no available nesting substrate. It is likely that loss of nesting substrate has caused local declines and shifts in distribution, but the overall effect on the population is difficult to assess, especially without considering the availability of foraging habitat, insect prey, and other breeding requirements.

The extent of foraging habitat required for successful breeding is much greater than the extent of nesting substrate, and once lost, large landscapes with suitable habitat are difficult to replace. Loss of foraging habitat has likely led to the extirpation of colonies from most of the coastal lowlands in southern California. 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. From 1973 to 2010, grasslands and shrublands in the Central Valley declined by an estimated 22% (a loss of 476,900 acres [1,930 km2]), due mainly to conversions to more intensive agriculture and urban development. The San Joaquin Valley region, which in recent decades has been the center of abundance for breeding Tricolored Blackbirds during the early nesting season, has experienced the largest amount of rangeland conversion, primarily to vineyards, orchards, and urban development. This region, which has experienced that largest Tricolored Blackbird population decline in the last 10 years, has abundant nesting substrate available in the form of triticale and other grain crops; the loss of foraging habitat has likely contributed to the population decline. In recent years, the rate at which grasslands and compatible crops (e.g., alfalfa) have been converted to orchards has accelerated. Large-scale losses are projected to continue into the future as agricultural practices evolve, cities continue to expand, and a changing climate makes large areas unsuitable for grassland communities.

Several HCPs and NCCPs cover Tricolored Blackbird in California, but only a small portion of the species' range is covered by approved conservation plans. In the Central Valley portion of the range, all approved plans are HCPs, which provide mitigation for habitat losses, but overall result in net decreases in the extent of nesting and foraging habitat. Much of the Central Valley, including the major breeding areas in Merced County and the southern San Joaquin Valley, are not covered by conservation plans. The southern California portion of the range is more thoroughly covered by NCCPs, with the Riverside and San Diego county portions of the range well-covered. Some of these plans are the earliest approved NCCPs in California, and were established under previous versions of the NCCP Act. As such, these plans provide little detail on how Tricolored Blackbird will be conserved. Recently approved NCCPs (e.g., East Contra Costa County, Santa Clara Valley) consider the full range of breeding needs for the species and provide meaningful conservation actions, but these plan areas are on the periphery of the species breeding range and have supported only few small colonies historically. The Western Riverside County NCCP includes perhaps the most important remaining area in southern California for Tricolored Blackbirds. The plan protects core Tricolored Blackbird areas and supports several thousand breeding birds each year, representing the majority of the breeding birds in southern California. However, large residential and commercial developments are planned for much of the San Jacinto Valley in western Riverside County. This will likely result in substantial loss of dairy lands and the alfalfa fields used by Tricolored Blackbirds that nest both on and off the San Jacinto Wildlife Area.

Easements have been acquired on a large acreage of rangeland in California, but acquisitions have not been directed by the needs of the Tricolored Blackbird. Many of the easements are in the Coast Ranges, where Tricolored Blackbird colonies are typically small, but others are in the Sierra Nevada foothills and may provide foraging habitat for breeding Tricolored Blackbirds, depending on location. The most important breeding areas for the species, including southern California, the San Joaquin Valley, and the central Sierra Nevada foothills, continue to lose large amounts of foraging habitat, and these losses are projected to continue into the future.

The state and federal governments have had some successes restoring and managing wetland nesting substrates on public and private lands, but many efforts have been temporary and funding shortages have resulted in loss of most of the wetland nesting habitat created on private lands under incentive

programs. No source of funding has been identified to provide long-term management or a consistent water supply for the benefit of Tricolored Blackbird.

Without a focused effort to identify and protect the most important landscapes for the Tricolored Blackbird, the species will continue to lose nesting and foraging habitat, and will become increasingly dependent on nonnative upland nesting substrates, including grain fields. If the loss of foraging habitats continue at projected rates, the species will continue to disappear from portions of the current range.

Overexploitation

A large portion of the Tricolored Blackbird population has nested annually on agricultural grain fields since the 1990s, mostly in grain grown for silage on dairies. In many cases the entire reproductive effort of silage colonies has been lost when the nesting substrate is harvested while the young or eggs are still in the nest. Since the early 1990s, a number of programs, primary funded by the federal government, have been implemented to protect nesting colonies on dairy silage fields and other grain crops. These efforts have had mixed success, with many colonies protected but with large colonies being lost in most years. In the two most recent breeding seasons, participation in colony protection programs has been very high, and most colonies have been protected. The recent success has resulted from the availability of consistent and sufficient funding sources for colony protection programs, a commitment by members of the Tricolored Blackbird Working Group to conduct outreach efforts, and the protections provided by CESA and law enforcement activities conducted by the Department since 2015, which have incentivized participation in colony protection programs.

The Tricolored Blackbird colonies that form on agricultural grain fields early in the breeding season are often the largest colonies formed each year. Reproductive success is variable across colonies but has often been low over the past decade, and increases in reproductive success may be the best approach to increase the Tricolored Blackbird population size. The destruction of grain colonies has contributed to declines in reproductive success, but other factors, including the recent drought, have likely also contributed. Following increases in precipitation in recent years, breeding conditions have improved and Tricolored Blackbirds appear to have experienced increased reproductive success. The success of the silage colony protection programs in the two most recent breeding seasons has likely allowed the large colonies in the San Joaquin Valley to contribute to increased rates of recruitment. This may be in part responsible for an apparent stabilization of the population size between 2014 and 2017.

The commitment of the working group members to continue conducting outreach to landowners and implementing colony protection programs is not in doubt, but funding to support colony protection programs has not been identified beyond the 2018 breeding season. The emergency listing of the species prior to the 2015 breeding season, the continued protection under CESA as a candidate for listing, and the resulting response to colony harvest incidents by Department law enforcement resulted in an increased incentive for landowners to participate in colony protection programs. Without long-term secured funding and the incentives provided by protection under CESA, the future success of these programs is uncertain. In the absence of successful protection programs, colonies associated with silage fields will likely become population sinks again.

Predation

Predation at Tricolored Blackbird colonies is a natural occurrence that has been documented since the early 1900s. Although infrequent, predation has at times had large impacts on colonies, even leading to complete nesting failure. Although a healthy population should be able to withstand natural levels of predation, breeding colonies should continue to be monitored for impacts due to predation, especially due to nonnative predators or unusually high predator populations.

Reproductive success at Tricolored Blackbird colonies has been low in many years since at least 2006, and increases in reproductive success may be the best approach to increasing the Tricolored Blackbird population. Because predation at Tricolored Blackbird colonies typically occurs on eggs, nestlings, and fledglings, predation can have a large effect on reproductive success. When predation has large effects or causes complete nesting failure at large colonies, it may negatively impact the annual reproductive output of the Tricolored Blackbird population.

Competition

The Department does not consider competition to be a significant threat to the continued existence of the Tricolored Blackbird in California.

Disease

The Department does not consider disease to be a significant threat to the continued existence of the Tricolored Blackbird in California.

Other Natural Events or Human-Related Activities

Contaminants—In the two decades since their introduction, neonicotinoid insecticides have become the most widely used insecticides in the world, including in California. They are highly effective at killing insects and have relatively low mammal and bird toxicity. However, at higher concentrations they can have lethal and sublethal impacts to vertebrates. Neonicotinoids have been implicated in the decline of invertebrate communities and, in a few cases, the decline of insectivorous birds. Ingestion of only a few neonicotinoid-coated seeds (a single seed in the case of corn) might be sufficient to kill a songbird, but there has been little work conducted on the availability and consumption of treated seeds by vertebrates, and no data are available on the acute toxicity of any neonicotinoid insecticide specifically to Tricolored Blackbirds. Neonicotinoids may also have chronic toxicity effects (exposure over longer time periods) on reproductive success, but chronic effects are even less studied than acute effects.

Neonicotinoids have been shown to have adverse effects on a number of non-target invertebrate species, and may indirectly affect Tricolored Blackbirds through suppression of insect prey populations. In the Netherlands, neonicotinoids were shown to have a negative association with insectivorous bird populations, likely due to insect food deprivation. Neonicotinoids were detected in 89% of water samples taken from rivers, creeks, and drains in agricultural regions of California, with 19% of samples exceeding the US Environmental Protection Agency guideline concentration. Long-term observational

data have revealed declines in the number of butterfly species and declines in abundance for many butterfly species in the Central Valley, both of which were negatively associated with annual application rates of neonicotinoid insecticides. Studies to date have relied on observational data to find correlations between neonicotinoids and potential effects. There is a need for mechanistic research to investigate exposure rates of Tricolored Blackbirds to neonicotinoids, effect of exposure on body condition and fitness (direct effects), and investigations into potential insect-based food-web impacts (indirect effects).

Drought and Climate Change—Drought reduces water supply reliability and has far-reaching impacts on most habitat types in California. The maintenance of wetland habitats in most of the Tricolored Blackbird's range depends on water deliveries. Recent droughts have resulted in reductions in surface water in the Central Valley, which likely resulted in reduced availability of wetlands for nesting. Several of the upland nesting substrates used by Tricolored Blackbirds are also reduced or eliminated in dry years. Drought also effects the abundance of grasshoppers and other insect species that are important to nesting Tricolored Blackbirds. Extreme or prolonged drought negatively affects grasshopper and other insect prey populations through desiccation of eggs or through decreased biomass of primary producer food sources (e.g., grasses and forbs). Climate change is projected to bring longer and more severe droughts to California in the future, exacerbating the impacts to Tricolored Blackbird habitat and prey availability.

The average temperature in California is expected to rise by approximately 2.7°F (1.5°C) by 2050, and depending on the emissions scenario, average temperatures could increase by 4.1–8.6°F (2.3–4.8°C) by the year 2100. The average number of extremely hot days (at least 105°F [41°C]) per year in Sacramento is expected to increase fivefold (up to 20 days) by the middle of the century, and may increase to as many as 50 days per year by 2100. Rising temperatures may directly affect annual Tricolored Blackbird productivity by truncating or interrupting the breeding season, although more work is needed on the effect of temperature on initiation and success of nesting attempts.

The areas of California with the largest climate-projected effects on a variety of bird species are largely concentrated within the Tricolored Blackbird range in the Central Valley. Two important Tricolored Blackbird communities, grassland and freshwater marsh, are projected to be among the natural communities most affected by climate change in California. Depending on the climate projection used, the extent of freshwater marsh in California is projected to decrease by 71%–97% by year 2100. The extent of grasslands is projected to decrease by 16%–48%. The current level of emissions is on track with the higher-impact scenarios.

PROTECTION AFFORDED BY LISTING

It is the policy of the State to conserve, protect, restore and enhance any endangered or threatened species and its habitat (Fish & G. Code, § 2052). The conservation, protection, and enhancement of listed species and their habitat is of statewide concern (Fish & G. Code, § 2051(c)). CESA defines "take" as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (Fish & G. Code, § 86). The Fish and Game Code provides the Department with related authority to allow "take" of species listed as threatened or endangered under certain circumstances through incidental take permits,

memoranda of understandings, natural community conservation plans, or other plans or agreements approved by or entered into by the Department (Fish & G. Code, §§ 2081, 2081.1, 2086, 2087, and 2835).

If the Tricolored Blackbird is listed under CESA, impacts of take caused by activities authorized through incidental take permits must be minimized and fully mitigated according to state standards. These standards typically include protection of the land in perpetuity with an easement, development and implementation of a species-specific adaptive management plan, and funding through an endowment to pay for long-term monitoring and maintenance to ensure the mitigation land meets performance criteria. Obtaining an incidental take permit is voluntary. The Department cannot force compliance; however, any person violating the take prohibition may be punishable under state law.

Additional protection of Tricolored Blackbird following listing would be expected to occur through state and local agency environmental review under CEQA. CEQA requires that affected public agencies analyze and disclose project-related environmental effects, including potentially significant impacts on rare, threatened, and endangered species. In common practice, potential impacts to listed species are examined more closely in CEQA documents than potential impacts to unlisted species. Where significant impacts are identified under CEQA, the Department expects that project-specific avoidance, minimization, and mitigation measures will benefit the species. State listing, in this respect, and consultation with the Department during state and local agency environmental review under CEQA, would be expected to benefit the Tricolored Blackbird in terms of reducing impacts from individual projects, which might otherwise occur absent listing.

For some species, CESA listing may prompt increased interagency coordination and the likelihood that state and federal land and resource management agencies will allocate funds toward protection and recovery actions. In the case of the Tricolored Blackbird, the Tricolored Blackbird Working Group signatory agencies already meet and coordinate regularly, but a state listing could result in increased availability of conservation funds.

LISTING RECOMMENDATION

CESA directs the Department to prepare this report regarding the status of the Tricolored Blackbird in California based upon the best scientific information available. CESA also directs the Department based on its analysis to indicate in the status report whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). In addition to evaluating whether the petitioned action (i.e., listing as endangered) was warranted, the Department considered whether listing as threatened under CESA was warranted.

Under CESA, an endangered species is defined as "a native species or subspecies…which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease" (Fish and G. Code, § 2062). A threatened species is defined as "a native species or subspecies…that, although not presently threatened with extinction, is likely to become an endangered species in the

foreseeable future in the absence of the special protection and management efforts required by [CESA]" (Fish and G. Code, § 2067).

The Department includes and makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science. In consideration of the scientific information contained herein, the Department has determined that listing the Tricolored Blackbird as threatened under CESA is warranted at this time.

MANAGEMENT RECOMMENDATIONS

The Department evaluated existing management recommendations and identified the following, listed in no particular order, as necessary to achieve conservation of the Tricolored Blackbird. The *Conservation Plan for the Tricolored Blackbird* (TBWG 2007) identifies goals, objectives, and tasks required to maintain a viable Tricolored Blackbird population throughout the current range of the species. The Department continues to support implementation of the conservation plan as revised by the Tricolored Blackbird Working Group. The goals, objectives, and tasks identified in the plan are not repeated in their entirety here, but many of the management recommendations listed below are related to, or based on, activities identified in the plan.

Habitat Protection, Restoration, and Enhancement

Land ownership patterns across the range of the Tricolored Blackbird, coupled with the diverse nesting and foraging habitats used by the species, necessitate cooperative efforts among government, industry, and the public in order to conserve the species.

Management of habitat must consider the large landscapes utilized by breeding colonies and the integral relationship between nesting colony sites and associated upland foraging areas (Hamilton 1993). Land management plans that do not specifically consider the landscape needs of Tricolored Blackbirds will not necessarily result in the protection or creation of suitable breeding habitat.

1. Determine the best areas for conservation, building off the recent research on habitat suitability conducted by the National Audubon Society (NAS 2017). It is difficult to predict the distribution of widespread species, and even more difficult when the distribution within the range is not stable, as with the dynamic colony site use of Tricolored Blackbirds. Breeding locations that should be prioritized for protection include those that are regularly occupied, those that support large colonies, those that support high reproductive success, and those with a secure foraging landscape (Meese and Beedy 2015).
2. Identify areas in the Tricolored Blackbird range with consistently high quality foraging landscapes, but that lack suitable nesting substrate. Consider conservation actions to enhance, create, or restore nesting substrate in areas with high probability of use by breeding Tricolored Blackbirds.
3. Secure funding and implement the highest priority nesting substrate protection, enhancement and restoration projects and foraging habitat protection projects.

4. Create a system for tracking habitat protection and restoration projects, including appropriate measures of success. Work with the Tricolored Blackbird Working Group to encourage reporting of habitat projects from all stakeholders.

Breeding Colony Protection

In addition to the long-term goal of providing suitable alternative habitat away from silage fields on public and private land, the near-term priority must continue to be placed on identifying and conserving the colonies nesting in silage on private property each year. In addition, the infrequent but large impacts to some colonies due to predation should be monitored and addressed if necessary.

5. Fully fund and implement a silage colony protection program. Continue work in the Tricolored Blackbird Working Group's agriculture subcommittee to plan for and implement a silage colony response plan, with participation from a diverse set of stakeholders including members of the dairy industry.
6. Identify locations that regularly support large and productive Tricolored Blackbird breeding colonies, with secure foraging landscape. Prioritize these locations for protection through acquisition or conservation easement.
7. Assess the effectiveness of provision of alternate nesting habitat (e.g., fresh emergent wetlands) to draw birds away from nesting in dairy silage fields (Beedy et al. 2017).
8. Monitor the effects of predation on colony reproductive success. Where persistent large negative impacts occur, especially due to nonnative or unusually large predator populations, evaluate potential actions to reduce the impacts.

Monitoring and Research

9. Determine the factors that influence nest site selection and especially whether relative insect abundance may affect site occupancy (Airola et al. 2016).
10. Determine the amount, type, and distribution of foraging habitat needed to support viable breeding colonies of various sizes. How does type, proximity to colony site, and diversity of foraging habitats influence the extent of foraging habitat required and the rate of reproductive success?
11. Determine the environmental factors that result in abundant large insect prey populations in grassland habitats and in commonly used agricultural crops, and their variability in time and space. Investigate prey selection by breeding birds.
12. Conduct mechanistic research to complement results from observational data that have shown correlations between neonicotinoid pesticides and declines in songbirds; these should include testing exposure rates of Tricolored Blackbirds to neonicotinoids, effect of exposure on body condition and fitness, and investigations into potential insect-based food web effects.
13. Estimate rates of within season and interannual movements and genetic exchange between populations breeding in different regions, especially between southern California and the Central Valley (Beedy et al. 2017). There is also a general need for evaluation of distribution and

    habitats used throughout the year to understand when and where threats are encountered, and to plan conservation actions across the full life cycle.

14. Quantify annual adult survivorship and investigate factors that affect survival, including the magnitude of post-breeding mortality caused by shooting to reduce crop depredation and other nonbreeding season sources of mortality.

15. Create a standardized method to measure productivity in Tricolored Blackbird breeding colonies. Current methods that utilize nest transects or counts of fledglings might not be comparable, and nest transects can be difficult to implement and may negatively affect breeding birds.

16. Examine degree of colony cohesion between first and subsequent breeding attempts, and between breeding seasons (Beedy et al. 2017).

17. Develop and implement a statistically valid, standardized protocol for the long-term, statewide monitoring of Tricolored Blackbird abundance, including population estimate confidence.

Education and Outreach

18. Raise awareness of Tricolored Blackbird nesting behavior and conservation options on ranch and farmlands, stressing the importance of protecting large silage nesting colonies. Build off recent efforts by the Tricolored Blackbird Working Group and the dairy and rice industries.

19. Conduct outreach and coordination with landowners whose grazing lands in the foothills support breeding colonies (Airola et al. 2015b).

20. Provide land managers with habitat management guidance for creation and management of Tricolored Blackbird habitat. Continue work recently undertaken by the Tricolored Blackbird Working Group's habitat subcommittee.

ECONOMIC CONSIDERATIONS

The Department is charged in an advisory capacity in the present context to provide a written report and a related recommendation to the Commission based on the best scientific information available regarding the status of Tricolored Blackbird in California. The topic areas and related factors the Department is required to address as part of that effort are biological and not economic, therefore the Department is not required to prepare an analysis of economic impacts (See Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)).

CITATIONS

Literature Cited

Airola, D.A., B. Cousens, and D. Kopp. 2014. Accelerating decline of the Sacramento Purple Martin breeding population in 2014: What are the possible causes? Central Valley Bird Club Bulletin 17:12-22.

Airola, D.A., R.J. Meese, and D. Krolick. 2015a. Tricolored Blackbird conservation status and opportunities in the Sierra Nevada foothills of California. Central Valley Bird Club Bulletin 17:57-78.

Airola, D.A, R.J. Meese, E.C. Beedy, D. Ross, D. Lasprugato, W. Hall … and J. Pan. 2015b. Tricolored Blackbird breeding status in 2015 in the foothill grasslands of the Sierra Nevada, California. Central Valley Bird Club Bulletin 18:96-13.

Airola, D.A., D. Ross, C.W. Swarth, D. Lasprugato, R.J. Meese, and M.C. Marshall. 2016. Breeding status of the Tricolored Blackbird in the grassland-dominated region of the Sierra Nevada, California in 2016. Central Valley Bird Club Bulletin 19:82-109.

Aksland, G. and S. Wright. 2005. Trends in cereal forage production. Proceedings of the 35th California Alfalfa & Forage Symposium, 12-14 December 2005, Visalia, California, Department of Agronomy and Range Science Extension, University of California, Davis, CA 95616.

Allen, L.W., K.L. Garrett, and M.C. Wimer. 2016. Los Angeles County breeding bird atlas. Los Angeles Audubon Society, Los Angeles, CA.

American Ornithologists' Union (AOU). 1957. Check-list of North American birds, 5th ed. American Ornithologists' Union, Baltimore, Maryland.

Ammon, E.M. and J. Woods. 2008. Status of Tricolored Blackbirds in Nevada. Great Basin Birds 10:63-66.

Arthur, S. 2015. Protecting, restoring, and enhancing Tricolored Blackbird habitat on agricultural lands through the Regional Conservation Partnership Program. Central Valley Bird Club Bulletin 17:122-125.

Audubon, J.J. 1839. Ornithological biography. Adam and Charles Black, Edinburgh.

Avery, M.L., D.G. Decker, D.L. Fischer, and T.R. Stafford. 1993. Responses of captive blackbirds to a new insecticidal seed treatment. Journal of Wildlife Management 57:652-656.

Baird, S.F., T.M. Brewer, and R. Ridgway. 1874. A history of North American birds: Land birds, vol. 2. Little, Brown, and Co., Boston, MA.

Barnett, K.L. and S.L. Facey. 2016. Grasslands, invertebrates, and precipitation: A review of the effects of climate change. Frontiers in Plant Science 7:1196.

Beauchamp, G. 1999. The evolution of communal roosting in birds: origin and secondary losses. Behavioral Ecology 10:675-687.

Beedy, E.C. 2008. Tricolored Blackbird species account *in* W.D. Shuford and T. Gardali. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, CA and California Department of Fish and Game, Sacramento.

Beedy, E.C. and A. Hayworth. 1992. Tricolored Blackbird (*Agelaius tricolor*) nesting failures in the Central Valley of California: general trends or isolated phenomena? *in*: Williams, D.F., S. Byrne and T.A. Rado, editors. Endangered and sensitive species of the San Joaquin Valley, California. Calif. Energy Comm., Sacramento, CA; pp. 33-46.

Beedy, E.C. and W.J. Hamilton III. 1997. Tricolored blackbird status update and management guidelines. Jones & Stokes Assoc. Inc., Sacramento CA, Rep. 97-099. Prepared for U. S. Fish and Wildlife Service, Sacramento CA, and Calif. Dep. of Fish and Game, Sacramento, CA.

Beedy, E.C., S.D. Sanders, and D. Bloom. 1991. Breeding status, distribution, and habitat associations of the tricolored blackbird (*Agelaius tricolor*), 1850-1989. Jones & Stokes Assoc. Inc., Sacramento CA, Rep. 88-187, ii + 42 pp. + tables, figures, append. Prepared for U. S. Fish and Wildlife Service, Sacramento, CA.

Beedy, E.C., W.J. Hamilton, III, R.J. Meese, D.A. Airola and P. Pyle. 2017. Tricolored Blackbird (*Agelaius tricolor*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna-org.bnaproxy.birds.cornell.edu/Species-Account/bna/species/tribla

Belding, L. 1890. Land birds of the Pacific district. Occasional papers of the California Academy of Sciences, II. San Francisco.

Bendire, C. 1895. Life histories of North American birds, from the parrots to the grackles, with special reference to their breeding habits and eggs. Government Printing Office, Washington, DC.

Bent, A.C. 1958. Life histories of North American blackbirds, orioles, tanagers, and allies. Smithsonian Institution U.S. Natl. Mus. Bulletin 211. [The commonly-available Dover edition, first published in 1965, is an unaltered republication of the original museum bulletin; Dover Publications Inc., New York, NY]

Berg, E.C., J.P. Pollinger, and T.B. Smith. 2010. Population structure of the Tricolored Blackbird (*Agelaius tricolor*) in California: Are northern and southern populations genetically distinct? Calif. Dept. Fish and Game, Nongame Wildlife Program Rpt. 2010-05 and Audubon California, Sacramento, CA. 25 pp.

Bousman, W. G. 2007. Breeding bird atlas of Santa Clara County, California. Santa Clara Audubon Society, Cupertino, CA.

Brown, C.R. 1988. Enhanced foraging efficiency through information centers: A benefit of coloniality in Cliff Swallows. Ecology 69:602-613.

Bucher, E.H. 1992. The causes of extinction of the Passenger Pigeon. Current Ornithology 9:1-36.

Butcher, G.S., D.K. Niven, and J.R. Sauer. 2006. Using Christmas Bird Count data to assess population dynamics and trends of waterbirds. The 105th Christmas Bird Count. American Birds 59:23-25.

Butcher, G.S., M.R. Fuller, L.S. McAllister, and P.H. Geissler. 1990. An evaluation of the Christmas Bird Count for monitoring population trends of selected species. Wildlife Society Bulletin 18:129-134.

Bryant, W.E. 1889. A catalogue of the birds of Lower California, Mexico. Proc. Calif. Acad. Sci., Series 2, 2:237-320.

Byrd, K.B., L.E. Flint, P. Alvarez, C.F. Casey, B.M. Sleeter, C.E. Soulard, A.L. Flint, and T.L. Sohl. 2015. Integrated climate and land use change scenarios for California rangeland ecosystem services: wildlife habitat, soil carbon, and water supply. Landscape Ecology 30:729-750.

California Department of Fish and Game (CDFG). August 2007. Findings of Fact under CEQ and NCCP Act, and NCCP permit 2835-2007-001-03 for East Contra Costa County NCCP.

California Department of Fish and Wildlife (CDFW). July 2013. Findings of Fact under CEQA and NCCP Act, and NCCP permit 2835-2012-002-03 for Santa Clara Valley Habitat Plan NCCP Permit.

California Department of Water Resources (DWR). 2014. The State Water Project final delivery reliability report 2013. 57 pp. + appendices.

California Department of Water Resources (DWR). 2015a. California's most significant droughts: Comparing historical and recent conditions. 80 pp. + appendix.

California Department of Water Resources (DWR). 2015b. Drought in California. 2015 Drought brochure. 15 pp.

Cameron, D.R., J. Marty, and R.F. Holland. 2014. Whither the rangeland?: Protection and conversion in California's rangeland ecosystems. PLoS ONE 9(8): e103468. doi:10.1371/journal.pone.0103468.

Central Valley Joint Venture (CVJV). 2006. Central Valley Joint Venture implementation plan – conserving bird habitat. U.S. Fish and Wildlife Service, Sacramento, CA. Available at: http://www.centralvalleyjointventure.org/science

Colibri Ecological Consulting, LLC. 2017. 2017 Tricolored Blackbird Monitoring Report. Report prepared for the California Department of Fish and Wildlife. 28 pp.

Cook, L.F. and C.A. Toft. 2005. Dynamics of extinction: population decline in the colonially nesting Tricolored Blackbird (*Agelaius tricolor*). Bird Conservation International 15:73-88.

Cook, R. 2010. Recent history and current status of the Tricolored Blackbird in southern California. A report of the Western Riverside County Multiple Species Habitat Conservation Plan. July 20, 2010.

Cook, R.R. 2016. Enhancement of Tricolored Blackbird breeding habitat at the San Jacinto Wildlife Area. Final report prepared for the California Department of Fish and Wildlife, Local Assistance Grant #P1382102. Sacramento, California.

Cooper, J.G. 1870. Ornithology. Land birds, vol. 1. Geological survey of California. S.F. Baird (ed.). University Press: Welch, Bigelow, and Co., Cambridge, MA. Published by authority of the Legislature [of California].

Crase, F.T. and R.W. DeHaven. 1977. Food of nestling tricolored blackbirds. Condor 79:265-269.

Crase, F.T. and R.W. DeHaven. 1978. Food selection by five sympatric California blackbird species. California Fish and Game 64:255-267.

Danchin, E. and R.H. Wagner. 1997. The evolution of coloniality: the emergence of new perspectives. Trends in Ecology & Evolution 12:342-347.

Dawson, W.L. 1923. The birds of California. Vol. 1. South Moulton Co., San Francisco, CA.

DeHaven, R.W. 2000. Breeding tricolored blackbirds in the Central Valley, California: A quarter-century perspective. Unpublished report to the U.S. Fish and Wildlife Service, Sacramento, CA. 22 pp.

DeHaven, R.W. and J.A. Neff. 1973. Recoveries and returns of tricolored blackbirds, 1941-1964. Western Bird Bander 48:10-11.

DeHaven, R.W., F.T. Crase, and P.D. Woronecki. 1975a. Movements of tricolored blackbirds banded in the Central Valley of California. Bird-Banding 46:220-229.

DeHaven, R.W., F.T. Crase, and P.D. Woronecki. 1975b. Breeding status of the tricolored blackbird, 1969-1972. California Fish and Game 61:166-180.

Diffenbaugh, N.S., D.L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. PNAS 112:3931-3936.

Dudek and Associates, Inc. 2003. Western Riverside County Multi-Species Habitat Conservation Plan, Volume II-B: Species Accounts, BIRDS- Tricolored Blackbird (*Agelaius tricolor*).

Dudek and Associates, Inc. July 2006. Draft Southern Orange County Subregional NCCP/MSAA/HCP (Southern NCCP/MSAA/HCP).

East Contra Costa County NCCP/HCP (ECCC). Oct 2006. Species Accounts. Birds, Tricolored Blackbird. 10pp.

East Contra Costa Habitat Conservancy (ECCHC). March 2011. East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan, Annual Report 2010. 32 pp. + App.

East Contra Costa Habitat Conservancy (ECCHC). June 2013. East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan, Annual Report 2012. 26 pp. + App.

East Contra Costa Habitat Conservancy (ECCHC). June 2016. East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan, Annual Report 2015. 58 pp. + App.

eBird Basic Dataset. 2016. Version: EBD_relAug-2016. Cornell Lab of Ornithology, Ithaca, NY.

Emlen, S.T. and N.J. DeLong. 1975. Adaptive significance of synchronized breeding in a colonial bird: A new hypothesis. Science 188:1029-1031.

Erickson, R.A., H. de la Cueva, and M.J. Billings. 2007. Nesting Tricolored Blackbird survey: Baja California 2007. Report submitted to the U.S. Fish and Wildlife Service.

Erickson, R.A. and H. de la Cueva. 2008. Nesting Tricolored Blackbird survey: Baja California 2008. Report submitted to the U.S. Fish and Wildlife Service.

Erickson, R.A., H. de la Cueva, J.S. Feenstra, and E.D. Zamora-Hernández. 2016. On the edge of extinction: Can the Tricolored Blackbird (*Agelaius tricolor*) persist in Mexico? Poster session presented at: North American Ornithological Conference VI; Washington, DC.

Evermann, B.W. 1919. A colony of Tricolored Blackbirds. Gull 1:2-3.

Falcone, C. 2010. Is Orthoptera abundance and distribution across a small grassland area affected by plant biomass, plant species richness, and plant quality? Environmental Studies Undergraduate Thesis, University of Nebraska, 2010.

Fankhauser, D.P. 1971. Annual adult survival rates of blackbirds and starlings. Bird-Banding 42:36-42.

Feenstra, J.S. 2009. The status of the Tricolored Blackbird (*Agelaius tricolor*) in southern California. Results of the spring 2009 census. Report prepared for U.S. Fish and Wildlife Service. 18 pp.

Feenstra, J.S. 2013. Breeding survey of Tricolored Blackbirds in Baja California, Mexico, 2013. Report prepared for U.S. Fish and Wildlife Service and Sonoran Joint Venture. 12 pp.

Forister, M.L., B. Cousens, J.G. Harrison, K. Anderson, J.H. Thorne, D. Waetjen, ... and A.M. Shapiro. 2016. Increasing neonicotinoid use and the declining butterfly fauna of lowland California. Biology letters 12(8):20160475.

Frayer, W.E., D.D. Peters, and H.R. Pywell. 1989. Wetlands of the California Central Valley: Status and trends 1939 to mid-1980s. U.S. Fish and Wildlife Service Region 1 report, Portland, OR.

Frazer, S. 2016. Tricolored Blackbird 2016 monitoring report. Report prepared for the California Department of Fish and Wildlife. 19 pp. + maps.

Garrett, K. and J. Dunn. 1981. Birds of southern California: Status and distribution. Los Angeles Audubon Society, Los Angeles, CA.

Garrett, K.L., J.L. Dunn, and B.E. Small. 2012. Birds of southern California. R.W. Morse Company, Olympia, WA.

Geisseler, D. and W.R. Horwath. 2016. Pistachio production in California. California Department of Food and Agriculture Fertilizer Research and Education Program. Available at: https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Pistachio_Production_CA.pdf.

Gilligan, J., D. Rogers, M. Smith and A. Contreras. 1994. Birds of Oregon: Status and distribution. Cinclus Publications, McMinnville, OR.

Glover, S. A. 2009. Breeding Bird Atlas of Contra Costa County. Mount Diablo Audubon Society, Walnut Creek, CA.

Godfray, H.C.J., T. Blacquiere, L.M. Field, R.S. Hails, G. Petrokofsky, S.G. Potts, ... and A.R. McLean. 2014. A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators. Proceedings of the Royal Society B 281:20140558.

Goulson, D. 2013. Review: An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology 50:977-987.

Goulson, D. 2014. Pesticides linked to bird declines. Nature 511:295-296.

Graves, E.E., M. Holyoak, T. Rodd Kelsey, and R.J. Meese. 2013. Understanding the contribution of habitats and regional variation to long-term population trends in tricolored blackbirds. Ecology and Evolution 3:2845-2858.

Green, M. and L. Edson. 2004. The 2004 Tricolored Blackbird April survey. Central Valley Bird Club Bulletin 7:23-31.

Gregory, R.D., D.W. Gibbons, and P.F. Donald. 2004. Bird census and survey techniques. Pages 17-56 *in* W.J. Sutherland, I. Newton and R.E. Green, editors. Bird Ecology and Conservation: A Handbook of Techniques. Oxford University Press, Oxford.

Grinnell, J. 1898. Birds of the Pacific slope of Los Angeles County. Publ. no. 11, Pasadena Academy Sciences, Pasadena.

Grinnell, J. 1928. A distributional summation of the ornithology of Lower California. University of California Publications in Zoology v. 32, no. 1.

Grinnell, J. and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27.

Gustafson, J.R. and D.T. Steele. 2004. Evaluation of petition from Center for Biological Diversity to list Tricolored Blackbird (*Agelaius tricolor*) as endangered. Calif. Dep. of Fish and Game, Habitat Conservation Planning Branch, Sacramento, 42 pp. + append.

Hallmann, C.A., R.P. Foppen, C.A. van Turnhout, H. de Kroon, and E. Jongejans. 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. Nature 511:341-343.

Hamilton, W.J., III. 1993. Tricolored Blackbird (*Agelaius tricolor*). Report prepared for the U.S. Fish and Wildlife Service, Portland OR, and California Department of Fish and Game, Sacramento, CA.

Hamilton, W.J., III. 1998. Tricolored blackbird itinerant breeding in California. Condor 100:218-226.

Hamilton, W.J., III. 2000. Tricolored blackbird 2000 breeding season census and survey - observations and recommendations. Report prepared for U.S. Fish and Wildlife Service, Portland OR, 61 pp.

Hamilton, W.J., III. 2004a. Tricolored Blackbird management recommendations and 2005 survey priorities. Report prepared for California Resource Management Institute. 15 pp.

Hamilton, W.J., III. 2004b. Management implications of the 2004 Central Valley Tricolored Blackbird Survey. Central Valley Bird Club Bulletin 7:32-46.

Hamilton, W.J., III, K. Hunting, and L. Cook. 2000. Tricolored Blackbird status report for 1999. Central Valley Bird Club Bulletin 3:7-11.

Hamilton, W.J., III, L. Cook, and K. Hunting. 1999. Tricolored blackbirds 1999 status report. Report prepared for California Department of Fish and Game, Sacramento CA, and U.S. Fish and Wildlife Service, Portland OR.

Hamilton, W.J., III, L. Cook, and R. Grey. 1995. Tricolored blackbird project 1994. Report prepared for U.S. Fish and Wildlife Service, 69 pp. + append.

Hamilton, W. J., III, R. Bowen, and L. Cook. 1992. Nesting activities of tricolored blackbirds, *Agelaius tricolor*, in the Central Valley, California, 1992. Report prepared for U.S. Fish and Wildlife Service. 23 pp.

Hardt, D. June 27, 2011. Email to Cheryl Harding regarding comments from David Hardt, [Refuge Manager, Kern NWR Complex] regarding Tricolored Blackbird survey.

Holyoak M., R.J. Meese, and E.E. Graves. 2014. Combining site occupancy, breeding population sizes and reproductive success to calculate time-averaged reproductive output of different habitat types: An application to Tricolored Blackbirds. PLoS ONE 9(5): e96980. doi:10.1371/journal.pone.0096980.

Hopwood, J., M. Vaughan, M. Shepherd, D. Biddinger, E. Mader, S.H. Black, and C. Mazzacano. 2012. Are neonicotinoids killing bees? A review of research in the effects of neonicotinoid insecticides on bees, with recommendations for action. The Xerces Society for Invertebrate Conservation, Portland, OR.

Hosea, R.C. 1986. A population census of the tricolored blackbird, *Agelaius tricolor* (Audubon), in four counties in the northern Central Valley of California. M.A. thesis, California State University, Sacramento, CA.

Hudson, M.A.R., C.M. Francis, K.J. Campbell, C.M. Downes, A.C. Smith, and K.L. Pardieck. 2017. The role of the North American Breeding Bird Survey in conservation. Condor 119:526-545.

Humple, D. and R. Churchwell. 2002. Tricolored blackbird survey report 2001. Point Reyes Bird Observatory draft report. Prepared for U.S. Fish and Wildlife Service. 13 pp.

ICF International (ICF). August 2012. Final Santa Clara Valley Habitat Plan, Santa Clara County, California. Prepared by: ICF International, 620 Folsom Street, Suite 200, San Francisco, CA 94107.

Iglecia, M. and R. Kelsey. 2012. Assessing the scope and scale of shorebird friendly management practices on managed wetlands in the Central Valley of California. Audubon California, Sacramento, CA.

Jaeger, M.M., R.L. Bruggers, B.E. Johns, and W.A. Erickson. 1986. Evidence of itinerant breeding of the Red-billed Quelea (*Quelea quelea*) in the Ethiopian Rift Valley. Ibis 128:469-482.

Jongsomjit, D., D. Stralberg, T. Gardali, L. Salas, and J. Wiens. 2013. Between a rock and a hard place: the impacts of climate change and housing development on breeding birds in California. Landscape Ecology 28:187-200.

Kelsey, R. 2008. Results of the tricolored blackbird 2008 census. Report submitted to the U.S. Fish & Wildlife Service, Portland, OR.

Kemp, W.P. and M.M. Cigliano. 1994. Drought and rangeland grasshopper species diversity. Canadian Entomologist 126:1075-1092.

Kern Water Bank Authority. October 1997. Kern Water Bank HCP/NCCP. Kern County, final.

Knopf, F.L. and S.K. Skagen. 2012. North American prairies: 21st century conservation initiatives and Partnerships. The All-bird Bulletin, Summer 2012 Issue:1-2.

Kyle, K. and R. Kelsey. 2011. Results of the 2011 Tricolored Blackbird Statewide Survey. Audubon California, Sacramento, CA.

Lack, D. and J.T. Emlen, Jr. 1939. Observations on breeding behavior in tricolored red-wings. Condor 41:225-230.

Lamb, C. and A.B. Howell. 1913. Notes from Buena Vista Lake and Fort Tejon. Condor 15:115-120.

Lehman, P.E. 1994. The birds of Santa Barbara County, California. Allen Press, Lawrence, KS.

Linton, C.B. 1908. Notes from Buena Vista Lake, May 20 to June 16, 1907. Condor 10:196-198.

Mailliard, J. 1900. Breeding of *Agelaius tricolor* in Madera Co., Cal. Condor 2:122-124.

Mailliard, J. 1914. Notes on a colony of tri-colored redwings. Condor 16:204-207.

Martin, T.E. 1987. Food as a limit on breeding birds: A life-history perspective. Annual Review of Ecology and Systematics 18:453-487.

Mazerolle D.F., S.G. Sealy, and K.A. Hobson. 2011. Interannual flexibility in breeding phenology of a Neotropical migrant songbird in response to weather conditions at breeding and wintering areas. Ecoscience 18:18-25.

Meese, R.J. 2006. Settlement and breeding colony characteristics of Tricolored Blackbirds in 2006 in the Central Valley of California. Report submitted to the U.S. Fish and Wildlife Service, Sacramento, CA, and Audubon California, Emeryville, CA. 34 pp. + appendix.

Meese, R.J. 2007. Settlement, breeding, productivity, and color-banding of Tricolored Blackbirds in 2007 in the Central Valley of California. Report submitted to the U.S. Fish and Wildlife Service, Portland, OR, and Audubon California, Emeryville, CA. 26 pp. + appendix.

Meese, R.J. 2008. Detection, monitoring, and fates of Tricolored Blackbird colonies in 2008 in the Central Valley of California. Calif. Dept. of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report 2008-07 and the U.S. Fish and Wildlife Service, Portland, OR. 29 pp. + appendix.

Meese, R.J. 2009a. Detection, monitoring, and fates of Tricolored Blackbird colonies in 2009 in the Central Valley of California. Report submitted to California Department of Fish and Game and U.S. Fish and Wildlife Service. 25pp.

Meese, R.J. 2009b. Contribution of the conservation of silage colonies to Tricolored Blackbird conservation from 2005-2009. Report submitted to U.S. Fish and Wildlife Service. 10pp.

Meese, R.J. 2010. Detection, monitoring, and fates of tricolored blackbird colonies in 2010 in the Central Valley of California. Calif. Dept. of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report 2010-06 and U.S. Fish and Wildlife Service, Sacramento, CA. 21 pp. + appendix.

Meese, R.J. 2011. Reproductive success of tricolored blackbird colonies in 2011 in the Central Valley of California. Calif. Dept. of Fish and Game, Wildlife Branch, Nongame Wildlife Program Report 2011-08, Sacramento, CA. 20 pp. + appendix.

Meese, R.J. 2012. Cattle egret predation causing reproductive failures of nesting tricolored blackbirds. California Fish and Game 98:47-50.

Meese, R.J. 2013. Chronic low reproductive success of the colonial tricolored blackbird from 2006 to 2011. Western Birds 44:98-113.

Meese, R.J. 2014a. Results of the 2014 Tricolored Blackbird Statewide Survey. UC Davis.

Meese, R.J. 2014b. Trapping and banding of tricolored blackbirds (*Agelaius tricolor*) from 2012 to 2014. Report submitted to the California Department of Fish and Wildlife. 8 pp.

Meese, R.J. 2015a. Efforts to assess the status of the Tricolored Blackbird from 1931 to 2014. Central Valley Bird Club Bulletin. Special Issue on the Status, Ecology, and Conservation of the Tricolored Blackbird. 17:37-50.

Meese, R.J. 2015b. Detection, monitoring, and fates of Tricolored Blackbird colonies in California in 2015. Calif. Dept. of Fish and Wildlife, Wildlife Branch, Nongame Wildlife Program Report 2015-03, Sacramento, CA. 13 pp. + appendices.

Meese, R.J. 2016. Detection, monitoring, and fates of Tricolored Blackbird colonies in California in 2016. Calif. Dept. of Fish and Wildlife, Wildlife Branch, Nongame Wildlife Program Report 2016-05, Sacramento, CA. 14 pp. + appendix.

Meese, R.J. 2017. Results of the 2017 Tricolored Blackbird statewide survey. Calif. Dept. of Fish and Wildlife, Wildlife Branch, Nongame Wildlife Program Report 2017-04, Sacramento, CA. 27 pp. + appendices.

Meese, R.J., J.L. Yee, and M. Holyoak. 2015. Sampling to estimate population size and detect trends in Tricolored Blackbirds. Central Valley Bird Club Bulletin. Special issue on the status, ecology, and conservation of the Tricolored Blackbird. 17:51-56.

Merkel and Associates, Inc. 1997. General description and overview of biological features of the San Miguel Conservation Bank an associated 500 acre acquisition parcel and 166 acre mitigation site. August 19.

Mineau, P. and C. Palmer. 2013. The impact of the nation's most widely used insecticides on birds. American Bird Conservancy, March 2013.

Mineau, P. and M. Whiteside. 2013. Pesticide acute toxicity is a better correlate of U.S. grassland bird declines than agricultural intensification. PLoS ONE 8(2):e57457. doi:10.1371/journal.pone.0057457.

Moser, S., J. Ekstrom, and G. Franco. 2012. Our Changing Climate 2012: Vulnerability and adaptation to the increasing risks from climate change in California. A summary report on the third assessment from the California Climate Change Center.

National Audubon Society (NAS). 2017. Drought-related monitoring, habitat-use, and prioritization of conservation sites for Tricolored Blackbirds. Report prepared 10 October 2017.

Natomas Basin Habitat Conservation Plan Sacramento and Sutter counties, California (NBHCP). April 2003. Prepared By: City of Sacramento City Hall, 915 I Street, Room 100 Sacramento, CA 95814. Sutter County P.O. Box 1555, Yuba City, CA 95992, The Natomas Basin Conservancy, 1750 Creekside Oaks Drive, Suite 290 Sacramento, CA 95833.

Nebel, S., A. Mills, J.D. McCracken, and P.D. Taylor. 2010. Declines of aerial insectivores in North America follow a geographic gradient. Avian Conservation and Ecology 5(2):1.

Neff, J.A. 1933. The Tri-colored Red-wing in Oregon. Condor 35:234-235.

Neff, J.A. 1934. Tri-colored Red-wing nesting in eastern Shasta County, California. Condor 36:42-43.

Neff, J.A. 1942. Migration of the Tricolored Red-wing in central California. Condor 44:45-53.

Neff, J. 1937. Nesting distribution of the Tricolored Redwing. Condor 39:61-81.

Niven, D.K., J.R. Sauer, G.S. Butcher, and W.A. Link. 2004. Christmas Bird Count provides insights into population change in land birds that breed in the boreal forest. The 104th Christmas Bird Count. American Birds 58:10-20.

North American Bird Conservation Initiative (NABCI). 2016. The State of North America's Birds 2016. Environment and Climate Change Canada: Ottawa, Ontario. 8 pp.

Nuttall, T. 1840. A manual of the ornithology of the United States and Canada. 2nd edition. Hilliard, Gray, and Co., Boston, MA.

Ogden Environmental and Energy Services Co, Inc. August 1998. Final Multiple Species Conservation Program, MSCP Plan, [San Diego County], San Diego, CA.

Orians, G.H. 1960. Autumnal breeding in the tricolored blackbird. Auk 77:379-398.

Orians, G.H. 1961a. Social stimulation within blackbird colonies. Condor 63:330-337.

Orians, G.H. 1961b. The ecology of blackbird (*Agelaius*) social systems. Ecological Monographs 31:285-312.

Orians, G.H. and G. Collier. 1963. Competition and Blackbird Social Systems. Evolution 17:449-459.

Orians, G.H. and G.M. Christman. 1968. A comparative study of the behavior of Red-winged, Tricolored, and Yellow-headed Blackbirds. Univ. Calif. Publ. Zool., volume 84.

Payne, R.B. 1969. Breeding seasons and reproductive physiology of Tricolored Blackbirds and Redwinged Blackbirds. Univ. Calif. Publ. Zool., 90:1-137.

Ray, M.S. 1906. A-birding in an auto. Auk 23:400-418.

Reiter, M.E., N. Elliott, S. Veloz, D. Jongsomjit, C.M. Hickey, M. Merrifield, and M.D. Reynolds. 2015. Spatio-temporal patterns of open surface water in the Central Valley of California 2000-2011: Drought, land cover, and waterbirds. Journal of the American Water Resources Association 51:1722-1738.

Remsen, J.V., Jr., J.I. Areta, C.D. Cadena, S. Claramunt, A. Jaramillo, J.F. Pacheco, J. Pérez-Emán, M.B. Robbins, F.G. Stiles, D.F. Stotz, and K.J. Zimmer. Version 21 January 2017. A classification of the bird species of South America. American Ornithologists' Union. Available from http://www.museum.lsu.edu/~Remsen/SACCBaseline.htm

Richardson, C. 1961. Tricolored Blackbirds nesting in Jackson County, Oregon. Condor 63:507-508.

Robinson, O., et al. 2018. Using citizen science data in integrated population models to inform conservation decision-making. Manuscript in preparation.

San Diego County Water Authority and RECON Environmental, Inc. (SDCWA and RECON) October 2010. San Diego County Water Authority Subregional Natural Community Conservation Plan Habitat Conservation Plan (NCCP/HCP). 4677 Overland Avenue, San Diego, CA 92123.

San Diego Gas & Electric Company (SDG&E). December 15, 1995. San Diego Gas & Electric Subregional Natural Community Conservation Plan. 127 pp. + Apps.

San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (SJMSCP). November 14, 2000.

Sanchez Johnson, Y., F. Hernandez, D.G. Hewitt, E.J. Redeker, G.L. Waggerman, H. Ortega Melendez, H.V. Zamora Trevino, and J.A. Roberson. 2009. Status of White-Winged Dove nesting colonies in Tamaulipas, Mexico. The Wilson Journal of Ornithology 121:338-346.

Sauer, J.R., D.K. Niven, J.E. Hines, D.J. Ziolkowski, Jr, K.L. Pardieck, J.E. Fallon, and W.A. Link. 2017a. The North American Breeding Bird Survey, results and analysis 1966 - 2015. Version 2.07.2017 USGS Patuxent Wildlife Research Center, Laurel, MD.

Sauer, J.R., K.L. Pardieck, D.J. Ziolkowski, Jr., A.C. Smith, M.R. Hudson, V. Rodriguez, H. Berlanga, D.K. Niven, and W.A. Link. 2017b. The first 50 years of the North American Breeding Bird Survey. Condor 119:576-593.

Schwertner, T.W., H.A. Mathewson, J.A. Roberson and G.L. Waggerman. 2002. White-winged Dove (*Zenaida asiatica*), The Birds of North America (P.G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology.

Searcy, W.A. and K. Yasukawa. 1981. Sexual size dimorphism and survival of male and female blackbirds (Icteridae). Auk 98:457-465.

Shuford, W.D., C.M. Hickey, R.J. Safran, and G.W. Page. 1996. A review of the status of the White-faced Ibis in winter in California. Western Birds 27:169-196.

Shuford, W.D. and T. Gardali. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds No. 1. Western Field Ornithologists, Camarillo, CA and California Department of Fish and Game, Sacramento.

Skorupa, J.P., R.L. Hothem, and R.W. DeHaven. 1980. Foods of breeding Tricolored Blackbirds in agricultural areas of Merced County, California. Condor 82:465-467.

Skutch, A.F. 1996. Orioles, blackbirds, and their kin. University of Arizona Press, Tucson, AZ.

Soulard, C.E. and T.S. Wilson. 2015. Recent land-use/land-cover change in the Central California Valley. Journal of Land Use Science 10:59-80.

Soykan, C.U., J. Sauer, J.G. Schuetz, G.S. LeBaron, K. Dale, and G.M. Langham. 2016. Population trends for North American winter birds based on hierarchical models. Ecosphere 7(5):e01351.

Spencer, K. 2003. Tricolored Blackbird. Pp. 578-580 *in* Birds of Oregon: A general reference. D.B. Marshall, M.G. Hunter, and A.L. Contreras, Eds. Oregon State University Press, Corvallis, OR.

Stallcup, R. 2004. Late nesting Tricolored Blackbirds in western Marin County, California. Central Valley Bird Club Bulletin 7:51-52.

Starner, K. and K.S. Goh. 2012. Detections of the neonicotinoid insecticide imidacloprid in surface waters of three agricultural regions of California, USA, 2010-2011. Bulletin of Environmental Contamination and Toxicology 88:316-321.

Stephens, P.A. and W.J. Sutherland. 1999. Consequences of the Allee effect for behavior, ecology and conservation. Trends in Ecology and Evolution 14:401-405.

Thorne, J.H., R.M. Boynton, A.J. Holguin, J.A.E. Stewart, and J. Bjorkman. 2016. A climate change vulnerability assessment of California's terrestrial vegetation. California Department of Fish and Wildlife (CDFW), Sacramento, CA.

Tottrup A.P., K. Rainio, T. Coppack, E. Lehikoinen, C. Rahbek, and K. Thorup. 2010. Local temperature fine-tunes the timing of spring migration in birds. Integrative and Comparative Biology 50:293-304.

Tricolored Blackbird Portal. 2017. Information Center for the Environment, University of California, Davis, and U.S. Fish and Wildlife Service. Accessed online and data retrieved from the online database in January 2017: http://tricolor.ice.ucdavis.edu/.

Tricolored Blackbird Working Group (TBWG). 2007. Conservation plan for the Tricolored Blackbird (Agelaius tricolor). Susan Kester (ed.). Sustainable Conservation. San Francisco, CA. Available at: http://tricolor.ice.ucdavis.edu/node/579.

Unitt, P. 2004. San Diego County bird atlas. Proc. San Diego Soc. Nat. Hist. 39.

U.S. Fish and Wildlife Service (USFWS). June 24, 2003. Intra-service Biological and Conference Opinion on issuance of a Section 10(a)(1)(B) Incidental Take Permit to the City of Sacramento and Sutter County for Urban Development in the Natomas Basin, Sacramento and Sutter Counties, California. Reference number 1-1-03-F-0225. Field Office Supervisor, Sacramento Fish and Wildlife Office, Sacramento, CA.

U.S. Fish and Wildlife Service (USFWS). December 4, 2007a. Intra-service Biological and Conference Opinion on issuance of a Section 10(a)(l)(B) Incidental Take Permit to Pacific Gas & Electric Company (PG&E) for the San Joaquin Valley Operations and Maintenance Program Habitat Conservation Plan, for portions of nine Counties in the San Joaquin Valley, California. Reference number 1-1-07-F-0445. Sacramento Fish and Wildlife Service Field Office, Sacramento, CA.

U.S. Fish and Wildlife Service (USFWS). January 10, 2007b. Biological Opinion 1-6-07-F-812.8, Intra-service formal Section 7 Consultation/Conference for issuance of an Endangered Species Act Section 10(a)(1)(B) Permit (TE144113-0, TE144140-0, and TE144105-0) for The Southern Orange Natural Community Conservation Plan/Master Streambed Alteration Agreement/Habitat Conservation Plan, Orange County, California. Carlsbad Fish and Wildlife Office, Carlsbad, CA.

U.S. Fish and Wildlife Service (USFWS). 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 87 pp.

Vose, J.M., J.S. Clark, C.H. Luce, and T. Patel-Weynand, eds. 2016. Effects of drought on forests and rangelands in the United States: a comprehensive science synthesis. Gen. Tech. Rep. WO-93b. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 289 p.

Wahl, T.R., B. Tweit and S.G. Mlodinow. 2005. Birds of Washington: Status and distribution. Oregon State University Press, Corvallis, OR.

Ward, P. and A. Zahavi. 1973. The importance of certain assemblages of birds as "information-centres" for food-finding. Ibis 115:517-534.

Weintraub, K., T.L. George, and S.J. Dinsmore. 2016. Nest survival of Tricolored Blackbirds in California's Central Valley. Condor 118:850-861.

Western Riverside County Multiple Species Habitat Conservation Plan (WRC-MSHCP), Biological Monitoring Program. March 28, 2011. Tricolored Blackbird (*Agelaius tricolor*), Survey Report 2010 with overview of recent history and current status in Southern California. Available online: http://wrc-rca.org/about-rca/monitoring/monitoring-surveys/.

Western Riverside County Multiple Species Habitat Conservation Plan (WRC-MSHCP), Biological Monitoring Program. April 22, 2013. 2012 Tricolored Blackbird (*Agelaius tricolor*) survey report.

Western Riverside County Multiple Species Habitat Conservation Plan (WRC-MSHCP), Biological Monitoring Program. May 8, 2014. 2013 Tricolored Blackbird (*Agelaius tricolor*) survey report.

Western Riverside County Multi-Species Habitat Conservation Plan (WRC-MSHCP), Biological Monitoring Program. June 8, 2016. 2015 Tricolored Blackbird (*Agelaius tricolor*) survey report.

Western Riverside County Multi-Species Habitat Conservation Plan (WRC-MSHCP), Biological Monitoring Program. February 14, 2017. 2016 Tricolored Blackbird (*Agelaius tricolor*) survey report.

Western Riverside County Regional Conservation Authority (WRCRCA). May 2015. Western Riverside County Multiple Species Habitat Conservation, Annual Report for the period January 1, 2013 through December 31, 2013.

Wheeler, S.S., C.M. Barker, Y. Fang, M.V. Armijos, B.D. Carroll, S. Husted, W.O. Johnson, and W.K. Reisen. 2009. Differential impact of West Nile virus on California birds. Condor 111:1-20.

Wheelock, I.G. 1904. Birds of California. A.C. McClurg and Co., Chicago.

Wilbur, S.R. 1987. Birds of Baja California. University of California Press, Berkeley, CA.

Willett, G. 1912. Birds of the Pacific slope of southern California. Pacific Coast Avifauna No. 7, Cooper Ornithological Club, Hollywood, CA.

Willett, G. 1933. A revised list of the birds of southwestern California. Pacific Coast Avifauna No. 21, Cooper Ornithological Club, Los Angeles.

Williams, A.P., R. Seager, J.T. Abatzoglou, B.I. Cook, J.E. Smerdon, and E.R. Cook. 2015. Contribution of anthropogenic warming to California drought during 2012-2014. Geophysical Research Letters 42:6819-6828.

Wilson, C.R., R.J. Meese, and A.C. Wyckoff. 2016. Breeding chronology, movements, and life history observations of tricolored blackbirds in the California central coast. California Fish and Game 102:162-174.

Personal Communications

Cook, R. Status review comments received November 28, 2017.

Holyoak, M. Status review comments received November 15, 2017.

Stone, B. Phone conversation and email received on July 27, 2017.

Appendix 1
Tricolored Blackbird surveys, 1986–2017

This Appendix briefly describes each effort to survey the Tricolored Blackbird population since 1986. As discussed in the body of the report, the survey approach varied across survey years, with two groups of years (1994, 1997, 2000; and 2008, 2011, 2014, 2017) following relatively consistent approaches and resulting in comparable results. Although surveys in these two groups of years followed similar approaches, there were several differences in methods and in survey effort that preclude direct comparisons of results across these two groups of survey years. Where possible, results have been adjusted for survey effort when discussed in the report.

1986-1990

Beedy et al. (1991) compiled all historical records of Tricolored Blackbird breeding colonies from published and unpublished sources to evaluate the long-term population trends and current status of the species for the USFWS. They also conducted intensive observations at seven colonies in four counties during 1987 and 1988 and made additional irregular observations in seven counties between 1986 and 1990. They concluded that the population had continued to decline since the 1970s (DeHaven et al. 1975b) to an average of 51,600 breeding birds at known colonies in the 1980s. In response to the report by Beedy et al. (1991), a more thorough survey was organized by the Department in 1992, with survey locations informed by ongoing research on the species by Bill Hamilton and others (see below). Results revealed the population to be much larger, indicating that an ad hoc compilation of observation records combined with a limited survey effort over multiple years does not provide an accurate measure of overall population size. Like previous efforts (Neff 1937, DeHaven et al. 1975b), the surveys by Beedy et al. (1991) included only sporadic surveys in the southern San Joaquin Valley.

1992-1993

Basic ecological investigations were conducted that included documentation of colony locations and sizes, discovery of large breeding colonies on grain fields in the San Joaquin Valley, and initial observations that suggested Tricolored Blackbirds are itinerant breeders, but efforts were not extensive enough to provide estimates of the statewide population (Hamilton et al. 1992, Hamilton 1993, Beedy and Hamilton 1997).

1994

Itinerant breeding had recently been documented in Tricolored Blackbirds and this was the first statewide survey conducted over a narrow time period to avoid double-counting birds that shift location between breeding attempts (Hamilton et al. 1995). The documentation of all historical colony sites (Beedy et al. 1991) and recent colony sites (Hamilton et al. 1992, Hamilton 1993) was used to inform a rangewide survey that attempted to visit all known Tricolored Blackbird breeding locations in 1994. The survey was largely volunteer-based and was carried out on a single day (April 23) early in the nesting season to detect as many birds as possible in colonies during their first breeding attempt of the year. The goals of the survey were to document occupancy status and to estimate the size of all active

colonies. Volunteers were asked to visit all known colony locations, estimate numbers at occupied sites, and to drive public roads near known breeding locations to identify previously undocumented colonies (Beedy and Hamilton 1997).

All colonies larger than 10,000 birds were revisited by Hamilton et al. (1995) to verify and sometimes refine estimates. At selected colony sites, the estimates of colony sizes provided by survey volunteers were adjusted using estimated nest densities. This was achieved by running transects through the nesting substrate when nests were active to obtain an estimate of average nest density and the proportion of observed nests that appeared active. More extensive transects were then run after breeding was completed to refine the estimate of nest density. This refined estimate was corrected for the proportion of active nests and multiplied by the total occupied area to obtain an estimate of the number of active nests in the colony. This number was then multiplied by 1.5 to account for an assumed male to female ratio of 1:2. The intent of this approach was to estimate the number of birds that ultimately nested in a breeding colony, but it might not have accurately represented the number of birds present during the survey period. For example, the approach would dismiss large groups of birds that may have been present during colony settlement that ultimately did not breed at a site (i.e., the method fails to account for the presence of any non-breeding adults). This is inconsistent with the goal of the statewide survey to estimate the total number of birds in the population. The approach also violates the condition that observations should be made during a narrow survey window to avoid double-counting birds.

Tricolored Blackbirds were observed in 32 California counties. One hundred active breeding colonies were observed in 28 counties. Ten previously occupied counties were not surveyed. The estimated number of birds observed was 369,400 (+/- 15%) (Beedy and Hamilton 1997). The assumed +/- 15% range in the estimate was based on a small sample of breeding colonies where visual estimates of colony size and estimates based on nest density varied by no more than 15% (Hamilton et al. 1995, Hamilton 1998).

Hamilton et al. (1995) felt that the survey effort in 1994 was "minimal" and that a larger number of birds would have been observed if a more substantial survey had been organized. The survey effort in the southern California portion of the range was especially limited. A single observer made two trips to southern California to search for colonies during the breeding season and organizers considered this portion of the range to be under-surveyed.

1995-1996

Volunteer surveys were conducted on a single day. Surveys were not informed by pre-survey monitoring as in the 1994 survey, and results did not include rangewide follow-up surveys. Some counties were surveyed incompletely, or not at all, and large breeding colonies may have been overlooked. Beedy and Hamilton (1997) concluded that the results of these surveys should not be considered total population estimates for Tricolored Blackbirds.

1997

The 1997 survey used the same coverage, methods, and personnel as did the 1994 survey (Beedy and Hamilton 1997). Participation was greater than in 1994 and most historically occupied counties received at least some coverage (Beedy and Hamilton 1997). The survey in the southern California portion of the range was much more thorough than that conducted in 1994 (Hamilton et al. 1995). The volunteer survey was conducted on April 26.

Breeding and nonbreeding birds were observed in 33 California counties, plus additional birds in one county in Oregon and in Baja California. Seventy-one active breeding colonies were observed (Hamilton 2000). The estimated number of birds observed was 232,960 (+/- 15%) (Beedy and Hamilton 1997).

Despite the 1994 survey being described as a minimal effort that overlooked some unknown number of birds (Hamilton et al. 1995), Beedy and Hamilton (1997) reported that 1994 and 1997 were the only two survey years to date with sufficient survey effort to detect "virtually all large colonies." The observed number of birds declined by 37%, with the greatest declines occurring in the core of the species' distribution in Sacramento, Fresno, Kern, and Merced counties (Beedy and Hamilton 1997).

1999

The organizers of the one-day survey in 1999 (Hamilton et al. 1999, 2000) attempted to follow the same methods as those used in 1994 and 1997, but participation in the survey was low and the total count of about 95,000 birds was considered an underestimate by Hamilton (2000). Much of the population began breeding later than in previous years and many colonies were not detected until after the survey date (Hamilton et al. 1999).

2000

As with the 1994 and 1997 surveys, the 2000 survey attempted to locate all breeding colonies and estimate the number of birds in each colony. The 2000 survey used the same methods used in these two previous surveys, although a greater number of observers participated and visited more locations. A workshop was also held before the 2000 survey to train participants in colony size estimation. Unlike the previous survey years that focused on a single day, the 2000 survey was conducted over four days, from April 21-24. Hamilton (2000) suggested that this differed little from the 1994 and 1997 surveys because records in those years were accepted from one day before and after the survey date, effectively accepting reports over a three-day period, and the addition of a fourth day in 2000 only accounted for an additional 1,750 birds observed. As in 1994 and 1997, survey locations were informed by pre-survey colony detection and monitoring.

Breeding and nonbreeding birds were observed in 25 California counties. Seventy-two active breeding colonies were observed (Hamilton 2000).

Although Hamilton concluded that the 2000 survey located a greater proportion of the entire population than did censuses in previous years, he still felt that the San Joaquin Valley, with its potentially large silage colonies, was not surveyed completely (Hamilton 2000). Nevertheless, he concluded that the

Tricolored Blackbird population had declined during the 1990s, from an estimated 370,000 birds in 1994 to 162,000 birds in 2000.

2001

The survey conducted in 2001 followed a very different approach compared to standardized methods used in the 1990s to survey the statewide population. Only 48 sites were surveyed and sites were visited throughout the breeding season rather than being restricted to a narrow survey window of a few days (Humple and Churchwell 2002). As had been demonstrated in the 1990s, a season-long approach to detecting and surveying colonies may result in double-counting of birds that move between locations. Conversely, the limited number of sites visited likely underrepresented the breeding population. The effect of these inconsistencies in methodology and effort on survey results is unclear, and results cannot be compared to those of other survey years.

2004

The four-day survey conducted in 2004 was not intended to produce an estimate of the statewide population size comparable to previous surveys. The survey was limited to colony sites that had historically supported more than 2,000 birds and focused on those located in the Central Valley (Green and Edson 2004). Participation was low with only 29 volunteers conducting surveys. Based on well-documented occupancy dynamics of Tricolored Blackbird, this approach is likely to miss large breeding colonies. No training was provided to participants prior to the survey.

2005

There was no report produced describing the 2005 survey and its results, and the only record available to the Department is a spreadsheet listing occupied sites with estimates of colony size at each location. There is no record of the survey methods used nor the effort expended in conducting the survey.

The number of birds observed was reported as about 258,000 birds at 121 occupied sites (Meese 2015).

2008

The survey methods used to obtain the population estimate in 2008 were similar to those used in statewide surveys conducted in the previous survey years of 1994, 1997, and 2000 (Kelsey 2008). However, the methods differed in a number of ways that likely affected the estimated number of birds and precluded a direct comparison of the earlier surveys with results from 2008:

1. The volunteer survey was conducted on a single day in 1994 and 1997 and over four days in 2000, compared to three days in 2008. However, in 1994 and 1997, birds that were observed one day before and after the survey day but not associated with a colony were included in the estimate, effectively expanding the survey to three days for incidental observations.

2. Despite the narrow survey windows established in each of the survey years, no survey has practiced strict adherence to the requirement that all observations occur during the survey window. For example, in the earlier survey years (1994-2000), birds seen at colonies before the survey date were included in the estimate if those colonies remained active after the survey window but were not observed during the survey dates. Also, breeding birds found after the

date of the surveys were included if nest phenology suggested a colony must have been active during the survey dates. Since 2008, there has been a greater emphasis on adhering to the survey dates, but exceptions have been made on a case-by-case basis each year if observations suggest that birds were missed during the survey window (July 2017 email from B. Meese to N. Clipperton; unreferenced).

3. In the earlier survey years, when multiple observations were available at colonies throughout the breeding effort, the number of birds at a colony was recorded based on the maximum number of nests, which ignored any changes in colony size over time, as opposed to using the number of birds observed only during the survey window. However, Hamilton et al. (1995) stated that the difference between maximum and minimum observations were not great at any large colony. In recent years, when multiple observations at a location during the survey window resulted in multiple estimates, the average has typically been reported as the number of birds for the location.

4. In the earlier survey years, the estimates of colony sizes provided by survey volunteers were sometimes adjusted using estimated nest densities, as described above under the 1994 survey. This adjustment has not been employed in surveys conducted since 2008. The proportion of colonies with estimates adjusted using this approach varied across survey years 1994, 1997, and 2000 and was not always reported.

These methodological differences between survey years may have had both positive and negative effects on the overall estimate, and the magnitude and direction of effect on the estimates are not known. Therefore, caution is warranted in making comparisons between the earlier group of surveys and those conducted since 2008.

The 2008 survey also included several enhancements relative to the earlier surveys:

1. County coordinators were used for the first time to ensure that each surveyed county was well-surveyed by local volunteers.
2. Maps with all survey locations were provided for the first time, and a website was developed prior to the survey that was available for downloading all survey materials and uploading survey data (Tricolored Blackbird Portal; http://tricolor.ice.ucdavis.edu/). The availability of the portal for distribution of materials allowed participants to be better informed about colony locations and likely contributed to the increase in number of sites surveyed.
3. The number of survey participants and the number of sites surveyed greatly increased relative to earlier surveys (Kelsey 2008). The result was a more complete survey and more reliable data collection and reporting.

In addition to these enhancements to the survey, several new colony locations in the San Joaquin Valley had been discovered in 2006 and 2007 through targeted searches. By surveying at dairies throughout the San Joaquin Valley (rather than relying on previously known colony locations), Meese (2006, 2007) located several colonies in new locations on grain fields that numbered in the tens of thousands of birds. The effect of these new procedures and increased effort on the proportion of the Tricolored Blackbird population observed is unknown, but a larger proportion of the population was likely observed in

surveys conducted since 2008 compared to previous surveys. As was first implemented in 2000, training sessions were also provided to survey volunteers. The 2008 survey was conducted from April 25-27.

A total of 155 volunteers participated in the 2008 survey and visited 361 historical and new locations in 38 counties (Kelsey 2008). The total estimate for number of birds observed was 394,858. Many of the larger colonies were visited by Tricolored Blackbird experts, which is consistent with earlier statewide surveys. Kelsey (2008) reported that some portion of the increase in observed number of birds since the 2000 survey may have been attributable to increased survey effort, but did not think that the increase was entirely due to the increased effort.

2011

The survey methods followed in 2011 were largely the same as those used during the 2008 survey (Kyle and Kelsey 2011), although a different approach to coordinating the survey was used. Rather than establishing county coordinators to ensure complete coverage of each surveyed county, the 2011 survey was organized by a statewide coordinator using online resources. Volunteers were asked to sign up for survey areas using the online portal and a statewide coordinator tracked survey coverage. The survey was conducted over three days, from April 15-17.

A total of 100 volunteers participated in the 2011 survey and visited 608 historical and new locations in 38 counties (Kyle and Kelsey 2011). The total estimate for number of birds observed was 259,322.

2014

The 2014 survey followed the methods used in 2008 and 2011. As in the 2008 survey, county coordinators were again used to ensure thorough coverage of each county (Meese 2014). The survey was conducted over three days, from April 18-20.

A total of 143 volunteers participated in the 2014 survey and visited 802 historical and new locations in 41 counties (Meese 2014). Based on number of volunteers, counties covered, and number of sites visited, this was the most complete statewide completed to date. The total estimate for the number of birds observed was 145,135.

2017

The 2017 survey followed the methods used in 2008-2014. The survey was conducted over three days, from April 7-9 (Meese 2017). For 2017, additional survey forms were used to collect additional information on weather conditions, survey effort, site occupancy, and the suitability of nesting habitat at each surveyed location. Maps of survey locations were also updated and included online maps that could be used to navigate to sites in the field using a smartphone app.

A total of 181 volunteers participated in the 2017 survey and visited 884 historical and new locations in 44 counties (Meese 2017). Based on number of volunteers, counties covered, and the number of sites visited, the 2017 survey was even more thorough than the 2014 survey. The total estimate for the number of birds observed was 177,656.

Appendix 2

Observations on the Tricolored Blackbird statewide survey methods and sources of uncertainty

Methods of estimating population abundance and the approach used in statewide surveys

In surveys designed to estimate the number of individuals in a population, abundance data may be collected through a sampling approach that focuses on a representative subset of locations, or through a census that aims at a complete count of all birds within a survey boundary (Gregory et al. 2004). Many different approaches have been developed to sample data from a population in a defined area of interest, with the underlying goal to provide an estimate of the full population size and some measure of estimation error. Species that are spatially highly-clumped, or rare and occurring within a restricted range or at a limited number of sites, are often not amenable to sampling approaches because of the difficulty in designing an approach that results in a sample representative of the full population (i.e., an unbiased sample). These species may be more amenable to censuses, especially when highly conspicuous like the Tricolored Blackbird (Gregory et al. 2004).

Conducting a census of colonial species requires that breeding locations first be identified. For species with high site fidelity to traditional breeding locations (e.g., seabirds, some herons) it can be fairly straightforward to identify breeding sites and monitor the population of interest. Due to the dynamic occupancy patterns of Tricolored Blackbird breeding colony locations and the large geographic scale where statewide surveys are conducted, it is not possible to ensure every breeding colony is located and counted in any given year. Because of these difficulties, the approach for statewide surveys to date (since 1994) has been to conduct early season colony detection work to identify active colonies, then to combine these with all historical colony sites to attempt a comprehensive search of known breeding locations over a short (usually 3-day) survey window.

Some unknown portion of the Tricolored Blackbird population is not located and counted during each survey, and therefore the results of statewide surveys might be best described as an index of abundance that can be compared over time to evaluate population trends. Indices are based on the idea that a fixed amount of searching effort will always locate a fixed proportion of the population; therefore, changes in the index should be directly proportional to changes in the population size (Gregory et al. 2004). The dynamic inter-annual occupancy patterns of the Tricolored Blackbird can complicate efforts to meet this assumption, but the somewhat predictable distribution in the early breeding season, paired with pre-survey efforts to locate large breeding colonies may help to address this issue. As described in the body of this report, the recent approach to statewide surveys has been an ever-increasing effort across survey years to visit as many of the known historical breeding locations as possible, which themselves increase as additional breeding locations are discovered by survey participants and as birds shift to establish new breeding locations on the landscape. An ever-increasing survey effort is not a sustainable approach to monitoring the species, and it violates the assumption of a constant search effort in indices of

abundance (an increasing effort over time may allow for documentation of a negative population trend, but may confound interpretation of any observed increase in population numbers).

Recent work to establish a survey design based on a random stratified sample has provided a method to estimate the number of birds that would result from a full census without the required effort to visit all known colony sites (Meese et al. 2015). The approach followed in sample surveys conducted in 2015 and 2016 was to attempt a complete census of five counties where the majority of the population occurs each April, and to survey the remaining counties based on a stratified sample, with bioregion and nesting substrate as sampling strata. The intent of this new survey design was to provide a method whereby the population could be monitored annually during years when a full triennial survey is not conducted, with a smaller force of volunteer surveyors. The data from these sample surveys are currently being analyzed and will likely result in revisions to the sampling approach. Results may also inform revisions to the triennial survey. Potential modifications to statewide surveys may include 1) removal of sites that are no longer suitable for Tricolored Blackbird nesting, 2) removal of sites that have not been occupied by Tricolored Blackbirds within a certain number of years, assuming sites have been surveyed on a regular basis, 3) removal of entire regions of the state where the species has declined or disappeared, or 4) increased opportunities to conduct multiple observations per colony site for estimation of detection probability and estimation error, or other modifications. Ultimately, the triennial attempts at a full census might be replaced with an annual or longer-duration sample survey.

Sources of uncertainty in Tricolored Blackbird population estimates

Geographic coverage

As shown in Figure 9 (distribution of colony sites visited 2008-2017) in the body of this report, survey locations visited during statewide surveys have been well distributed throughout the California range of the Tricolored Blackbird. As the survey effort has increased with each successive survey, the portion of the range surveyed has filled in as volunteers have visited more locations within the range. The addition of survey locations also results in an increased area searched as volunteers drive from one survey location to the next. In some years, birds at the geographic fringe of the range may have been excluded from the survey effort, but these areas have never supported large numbers of birds during the early breeding season and so this is unlikely to have a large effect on the overall estimate or index. For example, in statewide surveys in which Siskiyou County was included, it has held only 0-0.2% of the total estimate of birds observed. In some portions of the range (e.g., the Sierra foothills), there are areas with low road density and private property with no access and therefore some unknown number of colonies are likely missed each year. For example, Airola et al. (2016) estimated that only 36% of the available habitat was surveyed in a study of the Sierra Nevada foothills that utilized public roads (with a range of 26% to 44% depending on region of the foothills). This is a consistent omission in each survey year so it might not have a large impact on trend detection.

Detectability of colonies

Small breeding colonies are likely missed during each survey, especially in areas where small colonies might occur distant from any known colony site, and therefore are not located within the focused search area. Because Tricolored Blackbird colonies are extremely conspicuous leading up to and throughout most of the nesting cycle, most large colonies that would contribute substantially to the overall statewide estimate are likely to be observed during the 3-day search window, unless they occur at a large distance from public roads (Kelsey 2008). Given the concentration of birds in relatively few large colonies and within a few well-known and well-surveyed portions of their range, especially the San Joaquin Valley, Kelsey (2008) concluded that "it is unlikely that large numbers of Tricolored Blackbirds go undetected during the statewide surveys." Additionally, in areas of the state where most of the population breeds early in the nesting season (e.g., San Joaquin Valley), extensive pre-survey scouting occurs in an attempt to locate colonies, both for survey purposes and to initiate colony protection efforts where colonies occur on agricultural fields. Even if a colony site is not visible from a road, large colonies can be detected and identified by the species' diagnostic feeding flights as they move between the colony location and foraging habitat. The density of roads may limit observation of a portion of the landscape and some unknown proportion of colonies goes undetected each year; this is a limitation common to all survey years.

Julie Yee (Statistician with the USGS) used data from the 2008 statewide survey, which was the first statewide survey to consistently record colony absence information and contained incidentally collected double-observer data for certain colony sites, to evaluate colony detection rate. The per-visit detection probability (i.e., the likelihood that an occupied colony location will be detected) was 0.94, which is quite high (Nov 2016 email from J. Yee to N. Clipperton; unreferenced).

Timing of survey and nesting phenology

The number of birds present and visible at a colony location can vary dramatically across the nesting cycle. During settlement, many more birds may be present at a site than ultimately remain to breed, and the high level of activity can make estimation difficult. However, these birds are part of the adult population and should be included in survey estimates, although this may not have been the case in 1994-2000 when estimates were adjusted using nest densities. During incubation, females may be unaccompanied by males at the colony site and may remain on their nests hidden from view. At this stage the counts of birds at a colony may result in underestimates (Hamilton et al. 1995). Visual estimates of colony size are probably best made during the nestling/fledgling provisioning stage when both parents are visible and are making regular trips to and from the colony site (Hamilton et al. 1995).

The statewide surveys have regularly been conducted in the early part of the nesting season to capture the first breeding attempts of most of the population. The timing of nesting can vary annually, so there is no way to plan survey dates for a time when most colonies are at a certain stage of the nesting cycle. Tricolored Blackbirds have begun nesting earlier in the year, perhaps in response to climate change (e.g., see Tottrup et al. 2010, Mazerolle et al. 2011). Between 1939 and 2009, the mean date of first breeding date has shifted to occur about 22 days earlier (M. Holyoak pers. comm.), and the survey period for

statewide surveys has been shifted to accommodate this in an attempt to sample the population during similar times in the nesting cycle.

Colony size estimation

Estimation of colony size may be the largest source of uncertainty in the number of birds estimated on statewide surveys. Hamilton et al. (1995) suggested that observer variability was a substantial source of error in population estimates, but felt that colony size estimates were accurate to within 15% based on efforts to verify colony size using nest densities. For this reason, results from the 1994 and 1997 surveys were provided with an error range of +/- 15%.

In each of the four most recent survey years (2008, 2011, 2014, and 2017), several steps have been followed to reduce the amount of observer-based error. Volunteers were provided with training in Tricolored Blackbird identification, estimation of colony size, use of maps and online tools, and a standard survey protocol. Many of the participants, especially those coordinating county efforts, have been knowledgeable observers with experience participating in multiple survey years, and the same survey participants are enlisted from year to year when possible. As with surveys from previous years, most of the largest colonies have been revisited by experienced observers to verify colony size estimates.

Since 2008, volunteers have been asked to provide a best estimate of colony sizes, plus a range incorporating the minimum and maximum number of birds that could be present at a site. This request may be interpreted differently by different observers. For example, some observers may provide a large range to be certain that the minimum and maximum numbers capture the true size of the colony, whereas others may treat the range as a measure of their ability to accurately count the observed birds. However, it does provide some sense of how certain an observer is in their ability to accurately estimate the size of a colony. Observers show a natural tendency to overestimate small flocks and underestimate large flocks, although the extent to which different observers do this varies greatly (Gregory et al. 2004) and the effect on the overall population estimate from multiple colonies is unclear. The range provided by observers to capture the minimum and maximum estimates has averaged about +/-25% [range for 2008, 2011, and 2014 surveys of -29% to +33%] of the best estimates across all colony sites. Unfortunately, data have not been collected in a way that allows for statistical estimates of error around the annual indices of abundance, but the similar survey protocols and extensive and increasing survey effort have provided information sufficient for detecting a long-term population decline. Ongoing efforts to revise the statistical sampling scheme for monitoring the Tricolored Blackbird population will incorporate methods to produce error estimates (Meese et al. 2015).

Appendix 3
Analysis of Christmas Bird Count Data

Because the number of Christmas Bird Count (CBC) circles is known to have increased dramatically through the 1950s and 1960s, especially in the western region of the U.S. (Niven et al. 2004), data were evaluated to determine an appropriate year to use as a start date for trend analysis. The first CBC to detect Tricolored Blackbird in California was conducted in Marysville in count year 12 (i.e., the winter of 1911–1912). CBC circles in California were sparse and were conducted inconsistently for several decades before the number of circles detecting Tricolored Blackbird began to increase in the 1950s and 1960s. The year 1974 was selected as the start year for a trend analysis using CBC data for the following reasons:

1. Following a period of rapid increases in the number of CBC circles in California through the 1960s, 1974 was the first year when Tricolored Blackbirds were detected on more than 25 circles. Annual increases in the number of party hours spent searching for birds also began to level off in the mid-1970s. The number of circles with Tricolored Blackbird detections in California continued to increase through the 1970s and 1980s, with detection of the species on 35 circles by 1978, 40 circles by 1981, and 50 by 1986.
2. DeHaven et al. (1975b) assessed the population status of the Tricolored Blackbird in the early 1970s, so selection of 1974 as a start date for CBC analysis allows for trend assessment since that important benchmark.
3. Graves et al. (2013) used data collected between 1935 and 1975 to evaluate trends in average colony size during a period when the Tricolored Blackbird population was reported to have declined by about 50% (Neff 1937, DeHaven et al. 1975b), and observed a negative trend. They selected data from 1980 to 2009 to evaluate more recent trends without finding evidence of a continued decline in average colony size. The use of data starting in the mid-1970s for a CBC data analysis allows for comparison of winter population trend to the results for average colony size from Graves et al. (2013).

CBCs circles are not run consistently every year. To ensure that apparent trends were not artifacts of the years when certain circles were run, data from CBC circles were included only if the circle met the following criteria:

1. Tricolored Blackbird was detected on the circle in more than 50% of survey years from 1974 to 2015 (at least 22 of 42 years).
2. The first detection of Tricolored Blackbird on a circle occurred no later than 1985. As mentioned above, new CBC circles continued to be added over the years; this criterion was implemented to limit the effect that an increasing set of circles might have on long-term trends.

Based on these criteria, 46 CBC circles were selected to assess winter population trend from 1974 to 2015 (Figure A3.1). The circles provide decent coverage of the winter distribution of the Tricolored

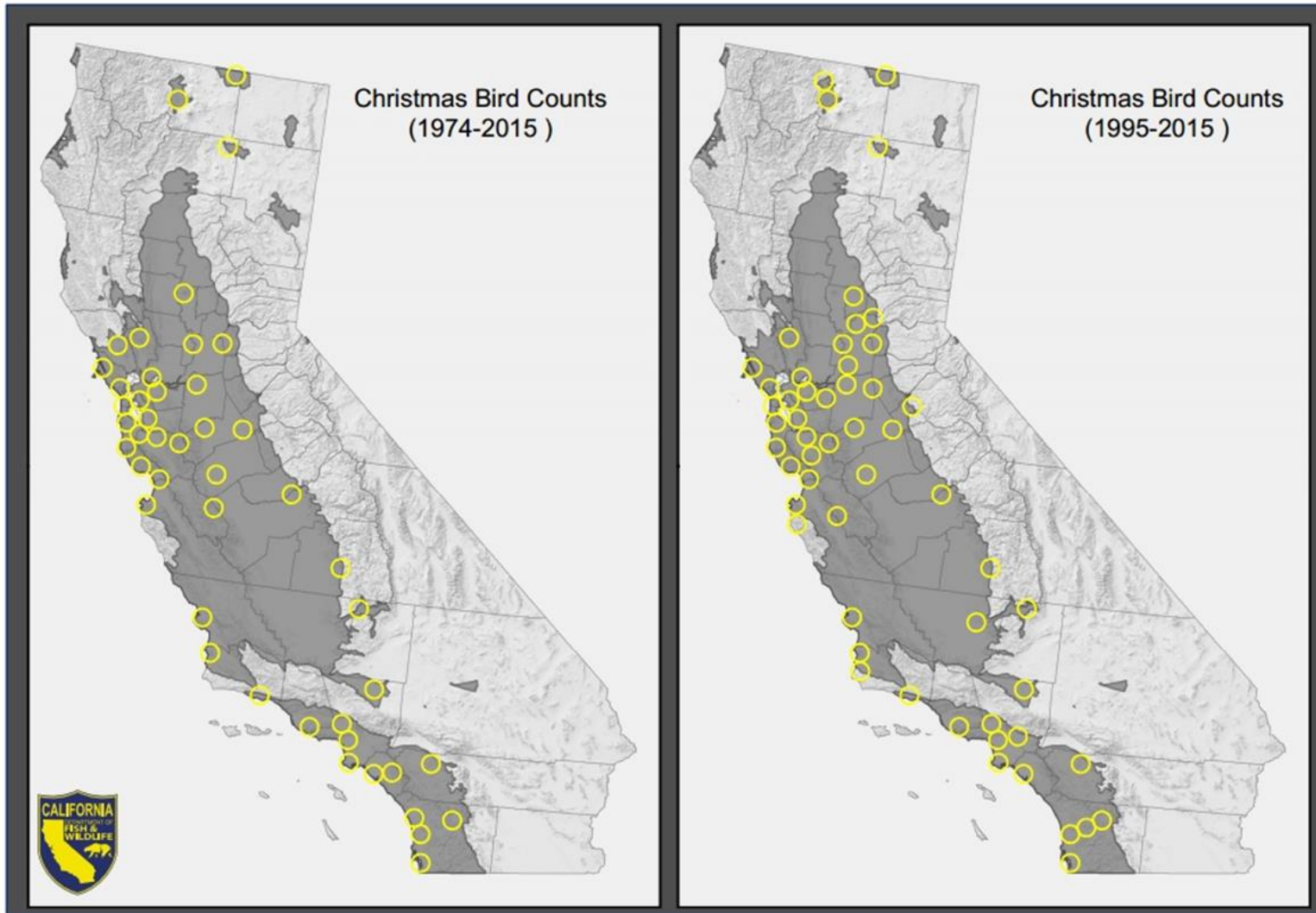a)   b)

Figure A3.1. Christmas Bird Count circles used for trend assessment. a) Circles for which data were analyzed over a long-term period (1974–2015). b) Circles for which data were analyzed for a shorter-term period (1995–2015) during which more data were available.

Blackbird on the central California coast, the Delta and adjacent portions of the Central Valley, and of southern California. Coverage of the southern San Joaquin Valley is limited.

Although some CBC circles are run in all or most years, annual survey coverage of established circles continues to vary. However, the number of circles run each year has been much more consistent since the early 1990s. For example, from 1992 to 2015 the number of circles with detections of Tricolored Blackbird ranged from 54 to 66. A separate analysis was conducted using data from years 1995–2015. This allowed for use of a larger number of circles for trend evaluation and a more consistent set of data from year to year. This is also the time period for which the best data are available from Tricolored Blackbird breeding season surveys. Data from circles were included for analysis of trends over this narrower time period only if Tricolored Blackbird was detected on the circle in at least 13 of the 21 survey years. The resulting 55 CBC circles provided somewhat improved coverage of the northern San Joaquin and southern Sacramento valleys compared to the 1974–2015 analysis (Figure A3.1).

Because of the variable number of observers and time spent surveying CBC circles each year, it is common practice to evaluate effort-corrected data (birds detected/party hour). Although results are highly variable from year to year, data from the 46 circles evaluated for the 1974–2015 period showed a clear decline (Figure A3.2). The graph in Figure A3.2 only includes circles for which at least one Tricolored Blackbird was detected because data on survey effort (party hours) were unavailable for counts that were conducted but observed zero Tricolored Blackbirds. Therefore, the value for average birds per party hour are likely inflated for years that included circles with many non-detections. This likely results in a trend that is biased upward (positive) in recent years, as the number of circles with zero Tricolored Blackbirds has been increasing over the last two decades (Table A3.1).
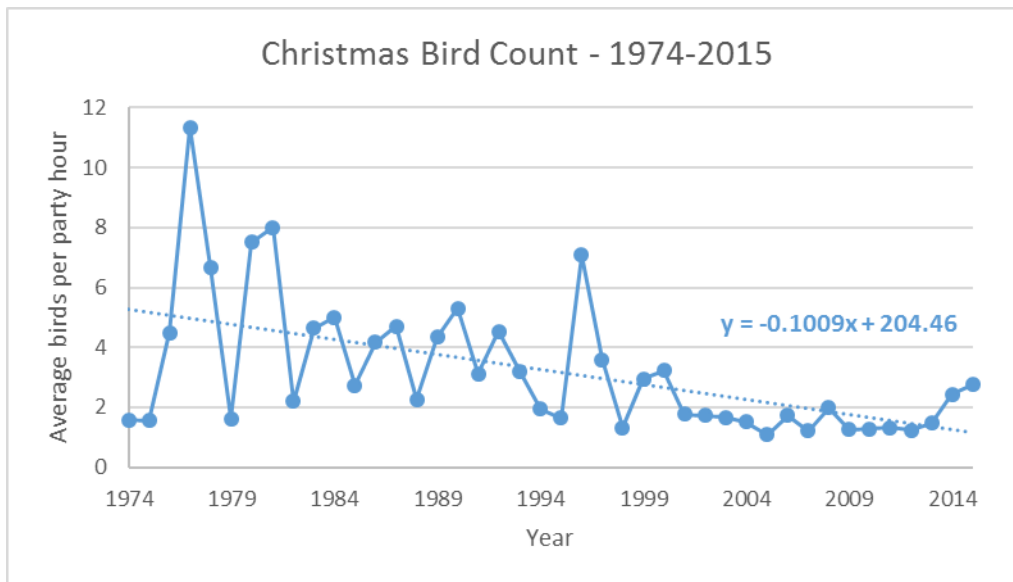

Figure A3.2. Effort-corrected numbers of Tricolored Blackbirds observed on Christmas Bird Counts conducted from survey year 74 (winter 1973–1974) to survey year 115 (winter 2014–2015).

A3-3

Table A3.1. Number of circles with no Tricolored Blackbirds detected over the last 25 years.

Survey years	Average annual number of circles with zero TRBL (percent)[1]
1991–1995	3.2 (7%)
1996–2000	5 (11%)
2001–2005	7 (15%)
2006–2010	10.6 (23%)
2011–2015	13.4 (29%)

[1] Percent of the total 46 circles included in the analysis.

Population trends were estimated from the slope of the regression of the log-transformed counts on year. Because of the need for log-transformation to obtain normally distributed data, only circles with at least one Tricolored Blackbird detection were included. Whether all circles in each year were treated as independent samples (Figure A3.3) or were averaged for a single annual value of birds/hour (Figure A3.4), the 1974–2015 data show a negative trend in number of birds observed (i.e., the slope is not zero; p-values <0.001).
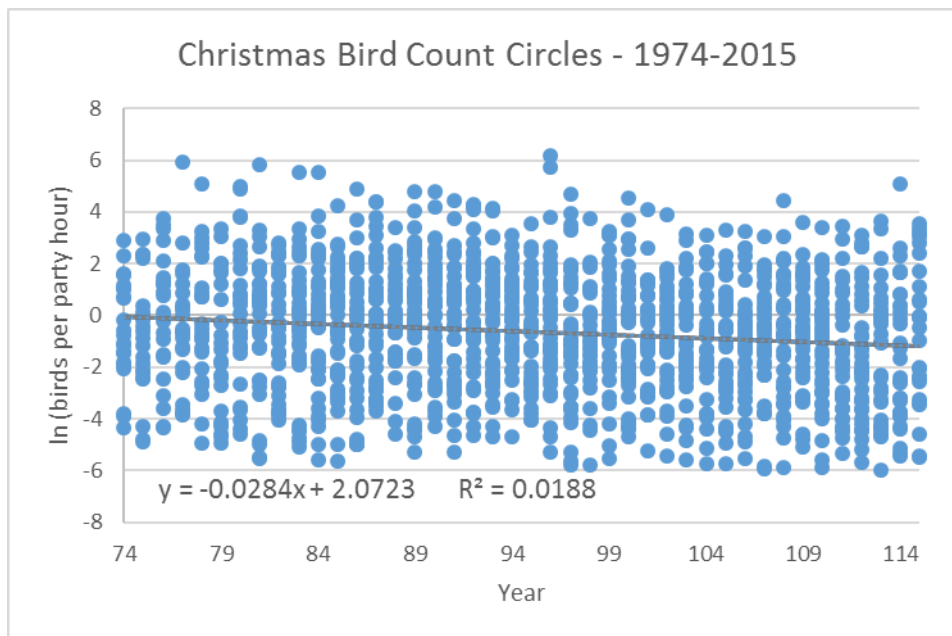

Figure A3.3. Christmas Bird Count data for all circles with Tricolored Blackbird detections (of the 46 circles selected for the analysis) from 1974 to 2015, with least squares line.
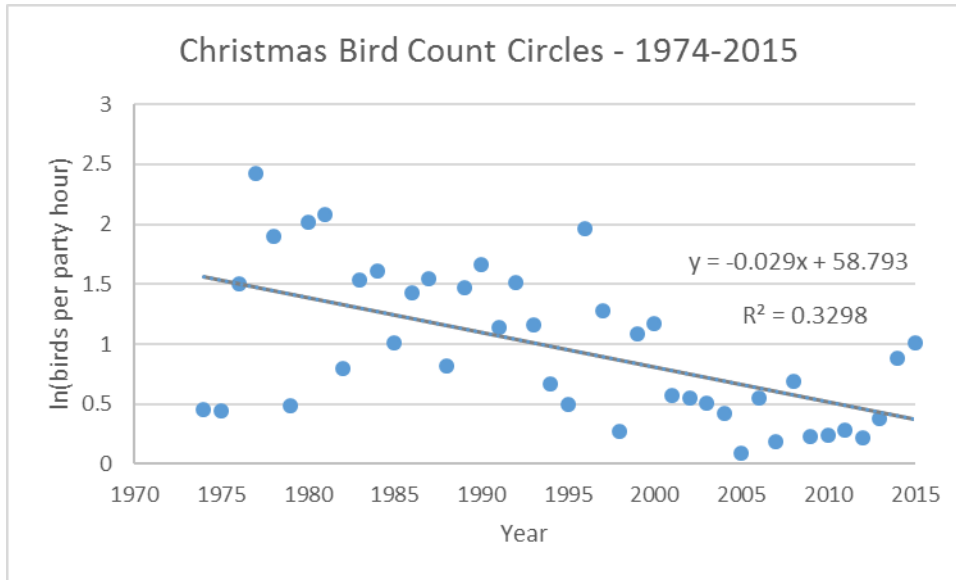
Figure A3.4. Christmas Bird Count data with circles averaged for a single value per year.

Data from the 55 circles evaluated for the 1995–2015 period show a decline, but this is primarily due to a large number of birds detected in 1996 (Figure A3.5). Since 1997, there is no apparent strong trend in the data, but rather a consistent low number of birds (<5 birds/party hour) observed in most years. This is a large contrast to the peaks in numbers seen 1977–1996. As with the analysis of data from 1974 to 2015, the graph in Figure A3.5 only includes circles for which at least one Tricolored Blackbird was detected. Therefore, the values for average birds per party hour are likely inflated for years that included circles with many non-detections, and this would have a larger effect in the most recent years (Table A3.1).
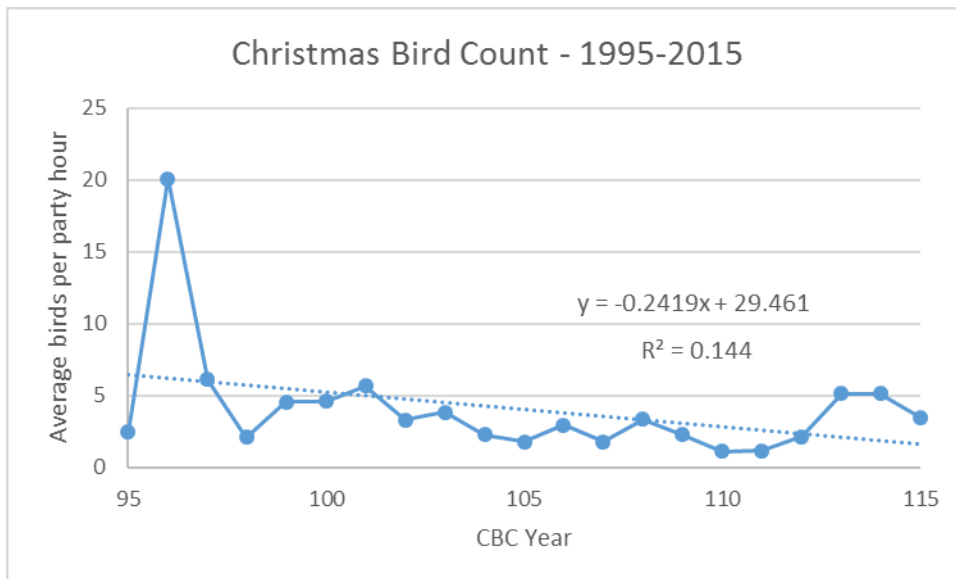

Figure A3.5. Effort-corrected numbers of Tricolored Blackbirds observed on Christmas Bird Counts conducted from survey year 95 (winter 1994–1995) to survey year 115 (winter 2014–2015).

For the shorter 1995–2015 time period, the requirement that Tricolored Blackbird be seen on a circle in at least 13 years for data from the circle to be considered had the unintended consequence of eliminating circles with previous detections of Tricolored Blackbird, but that in recent years have had none. For example, the Oceanside-Vista-Carlsbad circle had only two Tricolored Blackbirds detected in a single year since 2001, Orange County (northeastern) had only 12 birds seen in a single year since 2006, Palo Alto had birds seen in only two years since 2004, and Peace Valley (which recorded the largest number of Tricolored Blackbirds ever found on a CBC circle in 1977) had no birds detected since 2001. None of these circles were included in the analysis, which may have biased the observed trend to the positive. Additional count circles, although included in the analysis because they had at least 13 years of detections during 1995–2015, also saw declines to zero birds in recent years. These include the Los Angeles circle that had no Tricolored Blackbird sightings since 2011; Oakland, which had no Tricolored Blackbirds in 2015 and no more than seven birds since 2008; Orange County (coastal), with no birds detected since 2008; and San Fernando Valley, with only four birds seen in one year since 2008. Due to a lack of data, the effort at these circles where no birds were observed is not included in estimates of birds/party hour, which may obscure any negative trend in recent years.