CONSERVATION STRATEGY 2022 UPDATE

CENTRAL VALLEY FLOOD PROTECTION PLAN

NOVEMBER 2022

Cover Image: California Department of Water Resources 2007.
General description: An aerial view of the Sacramento River, the largest river in California, near Gerber at Oat Creek and Deer Creek. Photo taken May 25, 2007 by Dale Kolke.

Central Valley Flood Protection Plan Conservation Strategy 2022 Update

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This document was prepared for submission to the Central Valley Flood Protection Board Pursuant to the California Central Valley Flood Protection Act of 2008.

by

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Acronyms and Abbreviations

Acronym	Definition
BSOG	Butte Slough Outfall Gates
BWFS	Basin-Wide Feasibility Study
California EPA	California Environmental Protection Agency
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CNRA	California Natural Resources Agency
Conservation Strategy (or Strategy)	Central Valley Flood Protection Plan Conservation Strategy
CPA	conservation planning area
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVPIA	Central Valley Project Improvement Act
Delta	Sacramento–San Joaquin Delta
DFM	Division of Flood Management
DMI	Division of Multi-Benefit Initiatives
DWR	California Department of Water Resources
eDNA	environmental deoxyribonucleic acid
EIR	environmental impact report
ESA	Endangered Species Act

Acronym	Definition
Flood-MAR	flood-managed aquifer recharge
FPTS	Flood Performance Tracking System
FROA	Floodplain Restoration Opportunity Analysis
GIS	geographic information system
GO	general obligation
HCP	habitat conservation plan
IRWM	integrated regional water management
LMA	local maintaining agency
MCA	mitigation credit agreement
MOOM	multiple-objective operations and maintenance
NCCP	natural community conservation plan
NEPA	National Environmental Policy Act
NGO	nongovernmental organization
NMFS	National Marine Fisheries Service
O&M	operations and maintenance
P3	public-private partnership
RCIS	regional conservation investment strategy
RFMP	regional flood management plan
SERP	Small Erosion Repair Program
SGMA	Sustainable Groundwater Management Act
SJRRP	San Joaquin River Restoration Program
SPA	systemwide planning area

Acronym	Definition
SPFC	State Plan of Flood Control
SRA	shaded riverine aquatic
SSIA	State Systemwide Investment Approach
State	State of California
Strategy (or Conservation Strategy)	Central Valley Flood Protection Plan Conservation Strategy
SWIF	Systemwide Improvement Framework
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WSAFCA	West Sacramento Area Flood Control Agency
YBCS	Yolo Bypass Cache Slough

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Species Names

Common Name	Scientific Name
bank swallow	*Riparia riparia*
California black rail	*Laterallus jamaicensis coturniculus*
California Central Valley steelhead distinct population segment	*Oncorhynchus mykiss*
Chinook salmon—Central Valley fall- and late-fall-run, Central Valley spring-run, and Sacramento River winter-run evolutionarily significant units	*Oncorhynchus tshawytscha*
delta button-celery	*Eryngium racemosum*
delta smelt	*Hypomesus transpacificus*
giant gartersnake	*Thamnophis gigas*
giant reed	*Arundo donax*
greater sandhill crane	*Grus canadensis tabida*
green sturgeon—southern distinct population segment	*Acipenser medirostris*
Himalayan blackberry	*Rubus armeniacus*
least Bell's vireo	*Vireo bellii pusillus*
monarch butterfly	*Danaus plexippus*
red sesbania	*Sesbania punicea*
riparian brush rabbit	*Sylvilagus bachmani riparius*
riparian (or San Joaquin Valley) woodrat	*Neotoma fuscipes riparia*

Common Name	Scientific Name
slough thistle	*Cirsium crassicaule*
Swainson's hawk	*Buteo swainsoni*
tricolored blackbird	*Agelaius tricolor*
valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*
yellow-breasted chat	*Icteria virens*

Preface

The publication of the 2016 Central Valley Flood Protection Plan (CVFPP) Conservation Strategy by the California Department of Water Resources (DWR) was an important event in the evolution of multi-benefit flood and river management in California's Central Valley. It represented the culmination of years of discussion, collaboration, negotiation, and hard work by DWR, the Central Valley Flood Protection Board (CVFPB), and a diverse range of flood management, agricultural, and environmental interests in the Sacramento and San Joaquin Basins. The precursor to the 2016 Conservation Strategy, the 2012 Conservation Framework, was the first comprehensive effort to assess how the Central Valley flood management system should contribute to the conservation of affected native fish and wildlife.

In the five years since its adoption, the Conservation Strategy has provided foundational guidance on how to develop flood management plans and projects that also benefit the fundamental geomorphic and ecological processes and habitats essential for native fish, birds, and other species. As described here, and combined with information gathered in multiple forums and partnerships, the Conservation Strategy has contributed to the implementation of iconic multi-benefit projects, including the Hallwood Side Channel and Floodplain Restoration Project on the Lower Yuba River and the Dos Rios Ranch Floodplain Expansion and Ecosystem Restoration Project, Phase I on the San Joaquin River.

This 2022 Update to the Conservation Strategy advances the state of knowledge on key topics, which include the following:

- Updating data sources, relevant information, and the list of target species.
- Reporting on progress toward meeting the measurable objectives developed in the 2016 Conservation Strategy.
- Strengthening alignment of the Conservation Strategy with the CVFPP through common themes.
- Identifying impediments to the pace and extent of multi-benefit project implementation.
- Providing detailed information about funding, partnerships, regulatory compliance, and CVFPB Advisory Board recommendations.

Perhaps the most significant contribution of the 2022 Update to the Conservation Strategy is the spotlight on how the escalating pace of climate change is a fundamental threat to the natural resources of the Central Valley. Current and impending changes in temperature, precipitation, and hydrology will directly and indirectly alter the geomorphic and ecological processes that influence riverine habitat formation, evolution, and diversity. For some species, including California's native fishes, this may have dire consequences in the coming decades.

As described in Appendix H (Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update), the Conservation Strategy provides the requisite guidance for adapting to a changing climate in relation to flood and ecosystem management in the Central Valley. Its measurable objectives build ecological resilience by focusing on the restoration of critical geomorphic and ecological processes, such as:

- Restoring river meander and complexity by increasing the floodplain width.
- Restoring connectivity and function of floodplain and riparian habitats.
- Removing hard bank protection and invasive plant species.

It is only by increasing the pace and scope of restoration of these processes that we can build the diversity and range of these riverine habitat assemblages that will provide the refuge, food, and ecological services necessary to allow our native fish and wildlife species the ability to adapt to the additional stresses of climate change.

And here is the opportunity: the compatibility between large-scale expansion of bypasses and river corridors, reconnection of floodplains, and restoration of native habitats also benefits the primary goal of the CVFPP: flood risk reduction. By implementing these nature-based solutions, we also benefit from increased flood system conveyance capacity, floodwater attenuation, and reduced flood risks to our communities and farmlands. Our goal is to prioritize the policies and actions that allow us to accelerate the rate and extent of multi-benefit projects that provide this range of benefits, in a manner that builds resilience for both human and natural communities, and we need to do this soon. Historical and current investments and policies likely will not be sufficient considering the rapid rate of change now occurring.

The time to act, the time to invest, and the time to implement multi-benefit projects is now. Let us use this Conservation Strategy as a guide for what to do and how to do it and redouble our efforts to form the effective partnerships and collaborations that will allow us to proactively address the challenges ahead.

CHAPTER 1

Overview

The Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy or Strategy) is a primary component of the CVFPP in accordance with the Central Valley Flood Protection Act of 2008. It aligns with and contributes to the attainment of all CVFPP goals, while focusing on improving ecosystem quality, quantity, function, and sustainability within the Systemwide Planning Area (SPA). Its purpose is to provide actionable and measurable targets to improve riverine, aquatic, wetland, and riparian habitat in the flood system through the integration of ecological principles with flood risk reduction projects, operation and maintenance activities, institutional support, and other means (e.g., the remediation of fish passage barriers). The Conservation Strategy also provides data, information, and guidance to floodplain managers to assist in the development of multi-benefit flood infrastructure improvement projects by integrating project components and management strategies that benefit native species and their habitats.

Despite recent progress implementing multi-benefit projects, which improve environmental conditions at specific locations, the historical configuration of the flood system and various anthropogenic factors continue to inhibit natural processes, fragment riverine habitats, and contribute to the decline of native species throughout the SPA.

Further, the projected impacts of climate change on ecological processes, habitats, and species require an expedited focus on building ecosystem resiliency and restoring ecological and geomorphic processes. This effort will require the pace of multi-benefit project implementation to increase and an emphasis on nature-based solutions, such as widening river corridors and expanding floodplains to allow riverine habitats and species to be resilient to projected changes in air and water temperatures, precipitation, and hydrology. In addition to providing more resilient ecological conditions, multi-benefit projects that restore geomorphic processes also support a more resilient, adaptive, and sustainable flood management system, particularly in consideration of climate change challenges.

The identification, development, and implementation of multi-benefit projects in the Central Valley is the primary mechanism to improve and restore ecosystems, and gradually build ecological resilience, while supporting a more adaptive and resilient flood protection system. It is now more important than ever to identify and leverage opportunities to further develop multi-benefit projects and promote management actions to address climate change risks to ecological conditions.

Every five years, the California Department of Water Resources (DWR) updates the Conservation Strategy to correspond with updates to the CVFPP and meet the following goals:

- Report on progress achieved over the previous five years toward meeting the measurable objectives.
- Support continued alignment with evolving DWR policies, programs, and initiatives.
- Update its content with the latest information, science, and guidance available to support the CVFPP's and DWR's commitment to public safety and environmental stewardship through state-of-the-art flood management practices, wise investments, and multi-benefit project implementation.

1.1 The 2022 Update

This 2022 Update to the Conservation Strategy provides new and updated information, focused on the five following key elements:

1. Update the list of target species; four new species have been added (delta smelt, tricolored blackbird, yellow-breasted chat, and monarch butterfly).
2. Report on progress toward measurable objectives and multi-benefit project implementation from 2016 to 2021, and provide detailed information about how progress toward measurable objectives is tracked and reported.
3. Provide details and further updates to the implementation of the Conservation Strategy and multi-benefit projects, including more details about funding, partnerships and collaboration opportunities, regulatory compliance and mitigation, and impediments to multi-benefit project implementation.
4. Identify a suite of proposed "priority actions" to address implementation barriers and increase the pace and extent of multi-benefit projects.
5. Summarize climate change risks and vulnerabilities for the Conservation Strategy processes, habitats, and species; climate adaptation strategies; and recommended actions.

In addition to these key elements, this update provides additional information about existing and new plans, programs, and scientific research that apply to the CVFPP. This document's information, data, and recommendations are based on collaboration and input from the Central Valley Flood Protection Board (CVFPB), DWR staff from multiple divisions, an array of local project proponents and maintainers, regulatory agencies, nongovernmental organizations (NGOs), and other stakeholders. The document is organized as follows:

- Chapter 1, "Overview," describes the background of the 2016 CVFPP Conservation Strategy, introduces the 2022 Update and discusses how it was developed, and explains the organization of this document.
- Chapter 2, "Implementation 2016 to 2021," summarizes the implementation of CVFPP projects, tracking, and adaptive management.
- Chapter 3, "2022 Conservation Strategy Update," summarizes the reevaluation of, and changes to, the Conservation Strategy's list of target species and measurable objectives; updates its implementation approach; provides a summary of Conservation Strategy-specific climate change risks, vulnerabilities, and adaptation strategies; suggests additional reevaluations of and revisions to Strategy components, and identifies "priority actions" to advance the implementation of the Conservation Strategy from 2022 to 2027.
- Chapter 4, "Glossary," defines terms used in the Conservation Strategy.
- Chapter 5, "References," provides information on literature and other sources cited in the text by chapter.
- Chapter 6, "Preparers," lists the authors and reviewers of the Conservation Strategy.
- Appendix A, "Target Species List Review and Update," provides the rationale for updating the list of target species, discusses the selection process for target species and focused conservation plans, and presents three additions to the target species list for the 2022 Update.
- Appendix B, "Focused Conservation Plans for New Target Species," addresses needs and opportunities for conserving delta smelt, tricolored blackbird, yellow-breasted chat, and monarch butterfly in the SPA.
- Appendix C, "Updates to 2016 Conservation Strategy Appendix J, 'Existing Conservation Objectives from Other Plans,'" summarizes established and ongoing planning efforts with geographic areas and conservation objectives that overlap with those of the Conservation Strategy, and consequently present opportunities for collaboration.
- Appendix D, "Updates to 2016 Conservation Strategy Appendix A, 'Regulatory Setting,'" describes applicable environmental permits and permitting mechanisms.
- Appendix E, "Mitigation Availability," summarizes the status of advance mitigation projects previously funded by DWR and the availability of compensatory mitigation for unavoidable impacts on the Conservation Strategy's target habitats and species.

- Appendix F, "Five-Year Implementation Summary Memorandum," summarizes the implementation of multi-benefit projects and other components of the Conservation Strategy from 2016 to 2021.

- Appendix G, "Central Valley Flood Protection Board Advisory Committee Recommendations," summarizes the recommendations provided by the CVFPB Advisory Committee for consideration by DWR to advance the implementation of the Conservation Strategy and CVFPP from 2022 to 2027. This appendix also provides information about how the recommendations are addressed, including the rationale if they are not included in either the Conservation Strategy or CVFPP.

- Appendix H, "Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update," describes climate change drivers and considers ecosystem responses to those changes for the physical processes, habitats, species, and stressors identified in the Conservation Strategy; and describes preliminary adaptation and management strategies based on identified risks and vulnerabilities.

1.2 The 2016 Conservation Strategy

DWR prepared the Conservation Strategy in 2016 based on the 2012 Conservation Framework (California Department of Water Resources 2012a). These documents were developed in accordance with the Central Valley Flood Protection Act of 2008, which called for a comprehensive approach to improve flood protection, including the promotion of ecosystem functions and multi-benefit projects. The 2016 Conservation Strategy provides information about the ecological conditions within the SPA and the need to improve geomorphological and ecological conditions of rivers and floodplains. Since the 1850s, approximately 95 percent of historical wetlands and riparian habitats in the Central Valley have been eliminated (The Bay Institute 1998). Natural river processes, such as floodplain inundation and channel meander migration, maintain the complex mosaic of riverine and floodplain habitats and support native species abundance and diversity. Natural river functions also provide increased flood management by providing space for floodwater retention and decreasing erosional forces, providing greater resiliency, particularly when factoring effects from climate change.

The 2016 Conservation Strategy provides a comprehensive, long-term, nonregulatory approach to improve riverine aquatic and riparian ecosystems in the SPA primarily through implementation of multi-benefit flood infrastructure improvement projects. The 2016 Conservation Strategy also recommends specific types of ecosystem improvements and set long-term objectives for improvements resulting from multi-benefit flood projects and operations and maintenance (O&M) in the Central Valley. In the context of the CVFPP, multi-benefit projects are designed to reduce flood risk and increase fish and wildlife habitat, and may also provide other public benefits (California Department of Water Resources 2017).

1.2.1 Geographic Scope

The Conservation Strategy's geographic scope is limited to the CVFPP's SPA. The SPA consists of State Plan of Flood Control (SPFC) channels and infrastructure, and lands that receive flood protection through the SPFC. The SPFC is a portion of the Central Valley's flood management system, which the State of California (State) has certain responsibilities for, as defined in the California Water Code (Section 9110[f]).

In the 2016 Conservation Strategy, the SPA was divided into five distinct regions referred to as Conservation Planning Areas (CPAs) (Figure 1-1). The CPAs facilitate planning and management actions to achieve the goals and objectives of the CVFPP and its Conservation Strategy. The five CPAs vary with regard to flood risk management and conservation needs, opportunities, and measurable objectives. Each CPA shares geography with one or two Regional Flood Management Planning groups composed of local maintaining agencies (LMAs), DWR staff, and regional stakeholders to develop regional flood management plans (RFMPs). The RFMPs identify regional priorities to improve the overall system function and O&M. The RFMP recommendations and project plans are aligned with the goals and objectives of the CVFPP and Conservation Strategy.

The five CPAs are described as follows:

1. **Upper Sacramento River CPA:** The Sacramento River and tributaries from Red Bluff to Fremont Weir (the Mid- and Upper Sacramento River RFMP region).

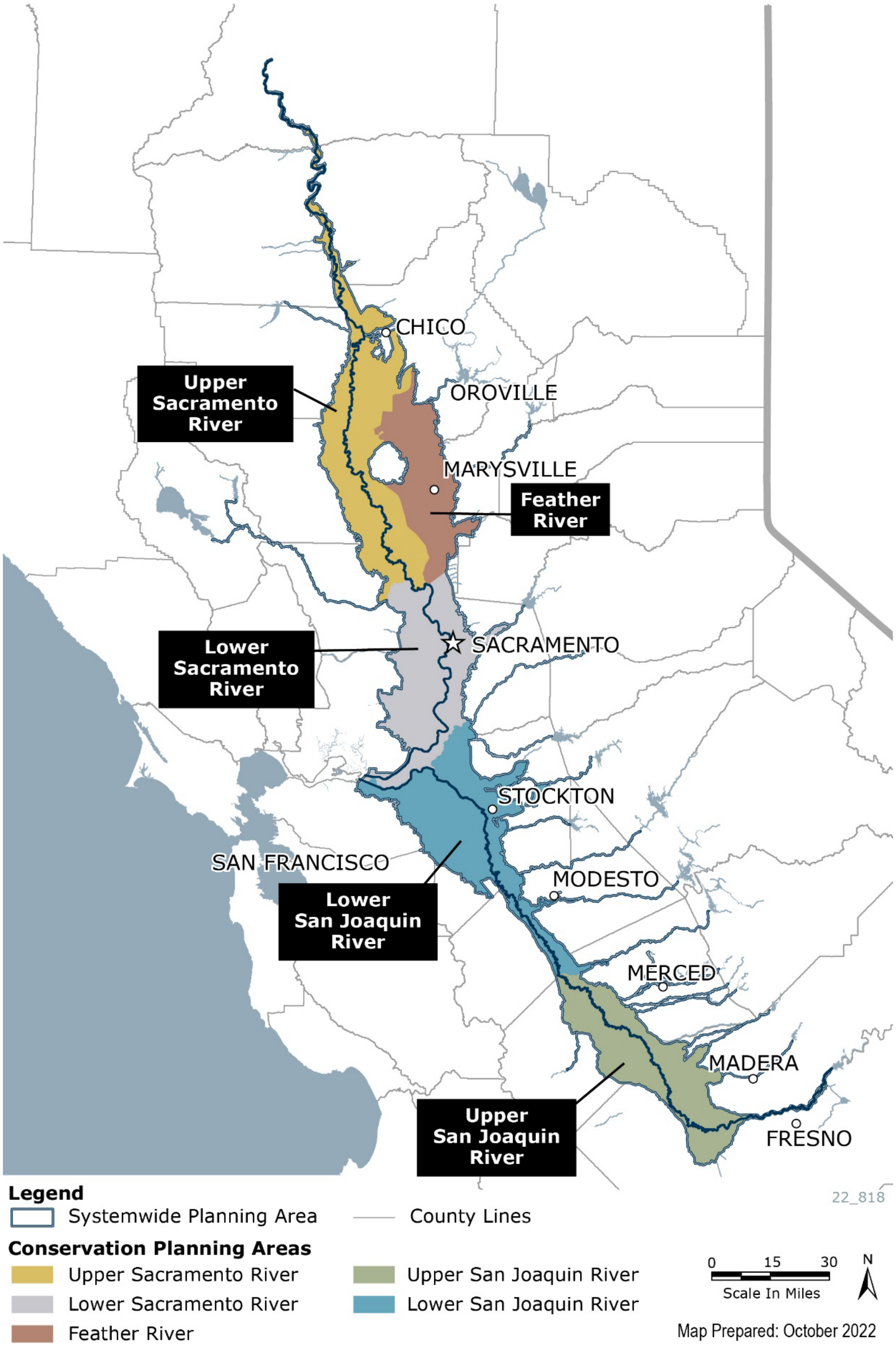
2. **Feather River CPA:** The Feather River, as well as the Yuba and Bear Rivers and other tributaries (the Feather River RFMP region).

3. **Lower Sacramento River CPA:** The Sacramento River and tributaries from Fremont Weir to Isleton (the Lower Sacramento River and Delta-North RFMP region).

4. **Upper San Joaquin River CPA:** The San Joaquin River and tributaries from Friant Dam to the Merced River (the Upper San Joaquin River RFMP region).

5. **Lower San Joaquin River CPA:** The San Joaquin River and tributaries from the Merced River to Stockton (the Lower San Joaquin River and Delta South, and the Mid-San Joaquin River RFMP regions).

Figure 1-1. Conservation Planning Areas in the CVFPP Conservation Strategy



1.2.2 From Goals to Measurable Objectives

The Central Valley Flood Protection Act of 2008 required the CVFPP to describe structural and nonstructural means of improving the performance and eliminating deficiencies of levees, weirs, bypasses, and facilities. Where feasible, it also required the CVFPP to meet multiple objectives, including 14 listed objectives (California Water Code Section 9616[a]). Specifically, it stipulated that the CVFPP provide “a description of structural and nonstructural means for enabling or improving systemwide riverine ecosystem function, including, but not limited to, establishment of riparian habitat and seasonal inundation of available floodplains where feasible” (California Water Code Section 9614 [j]).

Three of the listed objectives concerned promoting or increasing ecosystem processes, habitats, populations of native species, or overall biotic community diversity, and are the primary basis of the four goals of the 2012 CVFPP’s Conservation Framework (California Department of Water Resources 2012b). These four goals, with only minor revisions, became the goals of the 2016 Conservation Strategy:

1. **Ecosystem Processes: Improve dynamic hydrologic (flow) and geomorphic processes in the SPFC.** These ecosystem processes are critical for maintaining riverine and floodplain habitats and species. They include a diversity of flows, suitable sources of sediment, floodplain inundation, and a sufficiently broad river corridor to allow channel meandering, which are critical factors in sustaining fisheries and riverine habitat.

2. **Habitats: Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats.** These habitats include aquatic, riparian, wetland, shaded riverine aquatic (SRA) cover, and other floodplain habitats, as well as agricultural lands that can provide important wildlife values.

3. **Species: Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.** The native species addressed by the Conservation Strategy include species associated primarily with riverine and floodplain habitats that are at risk of extirpation or extinction. Although the preceding goals are the foundation for species conservation, this goal emphasizes the need to not only avoid, minimize, and mitigate adverse effects on sensitive species, as well as the need to contribute to their recovery.

4. **Stressors: Reduce stressors related to development and operation of the SPFC that negatively affect at-risk species.** These stressors include invasive plant species, constraints on sediment sources and channel meander migration, isolation of floodplains from rivers by levees and revetment, and fish passage barriers, all of which contribute to loss and degradation of ecosystem functions and habitat.

To achieve these goals, the 2016 Conservation Strategy focused on the target ecosystem processes, habitats, and species in need of recovery that showed the greatest potential to benefit from conservation actions integrated with flood risk management actions. The 2016

Conservation Strategy also focused on stressors to these processes, habitats, and species that could be addressed by multi-benefit flood risk reduction project implementation.

The 2016 Conservation Strategy targeted two ecosystem processes: riverine geomorphic processes and floodplain inundation; and three habitats: SRA cover, riparian habitats, and marshes and other wetlands. "Target species" are sensitive species that could be most affected by the CVFPP, primarily because of their strong dependence on the river and floodplain ecosystems of the Sacramento and San Joaquin valleys. Table 1-1 lists the 2016 Strategy's target species.

The 2016 Conservation Strategy also targeted the following stressors:

- Erosion-resistant materials, generally referred to as "revetment," that reinforce and protect riverbanks.
- Narrowly confining levees.
- Weirs and other structures that are barriers to fish passage, as identified in Appendix K of the 2016 Conservation Strategy.
- Specific invasive terrestrial plants, as identified in Appendix E of the 2016 Conservation Strategy.

Measurable objectives for the targets were developed to inform the CVFPP and related DWR flood management program funding guidelines and grant processes (e.g., the restoration of a given amount of riparian habitat through multi-benefit projects). Each objective was selected to address a targeted ecosystem process, habitat, or stressor in a CPA.

The sizes of the objectives represent net increases in ecosystem processes and habitats, reductions in stressors, and contributions to species recovery that may be achievable through multi-benefit projects and O&M pursuant to the CVFPP. The measurable objectives are based on the conservation needs of target species and opportunities for multi-benefit projects to provide that needed conservation. Appendix L of the 2016 Conservation Strategy documents the process for developing the measurable objectives, and provides an assessment of the needs and opportunities (California Department of Water Resources 2016). Appendix L continues to be the guiding document for measurable objectives and has not been updated in the 2022 planning cycle. Appendix F summarizes progress that has been made toward meeting the measurable objectives since 2016 and provides criteria for how progress is calculated.

To meet the needs of target species, measurable objectives were developed for the ecosystem process and habitat targets, and the fish passage barrier and invasive plant targets (both of which are stressors affecting target species, ecosystem processes, and habitats). Because the conservation needs of target species were a basis for these objectives, separate objectives were not developed for target species. Separate objectives were also not developed for levees as a stressor. Various efforts toward levee modification, removal, or relocation, combined with other actions, could provide comparable increases in ecosystem processes and habitats, and related benefits to species.

Table 1-1. Target Species of the 2016 Central Valley Flood Protection Plan Conservation Strategy

Species	Common Name [a] Scientific Name	FED Status [b]	CA Status [b]	CRPR Status [b]	USR [c]	FR [c]	LSR [c]	USJR [c]	LSJR [c]	Habitats [d]
Plants	Delta button-celery *Eryngium racemosum*	None	E	1B.1	No	No	No	Yes	Yes	Riparian scrub, inundated floodplain (in vernally mesic clay depressions)
	Slough thistle *Cirsium crassicaule*	None	None	1B.1	No	No	No	Yes [e]	Yes	Chenopod scrub, riparian scrub, and marsh along sloughs; inundated floodplain
Invertebrates	Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T	None	None	Yes	Yes	Yes	Yes	Yes	Elderberry shrubs in riparian habitat
Fish	California Central Valley steelhead DPS *Oncorhynchus mykiss*	T	None	None	Yes	Yes	Yes	Yes [e]	Yes	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain [f]
	Chinook salmon—Central Valley fall- and late-fall-run ESU *Oncorhynchus tshawytscha*	None	CSC	None	Yes	Yes	Yes	Yes [e]	Yes	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain [f]
	Chinook salmon—Central Valley spring-run ESU *Oncorhynchus tshawytscha*	T	T	None	Yes	Yes	Yes	Yes [e]	Yes	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain [f]
	Chinook salmon—Sacramento River winter-run ESU *Oncorhynchus tshawytscha*	E	E	None	Yes	No	Yes	No	No	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain [f]

Species	Common Name [a] Scientific Name	FED Status [b]	CA Status [b]	CRPR Status [b]	USR [c]	FR [c]	LSR [c]	USJR [c]	LSJR [c]	Habitats [d]
Fish	Green sturgeon—southern DPS *Acipenser medirostris*	T	CSC	None	Yes	Yes	Yes	No	Yes	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain [f]
Reptiles	Giant gartersnake *Thamnophis gigas*	T	T	None	Yes	Yes	Yes	Yes	Yes	Freshwater emergent wetlands, floodplain agricultural land (drainage canals, irrigation ditches, rice fields, and adjacent vegetation)
Birds	Bank swallow *Riparia riparia*	None	T	None	Yes	Yes	Yes	No	No	Natural banks and cliffs near aquatic habitat (nesting); riparian, grasslands, wetlands, open water, and croplands (foraging)
	California black rail *Laterallus jamaicensis coturniculus*	None	T, FP	None	No	No	Yes	No	Yes	Marsh
	Greater sandhill crane *Grus canadensis tabida*	None	T, FP	None	Yes	Yes	Yes	Yes	Yes	Open grasslands, floodplain agricultural land (grain fields), and open wetlands; does not breed in SPA
	Least Bell's vireo *Vireo bellii pusillus*	E	E	None	Yes [e]	Yes [e]	Yes [e]	Yes [e]	Yes	Riparian, adjacent to open water
	Swainson's hawk *Buteo swainsoni*	None	T	None	Yes	Yes	Yes	Yes	Yes	Riparian forest, larger trees (nesting); grasslands and croplands (foraging)

Species	Common Name [a] Scientific Name	FED Status [b]	CA Status [b]	CRPR Status [b]	USR [c]	FR [c]	LSR [c]	USJR [c]	LSJR [c]	Habitats [d]
Birds	Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	T	E	None	Yes	Yes	Yes [e]	Yes [e]	Yes [e]	Riparian, inundated floodplain
Mammals	Riparian brush rabbit *Sylvilagus bachmani riparius*	E	E	None	No	No	No	No	Yes	Riparian
	Riparian (= San Joaquin Valley) woodrat *Neotoma fuscipes riparia*	E	CSC	None	No	No	No	No	Yes	Riparian

Sources: California Interagency Wildlife Task Group 2014; Shuford and Gardali 2008; California Department of Fish and Wildlife 2020, 2021; California Native Plant Society 2021.

[a] DPS = Distinct Population Segment; ESU = Evolutionarily Significant Unit.
[b] Federal (FED), California (CA), and California Rare Plant Rank (CRPR) statuses are as follows:

FED
C = Candidate for listing under the federal ESA.E = Listed as endangered under the federal Endangered Species Act (ESA).
T = Listed as threatened under ESA.
CA
E = Listed as endangered under the California Endangered Species Act (CESA). T = Listed as threatened under CESA.
CSC = California Species of Special Concern.
FP = Fully protected under the California Fish and Game Code.
CRPR
1B.1 = Plants rare, threatened, or endangered in California and elsewhere. Seriously endangered in California.

[c] USR = Upper Sacramento River CPA; FR = Feather River CPA; LSR = Lower Sacramento River CPA; USJR = Upper San Joaquin River CPA; LSJR = Lower San Joaquin River CPA.
Yes = species is a target species in this CPA; No = species is not a target species in this CPA.
[d] SPA = Systemwide Planning Area; SRA = shaded riverine aquatic.
[e] Potential distribution in the CPA is based on historical distribution or poorly known.
[f] Inundated floodplain habitats include both natural and agricultural land covers.

Each of the 2016 Conservation Strategy's measurable objectives consist of one or more metrics (specific, measurable attributes, such as the acreage of riparian vegetation) and an amount of change in that metric (a magnitude of ecosystem improvement).

Metrics were selected based on several attributes:

- **Relevance***:* Metrics are related to the Conservation Strategy's goals and have implications for conservation and flood risk management activities.
- **Responsiveness***:* Metrics are capable of exhibiting changes in response to actions taken in the time frame required for adaptive management (e.g., within five to 10 years).
- **Cost-effectiveness***:* Individually and collectively, measuring the metrics will involve a reasonable expenditure relative to other metrics that could effectively assess progress and inform management decisions.
- **Reliability of interpretation***:* Changes in the metrics will reliably and clearly document the results of CVFPP implementation (as opposed to other causes, such as environmental fluctuations) and will highlight the types of changes that would improve implementation.
- **Transparency and ease of communication***:* As a set, tracking the metrics will tell a clear and concise story to a broad cross section of the interested public about the progress and results of CVFPP implementation related to the Conservation Strategy's goals.

Table 1-2 describes the selected metrics and Table 1-3 provides the measurable objectives.

Apart from objectives for invasive plants and fish passage barriers, the size of ecological objectives was determined as follows:

1. **The identified conservation needs of target species were synthesized**. Adopted plans for the recovery of target species have identified multiple actions and outcomes needed for species recovery. The actions and outcomes identified in adopted plans for the recovery of target species were synthesized for each targeted ecosystem process and habitat.

2. **The extent of opportunities for restoration through the CVFPP's multi-benefit flood projects was estimated.** These estimates were based on preliminary data from the Basin-Wide Feasibility Studies (BWFSs), evaluations conducted for the Conservation Strategy, and evaluations provided by NGOs.

3. **The objective was set to the conservation need or the opportunity for restoration through multi-benefit projects, whichever was smaller.** Consequently, if the need exceeded the opportunity, attaining the objective would contribute to but not fully meet the need; if the opportunity exceeded the need, attaining the objective would fully meet the need.

Table 1-2. Metrics for Ecosystem Process, Habitat, and Stressor Objectives

Conservation Strategy Goal	Targeted Ecosystem Process, Habitats, or Stressors	Metric
Ecosystem Processes	Floodplain Inundation	**Inundated Floodplain—total amount (acres) of 50% flows (i.e., a two-year event) with 14-day or longer duration during December to May:** This is a metric of the amount of inundated floodplain benefiting riverine ecosystems, particularly target fish species. These amounts are derived from hydraulic modeling, using data developed for planning flood management projects.
	Riverine Geomorphic Processes	**Natural Bank—total length (miles):** Natural bank is a component of SRA cover and bank habitat and is necessary for migration of a river channel. Its length is related to the area of floodplain potentially reworked by channel migration (river meander). The length of natural bank may be measured by DWR and other agencies, and maintained inventories of revetment measured and verified in the field.
		River Meander Potential—total amount (acres): This is the movement of a river channel across its floodplain regenerates channel and floodplain habitats. River meander potential is the area of floodplain that has the potential to be reworked by the meandering channel because it is within the river's natural meander zone, not underlain by substrates resistant to erosion and not isolated by revetted banks or levees (project and non-project). Areas with river meander potential can be mapped using aerial photography, topographic data, inventories of revetment and levees, and existing geologic and soils data.
Habitats	SRA Cover	**Natural Bank—total length (miles):** This is described for Natural Bank under "Riverine Geomorphic Processes."
		Riparian-lined Bank—total length (miles): Riparian-lined banks are natural or revetted banks bordered by trees and shrubs. Riparian-lined banks are an attribute of SRA cover, and because SRA cover only exists along channel margins, length is a direct measure of its quantity.
	Riparian	**Habitat Amount—total amount (acres) in floodways:** The area of riparian vegetation (i.e., riparian forests, woodlands, and scrub) is a direct measure of its quantity.
	Marsh (and Other Wetlands)	**Habitat Amount—total area (acres) in floodways:** The area of marsh and other wetlands is a direct measure of their quantity.

Conservation Strategy Goal	Targeted Ecosystem Process, Habitats, or Stressors	Metric
Stressors	Fish Passage Barriers	**Fish Passage Barriers—number of high-priority barriers remediated:** This metric documents the number of high-priority barriers modified to improve passage.
	Invasive Plants	**Invasive Plant-dominated Vegetation in Channel Maintenance Areas—total area reduced (acres):** Land identified in the SPFC Descriptive Document (California Department of Water Resources 2010) as channel maintenance areas includes areas dominated by invasive plants. For species prioritized for treatment, this metric measures reduction in the extent of infested areas.

Source: Data compiled by DWR in 2012.
Notes:
Target species needs were a basis for process, habitat, and stressor objectives; for this reason, they are not represented by separate objectives. Amounts of levee and revetment modification would be determined during project and plan formulation as a means of providing needed improvements to processes, habitats, and other stressors; because of this, objectives were not established for these two stressors.
DWR = California Department of Water Resources
SPFC = State Plan of Flood Control
SRA = shaded riverine aquatic

Table 1-3. Measurable Objectives by Conservation Planning Area

Conservation Strategy Goal	Targeted Ecosystem Process, Habitat, or Stressor and Metrics	USR [a]	FR [a]	LSR [a]	USJR [a]	LSJR [a]	Total
Ecosystem Processes	Floodplain Inundation: Inundated floodplain—major river reaches (acres) [b]	6,300	3,700	7,650	2,800	11,600	32,050
	Floodplain Inundation: Inundated floodplain—bypasses transient storage areas (acres) [c]	9,600	0	7,500	0	200	17,300
	Riverine geomorphic processes: Natural bank (miles) [d]	20	0	4	8	13	45
	Riverine geomorphic processes: River meander potential (acres)	5,600	400	1,300	2,100	4,300	13,700

Conservation Strategy Goal	Targeted Ecosystem Process, Habitat, or Stressor and Metrics	USR [a]	FR [a]	LSR [a]	USJR [a]	LSJR [a]	Total
Habitats	SRA cover: Natural bank [d] (miles)	20	0	4	8	13	45
	SRA cover: Riparian-lined bank (miles)	8	0	3	2	6	19
	Riparian habitat (acres) [e]	3,400	1,800	1,900	2,100	5,800	15,000
	Marsh and other wetland habitat (acres) [f]	2,400	0	3,500	0	100	6,000
Stressors	Fish passage barriers: Channel-wide structures	5	0	4	0	0	9
	Invasive plants: Prioritized species (infested acres)	268	257	363	143	34	1,065

Source: California Department of Water Resources 2016.

[a] USR = Upper Sacramento River CPA; FR = Feather River CPA; LSR = Lower Sacramento River CPA; USJR = Upper San Joaquin River CPA; LSJR = Lower San Joaquin River CPA.

[b] Area inundated by two-year, 14-day, or longer flows, December–May (acres); includes both natural and agricultural land cover.

[c] Not inundated in 50 percent of years or more frequently for 14 days or longer; includes both natural and agricultural land cover.

[d] This condition is provided under both riverine geomorphic processes and SRA cover.

[e] With grassland inclusions.

[f] With inclusions of upland vegetation.

Notes:
Values have been rounded to the nearest 100 acres and 1 mile, excluding invasive plant acreages, which are provided to the nearest acre. A significant limitation to this basis for the objectives is the moderate level of uncertainty regarding the conservation needs of target species and the opportunities. To address this limitation, the objectives are reevaluated during the five-year updates to the CVFPP.

1.2.3 Implementation Approach

The 2016 Conservation Strategy described several key components of its implementation: coordination, collaboration, outreach, and engagement; regulatory compliance; funding; and adaptive management.

1.2.3.1 Coordination, Collaboration, Outreach, and Engagement

The 2016 Conservation Strategy relied on the integration of ecosystem improvements with flood risk management and related conservation planning efforts in actions taken by DWR and other State and federal agencies, LMAs, landowners, local communities, and NGOs. Consequently, coordination and collaboration among these organizations is a key component of the Strategy's implementation.

1.2.3.2 Regulatory Compliance

Mechanisms to simplify and expedite permitting are particularly important for multi-benefit projects. To date, however, the Conservation Strategy approach relies on existing mechanisms to permit restoration actions and multi-benefit projects. Other ongoing efforts include improving collaboration with regulatory agencies to expedite and develop efficient approaches to permitting multi-benefit projects and related O&M. For example, DWR has been meeting with regulatory agencies to develop advance mitigation and achieve permitting efficiencies through landscape-scale permitting of maintenance activities, as well as collaborating on efforts to develop programmatic approaches for habitat restoration and enhancement, and multi-benefit projects.

1.2.3.3 Funding

Ecosystem improvements in the Central Valley flood system will be funded and implemented as important components of multi-benefit flood projects, consistent with the CVFPP. State policies and legislation have prioritized multi-benefit projects. Section 3.4.3 provides an updated discussion of funding considerations.

1.2.3.4 Adaptive Management

Adaptive management is a decision-making process to continually improve the effectiveness of a program to achieve its objectives. It emphasizes the use of science and monitoring to inform managers making decisions under uncertain conditions. Refinements to the Conservation Strategy are implemented in conjunction with updates to the CVFPP. These adjustments are based not only on changes to the CVFPP, but on the following factors:

- Monitoring (tracking) effectiveness of actions to progress toward measurable objectives.
- New information (e.g., best available science).
- Focused studies.
- Systemwide or regional resource inventories.
- Input solicited from agencies, practitioners, and other stakeholders.

CHAPTER 2

Implementation 2016 to 2021

This chapter summarizes implementation progress toward the goals of the Conservation Strategy from 2016 to 2021. The following sections describe project implementation, progress toward the Strategy's four goals, and the adaptive management of implementation, including implementation tracking, updates to regional datasets, and solicited input regarding implementation.

2.1 Project Implementation

2.1.1 Multi-benefit and Restoration Projects

The 2016 Conservation Strategy includes the following four goals to attain the Central Valley Flood Protection Act's objectives of promoting ecosystem functions by integrating recovery and restoration of key physical processes, self-sustaining ecological functions, riverine habitats, and native species into flood management activities:

1. **Ecosystem Processes**. Improve dynamic hydrologic (flow) and geomorphic processes in the SPFC plan area or SPA.

2. **Habitats**. Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats.

3. **Species**. Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.

4. **Stressors**. Reduce stressors related to development and operations of the SPFC that negatively affect at-risk species.

To achieve these goals, measurable objectives were developed to target processes, habitats, and species in need of recovery, as well as the associated stressors that could be addressed by implementation of habitat restoration, multi-benefit flood infrastructure improvement projects, and improved O&M practices in the flood system. The CVFPP defines multi-benefit projects as follows (California Department of Water Resources 2017):

> *"[P]rojects designed to reduce flood risk and enhance fish and wildlife habitat; multi-benefit projects may also create additional public benefits such as sustaining agricultural production, improving water quality and water supply reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and educational opportunities, or any combination thereof."*

The targets of the Conservation Strategy's measurable objectives (or the amount of restoration needed) were determined by review and consideration of existing recovery plans for targeted species, consultation with species experts, mapping existing vegetation, research and analysis of historic floodplain records, and evaluating restoration needs and opportunities across the flood system. Progress toward the measurable objectives will inform CVFPP implementation and future State funding guidelines and grant programs.

The flood infrastructure improvement projects identified here have been implemented and meet the following criteria for contributions to measurable objectives:

- The project was designed after 2012 and completed between 2016 and 2021. Although the planning, permitting, and funding of many projects progressed during the 2016-to-2021 period, only projects, or phases of projects, completed in this period are reported here. In addition, projects that were planned and designed before 2012 were generally considered part of baseline conditions as the measurable objectives were developed and, therefore, do not represent ecosystem improvements resulting from the CVFPP's implementation. It should be noted that many projects implemented prior to 2016 provided early benefits ahead of this timeframe and are also good examples of multi-benefit projects (e.g., the Bear River Levee Setback project in the Feather River CPA).

- The project implements the CVFPP via a multi-benefit project or through a habitat enhancement project with a positive result for one or more measurable objective, as identified in the Conservation Strategy.

- The project is within the geographic scope of the CVFPP (i.e., the SPA), and within SPFC facilities or on lands protected by the SPFC.

Note, if an identified fish passage barrier from Appendix K of the 2016 Conservation Strategy has been removed or remediated as part of the CVFPP or any other program or project (e.g., Fremont Weir Adult Fish Passage Modification Project), it is considered resolved and counts toward meeting the measurable objective for this stressor, regardless of the effect on flood risk (i.e., not necessarily a multi-benefit project).

The outcomes reported here are planned project outcomes as reported in environmental documents, permits, and spatial data provided by project managers. These outcomes will be monitored and verified so the achieved outcomes are documented accurately. The Flood Performance Tracking System (FPTS) will be updated once data become available for verified outcomes. When project outcomes are used to mitigate habitat loss caused by other projects, contributions to the measurable objectives will be reduced to account for that debit.

The four projects summarized here were completed between 2016 and 2021, and contributed to the measurable objectives by reconnecting floodplains, restoring riparian habitats, and providing other ecosystem benefits. Components of these projects were funded through DWR's flood management programs and meet the CVFPP criteria for a multi-benefit or habitat enhancement project:

- **The Oroville Wildlife Area Flood Stage Reduction Project (Feather River CPA)** reduced flood risk, increased the area of inundated floodplain, and restored riparian habitat by augmenting the existing system of inflow and outflow weirs to safely divert additional floodwaters through the Oroville Wildlife Area and by improving drainage to reduce fish stranding. The project area is approximately 1,500 acres located on the west side of State Route 70 across the Feather River from the Thermalito Afterbay outlet.

- **The Three Rivers Levee Improvement Authority Feather River Conservation Bank (Feather River CPA)** restored 500 acres of a previously created levee setback area to a mosaic of mixed riparian forest and riparian scrub. Significant flood control benefits were also achieved in this region because of the setback levee and the bank is contributing toward broader multi-benefits in the landscape. This project is anticipated to be used as a bank; for that reason, measurable objectives contributions will be reduced as credits are used.

- **The Southport Setback Levee Project (Lower Sacramento River CPA)** restored 120 acres of inundated floodplain and riparian habitat by constructing a setback levee along the west bank of the Sacramento River. A portion of this project may be used as mitigation in the future; however, it is currently providing temporary uplift. Therefore, contributions to measurable objectives may be reduced as credits are used.

- **The Dos Rios Floodplain Expansion and Ecosystem Restoration Project, Phase I (Lower San Joaquin River CPA)** reconnected approximately 1,000 acres of inundated floodplain by constructing notches in agricultural berms, resulting in restored riparian habitat on most of the reconnected floodplain.

Multi-benefit projects being developed within the legal Sacramento–San Joaquin Delta (Delta) independent of the CVFPP before 2016 (e.g., the McCormack-Williamson Restoration Project) were excluded from the measurable objectives and, for this reason, are not included in this summary of multi-benefit projects implemented between 2016 and 2021. Other projects were completed during this time frame but may not contribute to the measurable objectives because they do not meet the required criteria. In addition, one project did not meet the criteria as a multi-benefit project and was not implemented under the CVFPP, but it is included because it contributed to addressing a Conservation Strategy measurable objective:

- **The Fremont Weir Adult Fish Passage Modification Project (Lower Sacramento River CPA)** was implemented as a mitigation requirement for the Central Valley Project and State Water Project operations. This project remediated a stressor (fish passage barrier), as identified in Appendix K of the 2016 Conservation Strategy. This project improved fish passage by replacing the existing fish ladder at Fremont Weir with a step pool channel leading up to the weir and gated notch through the weir. Note that only the fish passage barrier component of the project is being counted toward that stressor's measurable objective.

Additional projects are under construction or may be proposed for consideration by 2027 (i.e., proposed projects between 2022 and 2027). Table 2-1 lists projects that will be constructed, are under construction, or are anticipated to be proposed between 2022 and 2027, by their CPA. Not all of the projects in Table 2-1 are multi-benefit projects, but they may contain components that contribute to the Conservation Strategy's measurable objectives. For further details about these projects, refer to Appendix F, Attachment F.1, "Five-Year Implementation Summary Memorandum."

Table 2-1. Constructed, Under Construction, and Proposed 2022 to 2027 Projects that may Contribute to Conservation Strategy Measurable Objectives

Conservation Planning Area	Constructed Projects	Under Construction Projects	Proposed Projects
Upper Sacramento River	• None	• None	• Knights Landing Flood Management Project • Lower Deer Creek Flood and Ecosystem Improvement Project, Phase I • Kopta Slough Flood Damage Reduction and Habitat Project • Tisdale Weir Rehabilitation and Fish Passage Project • Sutter Bypass Weir #1 Remediation Project
Feather River	• Oroville Wildlife Area Flood Stage Reduction Project • Feather River Setback Conservation Bank [a]	• Hallwood Side Channel Project	• Sunset Pumps Facility Removal Project
Lower Sacramento River	• Fremont Weir Adult Fish Passage Modification Project (non-CVFPP) [b] • Southport Setback Levee Project [c]	• Lower Elkhorn Basin Levee Setback Project • Lookout Slough Tidal Habitat Restoration and Flood Improvement Project (non-CVFPP) [e]	• Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (non-CVFPP) [d] • Agricultural Road Crossing 4 Fish Passage Project (non-CVFPP) • Little Egbert Tract Multi-Benefit Project
Lower San Joaquin River	• Dos Rios Floodplain Expansion and Ecosystem Restoration Project, Phase 1 • Three Amigos Non-structural Alternative Flood Management Project [f]	• None	• Dos Rios Floodplain Expansion and Ecosystem Restoration Project and Hidden Valley Ranch Mitigation Project, Phase 2 • Paradise Cut Multi-Benefit Improvement Project

Conservation Planning Area	Constructed Projects	Under Construction Projects	Proposed Projects
Upper San Joaquin River	• None	• Eastside Bypass Improvements Project • Cottonwood, Dry, Berenda Creek Arundo Eradication and Sand Removal Project	• Reach 2B and Mendota Pool Bypass • Arroyo Canal Screening and Sack Dam Passage Project

[a] Because the Feather River Setback Conservation Bank is intended to provide mitigation, uplift is temporary until credits are used.

[b] The only component of the Fremont Weir Adult Fish Passage Modification Project that is being applied to the measurable objectives is the remediation of the fish passage barrier, per Appendix K of the 2016 Conservation Strategy

[c] The Southport Setback Levee Project is anticipated to be used for mitigation, So, uplift is temporary until credits are used.

[d] Because the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project is a non-CVFPP project and designated as mitigation, it may not contribute to Conservation Strategy measurable objectives unless surplus value can be quantified.

[e] The Lookout Slough Tidal Habitat Restoration and Flood Improvement Project falls within the footprint of the Lower Sacramento River CPA, and provides flood management benefits, in addition to providing for significant tidal habitat restoration in the lower Yolo Bypass. Consequently, this project qualifies as a multi-benefit project. The restoration component may contribute towards the Conservation Strategy measurable objectives if surplus value can be quantified.

[f] Three Amigos Non-structural Alternative Flood Management Project was completed in 2022. So, contributions to measurable objectives will be quantified in the Conservation Strategy 2027 Update.

Notes:

CPA = conservation planning area

CVFPP = Central Valley Flood Protection Plan

2.1.1.1 Funding

The total combined cost of the five constructed projects was approximately $298 million. Table F-5 in Appendix F provides a breakdown of funding by source and Attachment F.1. of Appendix F provides cost and funding sources for each constructed project. Funding for these projects came from a variety of State, local, and federal sources, and the contributions from these sources differed considerably. State bonds from Propositions 1E, 1, 13, and 84 were the greatest source of funding, accounting for 77 percent of the funding for the completed projects. Proposition 1E, which accounted for 61 percent of the funding, does not support ecosystem services beyond mitigation requirements. Multi-benefit projects that use Proposition 1E funds are often supplemented with additional funds from other sources to create beneficial environmental outcomes (California Natural Resources Agency 2019, 2020a, 2020b).

Local funding accounted for 14 percent of funding. Although local contributions are not as great a funding source for completed projects as State bonds, they are a required and important match to other funding. Counties, flood control agencies, and reclamation districts have provided these matching funds for multi-benefit projects. Of total funding, federal funding and other State funding accounted for 7 percent and 2 percent, respectively. Currently, more than $300 million is committed to in-progress projects throughout the SPA.

2.1.2 Operations and Maintenance Projects

Between 2016 and 2021, within the Upper Sacramento River and Lower Sacramento River CPAs, O&M projects along Cache Creek and Elder Creek removed approximately 40 acres of giant reed infestations. In-progress and anticipated 2022 to 2027 O&M projects that would remove infestations of prioritized invasive plants include Upper Cache Creek, Chico Creek area, and Sycamore Creek in the Upper Sacramento River CPA; and Bear River and Cherokee Canal in the Feather River CPA.

2.1.3 Advance Mitigation Projects

Advance mitigation projects establish habitat before projects that need mitigation are implemented. So, the mitigation credits created (in the form of acres of habitat) are ready to use as needed, avoiding project approval delays and reducing temporary habitat loss.

Support for advance mitigation is part of the Conservation Strategy’s approach to regulatory compliance. The 2016 Strategy listed four advance mitigation projects that had received more than $17 million in funding from DWR and were under development in 2016 (Appendix B, “Advance Mitigation,” of the 2016 Conservation Strategy). These projects provide advance mitigation for the habitats and species most commonly affected by flood risk management (i.e., the targets of this Strategy). Their current status is as follows:

- **Grasslands Mitigation Bank.** This 281-acre bank in Merced County has been completed, and DWR has received 130 giant gartersnake credits applicable to projects in the San Joaquin Valley and southern portion of the Delta.

- **Hidden Valley Ranch Acquisition.** This 497-acre property in the Lower San Joaquin River CPA has been acquired.

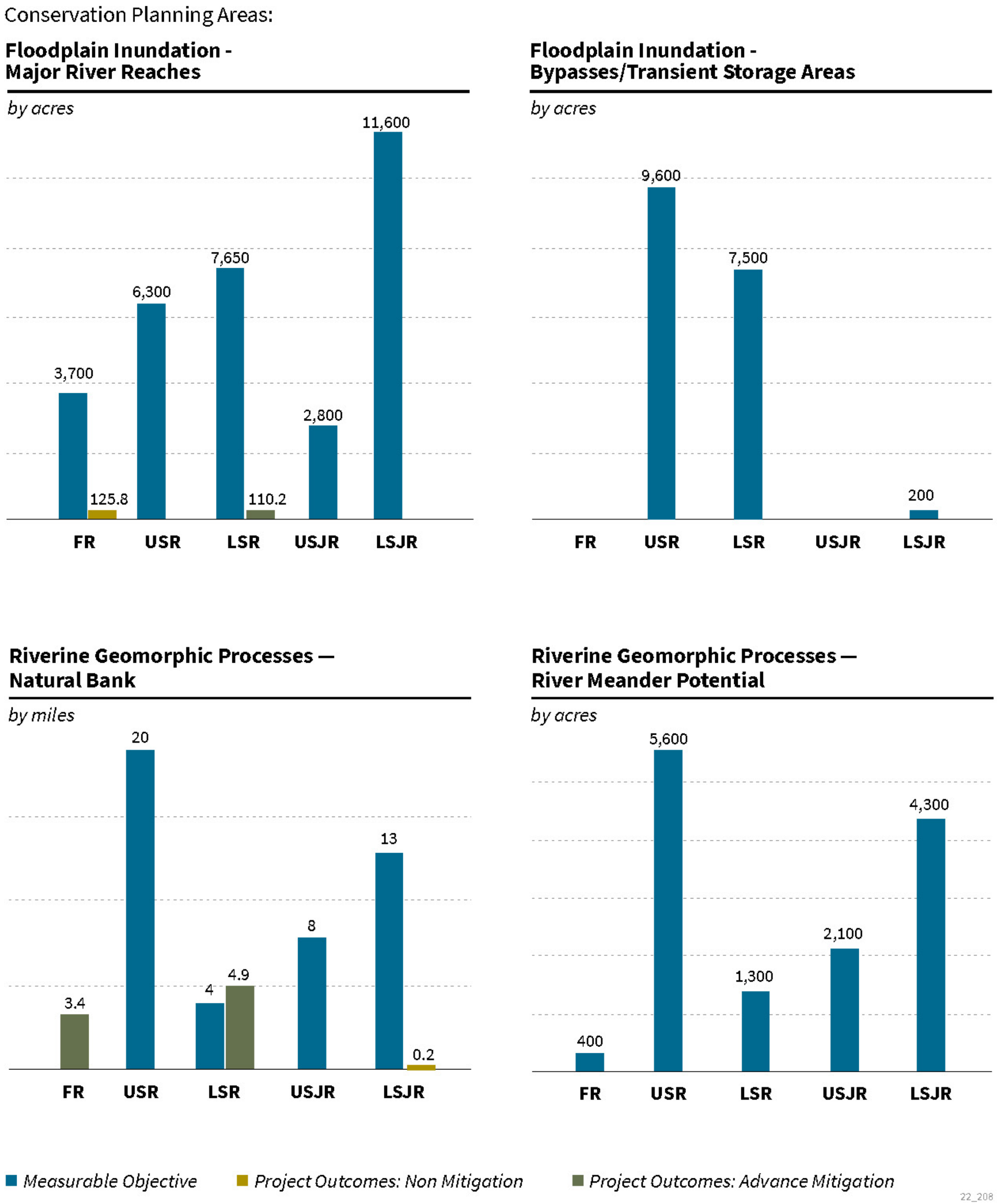
- **Bullock Bend Mitigation Bank.** The development of this 120-acre bank along the Sacramento River (between Colusa and Verona) has been completed; DWR has received 57.5 salmonid credits from this bank, and several of these credits have been used by projects in the service area of the bank.
- **Feather River Setback Conservation Bank.** This approximately 585-acre site has been restored to 502 acres of riparian forest and scrub, and mitigation credits for valley elderberry longhorn beetle and riparian habitat are being determined.

By funding these projects, DWR has contributed to the conservation of 1,483 acres of habitat, most of which has not yet been used as mitigation, and has supported the efficient implementation of flood management projects and maintenance.

2.2 Progress Toward Goals

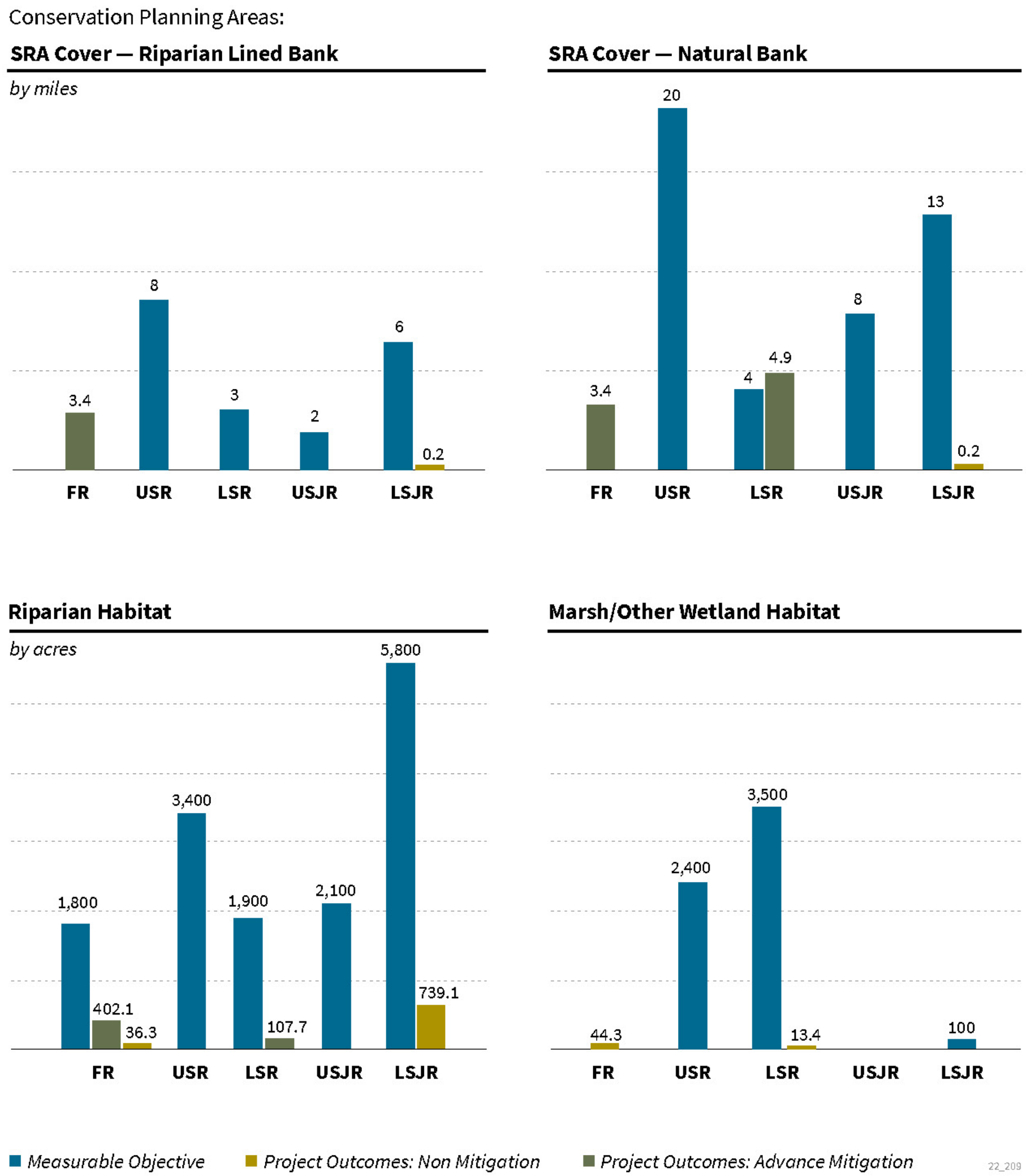
Figures 2-1 through 2-3 show progress toward each CPA's measurable objectives. The figures include contributions from advance mitigation (temporary uplift until used). Counting temporary uplift is appropriate when no pending mitigation needs are identified and the use of the credits is uncertain or in the distant future. Significant additional work is needed in each CPA to meet its objectives. Several additional projects are in the planning or funding stages. These in-progress projects, discussed in Attachment F.1, will make additional contributions to the measurable objectives in the next few years as they are implemented.

Figure 2-1. Potential Contributions of Completed Projects to Ecosystem Process Objectives



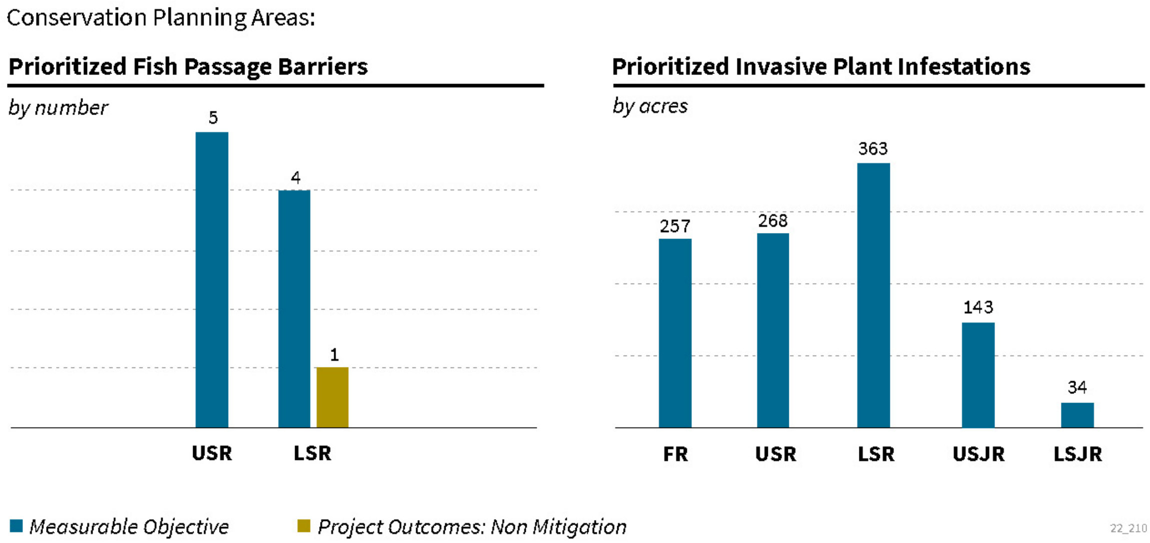
Notes: Advance mitigation and non-mitigation are displayed separately because using restored ecosystem processes as mitigation reduces progress toward the Conservation Strategy's measurable objectives. Floodplain inundation was calculated using the Floodplain Restoration Opportunity Analysis, as described in Appendix I of the 2016 Conservation Strategy

Figure 2-2. Potential Contributions of Completed Projects to Habitat Objectives



Note: Advance mitigation and non-mitigation are displayed separately because using restored habitats as mitigation reduces progress toward the Conservation Strategy's measurable objectives.

Figure 2-3. Potential Contributions of Completed Projects to Stressor Objectives



Note: Advance mitigation and non-mitigation are displayed separately because using reduced stressors as mitigation reduces progress toward the Conservation Strategy's measurable objectives.

The figures include restoration outcomes that may be used as advance mitigation (e.g., the Southport Levee Setback Project), but distinguish them from outcomes that will not become mitigation. Advance mitigation is distinguished from non-mitigation because the former represents reduced or no progress toward the goals of this Conservation Strategy. Section 3.3.1, "Measurable Objectives for Tracking Progress Toward Goals," provides a complete description of how using a restoration outcome as mitigation reduces or eliminates contributions toward fulfillment of the goals of this Conservation Strategy.

The following sections summarize the progress from completed projects toward each of the Conservation Strategy's goals.

2.2.1 Ecosystem Processes Goal – Improve Dynamic Hydrologic (Flow) and Geomorphic Processes in the SPA

For this goal, the Conservation Strategy's objectives quantify improvements in ecosystem processes as net increases in the acreage or mileage where the processes occur. Each CPA has objectives to restore inundated floodplain along major river reaches, in bypasses, or in transient storage areas, and to restore natural riverbanks and river meander potential.

In the Lower Sacramento River CPA, 122 percent of the objective for natural bank has been achieved (Tables F-2 and F-3 in Appendix F, "Conservation Strategy Five-Year Implementation Summary Memorandum"). The completed projects have achieved less than 5 percent or have not contributed to the other objectives for ecosystem processes. In-progress and anticipated 2022 to 2027 projects in the Yolo Bypass are anticipated to contribute more than half of the objective for inundated floodplain in bypasses or transient storage areas in the Lower Sacramento River CPA. In -progress and anticipated 2022 to 2027 projects would also contribute to ecosystem process objectives in the other CPAs, but the extent of their contributions is still uncertain.

2.2.2 Habitats Goal – Increase and Improve the Quantity, Diversity, and Connectivity of Riverine and Floodplain Habitats

For this goal, the Conservation Strategy's objectives quantify habitat increases and improvements as net increases in habitat amounts. Each CPA has objectives to restore SRA cover (natural bank and riparian-lined bank), riparian habitat, and marsh (and other wetlands) habitat.

In the Lower Sacramento River CPA, 122 percent of the objective for natural bank SRA cover has been achieved. In the Feather River, Lower Sacramento River, and Lower San Joaquin River CPAs, the completed projects have achieved 24 percent, 5.6 percent, and 12.7 percent, respectively, of the objective for riparian habitat (Tables F-2 and F-4 in Appendix F, "Conservation Strategy Five-Year Implementation Summary Memorandum"). Completed projects have achieved less than 5 percent of or have not contributed to the other objectives for habitats. In progress and anticipated 2022 to 2027 projects are anticipated to restore additional riparian habitat and substantial amounts of marsh and other wetland habitats. Most of that restoration will not be used as mitigation for the loss of these habitats. However, the extent of restoration of natural and riparian-lined riverbanks by these projects is still uncertain.

2.2.3 Species Goal – Contribute to the Recovery and Sustainability of Native Species Populations and Overall Biotic Community Diversity

The species goal has no species-specific measurable objectives separate from the broader objectives to achieve net increases in processes and habitats and reductions in stressors, which are based in part on the target species' conservation needs. The measurable objectives that would contribute to the recovery of each target species are identified in Section 3.3.1, "Measurable Objectives for Tracking Progress Toward Goals."

Progress toward this goal results from progress toward the ecosystem process, habitat, and stressor objectives and, for this reason, has been limited as described for those objectives (less than 5 percent of most objectives). In addition, the planned use of this restoration as compensatory mitigation will reduce contributions to the recovery of target species, as described in Section 3.3.1, "Measurable Objectives for Tracking Progress Toward Goals."

2.2.4 Stressors Goal – Reduce Stressors Related to the Development and Operations of the SPFC that Negatively Affect At-risk Species

For this goal, the Conservation Strategy identified priority anadromous fish passage barriers and prioritized invasive plant species, both of which are stressors that negatively affect at-risk species.

2.2.4.1 Fish Passage Barriers

The objectives for fish passage barriers were adopted from “Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System” (Appendix K of the 2016 Conservation Strategy), which prioritized specific fish passage barriers for remediation. There is no objective for prioritized fish passage barriers in the Upper San Joaquin River and Lower San Joaquin River CPAs. But, after the objectives were established, DWR prioritized three fish passage barriers in the Upper San Joaquin River CPA: the Mendota Dam, the Sack Dam, and the Eastside Bypass Control Structure.

A prioritized fish passage barrier (Fremont Weir) has been rectified in the Lower Sacramento River CPA. Although Fremont Weir is not a multi-benefit project associated with the CVFPP’s implementation, it has resulted in the remediation of a fish passage barrier identified in Appendix K of the 2016 Conservation Strategy, which is considered to have contributed to the measurable objectives of the 2016 Conservation Strategy. Two planned projects would also remediate barriers or stranding issues: one each in the Upper Sacramento River and Lower Sacramento River CPAs (Tisdale Weir Rehabilitation and Fish Passage Project and Agricultural Road Crossing 4 Fish Passage Project, respectively). The objectives of the Tisdale Weir project are to extend the design life of that facility by an additional 50 years and to reduce fish stranding by improving fish passage through the weir to the Sacramento River. The Agricultural Road Crossing 4 Fish Passage project is located on the Tule Canal in the Yolo Bypass, and was identified in Appendix K as one of five fish passage barriers during low-flow events along the Tule Canal.

2.2.4.2 Invasive Plants

The objectives for invasive plants were adopted from the Invasive Plant Management Plan (Appendix E of the 2016 Conservation Strategy), to reduce populations of four prioritized species from channel maintenance areas: giant reed, tamarisk, red sesbania, and Himalayan blackberry. For each CPA, the Invasive Plant Management Plan has objectives for each of these species, which were combined into a single objective for the 2016 Conservation Strategy.

Between 2016 and 2021, completed projects achieved 0 percent of the measurable objectives for removal of prioritized invasive plant species (Tables F-2 and F-4 in in Appendix F, “Conservation Strategy Five-Year Implementation Summary Memorandum”). The Invasive Plant Management Plan set an approximate 20 percent goal for achieving its objectives in five-year intervals as the adaptive management threshold for review of the plan and its implementation (the 2016 Conservation Strategy combines these species objectives into a single objective per CPA). Documented removals of prioritized invasive species were less than the 20-percent threshold, triggering a review of the plan and its implementation.

2.2.5 Other Contributions of Multi-benefit Projects to Conservation Strategy Goals

The Conservation Strategy's measurable objectives do not encompass all types of contributions multi-benefit projects and O&M can make toward the Conservation Strategy's goals. In particular, projects or maintenance activities can reduce stressors that were not prioritized and not included in the measurable objectives (e.g., the removal of aquatic invasive plants). Between 2016 and 2021, maintenance activities and several multi-benefit projects supported the Conservation Strategy's goals by removing non-prioritized invasive vegetation or impediments to fish passage:

- The Oroville Wildlife Area Flood Stage Reduction Project eradicated infestations of prioritized and non-prioritized species from 700 acres outside of channel maintenance areas in the Feather River CPA.
- The Eastside Bypass Improvements Project eliminated two weirs impeding fish passage in the Upper San Joaquin River CPA.
- Maintenance activities in all CPAs routinely remove invasive plants, and some removals of non-prioritized species substantially benefit target species. For example, the routine removal of invasive aquatic plants (such as water hyacinth and water primrose) from canals and other waterbodies enhances habitat for giant gartersnakes, fish, and other species.

2.3 Adaptive Management

The 2016 Conservation Strategy included adaptive management that involved implementation tracking and data dissemination; systemwide or regional inventories of targeted ecosystem processes, habitats, and stressors; studies focused on key uncertainties; and solicited guidance. The following sections describe each of these components between 2016 and 2021.

2.3.1 Implementation Tracking and Data Dissemination

The 2016 Conservation Strategy described a proposed system of tracking and data management to facilitate necessary reporting, information sharing, and adaptive management. Since 2016, to meet these needs, DWR has been creating new, more efficient systems for data management, including a system to manage data for the Conservation Strategy and other CVFPP metrics. The FPTS compiles and tracks flood management and environmental outcomes to gauge progress toward meeting CVFPP goals.

A related system that is under consideration would use a "one-landscape" approach to associate these flood management and environmental outcomes with the objectives of other DWR programs, and would support project prioritization and outcome-based evaluations of those programs. These new, centralized systems would use common data from across programs and applications, while maintaining the unique functionality of existing applications. This data management infrastructure would have the following characteristics:

- Relies on an integrated set of databases and applications.

- Integrates shared data across programs.
- Reduces redundancy and duplicated data management efforts by storing shared data in a single location that can be accessed across DWR.

Together, these data systems would manage information about projects, funding, habitat outcomes, and ecosystem metrics across DWR programs. They are described further in Section 3.4.5, “Adaptive Management,” which provides the updated approach to adaptive management.

2.3.2 Inventories

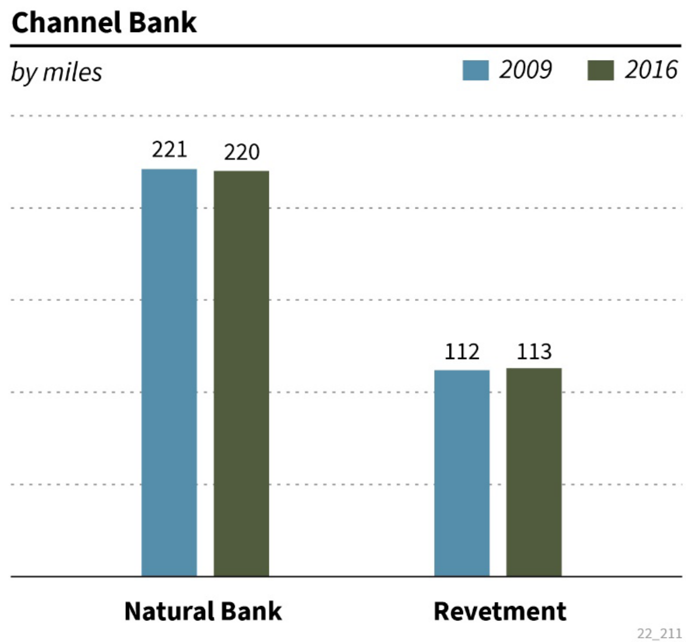
While developing the 2016 Conservation Strategy and 2017 CVFPP Update, DWR produced several systemwide and regional inventories of targeted ecosystem processes, habitats, and stressors. These inventories supported the development of the measurable objectives, and inform project planning. As described in the 2016 Conservation Strategy, updates to these datasets will occur every five to 10 years and document regional changes to the amount and distribution of these targets, thereby supporting adaptive management of implementation and development of multi-benefit projects (Table 8-1 in the 2016 Conservation Strategy).

Between 2016 and 2021, DWR updated vegetation mapping systemwide, in three separate efforts: the legal Delta, a portion of the Feather River CPA, and the rest of the SPA. These updates are based on 2016 imagery and field work, and validation studies conducted from 2018 to 2021. The previous map of vegetation in the SPA was based on 2009 imagery.

In addition, channel bank datasets (revetted and natural banks) were updated for the Upper Sacramento River and Lower Sacramento River CPAs. These updates were based on 2016 aerial imagery and field work conducted during 2019 and 2020. The Feather River CPA is scheduled to be updated in 2022. The previous mapping for the Lower Sacramento River CPA was based on an U.S. Army Corps of Engineers (USACE) inventory of revetment along the Sacramento River (U.S. Army Corps of Engineers 2007). The previous mapping for the Upper Sacramento River CPA was based on 2009 imagery and field work conducted in 2014.

The updated inventory of revetted and natural banks in the Upper Sacramento River CPA illustrates the value of regional inventories for adaptively managing implementation. During 2009 to 2016, revetment was eroded away from or deposited at almost 100 locations with a combined length of almost 3 miles. These changes resulted in a net decrease in natural bank of approximately 1 mile. Figure 2-4 shows this net reduction in ecosystem processes and habitat does not substantially alter 2009 conditions, but continues a trend that has already dramatically reduced ecosystem processes and habitat for target and other native species. Because revetment is placed on the most actively eroding locations along channel banks, the placement of revetment on approximately one-third of bank length has had a disproportionate impact on geomorphic processes and the regeneration of early successional vegetation (Fremier 2003).

Figure 2-4. Length of Revetment and Natural Channel Bank in the Upper Sacramento River CPA in 2009 and 2016



2.3.3 Focused Studies

The 2016 Conservation Strategy recommended using focused studies to complete key datasets and reduce uncertainty regarding the response of targeted habitats and species to management actions. The Strategy identified 17 studies as priorities (Table 8-2 in the 2016 Conservation Strategy). Seven of these studies would complete regional inventories of targeted ecosystem processes or habitats, nine are focused on targeted species, and the remaining one is focused on fish passage barriers.

None of these focused studies were conducted during 2016 to 2021, but their completion remains a priority to advance scientific understanding, as well as the implementation of the CVFPP and related conservation actions. New study priorities have also been identified, particularly related to the need to update older inventories and inform climate change adaptation. These new priorities are provided in Table 3-5, “Data Gaps Related to Targeted Ecosystem Processes, Habitats, and Species.”

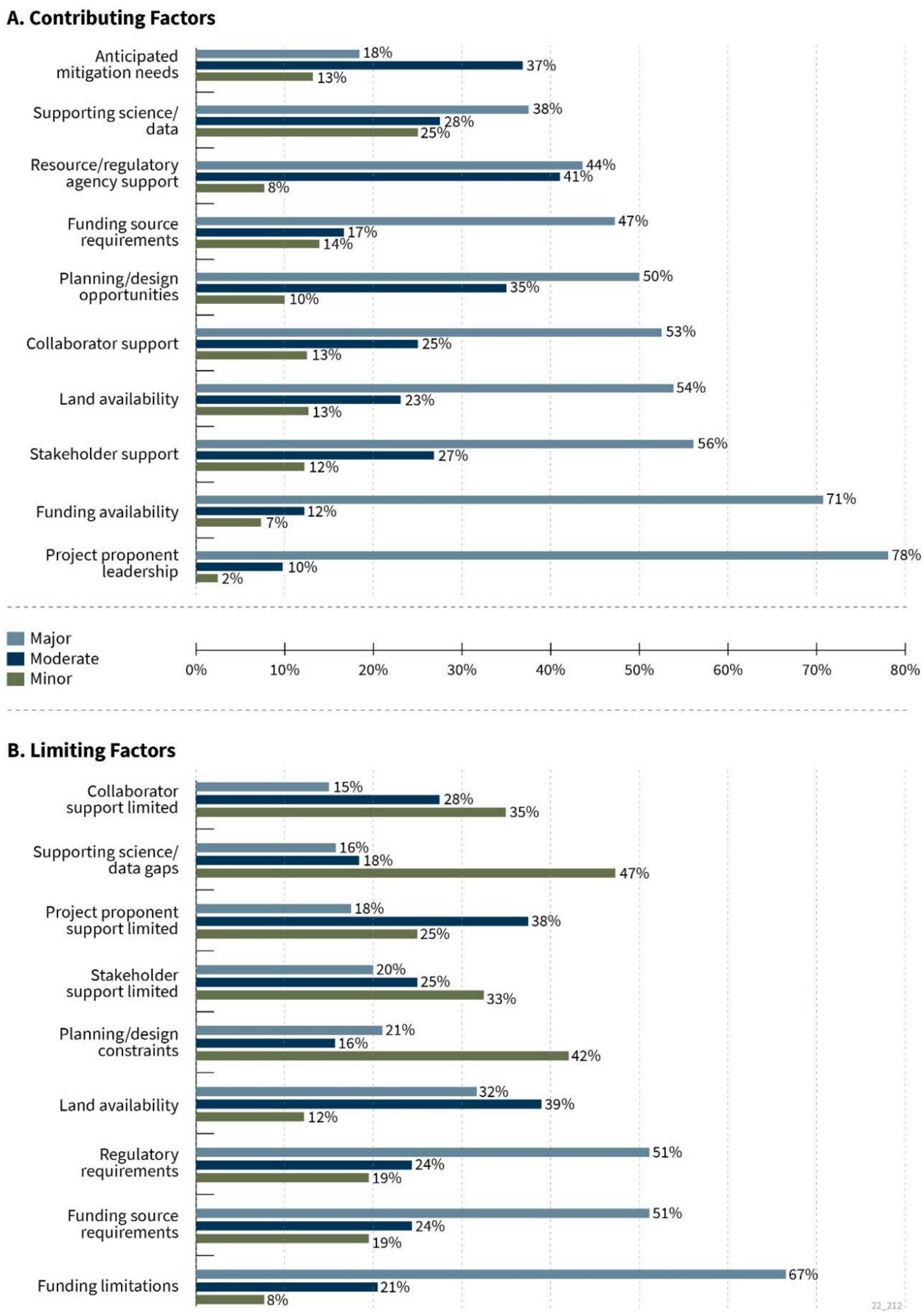
2.3.4 Implementation Guidance

As described in the 2016 Conservation Strategy, the adaptive management of implementation must be guided not only by project outcomes, regional resource inventories, and focused studies, but by input from other agencies and scientists. To obtain this guidance, an interagency advisory committee and scientific advisory committee were proposed. Neither of these committees has convened between 2016 and 2021. But, DWR solicited advisory input from agencies, NGOs, and project proponents, as described here.

In addition to its own assessment of implementation of the Conservation Strategy, DWR solicited input from the CVFPB, other project proponents and maintainers, regulatory agencies, NGOs, and other stakeholders. This input was initially solicited through a survey (distributed to approximately 240 individuals, 42 of whom responded) and 16 interviews, and subsequently through participation in the CVFPB Advisory Committee. The experience of survey recipients and interviewees represented the range of regions, roles, project types, and project phases relevant to the Conservation Strategy's implementation.

Survey respondents identified funding availability, funding source requirements, and regulatory requirements as major factors limiting multi-benefit projects, among other factors. They identified funding availability and project proponent leadership as the major factors contributing to the successful implementation of multi-benefit projects (Figure 2-5).

Figure 2-5. Survey Responses Regarding Factors Contributing to or Limiting Ecosystem Improvements by Multi-benefit Projects



Interview participants provided more extensive and detailed input regarding implementation needs. Major findings from the interviews included:

- **Better alignment is needed among agency policies, funding sources, and regulatory requirements.** Participants called for better policy integration and coordination within and among agencies to facilitate the development of multi-benefit projects. Such projects are subject to the policy and regulatory requirements of fish and wildlife agencies and USACE, and to the requirements of funding sources; particularly State bonds that often do not align well with the multi-benefit-project objectives described in the CVFPP. Much of this alignment must occur at higher State and federal policymaking levels, but participants also noted the need for a better alignment of divisions and programs within key CVFPP agencies to support the development and implementation of multi-benefit projects.

- **CVFPP criteria are needed that define multi-benefit projects and contributions to measurable objectives.** Participants also called for clearer policy guidance in the CVFPP; particularly regarding criteria that define multi-benefit projects and determine contributions to the measurable objectives (e.g., mitigation contributions, if any).

- **The CVFPP should consider how to strike an appropriate balance between multi-benefit and single-purpose projects.** Some participants expressed concern that because of the difficulty of developing multi-benefit projects, placing substantially greater emphasis on such projects could leave important flood safety needs unaddressed. They were also concerned that it may not be feasible to achieve meaningful ecosystem improvements for every flood management project.

- **Regional planning is working well, but more early engagement is needed between project proponents, stakeholders, and regulatory agencies.** Developers of multi-benefit projects reported that early engagement with local stakeholders and State and federal agencies, particularly regulators, is essential to a successful project. Participants considered the collaborative environments established by the RFMP process and the CVFPB's Advisory Committee to be effective at the planning level, but they also identified the need for additional, earlier engagement among all stakeholders and agencies (including divisions and programs within agencies) in the project development process.

- **Funding requirements are a major constraint, including the lack of funding for monitoring and long-term O&M associated with ecosystem improvements.** Project developers consistently cited the divergent requirements of various funding sources as a significant barrier to project development. Multi-benefit projects usually package funds from multiple sources, many of which can be used only for specified purposes, and which may have different deadlines and administrative requirements. The perennial lack of funding for post-construction O&M and monitoring is an even larger problem for restoring habitats through multi-benefit projects. Post-project monitoring and resource needs for ongoing O&M should be included in initial project cost estimates.

- **Improved post-construction monitoring, data management, and documentation of project outcomes are needed to adaptively manage implementation.** Participants reported that funding for post-construction activities, including monitoring, is generally inadequate. Some noted that data are recorded inconsistently, and project outcomes are documented insufficiently. Without more complete, consistent methods of tracking and recording project features and outcomes, it will be difficult to accurately assess progress toward the Conservation Strategy's measurable objectives, or to improve management strategies in response to ecological conditions and lessons learned from previous implementation experiences.

During summer 2020, the CVFPB Advisory Committee formed three stakeholder-led subgroups to provide input into the update of this Strategy and its implementation. The topics for the subgroups were:

- Implementation of multi-benefit projects.
- Permitting.
- Performance tracking.

Each subgroup met multiple times between August 2020 and February 2021 to formulate recommendations. DWR requested that these recommendations be grouped to distinguish those pertaining to this update of the Conservation Strategy from others. These subgroup-specific recommendations were finalized in January 2021. Cross-cutting themes (e.g., topics applicable to all three subgroups) were also identified and include: funding, O&M support, technical assistance for disadvantaged communities, and clarification on the definitions of mitigation and allocation of multi-benefit project features toward meeting the Conservation Strategy's measurable objectives. The recommendations from each subgroup are provided in Appendix G, along with their status for incorporation into the Conservation Strategy Update or the CVFPP Update.

2.3.5 Implementation Summary

During the past five years, DWR has developed a preliminary performance tracking system; updated vegetation mapping systemwide; updated mapping of natural and riparian-lined banks in the Upper Sacramento River and Feather River CPAs; developed permitting mechanisms for O&M activities; continued development of previously funded advance mitigation; funded and developed multi-benefit projects; and sought input on the implementation of this Strategy from resource agencies, project proponents, maintainers, and other stakeholders.

Overall, completed projects have attained only a small portion of most measurable objectives (less than 5 percent). In-progress and anticipated 2022 to 2027 projects are expected to result in contributions to additional objectives, and for multiple objectives, cumulative contributions could exceed 20 percent of the objective by 2027. Nonetheless, for the majority of the objectives, the cumulative contributions of projects could still be less than 20 percent of the objective in 2027.

Opportunities are likely missed by not implementing projects that effectively integrate ecological restoration with flood risk reduction projects. The pace of implementation indicates without systemic changes that address major impediments and expedite the development of multi-benefit projects, particularly those that expand the footprint of the flood system, multiple measurable objectives may not be attained, leaving the goals of this Conservation Strategy and CVFPP unfulfilled. The input solicited from DWR staff, survey respondents, interviewees, and the CVFPB's Advisory Committee indicated that project funding and permitting have been major impediments and that multiple factors are important contributors to the successful implementation of multi-benefit projects. This input also provides numerous recommendations to facilitate multi-benefit projects, which have been applied to updated content for the Conservation Strategy and priority actions for 2022 to 2027, provided in Chapter 3, "2022 Conservation Strategy Update."

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CHAPTER 3

2022 Conservation Strategy Update

This chapter reevaluates the list of target species, discusses how to make habitats and target species more resilient to climate change, and clarifies components to meet the measurable objectives. This chapter also presents updates to the Conservation Strategy's approach to guide implementation, whose main components are collaboration, coordination, and alignment; outreach and engagement; funding; regulatory compliance; and adaptive management.

3.1 Target Species

As described in the 2016 Conservation Strategy, one of the primary goals is to support the recovery and stability of native species populations and overall biotic community diversity. To address this goal, a broad set of species associated with Central Valley river and floodplain ecosystems was first identified; next, focused conservation planning took place for species with the greatest need for recovery and that could be most affected by implementation of the CVFPP ("target species"). Target species are selected based on their ability to meet the following three criteria:

1. **Sensitive or special-status.** The species is identified as sensitive or special-status in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife (CDFW), National Marine Fisheries Service (NMFS), or U.S. Fish and Wildlife Service (USFWS). Sensitive or special-status species include those listed as threatened or endangered under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); candidates for listing under the ESA or CESA; species identified as fully protected under the California Fish and Game Code or as California Species of Special Concern; and species with California Rare Plant Rank 1A, 1B, or 2.

2. **Associated with target habitats.** The species requires riverine aquatic (including SRA cover), riparian, marsh, or periodically inundated floodplain or associated habitats as the primary habitat for one or more life stages or ecological needs (e.g., reproduction or foraging).

3. **Major potential CVFPP effect.** Implementing the CVFPP, including flood projects and O&M, could substantially affect the species' populations in California either temporarily or permanently, based on the species' distribution, habitat associations, and ecology (effects may be adverse or beneficial).

A focused conservation plan was developed for each target species. These plans explain the relationship between the species' conservation needs and flood management activities in sufficient detail to support the development of the Strategy. Appendix G of the 2016 Conservation Strategy provided further details about target species selection and the focused conservation plans.

3.1.1 Target Species Review

For this update to the Conservation Strategy, all information relevant to determining target species was reviewed, including adopted conservation plans, status reviews and critical habitat designations, regional conservation planning documents, and relevant scientific literature. This review included target species as well as the potentially suitable species that were not selected as target species in the 2016 Strategy (i.e., non-target species). This information is summarized in Appendix A, "Target Species List Review and Update." The 2016 Strategy includes provisions for amending the list of target species as part of the five-year update process to reflect changing conservation needs and habitats. In addition to the 17 target species identified in the 2016 Conservation Strategy, four additional target species were identified:

1. **Delta smelt.** The recent precipitous decline of this San Francisco Bay and Delta estuary-endemic species (Figure 3-1) has led to its "warranted-but-precluded" uplisting from threatened to endangered under ESA since the completion of the 2016 Conservation Strategy. The delta smelt's recovery depends on existing and additional habitat in the SPFC's river corridors, sloughs, and the Yolo Bypass.

2. **Tricolored blackbird.** The recent precipitous decline of this near-California-endemic species (Figure 3-1), of which the Central Valley holds the vast majority of the largest colonies, has led the species' status to be elevated from California Species of Special Concern to listed as threatened under CESA since completion of the 2016 Conservation Strategy. Existing and additional nesting habitats along SPFC river corridors and in SPFC bypasses are important to this species' recovery.

3. **Yellow-breasted chat.** Yellow-breasted chat (Figure 3-1) is a riparian-obligate bird associated with early successional habitat. Flood management activities have caused substantial adverse effects to this California Species of Special Concern; conversely, the implementation of this Conservation Strategy would substantially benefit yellow-breasted chat and contribute to the recovery of its Central Valley population.

4. **Monarch butterfly.** The monarch butterfly, a candidate for listing as threatened under the ESA (Figure 3-1), breeds exclusively on plant species in the subfamily *Asclepiadoideae*. The SPA is home to the western North American monarch butterfly's early breeding zone (i.e., the geographic area where breeding occurs closest to coastal overwintering sites). The USFWS (2021a) has designated the early breeding zone as a "priority #1 conservation action zone" for monarch conservation actions.

A focused conservation plan has been prepared for each of these species (Appendix B, "Focused Conservation Plans for New Target Species"). Their conservation needs are considered in this update's review of the measurable objectives.

Figure 3-1. Additions to the Target Species List: Delta Smelt (top left), Yellow-breasted Chat (top right), Tricolored Blackbird (bottom left), and Monarch Butterfly (bottom right)

Sources: DWR, H. T. Harvey & Associates, River Partners

3.2 Increasing the Resilience of Target Species and Habitats to Climate Change

A key theme of the 2022 Update to the CVFPP and Conservation Strategy is climate resilience, supported by a body of work to describe and better understand flood and ecosystem management-related risks and vulnerabilities, and to provide a set of recommendations and adaptation strategies related to climate change. Climate change is a critically important issue for ecosystems in the Central Valley, with major ecological consequences leading to changes in the abundance and distribution of native habitats and species as a result of physical changes to the environment (Dunn and Møller 2019; Rosenzweig et al. 2008). These changes will include higher air and water temperatures, increased evapotranspiration, less precipitation falling as snow and reduced spring snowpack, increased precipitation intensity, increased winter runoff volumes and higher peak-winter runoff rates, changes in the seasonality of flows, more frequent and intense droughts, more frequent and intense wildfires, and sea level rise (Point Reyes Bird Observatory Conservation Science 2011; Central Valley Landscape Conservation Project 2017a; Bedsworth et al. 2018). Relative to historical patterns of precipitation, temperature, and hydrology, these changes will amplify in the coming decades, and will be especially pronounced by the end of this century.

The ability of native habitats and species to withstand the stressors associated with climate change depends on functioning natural physical processes that provide resiliency within the system. Rivers and riparian habitats are especially vulnerable to climate change because of their dependence and critical connections to various flows for critical functions. Additionally, effects such as weather, drought, and fires occurring in upstream watersheds, as well those occurring downstream, such as sea level rise, affect the entire span of river ecosystems.

Climate change affects ecosystems and species directly, and also interacts with other human stressors that have already negatively affected physical processes, habitats, and native species. Traditionally, the potential vulnerability of an ecosystem to climate change impacts has been measured in relation to the historical condition of the ecosystem, with the logic that populations, communities, and ecosystems will be best prepared to cope with new or variable conditions if that condition falls within the historical range of variability to which they are adapted. However, the realized and potential rates of change in temperature, precipitation, and hydrology as a result of climate change are outside the range of historical natural variability ecosystems in the Central Valley. In addition, the increase in climatic extremes increases the frequency and magnitude of natural ecological disturbances such as fire, flood, and drought; the stress these climatic changes and ecological disturbances will impart on natural communities may exceed the ecosystem's ability to recover.

Species differ in their vulnerability to impacts from climate change and their ability to recover from those impacts (i.e., their resilience). Unfortunately, a large portion of California's flora and fauna is moderately to highly vulnerable to climate change impacts (California Department of Fish and Wildlife 2015), including most of this Conservation Strategy's target species and habitats (Gardali et al. 2012; Moyle et al. 2012; Thorne 2016; Central Valley Landscape Conservation Project 2017b). Chinook salmon runs and delta smelt are particularly vulnerable. A species' vulnerability and its resilience are a product of its ecology, population and conservation status, and current habitat conditions. Consequently, actions can be taken to reduce vulnerability or increase resilience.

Appendix H, "Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update" uses recent climate modeling analyses that have been developed to inform the 2022 CVFPP Update, extends these data to determine climate risks and vulnerabilities, and proposes adaptation strategies focusing on the objectives and target species at the CPA scale, including:

- Building system resiliency by restoring critical landscape-level hydrologic, geomorphic, and ecological processes related to improving river functionality, floodplain activation, and habitat connectivity and complexity.

- Opportunistically incorporating habitat and species-specific adaptation measures into multi-benefit project planning and design.
- Further incentivizing, prioritizing, and removing impediments to multi-benefit project implementation.
- Performing more detailed analyses and developing additional tools and processes to better evaluate vulnerabilities and risks of Conservation Strategy processes, habitats, and species to climate change at regional and project-specific scales.
- Developing better communications and outreach protocols to convey the ecological risks and adaptation opportunities associated with climate change, and forming more effective partnerships with federal, regional, and local stakeholders.

These adaptations are guided by the following key principles of conservation biology and adaptive management (National Fish, Wildlife, and Plants Climate Adaptation Partnership 2012; California Natural Resources Agency 2014; Stein et al. 2014; Keeley et al. 2018):

- Protecting remaining habitats from loss and fragmentation and increase the size of protected areas.
- Providing for species movement and migration through habitat protection and restoration, and through compatible design of infrastructure.
- Reducing other (non-climatic) stressors on species through management actions.
- Using adaptive management to take action under uncertain and changing climatic conditions to increase understanding and inform actions.
- Increasing institutional capacity for effective management.

The 2022 Update to the CVFPP and Conservation Strategy provides a critical opportunity to increase the climate change resiliency of riverine habitats and species. This is primarily because rivers and floodplains are particularly important as corridors for the movement and migration of aquatic and terrestrial species (Seavy et al. 2009). The Central Valley's rivers and floodplains are also highly managed systems, and many opportunities are available to act to reduce vulnerability to climate change impacts and increase resilience. As DWR, regional maintaining agencies, LMAs, and other State and federal resource managers continue to advance multi-benefit projects within the SPA, floodplain managers will need to strive to build resilience into the system and develop countermeasures to mitigate the impacts of climate change by employing effective adaptation approaches.

The Conservation Strategy provides the guidance to make progress on developing the planning processes, strategies, and multi-benefit projects that increase system resilience. The main challenge DWR and its partners face in relation to climate change is primarily one of timing –

the pace and scope of multi-benefit project implementation must increase, which will require the resolution of the fundamental policy issues already identified in the CVFPP and Conservation Strategy, including funding, permitting, long-term O&M, and performance accounting. This will also require impediments to multi-benefit project development to be addressed and resolved.

3.2.1 Climate Adaptation Opportunities for Regional Multi-benefit Projects

Of the multi-benefit projects currently identified and evaluated in the CVFPP, those that will most effectively build resilience are those that are being developed at a landscape or regional scale, and focus on the restoration of geomorphic, hydrologic, and ecological processes along the primary river corridors. Strategically restoring riverine geomorphic processes and providing sufficient river corridor widths will provide the greatest degree of resilience for the Conservation Strategy habitats and species, and simultaneously provide flood risk reduction benefits for communities located along these channels. Chapter 5 of Appendix H provides a preliminary analysis of the potential opportunities to enact adaptation strategies along river corridors for identified reaches in each CPA. Because of the extreme risk and potential vulnerabilities of the Conservation Strategy habitat and species to the impacts of climate change, it is imperative that a more detailed analysis of regional multi-benefit opportunities is performed, followed by planning, design, and implementation once high-priority opportunities are identified. This work likely will require conversion of lands from agriculture, and the removal, modification, or setting back of levee systems, which poses significant challenges politically and financially for the State and its federal, regional, and local partners.

Historically, the bypass systems have been a primary focus of regional flood system improvement projects in the Central Valley, because they provide large flood risk reduction benefits for urban areas and agricultural lands. But, these bypass systems are not as ideal for restoring ecological resilience, because they are only secondarily connected (during flood flows) to the river channels that drive the fundamental geomorphic and hydrologic processes that support the diversity and resilience of native habitats and many target species. Despite this issue, there are some significant opportunities to approach bypass expansion and improvements in a manner that is consistent with the adaptation strategies identified in Appendix H.

For example, the Yolo Bypass Cache Slough (YBCS) Master Plan effort (currently in development) is evaluating how a suite of recently implemented, ongoing, and proposed projects in the bypass can improve the form, function, and habitat diversity of the Yolo Bypass at a landscape scale, while seeking to provide for long-term viability of agriculture. These efforts will also improve floodplain connectivity and activation, and potentially provide aquatic, riparian, and floodplain habitat improvements for a wide range of native species (including anadromous fish). By purposefully designing and maintaining habitat connectivity along areas in the bypass such as along the Tule Canal, and between different multi-benefit projects proposed in the bypass, migratory corridors can be established that might not otherwise be possible if the projects are planned and implemented individually. Through this process, these projects collectively contribute to the six pillars of the YBCS Partnership. In this region, by designing, operating, and maintaining a group of projects to function as a system, landscape-scale ecological processes can be leveraged, increasing habitat and species resilience to the effects of climate change.

In the San Joaquin watershed, the proposed Paradise Cut multi-benefit project is another project that is leveraging the restoration of landscape-level processes, such as floodplain reconnection and sediment management, to develop a suite of complex, interconnected habitats across a broad project footprint. In doing so, it can significantly improve the quality and quantity of riverine habitats and provide much-needed flood risk reduction in one of the most vulnerable regions of the Central Valley.

This 2022 Update is the first version of the Conservation Strategy to directly address the impacts of climate change to natural resources in the SPA. Climate adaptation likely will be the central theme of future updates, and because of the urgency and need for action, will influence many facets of the plan formulation approach and execution of the Conservation Strategy and the CVFPP.

3.3 Measurable Objectives

This section describes how progress toward the measurable objectives indicates progress toward the Conservation Strategy's goals, and clarifies the components of meeting the measurable objectives.

3.3.1 Measurable Objectives for Tracking Progress Toward Goals

As described in the 2016 Conservation Strategy and the CVFPP Final Supplemental Program Environmental Impact Report (EIR) (California Department of Water Resources 2017a), the measurable objectives are guidance for planning purposes. The size of the objectives represents net increases in ecosystem processes and habitats, reductions in stressors, and contributions to species recovery that may be achievable via multi-benefit projects and O&M during the CVFPP's 30-year time frame (i.e., its planning horizon).

Consequently, the objectives represent potential partial contributions to solutions for environmental problems. The objectives do not represent the total amount of habitat to be restored on the landscape (and within the flood system) by all mitigation and habitat restoration projects. In fact, the recovery of some species likely depends on the substantial restoration of ecosystem processes and habitats within the flood system in addition to that provided by the CVFPP's multi-benefit projects (Appendix L of the 2016 Strategy; Dybala et al. 2017).

In part, the objectives guide planning by tracking progress toward the Conservation Strategy's goals, which are to improve and increase ecosystem processes and habitats, reduce stressors, and contribute to the recovery of sensitive species. Attaining the measurable objectives would correspond to the achievement of these goals. But, as noted in the previous section, potential effects from climate change are addressed in this 2022 Update but have not been incorporated into the measurable objectives. It is likely that future updates will include modifications to the measurable objectives to better incorporate habitat and species needs in line with the extreme challenges related to climate change.

Within each CPA, a project could contribute to the measurable objectives and represent progress toward the corresponding goals, if it were a multi-benefit flood project constructed after 2016 that would result in a net increase in a targeted ecosystem process or habitat, or would reduce a targeted stressor. In the Lower Sacramento River and Lower San Joaquin River CPAs, there is an exception to this rule: multi-benefit projects being developed within the Delta independent of the CVFPP before 2016 (e.g., the McCormack-Williamson Restoration Project) were excluded from the measurable objectives, and, for this reason, their outcomes do not contribute to attainment.

For each CPA, the measurable objectives are used to measure progress toward each goal. However, the Conservation Strategy does not have separate measurable objectives for the recovery of target species. Rather, contributions toward target species recovery are measured by the applicable ecosystem process, habitat, and stressor objectives.

Table 3-1 summarizes each objective and metric related to each target species' recovery. Note, this table is currently unchanged from the 2016 Strategy, but its contents are not static. The assessments for each species are ongoing and this table likely will be updated for the next iteration of the Strategy. That is to say, a "not applicable" status may change in the future; this is also the case for species, along with the overall measurable objective estimates. In addition, although some aquatic and avian species may be categorized as "not applicable" in a given reach, there is still the possibility that they can benefit from habitat enhancement in the future.

Table 3-1. Measurable Objectives Contributing to the Recovery of Each Target Species [a]

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
Delta Button-celery	Inundated floodplain—major river reaches (acres) [c]	N/A	N/A	N/A	2,800	11,600	14,400
	Inundated floodplain—bypasses and transient storage areas (acres) [d]	N/A	N/A	N/A	NA	200	200
	Riparian habitat (acres) [e,f]	N/A	N/A	N/A	2,100	5,800	7,900
	Invasive plants (acres eradicated)	N/A	N/A	N/A	143	34	177

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
Slough Thistle	Inundated floodplain—major river reaches (acres) [c]	N/A	N/A	N/A	2,800	11,600	14,400
	Inundated floodplain—bypasses transient storage areas (acres) [d]	N/A	N/A	N/A	NA	200	200
	Riparian habitat (acres) [e,f]	N/A	N/A	N/A	2,100	5,800	7,900
	Marsh and other wetland habitat (acres)	N/A	N/A	N/A	None	100	100
	Invasive plants (acres eradicated)	N/A	N/A	N/A	143	34	177
Valley Elderberry Longhorn Beetle	Riparian habitat (acres) [e]	3,400	1,800	1,900	2,100	5,800	15,000
	Invasive plants (acres eradicated)	268	257	363	143	34	1,065
Monarch Butterfly	Riverine geomorphic processes and SRA cover—natural bank (miles)	20	0	4	8	13	45
	SRA cover—riparian-lined bank (miles)	8	0	3	2	6	19
	Riparian habitat (acres) [e]	3,400	1,800	1,900	2,100	5,800	15,000
	Marsh and other wetland habitat (acres)	2,400	N/A	3,500	0	100	6,000
	Invasive plants (acres eradicated)	268	257	363	143	34	1,065

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
California Central Valley Steelhead DPS and Chinook Salmon–Central Valley Fall- and Late-fall-run ESU and Central Valley Spring-run ESU	Inundated floodplain—major river reaches (acres) [c]	6,300	3,700	7,650	2,800 [g]	11,600	32,050
	Inundated floodplain—bypasses and transient storage areas (acres) [d]	9,600	N/A	7,500	None	200	17,300
	Riverine geomorphic processes—river meander potential (acres)	5,600	400	1,300	2,100[g]	4,300	13,700
	Riverine geomorphic processes and SRA cover—natural bank (miles)	20	None	4	8[g]	13	45
	SRA cover—riparian-lined bank (miles)	8	None	3	2[g]	6	19
	Fish passage barriers—channel-wide structures	5	None	4	None	None	9
Chinook Salmon—Sacramento River Winter-Run ESU	Inundated floodplain—major river reaches (acres) [c]	6,300	N/A	7,650	N/A	N/A	13,950
	Inundated floodplain—bypasses transient storage areas (acres) [d]	9,600	N/A	7,500	N/A	N/A	17,100
	Riverine geomorphic processes—river meander potential (acres)	5,600	N/A	1,300	N/A	N/A	6,900

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
Chinook Salmon—Sacramento River Winter-Run ESU	Riverine geomorphic processes and SRA cover—natural bank (miles)	20	N/A	4	N/A	N/A	24
	SRA cover—riparian-lined bank (miles)	8	N/A	3	N/A	N/A	11
	Fish passage barriers—channel-wide structures	5	N/A	4	N/A	N/A	9
Green Sturgeon–Southern DPS	Inundated floodplain—major river reaches (acres) [c]	6,300	3,700	7,650	N/A	11,600	29,250
	Riverine geomorphic processes—river meander potential (acres)	5,600	400	1,300	N/A	4,300	11,600
	Riverine geomorphic processes and SRA cover—natural bank (miles)	20	None	4	N/A	13	37
	SRA cover—riparian-lined bank (miles)	8	None	3	N/A	6	17
	Riparian habitat (acres) [e]	3,400	1,800	1,900	NA	5,800	12,900
	Fish passage barriers—channel-wide structures	5	None	4	N/A	None	9
Delta Smelt	Inundated floodplain—major river reaches (acres) [c]	N/A	N/A	7,650	N/A	11,600	19,250
	Inundated floodplain—bypasses and transient storage areas (acres) [d]	N/A	N/A	7,500	N/A	200	7,700
	Marsh and other wetland habitat (acres)	N/A	N/A	3,500	N/A	100	3,600

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
Giant Gartersnake	Marsh and other wetland habitat (acres)	2,400	None	3,500	None	100	6,000
	Invasive plants (acres eradicated)	268	257	363	143	34	1,065
Bank Swallow	Inundated floodplain— major river reaches (acres) [c]	6,300	3,700	7,650	N/A	N/A	17,650
	Riverine geomorphic processes and SRA cover—natural bank (miles)	20	None	4	N/A	N/A	24
	SRA cover—riparian-lined bank (miles)	8	None	3	N/A	N/A	11
	Riparian habitat (acres) [e]	3,400	1,800	1,900	N/A	N/A	7,100
	Marsh and other wetland habitat (acres)	2,400	None	3,500	N/A	N/A	5,900
	Invasive plants (acres eradicated)	268	257	363	N/A	N/A	888
California Black Rail	Riparian habitat (acres) [e]	N/A	N/A	1,900	N/A	5,800	7,700
	Marsh and other wetland habitat (acres)	N/A	N/A	3,500	N/A	100	3,600
Greater Sandhill Crane	Inundated floodplain—major river reaches (acres) [c]	6,300	3,700	7,650	2,800	11,600	32,050
	Inundated floodplain—bypasses and transient storage areas (acres) [d]	9,600	N/A	7,500	None	200	17,300
	Marsh and other wetland habitat (acres)	2,400	None	3,500	None	100	6,000
	Invasive plants (acres eradicated)	268	257	363	143	34	1,065

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
Least Bell's Vireo, Swainson's Hawk, Yellow-breasted Chat, and Western Yellow-billed Cuckoo	Inundated floodplain—major river reaches (acres) [c]	6,300 [h]	3,700 [h]	7,650 [i]	2,800 [i]	11,600 [j]	32,050
	Riverine geomorphic processes—river meander potential (acres)	5,600 [h]	400 [h]	1,300 [i]	2,100 [i]	4,300 [j]	13,700
	Riverine geomorphic processes and SRA cover—natural bank (miles)	20 [h]	None [h]	4 [i]	8 [i]	13 [j]	45
	SRA cover—riparian-lined bank (miles)	8 [h]	None [h]	3 [i]	2 [i]	6 [j]	19
	Riparian habitat (acres) [e]	3,400 [h]	1,800 [h]	1,900 [i]	2,100 [i]	5,800 [j]	15,000
	Invasive plants (acres eradicated)	268 [h]	257 [h]	363 [i]	143 [i]	34 [j]	1,065
Tricolored Blackbird	Inundated floodplain—major river reaches (acres) [c]	6,300	3,700	7,650	2,800	11,600	32,050
	Inundated floodplain—bypasses and transient storage areas (acres) [d]	9,600	N/A	7,500	None	200	17,300
	Riverine geomorphic processes—river meander potential (acres)	5,600	400	1,300	2,100	4,300	13,700
	Riparian habitat (acres) [e,f]	3,400	1,800	1,900	2,100	5,800	15,000
	Marsh and other wetland habitat (acres)	2,400	None	3,500	None	100	6,000

Species	Objective and Metric	USR [b]	FR [b]	LSR [b]	USJR [b]	LSJR [b]	Total
Riparian Brush Rabbit and Riparian (San Joaquin Valley) Woodrat	Riparian habitat (acres) [e]	N/A	N/A	N/A	N/A	5,800	5,800

Sources: Objectives contributing to each species recovery are from Appendix G, "Identification of Target Species and Focused Conservation Plans," and objective amounts are from Section 5.0, "Ecological Objectives," of the 2016 CVFPP Conservation Strategy (California Department of Water Resources 2016). This table is provided verbatim from the 2016 Conservation Strategy; corrections and revisions will occur during future updates. For delta smelt, yellow-breasted chat, tricolored blackbird, and monarch butterfly, considerations when implementing flood-related projects that could contribute to recovery are identified in Appendix B, "Focused Conservation Plans for New Target Species."

[a] A portion or all of identified objectives contribute to recovery of species as described in the focused conservation plans.

[b] FR = Feather River CPA; LSJR = Lower San Joaquin River CPA; LSR = Lower Sacramento River CPA; USJR = Upper San Joaquin River CPA; USR = Upper Sacramento River CPA.

[c] Area inundated by two-year, 14-day, or longer flows, December to May (acres); includes both natural and agricultural land cover.

[d] Not inundated in 50 percent of years or more frequently for 14 days or longer.

[e] With grassland inclusions.

[f] Habitat provided by portion restored as riparian scrub, inclusions.

[g] Potential distribution in CPA based on historical distribution or poorly known.

[h] Potential distribution of least Bell's vireo in CPA based on historical distribution or poorly known.

[i] Potential distribution of least Bell's vireo and yellow-billed cuckoo in CPA based on historical distribution or poorly known.

[j] Potential distribution of yellow-billed cuckoo in CPA based on historical distribution or poorly known.

Notes:

CPA = conservation planning area

ESU = Evolutionarily Significant Unit

N/A = not applicable

SRA = shaded riverine aquatic

The restoration outcomes of multi-benefit projects used as compensatory mitigation are tracked and evaluated separately from outcomes that are not used as mitigation. Depending on its timing, amount, location (e.g., proximity to existing habitat), and type, mitigation can improve ecological conditions (i.e., result in uplift) for some resources. However, the purpose of compensatory mitigation is to reduce or offset unavoidable impacts to a resource, which substantially limits its potential to improve ecological conditions for resources in general, and reduces or eliminates their contribution toward the Strategy's goals as follows:

- **Goal 1. Ecosystem Processes:** Improve dynamic hydrologic (flow) and geomorphic processes in the SPFC. This Conservation Strategy's objectives quantify improvements in ecosystem processes as net increases in the area or length where the processes occur (e.g., acreage of inundated floodplain). If restored processes are used as compensatory mitigation, they represent gross increases, not net increases. To determine the net increase in amount, the permanent loss being mitigated must be subtracted (e.g., length of restored natural bank minus length of revetted bank being mitigated).

- **Goal 2. Habitats:** Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats. This Conservation Strategy's objectives quantify habitat increases and improvements as net increases in habitat amounts. If used as compensatory mitigation, habitats restored by multi-benefit projects represent gross increases, not net increases. To determine the net increase in amount, the permanent habitat losses being mitigated must be subtracted.

- **Goal 3. Species:** Contribute to the recovery and sustainability of native species populations and overall biotic community diversity. This Conservation Strategy has no measurable objectives for species recovery separate from the objectives for the net increases in processes and habitats, and reductions in stressors, which would contribute to species recovery. Restoration as compensatory mitigation of impacts on populations of ESA- or CESA-listed species does not contribute to the recovery of those species or to the recovery of other target species that use the affected habitats and, consequently, does not contribute to this goal.

- **Goal 4. Stressors:** Reduce stressors related to the development and operations of the SPFC that negatively affect at-risk species. This Conservation Strategy has objectives to reduce two of the four identified stressors that negatively affect at-risk species: (1) rectifying a list of priority barriers to anadromous fish passage, and (2) eliminating infestations of prioritized invasive plant species. If used as compensatory mitigation, the remediation of prioritized fish passage barriers or removal of infestations of invasive plants still contributes to the attainment of this goal (but does not contribute to the attainment of Goal 3, Species).

3.3.2 Updates to Target Species and Measurable Objectives

The 2016 Conservation Strategy established measurable objectives based on estimates of the conservation needs of target species and opportunities for multi-benefit flood projects to contribute to those needs (Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities," in California Department of Water Resources 2016). It also acknowledged uncertainty regarding the size of conservation needs, and that circumstances could change during the CVFPP's implementation. This Strategy addresses these uncertainties by including clarification of the measurable objectives in conjunction with the five-year updates.

As part of this five-year update, the measurable objectives were evaluated by reviewing relevant conservation planning since 2016, the conservation needs of the four new target species, changes to the CVFPP, and related scientific literature. Appendices A, B, and C of this document include summaries of new relevant conservation planning and literature, and focused conservation plans for delta smelt, yellow-breasted chat, tricolored blackbird, and monarch butterfly. The results of this review are:

- Conservation planning for delta smelt, yellow-breasted chat, tricolored blackbird, and monarch butterfly has not identified a need for greater amounts of restoration than already included in the measurable objectives (but the following discussion of underestimated conservation needs provides more information). But, conservation planning for tricolored blackbird indicates a potential conflict between the objectives for the removal of invasive plants and those for the recovery of tricolored blackbird. The invasive Himalayan blackberry has been prioritized for removal and accounts for a substantial portion of the invasive plant objectives, yet this species provides nesting habitat for tricolored blackbird. The avoidance of occupied habitat and replacement of Himalayan blackberry infestations with riparian scrub dominated by native species would reduce this conflict.

- Updated recovery plans for giant gartersnake and valley elderberry longhorn beetle have been published since 2016, but those plans do not identify additional conservation needs greater than the needs the measurable objectives are based on. The *Recovery Plan for Giant Gartersnake (Thamnophis gigas)* (U.S. Fish and Wildlife Service 2017) included the same wetland habitat needs as the draft revised recovery plan (U.S. Fish and Wildlife Service 2015), which were considered in establishing the measurable objectives for the 2016 Conservation Strategy. The *Revised Recovery Plan for Valley Elderberry Longhorn Beetle* (*Desmocerus californicus dimorphus)* includes a need for riparian habitat in all of this Strategy’s CPAs (U.S. Fish and Wildlife Service 2019), but the need is focused on preservation and is smaller than the restoration amounts in the measurable objectives for riparian habitat. As such, it does not increase the overall need for riparian habitat restoration the objectives are based on.

- The *Central Valley Flood System Fish Migration Improvement Opportunities Report* (California Department of Water Resources 2014) prioritized fish passage barriers for the Upper San Joaquin River CPA, including three high-priority barriers that were inadvertently not included in the 2016 measurable objectives: the Sack Dam, the Mendota Dam, and the Eastside Bypass Control Structure.

- Since the 2017 update to the CVFPP (California Department of Water Resources 2017b), no substantial changes have been made to the plan’s approach to system improvements, the major projects proposed to accomplish them, or the scale of the improvements in the CVFPP overall. So, the extent of opportunities for multi-benefit projects to provide restored processes and habitats remains comparable to previous estimates.

- This Strategy’s reliance on adopted recovery plans to determine conservation needs has likely caused needs to be underestimated, which has implications for the scope of this Strategy. Not all target species are addressed by adopted recovery plans, and some are addressed by an outdated plan. Also, some adopted plans have underestimated conservation needs; for example, recent research (Dybala et al. 2017) estimates that riparian birds' conservation needs are much greater than identified in the *Central Valley Joint Venture 2006 Implementation Plan* (Central Valley Joint Venture 2006). Because most conservation needs identified in the 2016 Conservation Strategy exceed or greatly exceed the potential contributions of multi-benefit projects, and those needs are likely underestimated, substantial amounts of restoration through single-purpose habitat restoration projects or habitat restoration with other water management purposes (e.g., not flood management) would also be needed for the recovery of target species. The 2016 Strategy acknowledges the need for habitat projects and acknowledges that the SPFC's design, performance, and O&M requirements are major constraints on their implementation. But, this Conservation Strategy has no objectives for reducing constraints on single -purpose habitat projects, nor have these constraints been systematically evaluated by State or regional flood planning efforts.

- New assessment methods (e.g., tools that quantify the value of habitat based on its amount and quality) and improved hydraulic models have been developed since 2016. These analytical tools aid restoration planning, and could provide metrics for revised or additional measurable objectives, particularly objectives for enhancing the value of habitats for target species. (The Strategy's existing objectives focus on the quantity of land cover types that provide habitat, not the value of that land cover for individual species.)

Based on this evaluation, two revisions have been made to the measurable objectives:

1. Based on the *Central Valley Flood System Fish Migration Improvement Opportunities Report* (California Department of Water Resources 2014), an objective to remediate three high-priority fish passage barriers (the Sack Dam, the Mendota Dam, and the Eastside Bypass Control Structure) has been added for the Upper San Joaquin River CPA.

2. The Sutter-Butte Basin is a priority area identified in the NMFS 2012 Central Valley Recovery Plan for steelhead and salmon. Within the basin, Butte Creek is only one of two creeks with naturally occurring spring-run salmon. The Butte Basin and the mainstem Sacramento River around the Butte Slough Outfall Gates (BSOG) structure is critical habitat under the ESA and identified for priority recovery actions. The BSOG connecting the basin and creek to the Sacramento River are known for stranding and delaying migration. NMFS has identified BSOG as a high-priority project. DWR is exploring options for remediating this barrier.

DWR is continuing to explore the application of tools that quantify habitat values for particular species to permitting, mitigation crediting agreements, and the Strategy's objectives. Habitat quantification tools provide a standardized means of quantifying the benefits of habitat restoration and enhancement for individual species (such as giant gartersnake [Environmental Defense Fund and Stillwater Sciences 2019]). O&M can and often does enhance habitats for target species. So, the metrics of habitat quantification tools could serve as the basis of measurable objectives for benefits from O&M activities that do not contribute to this Strategy's current objectives, most of which are for an increase in the amount of ecosystem processes or land cover types, rather than enhancing the value of existing processes or habitats for individual target species.

In flood planning and through coordination and collaboration with conservation planning efforts, DWR is also seeking to reduce the system's constraints on ecosystem processes and habitat restoration, confirm compatibility of restored habitat with O&M of the flood system, and increase the portion of restoration implemented by multi-benefit projects as opposed to single-purpose habitat and mitigation projects. This planning, coordination, and collaboration could also result in future revisions to this Strategy's measurable objectives.

As part of the next five-year update of the CVFPP and Conservation Strategy, it is anticipated that new measurable objectives may be added, and targets may be revised to reflect the most current understanding of ecological conditions and needs, and to identify how those can be addressed given the State's emphasis on multi-benefit projects and the urgency related to climate change impacts.

3.4 Implementation Approach

DWR and other State and federal agencies, LMAs, local communities, and NGOs work together to develop and implement multi-benefit projects and achieve the Conservation Strategy's objectives, and thereby attain the CVFPP's goal of promoting ecosystem functions. This section describes five key components of this Strategy's implementation that support these partnerships:

1. Coordination, collaboration, and alignment.
2. Outreach and engagement.
3. Funding.
4. Regulatory compliance.
5. Adaptive management.

For each of these key implementation components, a set of prioritized actions and recommendations are in the process of being developed for the 2022 to 2027 planning cycle based on identified impediments to multi-benefit project implementation, policy issues, and opportunities that have been recognized by DWR and the diverse range of stakeholders contributing to the Conservation Strategy Update process. Section 3.4.6 describes these actions and recommendations.

3.4.1 Coordination, Collaboration, and Alignment

The update, refinement, and implementation of the CVFPP, including the Conservation Strategy, relies on coordination, collaboration, and alignment among federal, State, and local agency partners and other stakeholders, including landowners, land conservancies, and NGOs. Projects are most successful in being efficiently implemented when there is a strong local, State, and federal collaboration. Many of these partners are involved in land use, flood management, water, or conservation planning efforts that overlap with the CVFPP (California Department of Water Resources 2012a). Accordingly, the effective implementation of the Conservation Strategy relies not only on coordination and collaboration among numerous actors, but on extensive alignment and integration with many other policies, plans, and programs that occur within the boundaries of the SPA.

This section identifies mechanisms for the coordination and collaboration needed to implement the Strategy. It is organized into the following subsections:

- Integration and alignment within DWR.
- Alignment with federal and State natural resource plans and programs.
- Coordination and collaboration with partners in flood management.
- Integration with and importance of agricultural lands. Coordination and collaboration with other habitat restoration and regional conservation planning efforts.
- This alignment, integration, and coordination is applied at the landscape scale. The varied requirements of flood management, conservation, agriculture, water supply, and recreation must be met on landscapes of limited extent, each with their own unique set of opportunities and constraints. The achievement of multiple important State goals and objectives will require coordination among the various plans and programs operating within these landscapes to avoid conflicts and counterproductive “crowding out” of some priorities at the expense of others.

Updates to the Conservation Strategy’s implementation approach will, therefore, facilitate a more coordinated, place-based application of plans and programs—a “one-landscape” approach—to river and floodplain management, to make better and more efficient use of land, water, and funding. A one-landscape approach recognizes that although there are many critical habitat- and species-based drivers (all with corresponding laws, plans, and programs) each competing to complete projects specific to individual species or habitats, they must all be completed on a single Central Valley landscape. A one-landscape approach assumes potentially conflicting plans and programs must undergo adaptive management and agile review and reconciliation to avoid conflicts and counterproductive outcomes that would limit the ultimate success of a restored Central Valley landscape reflecting all these plans and programs.

3.4.1.1 Integration Within the California Department of Water Resources

The formation of DWR’s Division of Multi-Benefit Initiatives (DMI) in 2019 was a foundational step toward greater integration of flood management and habitat restoration planning within DWR. DMI is responsible for producing the CVFPP and this Conservation Strategy, with matrix team support and close collaboration with the Division of Flood Management (DFM) and Division of Planning. DMI also provides funding and support for the DFM-led RFMP process to advance priorities for policy and multi-benefit project implementation across the Central Valley. In addition, DMI’s formation helps to strengthen alignment between the CVFPP; California EcoRestore; and the Delta Levees Program, In-Delta Investments, and Delta Ecosystem Enhancement programs, each of which is also housed within DMI and, as such, are collaboratively developing multi-benefit projects with local, State, and federal partners. The activities and projects of California EcoRestore and Delta programs extend beyond the SPA of the CVFPP into the Delta, and are summarized as follows:

- **California EcoRestore.** EcoRestore is a multi-agency effort to restore ecosystems in the south Delta and YBCS region. EcoRestore will address legacy impacts as well as effects from the ongoing operation of the State and federal water projects by coordinating and advancing at least 30,000 acres of tidal and floodplain habitat restoration.
- **Delta Levees Program, In-Delta Investments Program, and the Delta Ecosystem Enhancement Program**. DWR supports the maintenance and improvement of levees and ecosystems in the Delta through these three programs, which are part of DWR's Delta Levee System Integrity and Delta Habitat Restoration Branch. These programs build flood management projects (including required mitigation) and are charged with providing a net increase in fish and wildlife habitat.

The collective outcomes of implementation surpass individual programs, including the Strategy, to provide broader value to the State and its citizens. Other programs within DWR (outside of DWR's flood management programs) have a direct relationship to this Conservation Strategy. Strengthened alignment and integration with the following programs would help to attain the Strategy's goals:

- **Sustainable Groundwater Management Program**. The Sustainable Groundwater Management Act (SGMA) requires governments and water agencies of high- and medium-priority groundwater basins to halt overdraft and bring the basins into balance by 2040 and 2042, respectively. This law authorizes local agencies to form groundwater sustainability agencies to manage basins according to groundwater sustainability plans they adopt. The Sustainable Groundwater Management Program provides ongoing support, guidance, financing, and technical assistance to the local groundwater sustainability agencies. As land use changes are expected (such as agricultural land retirement) in the Central Valley as a result of implementation of SGMA, there may be opportunities for habitat restoration that contribute to the goals of the Conservation Strategy and CVFPP.
- **Flood-Managed Aquifer Recharge (Flood-MAR).** This is a voluntary resource management strategy that uses Flood-MAR on agricultural lands and working landscapes. DWR is pursuing expanded implementation of Flood-MAR projects in collaboration with landowners and other federal, State, Tribal, and local entities. Opportunities for ecosystem enhancement that contribute to the goals of the Conservation Strategy may be realized as part of Flood-MAR projects.
- **Integrated Regional Water Management (IRWM).** The Division of Regional Assistance is leading a collaborative effort to identify and implement water management solutions on a regional scale to increase regional self-reliance, reduce conflicts, and manage water concurrently to achieve social, environmental, and economic objectives. With DWR's assistance, regional water management groups develop, adopt, and update regional plans to identify specific strategies and projects to address the unique water needs of their regions.

Integration with the Sustainable Groundwater Management Program and Flood-MAR will be enhanced by improving internal collaboration. This collaboration will involve assessing the potential consistency of multi-benefit projects and Flood-MAR projects with local groundwater sustainability plans developed under SGMA, and collaborating with local agencies to advance projects that meet those criteria. To the extent that such projects also enhance water supplies, the implementation of this Conservation Strategy will also involve collaboration to incorporate those projects into pertinent IRWM plans, alongside their incorporation into RFMPs and, if appropriate, the CVFPP itself.

As an example of this type of recent cross-program collaboration, the DMI Conservation Strategy team is working closely with the Flood-MAR program on the development of the Ecological Floodplain Inundation Potential tool. This will update and improve the Floodplain Restoration Opportunity Analysis (FROA), a key component of DWR's CVFPP and the 2016 Conservation Strategy. FROA provided a systematic approach to rapidly identify habitat restoration opportunities for topographic modification or levee setbacks on floodplains for select ecological flows. This pilot study is evaluating how a refined set of modeling tools could be used to assess floodplain inundation, salmonid habitat suitability, and floodplain recharge for the current or future flow regimes. The floodplain recharge quantification tool will support efforts to link Flood-MAR with restoration planning. The resulting information will provide an updated framework for FROA, with potential application in future Conservation Strategy updates, and for screening potential project suitability for Flood-MAR.

The integration of DWR programs will also be enhanced by the development of new decision support and analysis capabilities (Section 3.4.5.1, "Implementation Tracking and Data Dissemination"). These tools will integrate the environmental objectives and mitigation obligations of multiple DWR initiatives into a single decision-making environment. This consolidation will allow DWR to plan, track, and achieve these objectives and mitigation obligations in a mutually supportive, complementary manner that enhances the integration of various DWR program activities. For example, these decision support capabilities will assist with the identification of specific opportunities for integrated project planning and development among multiple DWR programs. This is an important consideration because the projects of multiple DWR programs likely will be located in the same relatively constrained geographical areas.

3.4.1.2 Alignment with Federal and State Natural Resource Plans and Policies

Alignment with federal and other State policies and plans is a focus of the 2022 CVFPP Update and an objective of this Conservation Strategy Update. To meet that objective, this Strategy must align with natural resource policies, plans, and initiatives, including:

- **Governor's Water Resilience Portfolio.** Executive Order N-10-19 directs the secretaries of the California Natural Resources Agency (CNRA), the California Environmental Protection Agency (California EPA), and the California Department of Food and Agriculture to identify and assess a suite of complementary actions to provide safe and resilient water supplies, flood protection, and healthy waterways for the State's communities, economy, and environment.

- **2021 California Climate Adaptation Strategy.** The Newsom administration is currently updating California's Climate Adaptation Strategy, as required by the State Legislature. The 2021 strategy outlines the State's key climate resilience priorities, includes specific and measurable steps, and serves as a framework for action across sectors (including flood and ecosystem management) and regions in California (including the Sacramento and San Joaquin watersheds and the Central Valley).

- **Bay-Delta Water Quality Control Plan and voluntary agreements.** CNRA and the California EPA are leading an effort to negotiate voluntary agreements with water diverters and local agencies to improve conditions for native fish. The voluntary agreements, if reached, would implement the State Water Resources Control Board's Bay-Delta Water Quality Control Plan. They would increase flows for the environment, create 60,000 acres of new and restored habitat, and allocate $5 billion in new funding for environmental improvements and science.

- **Delta Plan.** The Delta Plan is a comprehensive, legally enforceable plan that guides how multiple federal, State, and local agencies manage the Delta's water and environmental resources. The Delta Stewardship Council coordinates and oversees State and local agencies' proposals to fund, carry out, and approve Delta-related activities. The council has regulatory and appellate authority over certain actions that take place in the Delta and Suisun Marsh.

- **California Water Plan.** The California Water Plan is the State's strategic plan, updated every five years in years ending in "3" and "8," to sustainably manage and develop water resources for current and future generations statewide. California Water Plan updates typically lag the CVFPP and Conservation Strategy by one year.

- **California Biodiversity Initiative.** Executive Order B-54-18, issued September 7, 2018, directs CNRA and the California Department of Food and Agriculture to implement the California Biodiversity Initiative, which identifies broad strategies to secure the futures of all native California species.

- **California's 30x30 Initiative.** The California Natural Resources Agency initiated the 30x30 conservation target to be consistent with international and federal efforts. This effort is a strategy to conserve 30 percent of the State's land and coastal waters by 2030 (California Natural Resources Agency 2022).

- **Nature-based Solutions.** Similar to the USACE Engineering with Nature Initiative described later in this chapter, this effort is led by the CNRA, and seeks to capitalize on the natural landscape to improve the natural landscape and build resiliency particularly related to climate change challenges.

- **Safeguarding California Plan 2018.** This document is the 2018 Update of California's Climate Adaptation Strategy, a compendium of current and planned actions by State agencies to protect communities, infrastructure, services, and the natural environment from the impacts of climate change.

- **San Joaquin River Restoration Program (SJRRP).** The SJRRP is a comprehensive, long-term, multi-agency effort to restore flows to the San Joaquin River from Friant Dam to the confluence with the Merced River and to restore a self-sustaining Chinook salmon fishery in the river, while reducing or avoiding adverse water supply effects from restoration flows. The SJRRP is being implemented within the Upper San Joaquin River CPA.
- **Natural Community Conservation Plans (NCCPs) and associated habitat conservation plans (HCPs).** NCCPs are legally binding regional plans written under the aegis of the Natural Communities Conservation Planning Act and approved by CDFW. They protect species, contribute to their conservation, and serve as the basis for take authorizations for species listed under CESA. An NCCP is generally prepared in conjunction with an HCP and serves as the basis for take authorization for species listed under the ESA.
- **Regional Conservation Investment Strategies (RCISs).** California's RCIS program, authorized under Assembly Bill 2087, is in its fifth year of implementation. These voluntary, nonregulatory, regional plans identify conservation and enhancement opportunities intended to protect, create, restore, and reconnect habitat and contribute to species recovery. RCISs provide the basis for the development of mitigation credit agreements (MCAs) that may be used as compensatory mitigation for impacts under the California Environmental Quality Act (CEQA), CESA, and the Lake and Streambed Alteration Program. Several RCISs focus on flood and other water management issues, and are in various stages of development or have been approved, including for Yolo County (approved October 2020) and the Mid-Sacramento Valley (approved December 2020). The guidelines for MCAs are still in draft form, and no RCIS proponent has successfully developed an MCA. The West Sacramento Area Flood Control Agency (WSAFCA) is in the process of developing a pilot MCA, but the process has been under negotiation between WSAFCA and CDFW for more than 2.5 years (Dirksen 2022).
- **Central Valley Project Improvement Act (CVPIA).** Passed by Congress in 1992, the CVPIA mandates changes in management of the Central Valley Project, particularly for the protection, restoration, and enhancement of fish and wildlife. The CVPIA has resulted in the development of restoration actions and projects to avoid significant adverse effects to species, including several within the SPA (such as the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project, which will include modifications to the Fremont Weir, and a connecting channel in the Yolo Bypass to improve fish passage).
- **USACE Engineering with Nature Initiative.** The Engineering with Nature Initiative enables USACE to deliver economic, social, and environmental benefits associated with infrastructure in a more sustainable manner. This is accomplished by:
  - Using natural processes to maximum benefits, thereby reducing demands on limited resources, minimizing the environmental footprint of projects, and enhancing the quality of project benefits.

- Broadening and extending the base of benefits provided by projects to include substantiated economic, social, and environmental benefits.
- Using science-based collaboration to organize and focus interests, stakeholders, and partners to reduce social friction, resistance, and project delays, while producing more broadly acceptable projects.

- **Federal Interagency Floodplain Management Task Force.** This Task Force was authorized and established by Congress in 1975 to carry out the President's responsibility to prepare for the Congress proposals necessary for a Unified National Program for Floodplain Management. In 1994, the Task Force submitted to the President "A Unified National Program for Floodplain Management," which called for the formulation of a more "comprehensive, coordinated approach to protecting and managing human and natural systems" in a sustainable development context. This includes defining the "wise use" of floodplains, which means enjoying the benefits of floodplain lands and waters while minimizing the loss of life and damage from flooding and preserving and restoring the natural resources of floodplains as much as possible.

Table 3-2 provides a high-level summary of several federal and State policies and plans that contain objectives, targets, approaches, or guidance relevant to this Conservation Strategy and the measurable objectives. DWR supports alignment with these and other relevant efforts, and when possible, will take actions within the context of this Strategy consistent or collaboratively with these policies and plans.

Finally, there is a need for more effective coordination between DWR and other State partners with the Tribes in the context of flood and ecosystem management. The Tribes recognize ongoing efforts to protect the health and safety of the communities and continued efforts to make that a priority. Additionally, they have a strong interest in the preservation of riparian habitats and the continued management and restoration of natural systems that will provide habitat for native wildlife and plant species, while protecting water resources.

To increase and strengthen the role in future planning and implementation of the Conservation Strategy, DWR will need to increase outreach and maximize Tribal representation in advisory committees and regional planning efforts, and further explore nature-based solutions to restore floodplains and reduce disruption to Tribal cultural resources, sacred sites, and burials from levee construction as part of multi-benefit project implementation. The Conservation Strategy provides guidance for the development of a nature-based approach to flood management; however, more engagement with the Tribes is needed to ensure compatibility and leverage Tribal knowledge within the Strategy. In addition, better engagement with the Tribes in planning, management, performance accounting, and adaptive management will assist in the early identification and prioritization of alternative solutions that are compatible with Tribal interests and priorities.

Table 3-2. Alignment of Conservation Strategy Goals and Objectives with Federal and California Natural Resources Agency Plans and Programs

Area	Supporting Plan	Ecosystem Processes – Floodplain Inundation	Ecosystem Processes – Riverine Geomorphic Process	Habitats – SRA Cover	Habitats – Riparian	Habitats – Marsh/Other Wetlands	Stressors – Fish Passage Barriers	Stressors – Invasive Plants
Entire Systemwide Planning Area	Governor's Water Resilience Portfolio	Direct Policy Support	Direct Policy Support	Indirect Policy Support	Indirect Policy Support	Direct Policy Support	Direct Policy Support	Direct Policy Support
	Bay-Delta WQCP/Voluntary agreements	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support	Not Applicable	Not Applicable
	California Biodiversity Initiative	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support
	Safeguarding California Plan 2018	Indirect Policy Support	Not Applicable	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Not Applicable
	California Water Plan	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support	Indirect Policy Support

Area	Supporting Plan	Ecosystem Processes – Floodplain Inundation	Ecosystem Processes – Riverine Geomorphic Process	Habitats – SRA Cover	Habitats – Riparian	Habitats – Marsh/Other Wetlands	Stressors – Fish Passage Barriers	Stressors – Invasive Plants
Upper Sacramento River and Feather River CPAs	Butte Regional Conservation Plan (HCP/NCCP)	Not Applicable	Not Applicable	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support	Not Applicable
	Mid-Sacramento Valley RCIS	Direct Policy Support	Direct Policy Support	Direct Policy Support	Direct Policy Support	Direct Policy Support	Direct Policy Support	Direct Policy Support
Upper and Lower Sacramento River CPAs	Yolo NCCP/HCP	Not Applicable	Not Applicable	Direct Program Support	Direct Program Support	Direct Program Support	Not Applicable	Not Applicable
Lower Sacramento River and Lower San Joaquin River CPAs	Delta Plan	Direct Policy Support	Indirect Policy Support	Indirect Policy Support	Direct Policy Support	Direct Policy Support	Indirect Policy Support	Direct Policy Support
	EcoRestore	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support	Direct Program Support

Area	Supporting Plan	Ecosystem Processes – Floodplain Inundation	Ecosystem Processes – Riverine Geomorphic Process	Habitats – SRA Cover	Habitats – Riparian	Habitats – Marsh/Other Wetlands	Stressors – Fish Passage Barriers	Stressors – Invasive Plants
Lower Sacramento River and Lower San Joaquin River CPAs	Delta Levees Program and Delta Ecosystem Enhancement Program	Not Applicable	Not Applicable	Direct Program Support	Direct Program Support	Direct Program Support	Not Applicable	Direct Program Support
	Delta Conservancy Strategic Plan	Direct Policy Support	Indirect Policy Support	Indirect Policy Support	Direct Policy Support	Direct Policy Support	Indirect Policy Support	Indirect Policy Support
Upper San Joaquin River CPA	San Joaquin River Restoration Program	Direct Program Support	Not Applicable	Direct Program Support	Direct Program Support	Not Applicable	Direct Program Support	Indirect Program Support

Notes:
“Program support” indicates the potential for direct collaboration in the development of multi-benefit projects; “policy support” indicates consistency of objectives, goals, and strategies between the Supporting Plan and the Conservation Strategy for the targeted item.
For additional information on conservation programs in this table and HCPs not associated with an NCCP, refer to Appendix C, “Updates to 2016 Conservation Strategy Appendix J, ‘Existing Conservation Objectives from Other Plans’.”
CPA = conservation planning area
HCP = habitat conservation plan
NCCP = natural community conservation plan
RCIS = regional conservation investment strategy
WQCP = water quality control plan

3.4.1.3 Coordination with Partners in Multi-benefit Flood Management

Multi-benefit projects in the Central Valley will be developed and constructed by DWR with State, local, and federal partners in flood management. Consequently, although the system improvements studied in the BWFSs would make major contributions to the Conservation Strategy's objectives, the attainment of the measurable objectives also depends on the implementation of other multi-benefit projects that may be planned implemented by other programs in DWR and by DWR's State, federal, regional, and local partners. So, the successful implementation of this Strategy requires robust coordination and partnerships between DWR and these other entities.

In addition to the support and guidance identified elsewhere in this Strategy, DWR will continue to coordinate actively with the sponsors of individual multi-benefit projects as they are planned, permitted, and constructed. Among its specific actions, DWR will share data and modeling resources with sponsors of multi-benefit projects, identify O&M strategies helpful to the development of such projects, and facilitate information sharing among LMAs, other partners, and DWR.

It is also critical that DWR continue to leverage existing partnerships and explore new, innovative partnership opportunities and models to facilitate multi-benefit project identification, funding, design, permitting, and implementation. Over the past several decades, some of the most iconic and successful multi-benefit projects in the Central Valley have been developed in a collaborative manner. DWR has contributed planning, funding, and technical support to local agencies, NGOs, and land trust partners to facilitate land acquisition and entitlement, enable project implementation, and coordinate long-term O&M. Some examples include the Bear River and Feather River levee setback projects, the Dos Rios Floodplain Expansion and Ecosystem Restoration Project, Phase I, and the Southport Levee Setback Project. These successful, collaborative, multi-partner models for project implementation should be leveraged and expanded in the coming years, especially considering the need to accelerate the pace and extent of multi-benefit projects to build ecosystem resiliency and mitigate the impacts of climate change.

Proponents of multi-benefit projects have cited a need for improved coordination between DWR, the CVFPB, and the fish and wildlife agencies regarding the permitting of multi-benefit projects. To help improve coordination, DWR will seek opportunities to collaborate with the CVFPB, CDFW, USFWS, and NMFS to develop a clear set of permitting conditions and methods to expedite permitting for multi-benefit projects. (Section 3.4.4.2, "Permitting Ecological Restoration by Multi-benefit Projects," describes existing mechanisms for expediting permitting for multi-benefit projects.) Ultimately, this effort can serve as the basis for greater policy alignment and more specific guidance from DWR and the CVFPB to project proponents.

Developers of multi-benefit projects have also identified improved post-construction monitoring as a significant need. To improve construction and maintenance practices in the future, monitoring should be designed to inform the implementation and widespread sharing of monitoring results (Section 3.4.5, "Adaptive Management"). It is difficult, however, for project proponents to fund and conduct such monitoring on a project-by-project basis, and no mechanism is available to ensure methods are consistent across projects.

DWR's ongoing investments in performance tracking and integrated planning-decision support includes the development of an overall performance tracking framework (the FPTS). This system uses an outcome-based planning approach to track the Conservation Strategy measurable objectives and other CVFPP-specific metrics over time to better understand how they contribute to regional flood management and conservation goals as a result of investments in project implementation and ongoing O&M actions (described in more detail in the 2022 CVFPP Update).

This overall effort includes the development of specific tools and processes that will improve the collection and sharing of multi-benefit project performance data from project proponents and O&M practitioners. This will require extensive collaboration between multiple divisions within DWR and partner agencies, local districts, regulators, researchers, and project developers.

3.4.1.4 Wildlife-friendly Agriculture

The Central Valley Flood Protection Act of 2008 did not provide any stipulation regarding agricultural sustainability, except related to its value as wildlife habitat. In the context of this Conservation Strategy, wildlife-friendly agriculture refers to practices that either increase the habitat value of existing agricultural land for targeted wildlife species or reduce the potential for mortality of targeted species and adverse effects on their habitats in adjacent natural areas.

The value of agricultural lands for sensitive and common fish and wildlife species varies greatly among crop types and agricultural practices. Seasonal flooding of rice fields creates surrogate wetlands that can be exploited by giant gartersnakes and a variety of resident and migratory birds. Dry and fallow rice fields can attract rodents and their predators (e.g., raptors). Flooding of agricultural land along rivers and within bypass channels can provide rearing habitat for juvenile salmonids.

Other field crops and row crops provide forage for raptors, waterfowl, and small rodents at various times of year. For example, pasture and irrigated hayfields provide valuable foraging habitat for raptors, particularly after disking or plowing, when rodents may be especially available for these species. However, orchards and vineyards have relatively low value for most wildlife, in part because understory vegetation that would provide food and cover typically is removed or maintained at a low height.

On floodplains, agricultural lands near natural land cover can provide functions that complement and increase the habitat value of the natural land cover. For example, several raptors (such as Swainson's hawks) nest in riparian forests and woodlands but forage in grasslands and croplands. Additionally, ecologically functional floodplains along rivers and within bypasses provide valuable habitat when the floodplain is inundated for an adequate duration during the appropriate time of year.

3.4.1.5 Coordination and Collaboration with Other Habitat Conservation and Regional Conservation Planning Efforts

The Conservation Strategy is not designed or intended to achieve full recovery of its target species; rather, it provides guidance for how DWR can contribute to the recovery of those species by implementing the CVFPP. USFWS, CDFW, and NMFS have developed legally required recovery plans for target species listed under ESA or CESA, and multiple agencies have adopted plans for the recovery of other, non-listed, target species (e.g., the Central Valley Joint Venture Implementation Plan [Central Valley Joint Venture 2006]). These plans identify the actions necessary for species' recovery. The Conservation Strategy is designed to contribute to the recovery of its target species by restoring ecosystem processes and habitats through multi-benefit flood projects. Also, habitat restoration, mitigation, multi-benefit flood projects, and single-purpose flood projects on a landscape affect each other's design and outcomes. Therefore, by implementing the CVFPP, DWR will seek to coordinate and integrate with other habitat restoration efforts in the Central Valley's riparian landscapes, even if those efforts do not provide direct flood management benefits. This integration is desirable for several reasons:

- Habitat restoration projects on active floodplains could affect O&M of the flood system.
- DWR's hydraulic models could be used to evaluate the potential benefits and impacts of restoration projects, and could provide a standardized modeling environment from which to plan and optimize habitat restoration projects.
- The design or feasibility of future flood or multi-benefit projects could be affected by habitat restoration that occurs beforehand.
- Opportunities may be available to integrate flood management benefits into projects that were initially conceived only as habitat improvements.
- Opportunities for building ecological resilience to climate change by implementing climate adaptation measures identified in Appendix H may occur for a wide variety of projects along the river corridors.
- DWR's project tracking and decision support capabilities will support coordinated planning of multi-benefit, habitat restoration, and mitigation projects so that multiple goals and objectives can be met across the flood system as a whole (Section 3.4.5.1, "Implementation Tracking and Data Dissemination").

In addition, the CVFPP will be implemented alongside existing and in-progress regional conservation plans, including NCCPs, HCPs, RCISs, species recovery plans, and management plans for conserved lands. DWR will continue to coordinate and, where possible, collaborate with conservation plans that overlap with the CVFPP SPA and contain objectives, strategies, or program actions that pertain to the measurable objectives. This Strategy supports coordination and collaboration with related conservation plans in six ways:

1. Identifying and resolving potential conflicts with regional conservation plans during CVFPP updates.
2. Minimizing SPFC-related constraints on the success of other regional conservation plans in attaining their objectives.
3. Collaborating on, and sharing the funding of, projects of common interest.
4. Implementing conservation actions that complement, and do not preclude, those of other conservation plans (e.g., restoration projects that increase regional habitat connectivity).
5. Implementing conservation actions that contribute directly to the attainment of the objectives of other conservation plans.
6. Participating in regional conservation plans when such participation contributes to attainment of this Strategy's objectives.

3.4.2 Outreach and Engagement

As described here, DWR will continue to share work products as they are developed, interact with stakeholders and the public, and report on the CVFPP's implementation, including its environmental conservation components. Through this investment of time and resources in transparent communication, outreach, and engagement, DWR will increase project benefits to the people and ecosystems of California.

DWR plans to continue to:

- Engage with LMAs through the RFMP process and other forums, with a particular focus on determining how to best apply the Strategy to RFMPs, and on successfully planning and implementing multi-benefit projects.
- Participate in the CVFPB Advisory Committee, CVFPB Coordinating Committee, and other stakeholder forums, as appropriate.
- Engage on proposals for multi-benefit projects and needs for long-term maintenance.

DWR also commits to increasing the level of engagement and participation with the Tribes during development and implementation of the Conservation Strategy, including encouraging increased Tribal participation in the planning forums identified here.

This approach to outreach and engagement focuses DWR efforts on the venues that have been most successful to date, particularly the CVFPB Advisory Committee and the RFMP process. The CVFPB Advisory Committee provides a productive, collaborative forum for dialog on a wide range of matters pertinent to the successful implementation of the CVFPP and its Conservation Strategy. DWR is committed to continuing its participation in the CVFPB Advisory Committee to maintain and expand collaboration with all stakeholders, including NGOs not otherwise directly engaged in the development of multi-benefit projects. It is also committed to continued engagement on proposals such as the potential revival of the Sacramento-San Joaquin Drainage District as a mechanism for funding the long-term maintenance of multi--benefit projects and other flood management infrastructure. DWR will also seek to engage with other important stakeholder forums, such as the Flood Study Group, as appropriate.

One of DWR's most successful outreach and engagement efforts has been with local agencies in a bottom-up approach to identify and address deficiencies in the flood control system. Using local knowledge and initiatives, the RFMP process has successfully engaged local stakeholders and facilitated dialog with DWR. This open communication has helped to elevate local concerns regarding the highest-priority projects and needs (such as the need to work with local landowners).

DWR will continue its outreach and engagement with local agencies through the RFMP process and other forums, with a particular focus on how to incorporate the Conservation Strategy into RFMPs and how to successfully plan and implement multi-benefit projects. DWR will continue to engage with RFMP leads routinely in the development of the 2022 RFMP content (e.g., primarily white papers), and will seek to maintain such engagement periodically after the RFMPs are complete, as resources allow. Through these engagements, DWR will emphasize the importance of early local engagement with landowners to project success, as they are generally more effectively engaged by local agencies than by DWR and other State partners.

3.4.3 Funding

The funding approach for the 2016 Conservation Strategy relied on the CVFPP's Investment Strategy, which was then under development and completed the following year (California Department of Water Resources 2017c). This approach described achieving the Conservation Strategy's measurable objectives through ecological restoration as an integral part of implementing the CVFPP and its refined State Systemwide Investment Approach (SSIA) portfolio of management actions. The SSIA portfolio is made up of a diverse collection of individual projects, concepts, and management actions (including many that are multi-benefit) from multiple sources and partners that help support the implementation of the CVFPP and the Conservation Strategy.

As described in the 2017 CVFPP Investment Strategy (California Department of Water Resources 2017c), the CVFPP's funding priorities are to support the equitable distribution of project costs among beneficiaries and to encourage actions that provide broad public benefits (including ecosystem vitality) and help achieve added flexibility in the SPFC. Consistent with the 2008 Central Valley Flood Protection Act, the State has prioritized investment needs, advocated for a greater State cost share for multi-benefit projects, and communicated those priorities broadly to State elected officials and decision-makers.

The 2017 CVFPP Investment Strategy provided an approach, shared among State, federal, and local cost-sharing partners, to fund and implement the SSIA portfolio over the next 30 years. Multi-benefit projects are part of the integrated approach to fund and implement the SSIA portfolio. The following sections draw on the work performed since the 2017 CVFPP Update, summarizing CVFPP's role with regards to funding. This information is intended to help provide the background and context for how multi-benefit projects that advance the Conservation Strategy measurable objectives are currently funded, as well as to identify additional funding mechanisms and programs that are available to multi-benefit projects.

3.4.3.1 Summary of CVFPP Role for Funding

The CVFPP's role with regard to funding is to describe, estimate, and highlight the investment needed across the SPFC, and support the societal values of public health and safety, ecosystem vitality, economic stability, and opportunities for enriching experiences, such as outdoor recreation. A key piece of CVFPP's role is to educate a broader base of decision-makers at the State, federal, and local levels of the investment needed and the resulting benefits. This translates into how policies are created and, ultimately, how grant and direct funding programs are administered.

Within the CVFPP planning process, one key to success is that project proponents get the support and funding they need to implement multi-benefit projects. The CVFPP attempts to bridge that information gap between project proponents and State and federal policy. This motivates the bottom-up formulation of projects and the high-level attempt to identify current and future funding.

CVFPP's support and funding role is summarized in the following actions:

- **Understanding and collecting** the types of management actions and projects that will be most effective as a portfolio to support the CVFPP goals, measurable objectives, and societal values. Varying levels of detail are presently available for management actions required over the 30-year period, which creates difficulty in the prioritization and phasing of actions. A portfolio approach is key to maximizing the CVFPP's ability to work toward achieving its goals, while continuing the planning process for actions that are not yet fully developed.

- **Defining and quantifying** changes in flood risk, ecosystem improvements, and climate adaptation, as well as the estimated costs associated with implementing different types of management actions and multi-benefit projects. This includes design and construction costs, but also operational costs to implement nonstructural types of actions.

- **Informing** State, federal, local, public and private partners, and elected officials about the anticipated flood, climate change, and ecological risks in the SPFC, what is needed to address those risks, and how much that risk reduction is projected to cost.

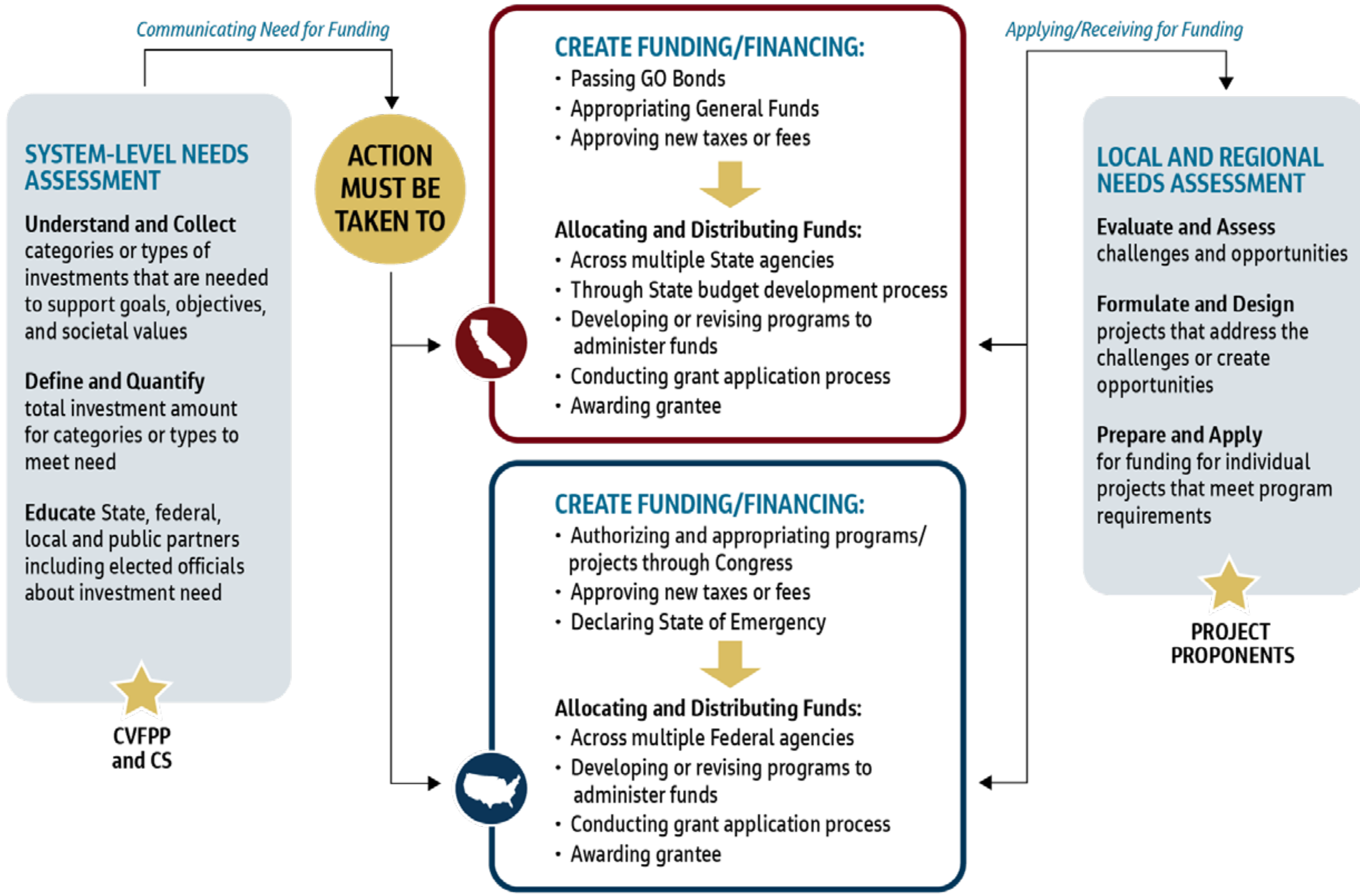
- **Supporting action** by others to create policy or funding opportunities. For example, the CVFPP can provide the information and highlight needs for a general obligation (GO) bond and increased general fund contributions, but action is needed from the State Legislature, elected officials, and the public to ultimately support and pass a GO bond that could provide funding opportunities for multi-benefit projects.

CVFPP’s role with regards to funding does not include:

- Endorsing individual projects or programs for funding decisions.
- Directly appropriating funding to individual projects or programs.
- Generating cash flow to grant or direct assist programs to be administered to individual projects.

There is an extensive process for State and federal funding to be awarded to individual projects. In some cases, this process can take multiple years and even decades, depending on the scale and complexity of the project. This is often frustrating for local project proponents because funding projects at the local level can be more straightforward and shorter in duration. However, the magnitude of funding can be much greater from State and federal sources. The key is to understand the funding process and the avenues that make the most sense for individual project needs. The CVFPP plays an indirect role in the extensive process that individual project proponents and State and federal programs engage in to fund specific projects. The CVFPP’s role is primarily to communicate the needs of the SPFC and educate elected officials and decision-makers. Figure 3-2 illustrates the many steps involved in creating funding opportunities at the State and federal level, and ultimately providing those funds to individual multi-benefit projects, as well as CVFPP’s specific role in the process.

Figure 3-2. Budget Development Process for Programs and Projects



3.4.3.2 Updating the CVFPP Investment Need

Building on the 2017 CVFPP Investment Strategy, investment information, financial drivers, and costs are being updated for the 2022 CVFPP Update, using new information and with the help of State, federal, regional and local partners. In Chapter 4 of the 2022 CVFPP Update, it is estimated that a $25- to $30-billion investment is needed for ongoing and capital investments over the next 30 years. This amount includes investment needs such as the Yolo Bypass multi-benefit improvements, urban levee improvements, rural levee setbacks and floodplain storage actions, O&M activities, and emergency management actions, among many others, and includes multi-benefit projects that have been identified by the State and RFMPs. Although many aspects of these actions in the portfolio consider climate change resiliency, future updates to the Investment Strategy may include additional costs to implement further actions, as well as refinements to currently proposed projects that will address increased runoff and flow projections, changes to precipitation patterns, and evolving climate science.

As in 2017, the investment needed is largely informed by the proposed actions from the BWFS and RFMP planning processes. The partial restoration of ecosystem processes and habitats as components of multi-benefit projects are included in the proposed actions through BWFSs and RFMPs. Because such restoration is an integrated component of multi-benefit projects, restoration funding is part of the funding appropriation process for the overall project that includes flood risk reduction and other public benefits. BWFS and RFMP processes and their relevance to incorporating multi-benefit projects into those efforts are described briefly as follows:

- **Basin-Wide Feasibility Studies.** The BWFSs for the Sacramento River and San Joaquin River basins identified projects with the potential to improve systemwide functions and resiliency (system improvements). The planning effort for these studies formulated options for system improvements consisting of combinations of bypass, storage, and weir expansions; these options were a basis for the 2017 CVFPP Update (California Department of Water Resources 2017b, 2017c). Many of these system improvements are expected to be multi-benefit projects that restore ecosystem processes and habitats. There is not an update to the BWFSs for the 2022 CVFPP Update. However, DWR has advanced several multi-benefit projects through its flood management programs with State, federal, and local partners, and costs have been updated for all improvements based on new information or cost escalation.

- **Regional Flood Management Plans.** Following the adoption of the 2012 CVFPP, DWR funded six regionally led RFMPs that listed regional and local flood management priorities (California Department of Water Resources 2017c). These six plans provided information about various regionally supported management actions and project opportunities, along with associated costs and timelines. RFMPs also identified opportunities to promote habitat restoration and reconnection projects in rural areas and small communities. These habitat restoration and reconnection projects are intended to supplement systemwide improvements and to focus more closely on improving or connecting habitat areas than on reducing flood risk. As part of the 2022 CVFPP Update, RFMP efforts were reinitiated to provide updated recommendations and cost information regarding local flood-related priorities, projects, and concepts. The RFMP planning process provides a platform for meaningful engagement among DWR and regional and local flood planning entities. It also allows for collaboration with the proponents of related planning efforts for water management and conservation across the Sacramento River and San Joaquin River basins.

3.4.3.3 Identifying Funding Mechanisms

Investments in management actions that incorporate ecosystem restoration benefits and other multi-benefit aspects have a wide variety of funding mechanisms available to them. Typically, monies are created through funding or financing mechanisms such as a passage of GO bonds, appropriation of State general funds, passage of a new tax or fee, authorization and appropriation through Congress. Funding is then allocated or distributed to corresponding direct-assistance, competitive grant, or budget processes across a multitude of State, federal, and local agencies. These opportunities for funding are then considered funding sources and create cash flow that can be applied to individual projects that meet the criteria, guidelines, or specific requirements of those programs.

Primary State mechanisms include:

- **State General Fund:** The General Fund has traditionally funded a portion of flood management planning and implementation activities. DWR typically receives between 0.1 and 0.2 percent of State General Fund revenues, and approximately 25 percent of that contributes to Central Valley flood management. The applicability of this mechanism is high as there is a nexus between lowering the risk of flooding and benefits to the State economy.

- **State GO Bonds**: The issuance of new State GO bonds requires a statewide vote. This mechanism requires time to prepare language for the bond measure for the statewide vote, as well as a two-year lag before funds become available following bond passage. The applicability of this mechanism is high because of the nexus of reducing the flood risk with the benefits to the State economy. It is important to note that since 2006, State GO bonds have been the primary mechanism for funding implementation of the CVFPP, with almost $5 billion provided through Proposition 1E and Proposition 84. Subsequently, Proposition 1 allocated $395 million and Proposition 68 allocated $536 million to flood management (California Natural Resources Agency 2020c).

  GO bonds can be used separately to fund or cost-share portions of projects that may provide greater benefits consistent with the State's broader interest and policies; they are generally a good fit for multi-benefit projects. Practitioners and project proponents have noted challenges when expending GO bond funds on their projects. Some of these issues have revolved around the inability to effectively blend different funds. For example, although the cost allocations for Proposition 68 have seemed effective, some GO bonds—such as Proposition 1E—have stipulated that funds for creating habitat can be used only when called "mitigation," putting them into conflict with other funding opportunities. These requirements have resulted in piecemeal funding, and in other delays and inefficiencies that increase costs without notable benefits. Developing language to alleviate these issues while maintaining the objective of the funding mechanism could more efficiently support implementing multi-benefit projects.

The 2022 CVFPP Update recommends greater use of existing and the establishment of new State mechanisms to create the funding and financing capacity to implement the CVFPP. New mechanisms could provide stable and consistent cash flow streams that could sustain implementation over the 30-year planning horizon. The following new mechanisms are recommended in the 2022 CVFPP Update:

- Sacramento and San Joaquin Drainage District.
- State River Basin assessment or tax.
- State Flood Insurance Program.

Chapter 4 of the 2022 CVFPP Update provides more information on each of the new recommended mechanisms, along with their applicable management actions, targeted revenue generation potential, and development status. Chapter 4 also provides more detail on federal and local mechanisms that are included in the CVFPP 30-year funding plan.

Other primary mechanisms include:

- **Federal authorization and appropriation process through Congress** for multiple federal agencies, such as USACE, U.S. Department of Agriculture, and Bureau of Reclamation, among others.

- **Local-level mechanisms,** such as benefit assessments and special taxes, enhanced infrastructure financing districts, and developer fees.

- **Public-private partnerships (P3s).** These are also viable mechanisms that apply to multi-benefit projects. P3 agreements are generally between a private financial institution and State, local, or federal agencies. The private financial institution provides the public asset or service that is repaid, with interest, through a revenue source related to the investment. The private financial institution bears the risk and may have management responsibility. Current California water resources management P3 agreements are primarily between local agencies and private financial institutions. P3 agreements do not operate like traditional funding sources. Cost-sharing could be up to 100 percent, with potential reductions from innovation and cost savings. P3 agreements apply to management actions in all water sectors that can qualify for a partnership with a private financial institution. P3 agreements may be subject to external market forces; otherwise, they are a potential reliable funding mechanism for water resources management in California.

3.4.3.4 Identifying Potential Funding Programs

Once funding mechanisms have created the monies for funding or financing opportunities, funding is then allocated or distributed to corresponding direct-assistant and competitive grant programs within State and federal agencies. Individual programs have criteria, guidelines, or specific requirements that project proponents must comply with to be eligible for funding. Generally, the program criteria and guidelines must also comply with requirements of how the funding mechanism was created to ensure the entitled benefit is received or the distribution of funds is legal.

Table 3-3 describes existing funding programs that are available from State and federal sources. It also identifies the following information for each program:

- **Funding Program Name and Description:** The agency that administers program, general purpose of the program, and information about the program.
- **Applicability:** The geographic scope and types of management actions that have a strong nexus with the funding program. Applicability is rated as high if targeted management activities include multi-benefit projects specifically, or flood and conservation-related activities individually, over a broad geographic swath of the SPFC footprint. Applicability is rated as low if the geographic scope is limited to small portions of the SPFC footprint. Funding programs are rated as moderate if they target only conservation activities, but cover a wide geography.
- **Program Type and Current Funding Level:** The available information on how much the program is funding, what is to be expected in the future based on historical trends, and what type of program it is (e.g., competitive grant, direct-assistance).

To further aid in connecting project proponents to appropriate funding programs, the State has centralized its available programs, grants, and loans through the *California Grants Portal (www.grants.ca.gov)*. The *California Grants Portal* provides information and links to all grants and loans offered on a competitive or first-come basis by California State agencies.

Table 3-3. Potential State and Federal Funding Programs for Multi-benefit Projects

Funding Program	Description	Applicability	Program Type and Current Funding Level
Department of Water Resources – Flood Management Programs and Subprograms	DWR implements a range of grant programs related to flood management and risk reduction, including multi-benefit projects, through their flood management programs and subprograms. Refer to the 2022 CVFPP Update for more detail on these programs.	**High.** Funding is available to flood managers for multi-benefit flood projects.	**Competitive Grants and Direct Local Assistance.**
Department of Water Resources – Riverine Stewardship Program	The Riverine Stewardship Program supports fish passage improvements and similar projects that increase ecological, stream management, climate, and community improvement benefits. Program goals include protecting, restoring, and enhancing the natural environment of riparian systems. This program supports innovations in green infrastructure to provide habitat enhancements that benefit aquatic species and fish migration and help wildlife endure drought and adapt to climate change.	**Moderate.** Public entities are eligible to apply. No matched funding is required.	**Continuous Competitive Grant Process.** $13 million available in 2022 funding cycle (California Grants Portal 2022).
Department of Water Resources – San Joaquin Fish Population Enhancement Program	The San Joaquin Fish Population Enhancement Program funds projects to: enhance native fish populations in the lower San Joaquin River watershed; and reduce the vulnerability of native fishes to water diversions, predation, and other impacts to their populations at all life stages within or upstream of the Delta. This program's projects improve conditions for the survival of various life stages of salmonids and other native fishes in the lower San Joaquin River watershed.	**Moderate.** Public entities, nonprofits, and Tribal governments are eligible to apply. No matched funding is required.	**Continuous Competitive Grant Process.** The 2022 funding cycle is not yet open (California Grants Portal 2022).

Funding Program	Description	Applicability	Program Type and Current Funding Level
California Department of Conservation – Working Lands and Riparian Watershed Restoration Grants	Watershed restoration grants fund restoration and enhancement efforts on working agricultural lands, with the goal of improving climate adaptation and resilience by improving soil health, sequestering carbon, and improving habitat.	**Moderate.** Funding is available to Resource Conservation Districts for restoration on working lands. Requires a 25% funding match.	**Annual Competitive Grant.** $2.4 million available in the 2022 grant cycle (California Grants Portal 2022).
California Department of Fish and Wildlife – Endangered Species Conservation and Recovery Grant Program and Land Acquisition Program	This grant program promotes the conservation and recovery of special-status species under the federal Endangered Species Act, particularly on nonfederal land. Covers a variety of funded activities, including habitat restoration, species status surveys, and development of management plans.	**Moderate.** Funding is available to a variety of entities for the covered activities and could apply to the conservation component of a multi-benefit project. Program requires a 25% funding match.	**Annual Competitive Grant.** Approximately 11 projects are funded per year (California Natural Resources Agency 2021). Total estimated available funding is $22.5 million (California Grants Portal 2022).
California Department of Fish and Wildlife – California State Duck Stamp Project Grant Program	The State Duck Stamp Accounts funds projects beneficial to California's waterfowl species. The grant program funds projects that preserve, restore, enhance, and develop migratory waterfowl breeding and wintering habitat and carry out waterfowl related assessments and research.	**Moderate.** Funding is available to nonprofit organizations, local government agencies, State departments, and federal agencies.	**Annual Competitive Grant.** Approximately six projects are funded per year (California Natural Resources Agency 2021). Total estimated available funding is $1.5 million (California Grants Portal 2022).

Funding Program	Description	Applicability	Program Type and Current Funding Level
California Department of Fish and Wildlife – Fisheries Restoration Grants Program	The Fisheries Restoration Grants Program funds ecological restoration projects in coastal and Central Valley streams and watersheds that benefit salmon and steelhead recovery. Applicable project types include riparian and stream restoration, sediment reduction, fish passage improvement, education, water conservation, and organizational support.	**Moderate.** Funding is available to public agencies and nonprofits. Matching funds are not required, but projects without matching funds lose points in the evaluation process.	**Annual Competitive Grant.** Approximately 35 projects are funded per year (California Natural Resources Agency 2021). Total estimated available funding is $14 million (California Grants Portal 2022).
California Department of Fish and Wildlife – California Winter Rice Habitat Improvement Program	The California Winter Rice Habitat Improvement Program provides incentive payments for winter flooding of harvested rice fields to enhance habitat for wintering waterbirds in the Sacramento and San Joaquin valleys. Flooding is to be carried out as prescribed in a management plan for each enrolled property.	**Low.** Funding is available to private landowners who have grown rice on at least 40 acres of land and are able to flood their fields in the fall and winter.	**Annual Competitive Enrollment Process.** Approximately 35 projects are funded a total of $3 million per cycle. The program pays participants an annual incentive of $15 per acre (California Natural Resources Agency 2021).
California Department of Fish and Wildlife – Endangered Species Conservation and Recovery Habitat Conservation Planning Assistance Grant Program	This grant program provides funding for tasks necessary in the planning phase of an HCP for endangered species, such as baseline surveys, preparation of planning documents, and outreach.	**Moderate.** Funding available to public, nonprofit, academic, and Tribal entities for HCP planning activities. A 25% match is required.	**Annual Competitive Grant.** Approximately 10 projects are funded per cycle (California Natural Resources Agency 2021). $8 million awarded in the 2022 funding cycle (California Grants Portal 2022).

Funding Program	Description	Applicability	Program Type and Current Funding Level
California Department of Fish and Wildlife – Prop 1 Delta Water Quality and Ecosystem Restoration Grant Program	This grant program aims to fund multi-benefit ecosystem and watershed protection projects that benefit the Delta. Its three broad objectives are to provide more reliable water supplies, restore important species habitat, and create a more sustainably managed water resources system (including water quality and flood protection) that can better weather a changing climate.	**High.** Public entities and nonprofits are eligible to apply for funding to pursue multi-benefit restoration projects in the Delta.	**Annual Competitive Grant.** CDFW awarded $5 million in 2022 funding cycle. Approximately 11 projects are funded per cycle (California Natural Resources Agency 2021).
California Department of Fish and Wildlife – Prop 1 Watershed Restoration Grant Program	This grant program aims to fund multi-benefit ecosystem and watershed protection projects that are located outside of the Delta. Its three broad objectives are to provide more reliable water supplies, restore important species habitat, and create a more sustainably managed water resources system (including water quality and flood protection) that can better weather a changing climate.	**High.** Public entities and nonprofits are eligible to apply for funding to pursue multi-benefit restoration projects outside of the Delta.	**Annual Competitive Grant.** CDFW awarded $21 million in the 2022 funding cycle. Approximately 21 projects are funded per cycle (California Natural Resources Agency 2021).
California Department of Fish and Wildlife – Environmental Enhancement Fund	The Environmental Enhancement Fund supports projects that acquires habitat for preservation or improves habitat quality and ecosystem function above baseline conditions. Projects must be within or adjacent to waters of the state, have measurable outcomes, and be designed to acquire, restore, or improve habitat or ecosystem function to benefit fish and wildlife.	**Moderate.** Public entities and nonprofits are eligible to apply for funding. No funding match is required.	**Annual Competitive Grant.** $850,000 was available in the 2021 funding cycle; $750 was available in the 2022 funding cycle (California Grants Portal 2022).

Funding Program	Description	Applicability	Program Type and Current Funding Level
Sacramento–San Joaquin Delta Conservancy – Prop 1 Ecosystem Restoration and Water Quality Grant Program	This grant program makes funding available to multi-benefit projects that restore important species and habitat, improve water quality, and support sustainable agriculture within the legal Delta and Suisun Marsh.	**Low.** Public entities and nonprofits are eligible to apply for funding. Projects must be located in the Delta or Suisun Marsh. Some projects outside the Delta that meet certain specifications may also qualify.	**Annual Competitive Grant.** $3 million available in most recent funding cycle (California Grants Portal 2022).
Wildlife Conservation Board – Habitat Enhancement and Restoration Program	Consistent with Fish and Game Code section 1301, this program aids the restoration and enhancement of fish and wildlife resources. Eligible projects include: native fisheries restoration; restoration of wetlands; restoration of coastal, tidal, or fresh water habitat; other native habitat restoration projects including coastal scrub oak, grasslands, and threatened and endangered species habitats; instream restoration projects, including the removal of fish passage barriers and other obstructions; and other projects that improve the quality of native habitat throughout California.	**Moderate.** Public entities, nonprofits, and Tribal governments are eligible to apply. No matched funding is required.	**Continuous Competitive Grant Process.** $5 million available in current funding cycle (California Grants Portal 2022).
Wildlife Conservation Board – Inland Wetlands Conservation Program	The Inland Wetlands Conservation Program was created to assist the Central Valley Joint Venture in its mission is to protect, restore, and enhance wetlands and associated habitats. The joint venture, a partnership of 22 public and private organizations and agencies, has identified through its Implementation Plan specific goals to increase migratory bird populations.	**Moderate.** Public entities, nonprofits, and Tribal governments are eligible to apply. No matched funding is required.	**Continuous Competitive Grant Process.** $2 million available in current funding cycle (California Grants Portal 2022).

Funding Program	Description	Applicability	Program Type and Current Funding Level
U.S. Army Corps of Engineers – Congressional Authorizations	The Water Resources Development Act authorizes the Secretary of the U.S. Army to study or implement various projects and programs for improvements and other purposes to rivers and harbors of the U.S. In California, the majority of federal flood protection projects are the responsibility of USACE. Federal authorized funds would require appropriation by Congress.	**High.** Applicable projects must demonstrate national benefits. Project types range from capital improvements, land acquisition, levee setbacks, floodplain storage, habitat restoration, floodproofing and planning.	From 2003 to 2019, average annual expenditures ranged from $64 million to $97 million (depending on inclusion of the Folsom Joint Federal Project). The maximum over the period (which includes the Folsom Joint Federal Project) was $139 million.
U.S. Bureau of Reclamation – Central Valley Project Improvement Act Conservation Program and Habitat Restoration Program	The CVPIA Conservation Program and Habitat Restoration Program are integrated efforts with the goal of improving conditions for CVP-affected species and habitats. The programs were originally formed to address Reclamation's Endangered Species Act requirements. The programs targets actions that will protect, restore and enhance special-status species that are affected by the CVP and their habitats.	**Moderate.** Funds apply to the Central Valley Project Area. CVPIA funds are applicable to programs and activities that support fish and wildlife protection, restoration, and mitigation.	**Annual Competitive Grant.** The Conservation Program is typically funded at between $1 and 2 million annually. The Habitat Restoration Program is usually funded at $1.5 million annually.
National Park Service – Land and Water Conservation Fund	The Land and Water Conservation Fund provides grants to States and localities for acquisition, development, and planning of outdoor recreation opportunities in the U.S. Grants have supported purchase and protection of 3 million acres of recreation lands and more than 29,000 projects to develop basic recreation facilities in every State and territory of the nation (National Park Service 2021a).	**Moderate.** Program funds could be applied to the recreation component of a multi-benefit project. Grants apply to public recreation areas, facilities, and conservation strategies.	**Annual Competitive Grant.** The LWCF is permanently funded going forward, with a portion of funding going to State grants. In fiscal years 2018 and 2019, California awarded $16.4 and $10.4 million, respectively, in LWCF grants.

Funding Program	Description	Applicability	Program Type and Current Funding Level
U.S. Fish and Wildlife Service – Cooperative Endangered Species Conservation Fund (Endangered Species Act Section 6 Grant Program)	USFWS's Cooperative Endangered Species Conservation Fund Grants provide funding to States for species and habitat conservation on private lands (U.S. Fish and Wildlife Service 2021a). The program's goal is to work with landowners, communities, and Tribes to foster voluntary stewardship efforts for the recovery of endangered species. The program has four specific grant programs: Conservation, HCP Planning Assistance, HCP Land Acquisition, and Recovery Land Acquisition.	**Moderate.** Program funds can apply to species and habitat conservation projects that are located in floodplains. Program provides funding for land acquisition.	**Annual Competitive Grant.** The maximum grant through this program is $1 million per project.
U.S. Fish and Wildlife Service – North American Wetlands Conservation Act Program	The USFWS administers the North American Wetlands Conservation Act program, which provides grant funding for wetland protection, restoration, and enhancement. The program provides matching grants to projects that benefit wetlands-associated migratory birds and wildlife. Program includes a Standard and a Small Grants Program.	**High.** These funds apply to multi-benefit projects that provide improved flood management, as well as ecosystem enhancement.	**Annual Competitive Grant.** The Small Grants program awarded $3.2 million in 2020, with maximum awards of $100,000. The Standard Grants program awarded $46 million in 2020 for projects exceeding $100,000.

Funding Program	Description	Applicability	Program Type and Current Funding Level
U.S. Fish and Wildlife Service – Refuge Enhancement/ Infrastructure Partnerships Initiative	The National Infrastructure Partnerships initiative of the USFWS encourages National Wildlife Refuge System field stations to partner with local, regional, and national nonprofit organizations; other land management groups; State and Tribal partners; and others to accomplish projects that: promote the stewardship of resources of the refuge through habitat maintenance, restoration and improvement, biological monitoring, or research; support the O&M of the refuge through constructing, operating, maintaining, or improving the facilities and services of the refuge; and increase awareness, education, and understanding of the refuge and the National Wildlife Refuge System.	**Low.** Successful projects will be research/ assessments related to identified Service priorities or infrastructure projects at national wildlife refuges.	**Competitive Grant.** $5 million available for current funding cycle with each award ranging from $5,000 to $250,000 (Grants.gov 2022).
U.S. Department of Agriculture – Natural Resources Conservation Service	The NRCS is part of the U.S. Department of Agriculture, providing funding for farmers, ranchers, and forest landowners to boost agricultural productivity and protect natural resources through conservation (U.S. Department of Agriculture, Natural Resources Conservation Service 2021a). Individual grant programs include Conservation Innovation Grants and the Regional Conservation Partnership Program.	**Moderate to High.** These funds could be used for easements, improving habitat, and flood protection. Some of the NRCS programs have provided funding for floodplain easements, and others will fund improving or restoring habitat.	**Annual Competitive Grant.** The maximum amount for each fiscal year is established by the Chief for NRCS.

Funding Program	Description	Applicability	Program Type and Current Funding Level
U.S. Department of Agriculture - Watershed and Flood Prevention Operations Program	The Watershed and Flood Prevention Program is implemented through three subprograms: Watershed Surveys and Planning, WFPO, and Watershed Rehabilitation. The WFPO Program provides funding to protect and restore watersheds that are up to 250,000 acres in size; funding can be used to prevent damage as well as for conservation development The Watershed Rehabilitation program focuses on the rehabilitation of dams originally constructed under Public Law 83-566, Public Law 78-534, the Pilot Watershed Program, or the Resource Conservation Program (U.S. Department of Agriculture, Natural Resources Conservation Service 2021b).	**Moderate.** Authorized project purposes include, but are not limited to, flood prevention and flood damage reduction, watershed protection, public recreation, fish and wildlife conservation, and agricultural water management. At least 20% of total project benefits must go to agricultural and rural communities.	**Annual Competitive Grant.** $150 million was invested in 2017 (U.S. Department of Agriculture, Natural Resources Conservation Service 2021c). However, the program has not been authorized since fiscal year 2010. Cost-share requirements for wetland and floodplain conservations easement acquisition ranges from 50 to 100 percent.
National Fish and Wildlife Foundation – National Coastal Resilience Fund	Established in 2018, the National Coastal Resilience Fund is administered by the NFWF and seeks to benefit coastal communities, as well as fish and wildlife by reducing coastal flooding, improving water quality and recreation, and enhancing ecosystems (National Fish and Wildlife Fund 2021a).	**Low.** Funds could be used for coastal flood protection as well as habitat restoration and enhancement.	**Annual Competitive Grant.** The 2021 round of funding provided $34 million in coastal resilience grants. $39.5 million will be awarded in 2022.

Funding Program	Description	Applicability	Program Type and Current Funding Level
National Fish and Wildlife Foundation – Emergency Coastal Resiliency Fund	Established in 2019, the Emergency Coastal Resiliency Fund is administered by the National Fish and Wildlife Foundation and aims to support conservation and resilience projects in areas affected by past disasters, including 2018 wildfires. Funding is focused on recovery from past natural disasters, reducing the impact of future events, and enhancing fish, wildlife, and ecosystems (National Fish and Wildlife Fund 2021b).	**Low.** Funds are applicable to coastal flood protection as well as habitat restoration and enhancement in disaster-affected areas.	**Annual Competitive Grant.** The NFWF awarded $25.2 million in grants in 2021.
Natural Resources Conservation Service – Agricultural Conservation Easement Program. Replaced the Wetland Reserve Program in 2014	USDA NRCS Agricultural Conservation Easement Program, includes a Wetland Reserve Easement component, which offers landowners the opportunity to protect, restore, and enhance wetlands on their property. The program provides technical and financial support to help landowners with their wetland restoration efforts, including the opportunity to establish long-term conservation and wildlife practices and protection (U.S. Department of Agriculture, Natural Resources Conservation Service 2021d).	**Moderate.** Funds apply to working agricultural lands that are enrolled through a permanent, 30-year, or term easement.	**Non-competitive enrollment process.** After a one-time enrollment, NRCS pays 75 to 100 percent of restoration costs on permanent easements, and 50 to 75 percent of restoration costs on 30-year and term easements.

Funding Program	Description	Applicability	Program Type and Current Funding Level
Natural Resources Conservation Service – Environmental Quality Incentives Program	The EQIP is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air, and related natural resources on agricultural land and non-industrial private forestland. The program also may help producers comply with environmental permits and regulations (U.S. Department of Agriculture, Natural Resources Conservation Service 2021e).	**Moderate**. Funds apply to agricultural lands, ranchlands, and non-industrial private forestland.	**Non-competitive enrollment process.** NRCS provides financial assistance through 5-to-10-year contracts with a maximum payment of $200,000 upon completion and certification of conservation practices. For fiscal year 2020, California received roughly $100 million in EQIP funds (U.S. Department of Agriculture, Natural Resources Conservation Service 2021f).
Federal Emergency Management Agency – Hazard Mitigation Grant Program	The purpose of the HMGP is to help communities implement hazard mitigation measures following a major presidential disaster declaration. The HMPG is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Federal Emergency Management Agency 2021a).	**High.** Funds apply to flood risk reduction projects; an ecosystem service component improves project competitiveness. Funding is available after a presidential major disaster declaration in the State of California.	**Annual Competitive Grant.** There is $484 million allocated to California for the 2021 grant cycle, based on the Covid disaster declaration. The cost share for HMGP funded projects is 75% federal and 25% nonfederal.

Funding Program	Description	Applicability	Program Type and Current Funding Level
Federal Emergency Management Agency – Building Resilient Infrastructure and Communities	The BRIC program replaces the previous Pre-Disaster Mitigation program. Established in 2020, this program aims to provide funding to States, local communities, Tribes, and territories for hazard mitigation projects that reduce the impacts of natural hazards (Federal Emergency Management Agency 2021b).	**High.** Funds apply to flood risk reduction projects; an ecosystem service improvement component improves project competitiveness.	**Annual Competitive Grant.** For fiscal year 2021, $1 billion was available in BRIC funding. The cost share for BRIC-funded projects is 75% federal and 25% nonfederal. $600,000 maximum allocation for States, and $50 million maximum for subapplicant projects.

Notes:
% = percent
BRIC = Building Resilient Infrastructure and Communities
CDFW = California Department of Fish and Wildlife
CVFPP = Central Valley Flood Protection Plan
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
Delta = Sacramento–San Joaquin Delta
DWR = California Department of Water Resources
EQIP = Environmental Quality Incentives Program
HCP = habitat conservation plan
HMGP = Hazard Mitigation Grant Program
LWCF = Land and Water Conservation Fund
NFWF = National Fish and Wildlife Foundation
NRCS = Natural Resources Conservation Service
Prop = proposition
USACE = U.S. Army Corps of Engineers
Reclamation = U.S. Board of Reclamation
USFWS = U.S. Fisheries and Wildlife Service
WFPO = Watershed and Flood Prevention Operations

3.4.4 Regulatory Compliance

The CVFPP's implementation involves numerous flood risk management and conservation actions over a 30-year time frame. Actions to implement the CVFPP generally need to comply with a variety of federal and State environmental laws, such as the National Environmental Policy Act (NEPA), the Rivers and Harbors Act of 1899, the federal Clean Water Act, the federal ESA, CEQA, and CESA. Typically required approvals and laws are described in Appendix D, "Updates to 2016 Conservation Strategy Appendix A, 'Regulatory Setting'." In some situations, project proponents or maintainers comply with these laws by implementing activities in a manner that avoids or minimizes environmental effects. In most situations, however, permits and other types of regulatory approvals are also required, including those associated with the public safety requirements of the CVFPB and USACE.

The 2016 Conservation Strategy envisioned that multi-benefit projects could be implemented with more predictable and cost-effective permitting than single-purpose projects. This cost -effectiveness would result from greater support from the public and the regulatory agencies; more efficient permitting mechanisms for multi-benefit projects; and the ability to meet conservation and flood management needs through a smaller number of projects relative to separate, single-purpose, habitat and flood projects.

To date, that vision has not materialized. Furthermore, project proponents and other stakeholders have identified permitting requirements as a major impediment to implementing multi-benefit projects (Section 2.3.4, "Implementation Guidance"). Uncertainties regarding measures that will be required to avoid or minimize impacts, mitigation requirements, and the duration of the permitting process add to the challenges of permitting projects.

To address this persistent need for more efficient permitting of multi-benefit projects, DWR and others have been seeking additional efficiencies. Their efforts include mechanisms for all of the following:

- Permitting O&M at the landscape scale.
- Permitting restoration and multi-benefit projects.
- Increasing the availability of compensatory mitigation.

The following sections describe each of these efforts and identify regulatory compliance recommendations prioritized for 2022 to 2027.

3.4.4.1 Permitting Operations and Maintenance

Because they vary and are implemented in and around sensitive habitats, the permitting requirements for flood system O&M activities can be particularly complex. Routine O&M activities fall into four broad categories:

1. Levee maintenance, which includes erosion repair, rodent abatement and damage repair, vegetation management, and toe drain and pressure relief well repairs; levee crown and access road maintenance; unauthorized encroachment removals; and fencing and levee protection.

2. Channel maintenance, which includes sediment removal, debris and obstruction removal, vegetation management (including the removal of invasive aquatic weeds), and erosion (scour) repair.

3. Maintenance of flood control structures, which includes the repair, replacement, and abandonment of pipes and culverts, pumping plants, weirs, outfall gates, and bridges.

4. Data collection.

These activities have been chronically underfunded, resulting in deferred maintenance that increases flood risk and the eventual cost of maintenance (California Department of Water Resources 2017b). Regulatory compliance exacerbates this situation by adding to O&M costs and prolonging the schedules for completing O&M activities.

Consequently, as described in the 2016 Conservation Strategy, DWR collaborates with regulatory agencies and other flood system stakeholders to reduce or offset environmental impacts of O&M and to improve the efficiency of environmental compliance. Through DWR's Flood Maintenance and Operations Branch's Environmental Initiatives Program, DWR has continued this collaboration, with initiatives that include:

- Environmental Permitting for O&M EIR.
- Routine maintenance agreements.
- Small Erosion Repair Program (SERP) (has since lapsed).
- Systemwide Improvement Frameworks (SWIFs).
- "Low-effect" HCPs.
- MCAs.
- New methodologies for detecting endangered species.

Most of these initiatives address multiple activities at a landscape scale, which is a key aspect of how they improve the effectiveness and efficiency of environmental compliance. Also, each initiative not only improves the effectiveness and efficiency of DWR's maintenance activities, but also serves as a model that may be adapted by other maintainers. These initiatives are described as follows:

- **Environmental Permitting for O&M EIR.** Through this EIR, DWR evaluated its O&M of a portion of the Sacramento River Flood Control Project and Middle Creek Project in Lake County, which are components of the SPFC. Besides providing up-to-date CEQA compliance required for State permits, the project description of this EIR is a comprehensive, detailed description of O&M activities.

- **Routine maintenance agreements**. For the Sacramento and Sutter yards, DWR has worked with CDFW to establish 12-year-long lake and streambed alteration agreements for routine maintenance activities. These routine maintenance agreements apply standardized measures to DWR's routine maintenance activities, which are disclosed in annual maintenance plans and reports from DWR to CDFW, and are more efficient than obtaining numerous separate agreements for individual activities.

- **SERP**. This pilot program has lapsed, but for a period of five years, DWR developed a regulatory review and authorization process for annual repairs of small erosion sites on levees to improve levee reliability, facilitate more efficient project delivery, and often provide environmental benefits. The SERP, developed by a working group of the Interagency Flood Management Collaborative, covered approximately 300 miles of levees maintained by the State within the Sacramento River Flood Control Project. Regulatory approvals were secured, with a goal of making the permitting process more efficient, cost-effective, and consistent. Because these permits have expired and renewals have proved difficult, this pilot program is no longer active.

- **SWIFs.** For SPFC facilities, DWR has been working with USACE to develop the first SWIF in the nation with an associated ESA-compliance mechanism. A SWIF is a plan developed to address systemwide levee issues, including those found during inspections. USACE would append SWIF activities to the applicable O&M manual for the duration of the proposed activities, along with any requirements of the associated Section 7 biological opinion. For grouting of levees in MA05 and Butte Creek, which may adversely affect the federally listed giant gartersnake, DWR is developing a SWIF and biological assessment (to support the biological opinion). This SWIF is a pilot effort that may subsequently be expanded to cover a larger area and other activities that potentially affect additional federally listed species.

- **"Low-effect" HCPs.** DWR has been developing a "low-effect" HCP for a set of locations in the Sutter and Sacramento maintenance yards where maintenance activities cannot avoid affecting elderberry shrubs, which are the host of the federally listed valley elderberry longhorn beetle. This HCP may serve as a model for similarly focused HCPs covering valley elderberry longhorn beetle or other species.

- **New methodologies for detecting endangered species.** DWR has been funding the development of protocols for detecting giant gartersnakes using scent dogs and environmental deoxyribonucleic acid (eDNA). Because of the species' use of small subterranean spaces, the detection of giant gartersnakes is problematic and costly. Scent dogs and eDNA are promising technologies to detect giant gartersnakes more effectively than current technologies. If these new technologies are demonstrated to be effective, and are approved by USFWS and CDFW, they would reduce harm to and mortality of snakes, while reducing the cost of environmental compliance. Protocols using these technologies may also be developed for the detection of other endangered species.

Recently, DWR's Flood Maintenance and Operations Branch undertook the clearing of 7,540 cubic yards of invasive aquatic weeds from approximately 26,000 lineal feet of a low-flow channel within the Sutter Bypass. The Sutter Bypass East Borrow Canal Fish Rescue Project removed dense patches of water hyacinth and water primrose that were impeding pumping plant operations, flood maintenance, and the migration of adult and juvenile salmon. By working collaboratively with State and federal partners, the permitting process was expedited, allowing for the timely removal of the vegetation for the benefit of sensitive species, while improving drainage and water quality. This activity occurred over several weeks from March through June of 2022. Because CDFW and NMFS requested that DWR conduct this work, the CESA 2081(a) and ESA 4(d) rule permitting path focused on the beneficial management actions for species, rather than the typical process requiring mitigation and fees, and included fish rescue methods to prevent injury to the species.

Multiple-objective Operations and Maintenance

CVFPP implementation includes multi-benefit projects throughout the SPA that would need to be maintained for the variety of benefits they are intended to provide (e.g., flood risk reduction, ecosystem vitality, recreation, water quality, and agricultural production). The long -term O&M of those multi-benefit SPFC improvements would need to include activities to maintain both flood protection and habitat quality. In addition to the strategies described, DWR and several local agencies are currently evaluating the feasibility of developing regional multiple-objective O&M (MOOM) programs in the SPA (e.g., YBCS Partnership O&M efforts). MOOM programs are a flood system maintenance approach that incorporates other non-flood objectives, such as habitat stewardship and enhancement. System maintenance activities are still focused on flood management, but also include objectives and activities related to managing ecosystem processes, habitats, species, and stressors, and prioritization of investments in the system are allocated based on monitoring data and adaptive management.

MOOM programs identify the synergies between flood and ecosystem management, and provide a framework, processes, and mechanisms that can improve collaboration, efficiencies, and cost savings in relation to permitting O&M. By definition, MOOM programs seek to improve the condition of ecosystem processes, habitats, and species, and alleviate stressors, both through impact avoidance and direct resource maintenance and restoration actions performed as part of routine maintenance activities and, for these reasons, can help to avoid the need for mitigation and help reduce some the complexities and costs of permitting.

Several MOOM programs are in place in California; some programs have been in operation for many years, and others have been implemented as recently as five years ago. General characteristics include the following:

- Establishes a common vision among the flood management and resource agencies that includes goals related to each of the program objectives.
- Includes habitat management and enhancement activities in the program, rather than implementing environmental measures solely in response to environmental compliance requirements.
- Incorporates hydrologic, geomorphic, and biological processes, and adaptively manages and maintains the system based on those underlying processes.

- Has a programmatic environmental permitting process based on interagency collaboration, including during program development.
- Provides organization around a single plan or document and an annual planning process that includes resource agency review.
- Has an emphasis on finding solutions that are compatible with each of the program objectives, which leads to creative management techniques.
- Includes performance-based and data-driven adaptive management.
- Provides reliable and adequate funding for system management for all program objectives.

Performance tracking and an annual maintenance planning cycle are important components of a MOOM program's effective implementation.

3.4.4.2 Permitting Ecological Restoration by Multi-benefit Projects

Both single-purpose and multi-benefit projects that create habitat produce long-term benefits for ecosystems, habitats, and species. Nonetheless, these projects may require the disturbance of existing habitats and the displacement—and potentially injury or death—of the animals using them. Consequently, projects restoring habitat typically require the same permits and other approvals as other projects and are subject to the same permitting inefficiencies.

Because they contain both habitat and flood management components, multi-benefit projects can even have more complex permitting requirements than single-purpose habitat or flood management projects. The CNRA, along with regulatory agencies, have been developing more efficient mechanisms for permitting ecological restoration through habitat and multi-benefit projects. These compliance mechanisms are potentially applicable to the full range of ecological restoration actions, which include the following:

- Improvements to stream crossings and fish passage.
- Removal of pilings and other in-water structures.
- Removal of small dams, tide gates, and legacy structures.
- Bioengineered bank stabilization.
- Restoration of off-channel and side-channel habitat features.
- Restoration of floodplains.
- Restoration of tidal and nontidal wetlands.
- Restoration of riparian habitat.
- Removal of non-native invasive plants, including aquatic weeds and native plant revegetation.

Although focused on restoration actions, some of the expedited compliance mechanisms identified in Table 3-4 are intended to apply to multi-benefit projects in their entirety. However, most of these permitting mechanisms have criteria that must be satisfied for their use, particularly regarding the project's design (e.g., the inclusion of specific protection measures).

For a comprehensive description of the statutes and typical authorizations required by multi-benefit flood projects, refer to Appendix D.

Table 3-4. Expedited Compliance Mechanisms for Restoration and Multi-benefit Flood Projects

Agency	Statute	Expedited Compliance Mechanisms
Federal Agencies	Lead Federal Agency—NEPA	• National Oceanic and Atmospheric Administration Restoration Center Programmatic Environmental Impact Statement
	U.S. Army Corps of Engineers—Section 404 of the Clean Water Act; Section 10 of the Rivers and Harbors Act of 1899	• NWP 13 Bank Stabilization [a] • NWP 27 Aquatic Habitat Restoration • NWP 33 Temporary Construction Access and Dewatering • RGP 16 Anadromous Salmonid Fisheries Restoration
	U.S. Army Corps of Engineers—Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408)	• Categorical Permission Alteration 8 Environmental Restoration
	U.S. Fish and Wildlife Service—ESA	• Multi-Agency Implementation of Aquatic, Riparian, Floodplain, and Wetland Restoration Projects to Benefit Fish and Wildlife in California (pending)
	National Marine Fisheries Service—ESA; Magnuson-Stevens Fishery Conservation and Management Act [c]	• Programmatic Biological Opinion for Restoration Projects in the Central Valley of California
State Agencies	Lead State or Local Agency—CEQA	• Categorical Exemption 15333 Small Habitat Restoration Projects [b,c] • Categorical Exemption 15304 Minor Alterations to Land [d]
	California Department of Fish and Wildlife—Section 1600 of the California Fish and Game Code	• Habitat Restoration and Enhancement Act [e]
	California Department of Fish and Wildlife—CESA	• Habitat Restoration and Enhancement Act [e]

Agency	Statute	Expedited Compliance Mechanisms
State Agencies	Central Valley Regional Water Quality Control Board—Clean Water Act (Section 401); Porter-Cologne Water Quality Control Act	• Clean Water Act Section 401 Water Quality Certification for Small Habitat Restoration Projects [f] • Clean Water Act Section 401 Water Quality Certification and Waste Discharge Requirements for Restoration Projects Statewide (pending) [g]

[a] Applicable to projects directly affecting 500 linear feet of streambank or less.

[b] Consultations on actions that may adversely affect essential fish habitat (required by the Magnuson -Stevens Fishery Conservation and Management Act) may be conducted in conjunction with NEPA compliance, ESA compliance, or U.S. Army Corps of Engineers permitting, or as a separate consultation.

[c] Applicable to projects not exceeding 5 acres.

[d] State CEQA Guidelines Section 15300.2 describes exceptions to categorical exemptions (e.g., if the project could cause a substantial adverse change in the significance of a historical resource).

[e] To qualify for the Habitat Restoration and Enhancement Act, projects must meet eligibility requirements for the Clean Water Act Section 401 Water Quality Certification for Small Habitat Restoration Projects. Restoration and enhancement projects approved by CDFW pursuant to the Habitat Restoration and Enhancement Act do not require additional permits from CDFW, such as a lake and streambed alteration agreement or CESA permit.

[f] Applicable to projects not exceeding 5 acres or a cumulative total of 500 linear feet of stream bank or coastline, and that also qualify for a CEQA Class 33 categorical exemption.

[g] Anticipated to be considered for approval by the State Water Resources Control Board in 2022.

Notes:
CDFW = California Department of Fish and Wildlife
CEQA = California Environmental Quality Act
CESA = California Endangered Species Act
ESA = Endangered Species Act
NEPA = National Environmental Policy Act
NWP = Nationwide Permit
RGP = Regional General Permit
USC = United States Code

These compliance mechanisms benefit ecological restoration and multi-benefit projects in several ways. With their standardized measures and other requirements, they may provide greater certainty regarding the cost, timeline, and other implications of compliance with environmental laws and regulations. The design and planning practices (such as including biologists and regulatory agency staff in project planning) facilitate permitting; the avoidance and minimization measures are typically applicable and acceptable to multiple regulatory agencies.

Appendix F provides guidance about what constitutes a multi-benefit project, and identifies project components that meet Conservation Strategy measurable objectives. To effectively convey these project attributes to the regulatory agencies, it is recommended that project proponents clearly identify features that meet these criteria in their permit applications.

Working with the agencies early in the process can help highlight and maximize the ecological benefits of a project and potentially expedite the permitting process. DWR is considering developing guidance to help project proponents include these key components in early project planning design.

3.4.4.3 Operations and Maintenance of Multi-benefit Projects

The long-term permitting needs related to O&M of multi-benefit projects are often not considered during the initial regulatory compliance process. Agencies and project proponents have both advocated for a need to include this up front to reduce costs and delays related to performing needed O&M in areas that will potentially contain wildlife habitat and sensitive species. The development of a long-term O&M plan for multi-benefit projects can also provide predictability and assurances about the types of maintenance actions that are likely to occur, and provide measures to minimize and avoid impacts. Implementers of multi-benefit projects should consider developing O&M plans and incorporating them into their overall project description and regulatory applications.

3.4.4.4 Compensatory and Advance Mitigation

Regulatory compliance requires that compensatory mitigation be provided for unavoidable impacts to sensitive habitats and species. When the supply of mitigation is insufficient, mitigation may cost more, projects may be delayed, or mitigation amounts may be increased to account for the temporal loss of habitats during the interval between when impacts occur and when mitigation is provided.

Additionally, when the supply of compensatory mitigation is insufficient, more of the ecological restoration resulting from multi-benefit projects may be needed to meet other projects' mitigation needs, reducing contributions toward species recovery and the goals of this Conservation Strategy. As described in Section 2.1, "Project Implementation," and Appendix F, "Five-Year Implementation Summary Memorandum," a considerable portion of the restoration by multi-benefit projects is being used as compensatory mitigation for other projects.

Current and planned projects, such as Sacramento River Bank Protection Project Phase II and the projects of the *American River Watershed Common Features General Reevaluation Report* (U.S. Army Corps of Engineers 2015, 2020), will require substantial amounts of compensatory mitigation for impacts on this Strategy's target species and habitats. However, as summarized in Appendix E, "Mitigation Availability," the amount of available mitigation is limited and subject to change as other projects purchase credits. In fact, for more than half of the target species that are federally listed or State-listed, no mitigation credits were available for purchase from a bank, nor were they available from an in-lieu fee program. When not available from banks or an in-lieu fee program, required compensatory mitigation could be provided by a permittee-responsible mitigation project, but this is not practical for smaller projects or O&M activities. Compensatory mitigation could also be provided by multi-benefit projects, but this would effectively reduce their contributions to species recovery and to net increases in ecosystem processes or habitats.

Compensatory mitigation reduces or offsets the unavoidable impacts of project activities on regulated biological resources through restoration, enhancement, or preservation. Therefore, to avoid inefficiencies and reductions in the contributions of multi-benefit projects to this Conservation Strategy's goals, DWR has been pursuing opportunities to develop advance mitigation for CVFPP projects and routine O&M. Advance mitigation does not substitute for net increases and contributions to the measurable objectives once the advance mitigation gains are used to compensate for project impacts.

Advance mitigation can reduce delays in project approval and temporary loss of habitat. These mitigation projects can also provide better conservation outcomes than project-by-project mitigation: They can be larger and better connected to existing conservation areas, easier to maintain, and more viable long-term.

Because mitigation projects entail real estate transactions, management plans, endowment establishment, and multiple approvals from regulatory agencies, and can also include restoration actions, mitigation projects often require at least two years to implement.

By funding such projects to develop compensatory mitigation in advance of anticipated needs, particularly for this Strategy's target species and habitats, DWR can expedite flood projects and help O&M avoid inefficiencies. Having readily available sources to provide mitigation may also reduce the incentive to use multi-benefit projects as mitigation for other projects.

3.4.5 Adaptive Management

Adjustments to the Conservation Strategy are made at five-year intervals as part of the CVFPP updates. These adjustments may include a reevaluation of the Strategy's target species, stressors (such as adding specific invasive aquatic plant species), measurable objectives, and the implementation approach. The overall CVFPP performance tracking and adaptive management approach, and the integration of the Conservation Strategy goals and objectives into that framework, are described in greater detail in the 2022 CVFPP Update.

Adaptive management uses new information to adjust plans and practices, collected from sources such as monitoring. It allows managers to make decisions and take actions under uncertain conditions, rather than waiting until more specific information is available. Given scientific and institutional uncertainties around multi-benefit floodplain management, this Conservation Strategy requires a flexible approach to be able to quickly adapt to new information, including new project and program outcomes.

Besides the five-year updates and applying adaptive management, these reevaluations are informed by the following sources of information (described in the following sections):

- Monitoring (tracking) of progress toward measurable objectives.
- Focused studies.
- New information.
- Systemwide or regional resource inventories.
- Input solicited from agencies, practitioners, and other stakeholders.

3.4.5.1 Implementation Tracking and Data Dissemination

For this Conservation Strategy, implementation tracking and data dissemination serve three general purposes:

1. Monitor and document the effects and effectiveness of CVFPP and Conservation Strategy activities (which are primarily "projects" but are also related to ongoing flood system O&M activities), particularly as they contribute to the Strategy's goals and measurable objectives.
2. Allow agencies and the public to review the progress of Strategy implementation and compliance with associated regional permits.
3. Allow access to, and use of, information to support adaptive management.

To track project implementation, DWR uses data tracking and information sharing systems. These systems allow for numerous related queries, reports, and data views to facilitate reporting, information sharing, and adaptive management. The following section describe these data systems in more detail.

Past and Current Data Management Systems

Historically, DWR has employed several separate applications to manage information across programs, with project data stored in multiple applications and different formats. This often resulted in duplicated or inconsistent data collection processes and outcomes, and it limited DWR's ability to integrate and report data across projects and programs.

But, since 2016, DWR has been coordinating and creating more efficient systems for data management. As a result, common data are being integrated across programs and applications, while maintaining the unique functionality of existing applications and the discrete needs of programs. This data management integrates shared data across programs, and reduces redundancy and duplicated data management efforts. Shared data are stored in a single location that can be accessed internally across DWR. This data system encompasses the information about projects, funding, habitat outcomes, and ecosystem metrics used across DWR programs.

Flood Performance Tracking System

The FPTS allows DWR to monitor progress on flood planning efforts related to the CVFPP, including this Conservation Strategy. Specifically, the FPTS archives data on actions that contribute to the Flood System Status Report's content or this Strategy's measurable objectives. It is a retrospective data tracking tool that captures what has been done to date and determines how those accomplishments compare to flood risk reduction and ecosystem objectives. It provides a simple, clear process for collecting and managing data around project outcomes. The FPTS also increases DWR's ability to internally track the status and outcomes of both multi-benefit and single-purpose projects across the flood system.

Detailed procedures for data collection are being provided to all project proponents that enter project-level inputs into DWR's FPTS. DWR also uses methodology sheets for each tracked metric in the system to capture definitions and accounting rules aligned with specific data tracking fields.

Habitat and Mitigation Tracking Systems

DWR has been developing internal data management and decision support tools to balance its compensatory mitigation needs and other habitat obligations, while working toward goals for increasing the quantity and quality of habitats and contributing to species' recovery. These decision support tools complement the FPTS in that they are forward-looking, comparing project data from the FPTS to forecasted needs and objectives across DWR programs.

The decision support tools apply the one-landscape approach to managing the flood system and planning future projects. This one-landscape approach recognizes that there is a finite amount of available land for projects, but that each acre can create multiple different values (e.g., flood risk reduction, high-quality habitat, recreation). This approach helps DWR to coordinate implementation to meet mitigation needs and other permitting obligations, while making progress toward conservation objectives across programs and plans.

In their tracking of habitats and compensatory mitigation obligations, these tools provide the following benefits:

- Track DWR's past, present, and planned conservation, restoration, and mitigation actions in the flood system.
- Enable DWR to identify future habitat needs and opportunities.
- Provide decision support to align project development timeliness and funding with identified needs.
- Document the habitat outcomes of specific programs, plans, and funding sources, and allow DWR to communicate progress externally to create a clear recognition of the habitat values that DWR provides and maintains.

By providing data on project outcomes and near-term project needs, habitat and compensatory mitigation tracking helps DWR prioritize projects and determine where to focus efforts and funds. While still these systems are currently still in development, they will leverage DWR's existing Enterprise geographic information system (GIS) capacity and FPTS outputs to meet a variety of user data needs.

3.4.5.2 Focused Studies

Data about Central Valley's habitats, processes, species, and stressors have generally been sufficient for developing the Conservation Strategy and implementing multi-benefit actions and projects, with a few exceptions. This finding is supported by the fact that most project proponents and other stakeholders consider data gaps to be a relatively minor limitation on the implementation of multi-benefit projects (Figure 2-5). Current data gaps include existing conditions for some metrics used in this Strategy's objectives (e.g., the extent of natural bank in the Upper San Joaquin River CPA) and uncertainties about the population status and ecological relationships of target species and their response to climate change.

While developing the Strategy and its conservation plans for targeted species, data gaps were identified and prioritized based on their significance:

- Lack of data for objective metrics was considered to have high significance.
- Uncertainties with the potential to substantially affect the size of objectives were considered of moderate significance.
- Data gaps were considered of moderate or low significance depending on their potential effect on conservation at a regional scale.

Table 3-5 provides an updated list of important data gaps, and notes their significance and size. (Size is the relative level of effort and expenditure required to fill the data gap.) These updated priorities are focused on supporting restoration planning and adaptive management forthis Strategy; however, most of these priorities also would support other conservation programs.

Table 3-5. Data Gaps Related to Targeted Ecosystem Processes, Habitats, and Species

Type of Data Gap by Conservation Strategy Goal	Description of Data Gap	Size [a]	Significance [b]
Ecosystem Processes	Floodplain Inundation—Projected Floodplain Inundation Potential. Identify anticipated future hydrologic conditions throughout all CPAs in consideration of management actions and climate change to support restoration project planning and the adaptive management of this Strategy.	Large	High
	Riverine Geomorphic Processes—Natural and Revetted Bank Locations. Inventory natural banks and revetment in the Upper and Lower San Joaquin River CPAs, and update the inventory of natural banks for the Lower Sacramento River CPA to support restoration project planning and the adaptive management of this Strategy.	Large	High
	Riverine Geomorphic Processes—Locations of Unnecessary Revetment (revetment that no longer serves its original purpose). Systematically identify and map unnecessary revetment in all CPAs to support restoration project planning.	Large	Moderate

Type of Data Gap by Conservation Strategy Goal	Description of Data Gap	Size [a]	Significance [b]
Ecosystem Processes	Riverine Geomorphic Processes—Meander Migration Potential. Update mapping of meander migration potential using new tools and anticipated hydrology resulting from climate change and future management throughout all CPAs to support restoration project planning and the adaptive management of this Strategy.	Large	Moderate
Habitat	SRA Cover—Location of Natural and Riparian-lined Banks. Update and complete mapping of natural and riparian-lined banks in the Upper and Lower San Joaquin River CPAs, and update mapping of natural and riparian-lined banks in the Lower Sacramento River CPA, to support restoration project planning and the adaptive management of this Strategy.	Large	High
Target Species – Plants	Slough Thistle—Confirm that species has been extirpated from the SPA by conducting surveys in the Lathrop area and south to the San Joaquin and Stanislaus County borders within the Lower San Joaquin River CPA (where the species was last documented) to support the adaptive management of this Strategy.	Small	Large
	Delta Button-celery—Distribution in Upper and Lower San Joaquin River CPAs: Survey known occurrences, most of which are historical (more than 20 years old), to determine current distribution to support restoration project planning.	Moderate	Moderate
Target Species – Fish	Delta Smelt—Model and map effects on delta smelt habitat resulting from climate change and changes to operations in the Yolo Bypass to support restoration planning.	Moderate	Moderate
	Salmonids—Update Rearing Habitat Modeling and Mapping. Use new analytical tools (e.g., the Salmonid Habitat Quantification Tool) to estimate the quantity and quality of salmonid rearing habitat on existing and potentially restored floodplains, to inform restoration project planning.	Large	Moderate
	Salmonids—SRA Cover Required for Recovery. Determine the quantity and distribution of SRA cover needed for recovery of target salmonid species through modeling or other methods to support the adaptive management of this Strategy.	Moderate	High

Type of Data Gap by Conservation Strategy Goal	Description of Data Gap	Size [a]	Significance [b]
Target Species – Fish	Salmonids—Habitat Value of Revetted, Riparian-lined Banks. Through field studies and modeling, determine the habitat value of woody vegetation planted in revetment, relative to SRA cover, to support the adaptive management of this Strategy.	Large	Moderate
	Green Sturgeon—Location of Deep Pool Habitats. Map the locations of important deep pool habitats in the Upper Sacramento River and Feather River CPAs, particularly adjacent to banks, to support restoration project planning.	Large	Moderate
Target Species – Birds	Yellow-breasted Chat—Breeding Territory Size Requirements. Conduct a field study in the Upper Sacramento River CPA to document the territory size of breeding yellow-breasted chats, to inform restoration project development and vegetation management to benefit this species.	Moderate	Moderate
	Bank Swallow—Location of Sites for Restoration of Breeding Habitat. Identify revetment locations in the Upper Sacramento River, Lower Sacramento River, and Feather River CPAs that would be suitable as breeding habitat for bank swallows following removal.	Small	Moderate
	Western Yellow-billed Cuckoo—Priority Locations for Habitat Restoration. Through an evaluation of recent cuckoo survey data, land cover mapping, and supplemental data collection, identify optimal locations for creation of more than 50 acres of continuous cuckoo habitat in the Feather River and Upper Sacramento CPAs to inform restoration project development and vegetation management to benefit this species.	Small	Moderate
	Tricolored Blackbird—Priority Locations for Breeding Habitat Restoration or Enhancement. Through an evaluation of colony records, land cover mapping, and supplemental data collection, identify optimal locations for restoration or enhancement (e.g., through restoring floodplain inundation) breeding habitat in all CPAs.	Moderate	Moderate

Type of Data Gap by Conservation Strategy Goal	Description of Data Gap	Size [a]	Significance [b]
Target Species – Mammals	Riparian Brush Rabbit and Riparian Wood Rat—Necessary Riparian Corridor Locations. Through evaluation of existing vegetation, inundation areas, and a synthesis of distribution and movement data, determine the location and extent of riparian corridors needed for riparian brush rabbit and riparian wood rat recovery in the Lower San Joaquin River CPA.	Moderate	Moderate
Stressors	No data gaps of moderate to high significance for implementation of this Strategy have been identified for fish passage barriers or invasive plants.	Not Applicable	Not Applicable

[a] Size is the relative level of effort and expenditure required to fill the data gap.

[b] Significance is with regard to the effect on objectives and restoration actions: Lack of data for objective metrics was considered to have high significance, uncertainties with the potential to substantially affect the size of objectives were considered of moderate significance, and other data gaps were considered of moderate or low significance depending on their potential effect on conservation at a regional scale.

Notes:
CPA = conservation planning area
SRA = shaded riverine aquatic
Strategy = Central Valley Flood Protection Plan Conservation Strategy

In addition to the specific data gaps described in Table 3-6, Appendix H, “Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update,” identifies the need for additional climate change modeling to better understand ecosystem-specific responses to climate change, based on changes to the frequency, magnitude, timing, and duration of regulated flows (in Section 4.2.3, “Adaptation Measure 3”).

Focused studies may be used to fill high-priority data gaps. Focused studies could also be conducted to confirm the benefits of restoration actions for targeted species (i.e., to monitor the effectiveness of restoration actions). Data gaps will be addressed as funding becomes available and based on needs related to priorities. Currently, an effort is underway to identify suitable locations along the San Joaquin River for restoration activities associated with salmonid floodplain inundation and groundwater recharge. The “Restoration Concepts and Managed Aquifer Recharge Opportunities for the Upper San Joaquin River” is a collaborative effort consistent with the one-landscape approach discussed in Section 3.4.1.

Because most focused studies would address data gaps that affect other conservation programs as well, there are considerable opportunities for collaboration (e.g., with California EcoRestore or the SJRRP) or for data gaps to be filled by other programs. For information about these other conservation-related efforts, refer to Appendix C, “Updates to 2016 Conservation Strategy Appendix J, ‘Existing Conservation Objectives from Other Plans’.” Resource Inventories

Systemwide or regional resource inventories supported development of the 2012 CVFPP and its Program EIR, the 2016 Conservation Strategy, and the 2017 CVFPP Update and Supplemental Program EIR. These inventories include GIS datasets that were developed to inform the CVFPP and the 2016 Strategy and its measurable objectives (e.g., floodplain inundation, vegetation types, and fish passage barriers). Table 3-6 lists these inventories, the date of their last update, and their anticipated frequency of updates. Updates to these inventories are anticipated to take place at intervals of five or 10 years, corresponding to the intervals between CVFPP updates. These updates support adaptive management by identifying the changes in ecosystem conditions to which CVFPP implementation contributes, and informing the development of future multi-benefit projects.

Table 3-6. Regional and Systemwide Inventories Related to the Conservation Strategy's Goals, Targets, and Metrics

Conservation Strategy Goal	Targeted Process, Habitat, or Stressor	Metric	Update Frequency (years)	Last Update
Ecosystem Processes	Floodplain inundation	Inundated Floodplain—total amount at selected frequency, timing, and duration of flows, including sustained flows (acres, expected annual habitat) [a]	± 10	2012
	Riverine geomorphic processes	Natural Bank—total length (miles) [b]	± 5	2015, 2020
	Riverine geomorphic processes	River Meander Potential—total amount (acres) [b]	± 10	2015
Habitats	SRA cover	Riparian-Lined Bank—total length (miles) [b]	± 5	2015, 2020
	SRA cover	Natural Bank—total length (miles) [b]	± 5	2015, 2020
	Riparian	Habitat Amount—total amount on active floodplain (acres) [c]	± 5	2020
	Marsh (and other wetland)	Habitat Amount—total amount on active floodplain (acres) [c]	± 5	2020
Stressors	Fish passage barriers	Fish Passage Barriers—priority barriers rectified [c]	± 5	2014

Conservation Strategy Goal	Targeted Process, Habitat, or Stressor	Metric	Update Frequency (years)	Last Update
Stressors	Invasive plants	Invasive Plant-dominated Vegetation—total area reduced (acres) on DWR-maintained land and facilities [c]	± 5	2020

[a] Floodplain Restoration Opportunity Analysis maps (California Department of Water Resources 2012b); modeling of salmonid expected annual habitat (Appendix H of 2016 Strategy; San Joaquin River Restoration Program 2012).

[b] Exists in part: Upper and Lower Sacramento River CPAs and Feather River CPA; Upper Sacramento River and Feather River CPAs updated in 2020.

[c] Data developed by a collaborative group that includes DWR.

Notes:

CPA = conservation planning area

DWR = California Department of Water Resources

SRA = shaded riverine aquatic

3.4.5.3 Agency, Practitioner, and Other Stakeholder Input

DWR solicited input from federal, State, and local agencies; NGOs; and other stakeholders while developing the 2016 Conservation Strategy and 2022 CVFPP Update (Section 2.3.4, "Implementation Guidance") and will solicit such input during future updates. This input is necessary to ensure the Strategy is implementable, is consistent with existing laws and regulations, is based on the best available science, incorporates new learning over time, and is broadly supported.

While developing the 2016 Conservation Strategy and the 2022 Update, this input has been solicited through an interagency advisory committee, the CVFPB Advisory Committee, and surveys and interviews with DWR staff members and other project implementers. Input will be solicited from similar sources during future updates. DWR will also seek scientific advice from experts in conservation biology, the ecology of Sacramento and San Joaquin Valley Rivers and floodplains, and flood risk management policy and engineering, through a scientific advisory committee as described in the Conservation Strategy.

3.4.5.4 Reporting

In conjunction with the CVFPP update process, DWR produces five-year reports assessing implementation progress for the Conservation Strategy. The purpose of the five-year report is to demonstrate to the public how progress is being made toward the Strategy's goals and measurable objectives. These reports summarize the activities of the previous five years. They describe implemented multi-benefit projects and O&M that benefit targeted processes, habitats, or species, and the resulting contributions to the Strategy's measurable objectives.

These reports also summarize cumulative progress toward the Conservation Strategy's objectives, progress anticipated in the coming five years based on anticipated 2022 to 2027 projects, and issues that have arisen during implementation of the Strategy. Appendix F summarizes the 2016 to 2021 five-year report.

3.4.6 Prioritized Actions 2022 to 2027

As a key part of the development process for this Strategy Update, and to achieve the goals of advancing multi-benefit project implementation and the implementation of this Strategy and the CVFPP overall, DWR is collaborating with the CVFPB Advisory Committee and other stakeholders to develop a set of prioritized actions and recommendations for the 2022 to 2027 planning cycle. These prioritized actions have been developed from a variety of sources, including:

- Stakeholder surveys and interviews described in Section 2.3.4, "Implementation Guidance."
- CVFPB Advisory Committee recommendations provided in January and February 2021 from the three subgroups (Implementation of Multi-benefit Projects, Permitting, and Performance Tracking, also described in Section 2.3.4).
- DWR recommendations.
- Technical analyses, including the Climate Change Adaptation study presented in Appendix H "Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update".

The CVFPB reconvened the Advisory Committee in summer 2020 to develop recommendations that would help inform the content of the Conservation Strategy Update. The Advisory Committee formed the following three subgroups to identify and address key issues:

1. Permitting.
2. Performance tracking.
3. Implementation of multi-benefit projects.

Appendix G provides the CVFPB Advisory Committee's recommendations, along with a status of how their incorporation is intended to be addressed via the CVFPP planning process. The status for each recommendation is in one or more of the following categories:

1. Included in the Conservation Strategy.
2. Included in the CVFPP.
3. Considered for use as guidance or best management practices to inform other program or planning activities.
4. Already being implemented by other ongoing activities.
5. Considered for future CVFPP planning cycles.
6. Not considered for inclusion in this CVFPP planning cycle.

The CVFPB Advisory Committee submitted 79 recommendations to DWR, several of which contain various actions and were subsequently placed in multiple categories. Many of these recommendations were incorporated into the Conservation Strategy or CVFPP, or both. Some recommendations address activities that are already ongoing or under consideration for future updates. Other recommendations fall outside the scope of the CVFPP or authorization of DWR, but may contain content that could be used as guidance or that aligns with the purpose of the CVFPP.

Table 3-7 provides the recommendations and priority actions for this Strategy Update, including most of the CVFPB Advisory Committee recommendations categorized as Category 1. Some of the recommendations are incorporated into the content of this 2022 CVFPP Update and are not included in Table 3-7. It is important to note that the implementation of any recommendations depend on the availability of sufficient staffing and funding resources.

Table 3-7. Recommendations and Priority Actions for 2022-2027 Included in this Conservation Strategy Update

Key Component of Strategy Implementation	Recommendations and Priority Actions
Coordination, Collaboration, and Alignment	• **Use existing regional working groups (e.g., RFMP groups) to improve the integration of projects with one another and with ecosystem functions at a landscape scale.** Where applicable, these working groups will be aligned with landscape-scale conservation and water resource planning efforts. • **Coordinate with other government agencies, Tribes, and NGOs in the development of floodplain mitigation, habitat, and water management projects.** • **Seek active collaboration within DWR to identify data gaps and multi-benefit projects that meet the shared objectives of this Conservation Strategy, Flood-MAR, and SGMA,** including strategically designed pilot studies to improve the understanding of potential for groundwater recharge on restored floodplains. • **Seek partnerships and coordinate with other federal and State agencies** to increase collaboration, support, and use of periodic updates to regional or systemwide inventories of vegetation, natural bank, riparian-lined bank, and salmonid rearing habitat.

Key Component of Strategy Implementation	Recommendations and Priority Actions
Outreach and Engagement	• **Identify opportunities, through established meetings and processes, for project proponents (including DWR) to engage with local agencies and potentially affected landowners**, and for regulatory agencies to become engaged early in project development. • **Increase the level of engagement and coordination with Tribes,** and include Tribal representation in the forums and venues that advise on Conservation Strategy development and implementation. • **Continue to fund the Teacher Floodplain Institute and identify other opportunities to support and promote public education about floodplain management** that includes environmental conservation information**.** • **Better communicate climate change risks and adaptation opportunities to DWR partners and stakeholders.**
Funding	• **Seek revisions to federal funding guidelines to fully account for the benefits provided by restored ecosystems, wildlife-friendly agricultural lands, and recreation**, and thereby increase federal funding for multi-benefit flood projects. • **Coordinate internally and with local agencies, private partners, and other entities to support and supplement funding for ecosystem improvements** through multi-benefit projects. • **Seek funding from the Greenhouse Gas Reduction Fund to implement the conservation components** of multi-benefit flood projects. • Through RFMPs and funding requirements, **identify "multi-benefit improvement zones" in which actions contributing to Conservation Strategy objectives could be coupled with other flood projects to satisfy grant funding requirements** for multiple benefits. • **Seek funding to continue the Small Communities Flood Risk Reduction grant program** with a greater State share of project funding available for multi-benefit projects. • **Participate in drafting bond language and implementing regulations** to allow more comprehensive funding of projects and reduce conflicts with other requirements. • **Seek funding to expand the Systemwide Flood Risk Reduction Program** to increase State contributions in multi-benefit projects, and explore new multi-benefit project partnerships and implementation models to accelerate implementation. • **Seek funding to support flood system O&M needs associated with multi-benefit projects** where levees are being set back, channels widened, and new habitat areas being created.

Key Component of Strategy Implementation	Recommendations and Priority Actions
Regulatory Compliance	• **Seek a memorandum of agreement or memorandum of understanding between DWR, LMAs, and regulatory agencies that establishes standard avoidance and minimization measures** for multi-benefit projects and O&M. • **Continue to advance MOOM pilot studies in the SPFC,** and work with other LMAs and agencies to develop other approaches to manage natural resources as part of the routine O&M approach. • **Secure funding for advance mitigation projects.** Numerous multi-benefit flood, O&M, and single-purpose projects will require mitigation for impacts on multiple resources; funding advance mitigation increases the availability of compensatory mitigation and could provide conservation benefits over time. • **Consider developing a regional permitting approach to facilitate the implementation of multi-benefit projects.** Using established permitting mechanisms such as HCPs, RCISs/MCAs, and others can facilitate the coordinated planning of multi-benefit projects throughout a region or corridor, potentially expediting permitting and providing a mechanism to secure advance mitigation. • **Promote early engagement and coordination with regulatory agencies to improve the permitting process and conservation outcomes.** DWR, project proponents, and RFMPs may benefit by convening workshops and meetings with the regulatory agencies when developing project priority lists and during project design. • **Develop guidance to help project proponents identify components in their projects that meet multi-benefit and Conservation Strategy measurable objectives.** This can be used by project proponents beginning in the early design phase and through project permitting to optimize ecological features and potentially expedite the regulatory process. • **Encourage and assist implementers of multi-benefit projects to develop O&M plans** and incorporate these into their overall project description and regulatory applications. • **Develop guidance with standardized avoidance and minimization measures** that can be incorporated into O&M plans for multi-benefit projects to maintain and optimize habitat quality, while providing assurances and standardized methods for completing O&M. • **Develop landscape-scale permitting mechanisms** that apply or complement existing means of expediting the permitting of multi-benefit projects. • **Consider reconvening the interagency advisory committee workgroup** to collaborate on effectively permitting multi-benefit projects and develop protocols to find efficiencies amongst agencies as appropriate.

Key Component of Strategy Implementation	Recommendations and Priority Actions
Adaptive Management	• **Consider revisions to target species list and stressors, as appropriate.** Target species could be removed from or added to the list, depending on filled data gaps or other new information. Consideration should be given to the addition of new specific stressors, such as additional fish passage barriers (not previously identified) or additional targeted invasive weeds (terrestrial or aquatic). • **Consider revisions to objective amount for all measurable objectives.** Given new information regarding climate change and other stressors, acreage amounts may be revised to incorporate greater need for Conservation Strategy habitats and species. • **Create and maintain a central repository of project information** that is accessible and regularly updated by project managers. • **Create clear reporting guidance for managers on documenting ecosystem improvements**, and their use as compensatory mitigation. • **Seek the establishment of an online, publicly accessible clearinghouse**- post-construction monitoring reports for habitat projects and O&M covered by incidental take permits or biological opinions, and for habitat management lands provided as compensatory mitigation. • **Re-inventory vegetation, natural bank, and riparian-lined bank throughout all CPAs** and continue to make this data publicly available. • **Model the distribution of salmonid rearing habitat** using current modeling tools for existing and planned changes in facilities and operations, and anticipated changes in hydrology.

Key Component of Strategy Implementation	Recommendations and Priority Actions
Climate Adaptation	• **Build ecosystem resilience** to reduce or mitigate the risks of climate change to the ecological processes, habitats, and species identified in the Conservation Strategy by implementing projects and management actions that restore ecosystem functions, increase the quantity and quality of essential habitats, and improve conditions for specific species (refer to Appendix H, Section 4.2.1, for specific adaptation measures and actions). • **Increase the pace, scale, and geographic extent of multi-benefit project implementation**, given the likely impending impacts of climate change and the escalating need to build ecological resilience at a rate that can mitigate those impacts (refer to Appendix H, Section 4.2.2, for specific adaptation measures and actions). • **Perform more detailed analyses of climate change impacts to Conservation Strategy processes, habitats, and species** to better understand risks and adaptation opportunities (refer to Appendix H, Section 4.2.3, for specific adaptation measures and actions). • **Develop more effective tools and processes** to evaluate climate change impacts at a regional or project-specific level, and assist with multi-benefit project design and implementation (refer to Appendix H, Section 4.2.4, for specific adaptation measures and actions).

Notes:
Conservation Strategy = Central Valley Flood Protection Plan Conservation Strategy
DWR = California Department of Water Resources
HCP = habitat conservation plan
LMA = local maintaining agency
MCA = mitigation credit agreement
MOOM = multiple-objective operations and maintenance
NGO = nongovernmental organization
O&M = operations and maintenance
RCIS = regional conservation investment strategy
RFMP = regional flood management plan
SGMA = Sustainable Groundwater Management Act
SPFC = State Plan of Flood Control
State = State of California
Strategy = Central Valley Flood Protection Plan Conservation Strategy

CHAPTER 4

Glossary

Term	Definition
adaptation	"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects." (Intergovernmental Panel on Climate Change 2014).
adaptive management	"(1) a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives" (California Water Code Section 8502). "(2) management that improves the management of biological resources over time by using new information gathered through monitoring, evaluation, and other credible sources as they become available, and adjusts management strategies and practices to assist in meeting conservation and management goals. Under adaptive management, program actions are viewed as tools for learning to inform future actions" (California Fish and Game Code Section 13.5).
advance mitigation	Ecological uplift that will be used as mitigation for future project- or activity-specific impacts.
anadromous fish	Fish that spend a part of their life cycle in the sea and return to freshwater to spawn.
avoidance	Measures taken to avoid creating impacts from the outset, such as a change in a project's footprint to avoid affecting a resource. (Definition adapted from International Union for Conservation of Nature 2014.)
baseline	The current condition of a natural resource, or its condition at a time of assessment—used as a starting point against which future conditions can be measured or compared.

Term	Definition
Basin-Wide Feasibility Studies (BWFSs)	The Sacramento and San Joaquin BWFSs focused on refining the improvements of the 2012 CVFPP through technical analyses and evaluations. These analyses and evaluations were done in two phases. Phase 1 focused on developing specific planning objectives and exploring different physical features for system improvements. Phase 2 evaluated and compared the physical improvement components of the CVFPP on a systemwide scale, considering their costs, effects, and benefits.
biotic community diversity	The taxonomic or functional richness (number) and equitability of abundance of species in and among communities (co-occurring assemblages of species).
bypass	An engineered wide and shallow channel or confined floodplain, usually flanked by levees, that periodically receives floodwaters to reduce the amount of flow in a river or stream.
capacity	Defined under *conveyance capacity*.
Central Valley Flood Protection Board (CVFPB)	An agency (formerly known as the State of California Reclamation Board) created by the California Legislature in 1911 to carry out a comprehensive flood control plan for the Sacramento and San Joaquin rivers. The CVFPB has jurisdiction throughout the Sacramento-San Joaquin Valley, which is synonymous with the drainage basins of the Central Valley and includes the Sacramento-San Joaquin Drainage District.
Central Valley Flood Protection Plan (CVFPP)	A State plan that describes the challenges, opportunities, and vision for improving integrated flood management in the Central Valley. The CVFPP documents current and future risks associated with flooding and recommends improvements to the State- federal flood protection system to reduce the occurrence of major flooding and the consequences of flood damage that could result. The initial plan was submitted to the CVFPB on December 30, 2011, and adopted June 29, 2012. It is updated every five years.

Term	Definition
compensatory mitigation	The restoration (reestablishment or rehabilitation), establishment (creation), enhancement, or, in certain circumstances, preservation of a resource as required by a permit or approval for the purpose of reducing or offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. (Definition adapted from "Compensatory Mitigation for Losses of Aquatic Resources; Final Rule," 33 CFR Parts 325 and 332, 40 CFR Part 230; 73 *Federal Register* 19594–19705.)
conservation	"(1) In the context of natural resource management: Active management of the biosphere to protect the survival of the maximum diversity of species and the maintenance of genetic variability within species." (United Nations Environment Programme 2019) "(2) In the context of this Conservation Strategy: activities contributing to the environmental objectives of the Central Valley Flood Protection Act: (1) Promote natural dynamic hydrologic and geomorphic processes; (2) increase and improve the quantity, diversity, and connectivity of riparian, wetland, floodplain, and SRA habitats, including the agricultural and ecological values of these lands; and (3) promote the recovery and stability of native species populations and overall biotic community diversity" (California Water Code, Section 9616[a]). "(3) In the context of the ESA: all methods and procedures necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to [the Endangered Species] Act are no longer necessary" (ESA Section 3[3]). "(4) In the context of CESA: the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter [i.e., CESA] are no longer necessary. These methods and procedures include, but are not limited to, all activities associated with scientific resources management, such as research, census, law enforcement, habitat acquisition, restoration and maintenance, propagation, live trapping, and transplantation, and in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking" (California Fish and Game Code Section 2061).

Term	Definition
conservation bank	A publicly or privately owned and operated site that is to be conserved and managed in accordance with a written agreement with CDFW, NMFS, or USFWS that includes provisions for the issuance of credits created to: compensate for take of species listed under ESA or CESA, impacts on fish and wildlife resources, or significant effects on the environment. (Definition adapted from California Fish and Game Code Section 1797.5.)
conservation planning area (CPA)	One of five subdivisions of the SPA that differs from other CPAs in regard to natural resources and CVFPP activities. Each CPA consists of one or more regional flood management plan regions and the adjoining upstream portions of the SPA.
conveyance capacity	The maximum rate of flowing water, usually expressed in cubic feet per second, that a river, canal, or bypass can carry without exceeding a threshold value such as flood discharge, or without using the freeboard distance from the top of a levee. Freeboard is a factor of safety, usually expressed in feet above a flood level, used for purposes of floodplain management.
developed land cover and land use	Developed lands with more than one unit (or structure) per acre, and containing infrastructure and landscaping.
distributary	A river branch flowing away from the mainstem.
dynamic equilibrium	In the context of river systems, the natural balance between sediment size and volume with stream slope and discharge. It can vary widely over short periods of time, depending on activities occurring in watershed including snowmelt time, and natural vegetation cover, among other reasons.
dynamic hydrologic and geomorphic processes	In the context of river systems, the dynamic processes of waterflow subsurface, overland, and in rivers, and the resulting entrainment, transport, and storage of sediment in river channels and on floodplains.

Term	Definition
ecosystem	A natural unit consisting of all the plants, fungi, animals, and microorganisms (the biotic community) together with the abiotic environment in a given area. (Definition adapted from Begon et al. 2006 and Levin 2009.) The biotic community and abiotic environment in an ecosystem are interdependent, frequently with complex feedback loops. The abiotic environment that sustains the biota of an ecosystem includes the soil or substrate, topographic relief and aspect, atmosphere, weather and climate, hydrology, geomorphic processes, nutrient regime, and salinity regime.
ecosystem benefits	The goods and services that people derive directly or indirectly from ecosystem functions.
ecosystem functions	"Intrinsic ecosystem characteristics related to the set of conditions and processes (such as primary productivity, food chain, and biogeochemical cycles) whereby an ecosystem maintains its integrity. Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy" (Millennium Ecosystem Assessment 2005).
enhancement	The manipulation of the physical, chemical, or biological characteristics of an ecosystem to heighten, intensify, or improve one or more ecosystem functions or properties. Enhancement results in the gain of selected ecosystem functions or properties, but may also lead to a decline in other ecosystem functions or properties. Enhancement does not result in a gain in ecosystem area (i.e., one type of ecosystem is not converted to another type of ecosystem). (Definition adapted from U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)
environmental stewardship	The concept of responsibly managing and protecting natural resources (water, air, land, plants, and animals) and ecosystems in a sustainable manner so that they are available for future generations.
expected annual habitat (EAH)	Expressed in units, the annual average of the area expected to be inundated in general or by flows meeting defined criteria for timing and duration (e.g., sustained spring flows) so as to provide habitat for a species (e.g., Chinook salmon).
feasible	"Capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors." (California Water Code Section 8307.)

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>fish passage barrier</td><td>A water management structure, such as a dam, weir, control structure, or water diversion, that blocks, delays, strands, or adversely influences anadromous fish as they migrate upstream or downstream. These structures can be total, temporal, or partial barriers, depending on physical characteristics (e.g., height, hydraulic conditions affecting water depth and velocity, attraction flow, and physical deterioration); operation (e.g., diversion rate and timing and flashboard or gate operations); and relation to species’ biological characteristics (e.g., mode of locomotion, species type, size, physical abilities, and fish condition).</td></tr>
<tr><td>flood</td><td>“A general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder’s property) from any of the following:
Overflow of inland or tidal waters.
Unusual and rapid accumulation or runoff of surface waters from any source.
Mudflow.
Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined” (Federal Emergency Management Agency 2020).</td></tr>
<tr><td>flood risk</td><td>The combined effect of the chance of flooding and the property that would be damaged if flooded.</td></tr>
<tr><td>flood system flexibility</td><td>The ability of a flood management system to adapt to changing conditions, such as hydrologic, social, political, regulatory, or ecological conditions. A more flexible flood system can provide adaptive capacity in the face of climate change and help make investments in regional and local flood protection more enduring in the face of future hydrological uncertainties.</td></tr>
</table>

Term	Definition
flood system resiliency	The ability of the flood management system to continue to function and recover quickly after damaging floods. Increased flood system resiliency can be achieved by increasing the robustness of flood management improvements; adapting measures that reduce the time and cost of flood recovery; improving emergency preparedness, emergency response, and flood recovery planning; and improving system redundancy, particularly in high-risk areas.
floodplain	*"Active" (or "connected") floodplain:* The geomorphic surface adjacent to the stream channel that is typically inundated on a regular basis (i.e., with a recurrence interval of approximately two to 10 years). It is the most extensive low-depositional surface, typically covered with fine overbank deposits, although gravel bar deposits may occur along some streams. *"Inactive" (or "disconnected") floodplain*: Historical floodplains that are no longer inundated because of channel incision, flow regime changes, or intervening levees. The floodplain surface often contains abandoned channels or secondary channels (i.e., chutes).
floodway	The channel of a stream and the portion of the adjoining floodplain required to reasonably provide for passage of the design flood (the selected flood against which protection is provided, or eventually will be provided, by means of flood protective or control works).
geomorphology	The study of the characteristics, origins, and development of landforms.
in-kind mitigation	"Compensatory mitigation involving a resource of a similar structural and functional type to the affected resource." (U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)
in-lieu fee program	A program involving the restoration, establishment, enhancement, or preservation of a resource through funds paid to a governmental or nonprofit natural resources management entity to satisfy compensatory mitigation requirements of permits or approvals. Similar to a mitigation bank, an in-lieu fee program sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the in-lieu program sponsor. (Definition adapted from U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)

Term	Definition
integrated water management	An approach to water management that combines flood risk management, water supply management, and ecosystem-oriented actions to deliver multiple benefits.
invasive plants	Non-native plants that could adversely affect this Conservation Strategy's objectives or public safety through the compromised O&M of the SPFC.
large woody material	Logs, typically more than 4 inches in diameter and more than 6 feet long, lying in river or stream channels. This material provides valuable cover and resting habitat for fish.
local maintaining agency (LMA)	Any city, county, district, or other political subdivision of the State that is authorized to maintain levees. DWR maintains levees pursuant to California Water Code Sections 8361 and 12878, but is not considered an LMA.
loss	Measurable reduction or decline in habitat extent or condition relative to a baseline.
metric	The attribute used for measuring the extent to which outcomes are (or can be) achieved.
measurable objective	The definition of what an action or plan will accomplish, which includes components for quantity and proportion (how much) and time (when the objective should be accomplished).
minimization	Measures taken to reduce the duration, intensity, or extent of impacts that cannot be completely avoided. (Definition adapted from International Union for Conservation of Nature 2014.)
mitigation	The actions intended to avoid, minimize, and offset a project's impact to the extent necessary to meet requirements of applicable regulations and authorizations.

Term	Definition
mitigation bank	A site, or suite of sites, where an aquatic ecosystem (e.g., freshwater wetland) is restored, established, enhanced, or preserved for the purpose of providing compensatory mitigation for impacts authorized by permits or approvals. In general, a mitigation bank sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the mitigation bank sponsor. The operation and use of a mitigation bank are governed by a mitigation banking instrument. (Definition adapted from U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)
multi-benefit project	"In the context of the CVFPP, multi-benefit projects are projects designed to reduce flood risk and enhance fish and wildlife habitat. Multi-benefit projects may also create additional public benefits such as sustaining agricultural production, improving water quality and water supply reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and educational opportunities, or any combination thereof." (California Department of Water Resources 2017.)
non-project levee	Any levee that is not part of the SPFC (California Water Code, Section 9602[c]) or other State-federal or local-federal flood protection facilities. Non-project levees are typically privately owned or under the authority of a local levee district.
non-SPFC levee	Any levee that is not part of the SPFC (California Water Code, Section 9602[c]). This includes State-federal levees outside the Sacramento and San Joaquin river watersheds and levees within the Sacramento and San Joaquin river watersheds that do not have (1) documented State assurances of nonfederal cooperation with the federal government or (2) State responsibility identified in California Water Code Section 8361.

Term	Definition
objectives	"Collectively, measures intended to define the overall accomplishments of the CVFPP. The objectives are not specific actions to achieve the goals, but rather, quantitative overall measures of success of the plan" (California Department of Water Resources 2010).
operations and maintenance (O&M)	The effort that must be expended to keep project facilities in good working condition so they continue to operate as designed—wear and tear on facilities that are not adequately maintained can reduce facilities' capacity or make them more vulnerable to failure. O&M also refers to the management of adjustable features (e.g., flow rate, stage, reservoir storage) to achieve the desired conditions.
out-of-kind mitigation	"Compensatory mitigation for a resource of a different structural and functional type from the affected resource." (U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)
partners	Individuals, organizations, or agencies with direct responsibilities for activities and actions anticipated by the CVFPP.
permittee-responsible mitigation	"A resource restoration, establishment, enhancement, or preservation activity undertaken by the permittee (or an authorized agent or contractor) to provide compensatory mitigation for which the permittee retains full responsibility." (U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)
preservation	The removal of a threat to, or preventing the decline of, ecosystems and resources by an action in or near their location. This term includes activities associated with the protection and maintenance of existing resources through the implementation of appropriate legal, financial, and physical mechanisms (e.g., acquisition of fee title to property and fencing, respectively). Preservation does not result in a gain of resource area or functions. (Definition adapted from U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008.)
project levee	Any levee that is a facility of the SPFC (California Water Code, Section 9602[c]).
public agency	Any city, city and county, county, or district organized, existing, and acting pursuant to the laws of this State (California Water Code, Section 8402([d]).

Term	Definition
public safety	The prevention of, and protection of the general public from, events (such as natural and human-made disasters) that could significantly endanger, injure, or harm people, or cause damage.
rearing habitat	Instream habitat with food, shelter, and water velocity, depth, and quality conditions adequate for juvenile salmonids to survive, avoid predators, and grow.
recovery	“In the context of the Endangered Species Act, improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the ESA (50 CFR 402.02). More generally, a recovered species is demographically and ecologically self-sustaining, genetically robust, with healthy populations, and resilient across its range.” (Redford et al. 2011.)
resilience	“The capacity of a resource and natural or constructed system to adapt to and recover from changed conditions after a disturbance” (California Department of Water Resources 2018).
restoration	The manipulation of the physical, chemical, or biological characteristics of a site to assist the recovery of a historical or degraded resource.
revetment	Erosion-resistant materials that reinforce and protect streambanks and levees.
riparian area	A transitional area between terrestrial and aquatic ecosystems, distinguished by gradients in biophysical conditions, ecological processes, and biota. These are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. Riparian areas include portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., they are zones of influence). Riparian areas are found adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines.
riparian habitat	As used in this Conservation Strategy, the forest, woodland, and scrub vegetation characteristic of riparian areas in the Sacramento and San Joaquin Valleys (as described in Sawyer et al. 2009 and Vaghti and Greco 2007).

Term	Definition
Sacramento River Flood Control Project	"The core of the flood protection system along the Sacramento River and tributaries. The Sacramento River Flood Control Project includes most of the levees, weirs, control structures, bypass channels, and river channels that make up the SPFC. Approximately 980 miles of levees were involved in the project. Portions of these levees were originally constructed by local interests and were either included directly in the project without modification or modified to meet USACE project standards. The project was originally authorized by the Flood Control Act of 1917 and subsequently modified and extended by the Flood Control Acts of 1928, 1937, and 1941. The State of California adopted and authorized the Sacramento River Flood Control Project in 1953" (California Department of Water Resources 2010).
Sacramento–San Joaquin River Flood Management System	A flood management system that comprises all of the following: (a) the facilities of the SPFC as the plan may be amended by the CVFPB and (b) any existing dam, levee, or other flood management facility that is not part of the SPFC if the CVFPB determines, upon recommendation by DWR, that the facility does one or both of the following: (1) Provides significant systemwide benefits for managing flood risks within the Sacramento-San Joaquin Valley or (2) includes project levees that protect a contiguous urban area of 10,000 or more residents within the Sacramento-San Joaquin Valley (California Water Code, Sections 9602 and 9611).
sensitive species	Species assigned special-status in local or regional plans, policies, or regulations, or by CDFW, NMFS, or USFWS, because they are at risk of extinction or extirpation, or species that meet the criteria for special-status (used synonymously with "at-risk species").

Term	Definition
shaded riverine aquatic cover (SRA)	"The unique, nearshore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. Key attributes of this aquatic area are: (1) The adjacent bank is composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (2) the water contains variable amounts of woody debris, such as leaves, logs, branches, and roots; often has substantial detritus; and has variable velocities, depths, and flows" (U.S. Fish and Wildlife Service 1992). SRA cover provides structural and functional integrity for several regionally important fish and wildlife species. It has drastically declined in area and become increasingly fragmented in the Central Valley.
State Plan of Flood Control (SPFC)	The State and federal flood control works, lands, programs, plans, policies, conditions, and mode of O&M of the Sacramento River Flood Control Project, described in California Water Code Section 8350, and of flood control projects in the Sacramento River and San Joaquin River watersheds, authorized pursuant to Article 2 (commencing with Section 12648) of Division 6, Part 6, Chapter 2, for which the CVFPB or DWR has provided the assurances of nonfederal cooperation to the United States, and those facilities identified in California Water Code Section 8361 (California Water Code, Section 9110[f]).
surplus value	Uplift created secondarily or unintentionally. Includes (a) additional benefits to species that were not intended; and (b) other secondary benefits such as providing greater habitat connectivity.
sustainable	Socially, environmentally, and financially feasible for an enduring period. In the context of the CVFPP, a sustainable project has the flexibility to adapt to potential future changes, such as climate change.
system	The Sacramento-San Joaquin River Flood Management System, as described in California Water Code Section 9611.
systemwide	At the scale of an entire system (e.g., the flood management system within the Sacramento-San Joaquin River Flood Management System).
Systemwide Planning Area (SPA)	The geographic area that encompasses lands receiving flood damage-reduction benefits from the existing SPFC facilities and operation of the Sacramento-San Joaquin River Flood Management System.
target	The specific entities with which goals are concerned and for which objectives have been developed.

Term	Definition
temporal loss	The time lag between the loss of a resource caused by an impact and the replacement of the resource by compensatory mitigation (Definition adapted from U.S. Army Corps of Engineers and U.S. Environmental Protection Agency 2008).
transitory storage	The temporary and periodic storage of peak flood flows from adjacent rivers or waterways. Storage occurs in modified floodplain areas acquired through easement or fee title.
uplift	Measurable improvement to habitat extent or condition above a baseline.
vulnerability	"The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (Intergovernmental Panel on Climate Change 2018).
watershed	"The land area from which water drains into a stream, river, or reservoir. The watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point" (California Department of Water Resources 2018).
wildlife-friendly agriculture	In the context of this Conservation Strategy, agricultural practices that benefit the target species, such as Swainson's hawk, giant gartersnake, and red-winged blackbird, which rely on some agricultural crops as surrogates for natural habitats that have been lost (California Department of Water Resources 2016).

Notes:
BWFS = Basin-Wide Feasibility Study
CDFW = California Department of Fish and Wildlife
CESA = California Endangered Species Act
Conservation Strategy = Central Valley Flood Protection Plan Conservation Strategy
CPA = conservation planning area
CVFPB = Central Valley Flood Protection Board
CVFPP = Central Valley Flood Protection Plan
ESA = Endangered Species Act
NMFS = National Marine Fisheries Service
O&M = operations and maintenance
SPA = systemwide planning area
SPFC = State Plan of Flood Control
SRA = shaded riverine aquatic
State = State of California
USFWS = U.S. Fish and Wildlife Service

CHAPTER 5

References

5.1 Chapter 1, "Overview"

California Department of Fish and Wildlife. 2020. Special Animals List. Sacramento (CA). November 2020.

California Department of Fish and Wildlife. 2021. Special Vascular Plants, Bryophytes, and Lichens List. Sacramento (CA). January 2021.

California Department of Water Resources. 2010. *State Plan of Flood Control Descriptive Document.* Central Valley Flood Management Planning Program, FloodSAFE California. Sacramento (CA): DWR Division of Flood Management, Central Valley Flood Planning Office. November 2010.

California Department of Water Resources. 2012a. *2012 Central Valley Flood Protection Plan* Attachment 2: Conservation Framework. Sacramento, California.

California Department of Water Resources. 2012b. *Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability*. Sacramento (CA).

California Department of Water Resources. 2016. *Central Valley Flood Protection Plan Conservation Strategy.* Sacramento (CA).

California Department of Water Resources. 2017. *Central Valley Flood Protection Plan 2017 Update.* Sacramento (CA). August 2017.

California Interagency Wildlife Task Group. 2014. California Wildlife Habitat Relationships (CWHR) System. Version 9.0. Sacramento (CA).

California Native Plant Society. 2021. Inventory of Rare and Endangered Plants. Sacramento (CA). Viewed online at: www.cnps.org. Accessed: January 5, 2021.

The Bay Institute. 1998. *From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed*. July. Novato, California.

Shuford WD and Gardali T (eds.). 2008. "California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Intermediate

Conservation Concern in California." Studies of Western Birds No. 1. Camarillo and Sacramento (CA). Western Field Ornithologists and California Department of Fish and Game.

5.2 Chapter 2, "Implementation 2016–2021"

California Department of Water Resources. 2017. *Central Valley Flood Protection Plan Update.* Sacramento (CA).

Fremier AK. 2003. Floodplain Age Modeling Techniques to Analyze Channel Migration and Vegetation Patch Dynamics on the Sacramento River, California. Master's thesis. Davis (CA): University of California, Davis.

U.S. Army Corps of Engineers. 2007. *Bank Revetment Inventory, Sacramento River Bank Protection Project.* Sacramento (CA). Prepared by Stillwater Sciences, Berkeley (CA).

5.3 Chapter 3, "2022 Conservation Strategy Updates"

Bedsworth L, Cayan D, Franco G, Fisher L, Ziaja S. 2018. *Statewide Summary Report: California's Fourth Climate Change Assessment.* Coordinating agencies: Governor's Office of Planning and Research, California Energy Commission and the California Natural Resources Agency. Publication SUMCCCA4-2018-013.

California Climate Investments. 2020. *Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds*. Sacramento (CA). March 2020.

California Department of Fish and Wildlife. 2015. *California State Wildlife Action Plan 2015 Update: A Conservation Legacy for Californians*. Sacramento (CA). September 2015. Viewed online at: www.wildlife.ca.gov.

California Department of Fish and Wildlife. 2018. *Regional Conservation Investment Strategies Program Guidelines.* Sacramento (CA). September 2018.

California Department of Water Resources. 2012a. *Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability.* Sacramento (CA).

California Department of Water Resources. 2012b. *2012 Central Valley Flood Protection Plan, Consolidated Final Program Environmental Impact Report.* State Clearinghouse No. 2010102044. Sacramento (CA).

California Department of Water Resources. 2014. *Central Valley Flood System Fish Migration Improvement Opportunities Report.* Sacramento (CA). December 2014.

California Department of Water Resources. 2016. *Central Valley Flood Protection Plan Conservation Strategy.* Sacramento (CA).

California Department of Water Resources. 2017a. *Central Valley Flood Protection Plan 2017 Update, Final Supplemental Program Environmental Impact Report.* Sacramento (CA). August 2017.

California Department of Water Resources. 2017b. *Central Valley Flood Protection Plan 2017 Update.* Sacramento (CA). August 2017.

California Department of Water Resources. 2017c. *Central Valley Flood Protection Plan 2017 Investment Strategy.* Sacramento (CA). August 2017.

California Grants Portal. Environment and Water Grants. 2022. www.grants.ca.gov. Accessed July 6, 2022.

California Natural Resources Agency. 2014. *Safeguarding California: Reducing Climate Risk. An Update to the 2009 California Climate Adaptation Strategy*. Sacramento (CA). July 2014. Viewed online at: www.resources.ca.

California Natural Resources Agency. 2019. "Proposition 1E Allocation Balance Report as of March 29, 2019." Sacramento (CA). Viewed online at: www.resources.ca. Accessed November 9, 2020.

California Natural Resources Agency. 2020a. "Proposition 1 Allocation Balance Report as of January 20, 2020." Sacramento (CA). Viewed online at: www.resources.ca. Accessed November 9, 2020.

California Natural Resources Agency. 2020b. "Proposition 84 Allocation Balance Report as of January 29, 2020." Sacramento (CA). Viewed online at: www.resources.ca. Accessed November 9, 2020.

California Natural Resources Agency. 2020c. "Proposition 68 Allocation Balance Report as of July 25, 2020." Sacramento (CA). Viewed online at: www.resources.ca. Accessed November 9, 2020.

California Natural Resources Agency. 2021. Current Funding Opportunities: Grant and Loan Programs within the California Natural Resources Agency, and its Departments, Conservancies, Boards, Commissions, and Councils. Updated July 2021. www.resources.ca

California Natural Resources Agency. 2022. 30x30 California: Accelerating Conservation of California's Nature. Viewed online at: www.california-nature.ca. Accessed: June 23, 2022.

Central Valley Joint Venture. 2006. *Central Valley Joint Venture 2006 Implementation Plan—Conserving Bird Habitat.* Sacramento (CA) U.S. Fish and Wildlife Service. Viewed online at: www.centralvalley.org. Accessed January 4, 2021.

Central Valley Landscape Conservation Project. 2017a. *Vulnerability Assessments for Priority Natural Resources in the Central Valley*. Appendix D, "Overview of Projected Future Changes in the California Central Valley." Viewed online at:www.climate.org

Central Valley Landscape Conservation Project. 2017b. Vulnerability Assessments for Priority Natural Resources in the Central Valley. Viewed online at: http://climate.calcommons.org.

Dirksen, Paul 2022. Correspondence with Debra Bishop on 6/30/2022.

Dunn P.O. and A.P. Møller. 2019. Introduction. In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Dybala KE, Clipperton N, Gardali T, Golet GH, Kelsey R, Lorenzato S, Melcer R, Seavy NE, Silveira JG, Yarris GS. 2017. "Population and Habitat Objectives for Avian Conservation in California's Central Valley Riparian Ecosystems." San Francisco Estuary and Watershed Science Volume 15 (Issue 1).

Environmental Defense Fund and Stillwater Sciences. 2019. "Giant Garter Snake Habitat Quantification Tool." Part of the Multispecies Habitat Quantification Tool for the Central Valley Habitat Exchange: Scientific Rationale and Methods Document. Version 5.

Federal Emergency Management Agency. 2021a. Hazard Mitigation Grant Program. https://www.fema.gov. Accessed May 7, 2021.

Federal Emergency Management Agency. 2021b. Building Resilient Infrastructure and Communities (BRIC). https://www.fema.gov. Accessed May 7, 2021.

Gardali T, Seavy NE, DiGaudio RT, Comrack LA. 2012. "A Climate Change Vulnerability Assessment of California's At-Risk Birds." PLoS ONE Volume 7 (Issue 3): e29507. Viewed online at: https://doi.org.

Grants.gov. Environment and Water Grants. 2022. www.grants.gov. Accessed July 6, 2022.

Keeley ATH, Ackerly D, Basson G, Cameron DR, Hannah L, Heller NE, Huber PR, Roehrdanz PR, Schloss CA, Torne JH, Veloz S, Merenlender AM. 2018. *Migration Corridors as Adaptation to Climate Change: Why, How, and What Next. California's Fourth Climate Change Assessment*. Publication number: CCCA4-CNRA-2018-001. Sacramento (CA): California Natural Resources Agency.

Moyle PB, Keirnan JD, Crain PK, Quiñones RM. 2012. *Projected Effects of Future Climates on Freshwater Fishes of California*. Publication Number CEC-500-2012-028. Sacramento (CA): California Energy Commission.

National Fish and Wildlife Fund. 2021a. *National Coastal Resilience Fund*. [https://www.nfwf.org.](https://www.nfwf.org) Accessed May 7, 2021.

National Fish and Wildlife Fund. 2021b. *Emergency Coastal Resilience Fund.* [https://www.nfwf.org.](https://www.nfwf.org) Accessed May 7, 2021.

National Fish, Wildlife, and Plants Climate Adaptation Partnership. 2012. *National Fish, Wildlife and Plants Climate Adaptation Strategy.* Washington, D.C.: Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service.

National Park Service. 2021a. *Land and Water Conservation Fund: State and Local Grant Funding.* [https://www.nps.gov.](https://www.nps.gov) Accessed May 7, 2021.

Point Reyes Bird Observatory Conservation Science. 2011. Projected Effects of Climate Change in California: Ecoregional Summaries Emphasizing Consequences for Wildlife. Version 1.0. Viewed online at: www.climate.ca.

Rosenzweig C, Karoly DD, Vicarelli M, Neofotis P, Wu Q, Casassa G, Menzel A, Root TL, Estrella N, Seguin B, Tryjanowski P, Liu C, Rawlins S, and Imerson A. 2008. “Attributing physical and biological impacts to anthropogenic climate change.” Nature Volume 453 (Issue 7193: Page 353–358.

San Joaquin River Restoration Program. 2012. *Minimum Floodplain Habitat Area for Spring and Fall-Run Chinook Salmon.* Sacramento (CA). November 2012.

Seavy NE, Gardali T, Golet GH, Griggs FT, Howell CA, Kelsey R, Small SL, Viers JH, Weigand JF. 2009. “Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research.” Ecological Restoration Volume 27 (Issue 3): Page 330–338.

Stein BA, Glick P, Edelson N, Staudt A (eds.). 2014. *Climate-Smart Conservation: Putting Adaptation Principles into Practice.* Washington, D.C.: National Wildlife Federation.

Thorne JH, Boynton RM, Holguin AJ, Stewart JAE, Bjorkman J. 2016. *A Climate Change Vulnerability Assessment of California’s Terrestrial Vegetation.* Sacramento (CA): California Department of Fish and Wildlife.

U.S. Army Corps of Engineers. 2015. *American River Watershed Common Features General Reevaluation Report: Final Environmental Impact Statement/Environmental Impact Report*. State Clearinghouse Number 2005072046. Sacramento (CA). December 2020.

U.S. Army Corps of Engineers. 2020. *Final Sacramento River Bank Protection Project Phase II Supplemental Authorization Environmental Impact Statement/Environmental Impact Report*. State Clearinghouse Number 2009012081. Sacramento (CA). March 2020.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2021a. *About NRCS.* www.nrcsorg. Accessed May 7, 2021.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2021b. *Watershed and Flood Prevention Program*. www.nrcs.org. Accessed May 7, 2021.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2021c. *Watershed and Flood Prevention Program Operations (WFPO) Program*. www.nrcs.org. Accessed May 7, 2021.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2021d. *Wetlands Reserve Program*. www.nrcs.org. Accessed May 7, 2021.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2021e. *Environmental Quality Incentives Program*. www.nrcs.org. Accessed May 7, 2021.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2021f. *NRCS Conservation Programs: Environmental Quality Incentives Program (EQIP)*. www.nrcs.org. Accessed May 7, 2021.

U.S. Fish and Wildlife Service. 2015. *Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnopsis gigas*).* Sacramento (CA).

U.S. Fish and Wildlife Service. 2017. *Recovery Plan for the Giant Garter Snake (*Thamnopsis gigas*).* Sacramento (CA): USFWS Pacific Southwest Region.

U.S. Fish and Wildlife Service. 2019. *Revised Recovery Plan for Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)*. Sacramento (CA): USFWS Pacific Southwest Region.

U.S. Fish and Wildlife Service. 2021a. Western Monarch Butterfly Conservation Recommendations. August 31. www.xerces.org.

U.S. Fish and Wildlife Service. 2021a. Cooperative Endangered Species Conservation Fund Grants (Section 6 of the Endangered Species Act). www.fws.gov. Accessed May 7, 2021.

U.S. Fish and Wildlife Service. 2021b. North American Wetlands Conservation Act. www.fws.gov. Accessed May 7, 2021.

U.S. Fish and Wildlife Service. 2021c. *Anadromous Fish and Restoration Program.* www.fws.gov. Accessed May 7, 2021.

5.4 Chapter 4, "Glossary"

Begon M, Townsend CR, Harper JL. 2006. *Ecology: From Individuals to Ecosystems*. Fourth Edition. Malden (MA): Blackwell Publishing.

California Department of Water Resources. 2010. *State Plan of Flood Control Descriptive Document.* Sacramento (CA). November 2010.

California Department of Water Resources. 2017. *2017 Central Valley Flood Protection Plan Update*. Sacramento (CA).

California Department of Water Resources. 2018. "Glossary." In: *California Water Plan Update 2018*. Sacramento (CA).

Federal Emergency Management Agency. 2020. "Glossary." Viewed online at: www.fema.gov. Accessed: December 30, 2020.

Intergovernmental Panel on Climate Change (IPCC). 2014. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Barros, VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR and White LL (eds.). *Annex II: Glossary*. Agard, J, Schipper ELF, Birkmann J, Campos M, Dubeux C, Nojiri Y, Olsson L, Osman-Elasha B, Pelling M, Prather MJ, Rivera-Ferre MG, Ruppel OC, Sallenger A, Smith KR, St. Clair AL, Mach KJ, Mastrandrea MD and Bilir TE (eds.). In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part B: Regional Aspects. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Page 1,757–1,776.

Intergovernmental Panel on Climate Change (IPCC). 2018. *Annex I: Glossary* Matthews, JBR (ed.) In: "Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." Masson-Delmotte V, Zhai P, Pörtner HO, Roberts D, Skea J, Shukla PR, Pirani A, Moufouma-Okia W, Péan C, Pidcock R, Connors S, Matthews JBR, Chen Y, Zhou X, Gomis MI, Lonnoy E, Maycock T, Tignor M, and Waterfield T (eds.). In Press.

International Union for Conservation of Nature. 2014. *Biodiversity Offsets Technical Study Report.* Gland, Switzerland: Biodiversity Offsets Technical Study Group.

Levin SA (ed.). 2009. *The Princeton Guide to Ecology*. Princeton (NJ): Princeton University Press.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Well-Being: Synthesis*. Washington, D.C.: Island Press.

Redford KH, Amato G, Baillie J, Beldomenico P, Bennett EL, Clum N, Cook R, Fonseca G, Hedges S, Launay F, Lieberman S, Mace GM, Murayama A, Putnam A, Robinson JG, Rosenbaum H, Sanderson EW, Stuart SN, Thomas P, Thorbjarnarson J. 2011. "What Does It Mean to Successfully Conserve a (Vertebrate) Species?" Bioscience Volume 61 (Issue 1): Page 39–48.

Sawyer JO, Keeler-Wolf T, Evens JM. 2009. *A Manual of California Vegetation.* Second Edition. Sacramento (CA): California Native Plant Society.

U.S. Fish and Wildlife Service. 1992. Shaded Riverine Aquatic Cover of the Sacramento River System: Classification as Resource Category 1 Under the FWS Mitigation Policy. Sacramento (CA): USFWS Sacramento Field Office.

United Nations Environment Programme. 2019. Biodiversity Terms. World Conservation Monitoring Center. Available: www.biodiversity.org.

Vaghti MG, Greco SE. 2007. "Riparian Vegetation of the Great Valley." In Barbour MG, Keeler-Wolf T, Schoenherr AA (eds.), *Terrestrial Vegetation of California.* Berkeley (CA): University of California Press. Page 425–455.

CHAPTER 6

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Appendix A
Target Species List Review and Update

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APPENDIX A

Target Species List Review and Update

Acronym	Definition
2022 Update	2022 Update of Central Valley Flood Protection Plan Conservation Strategy
CESA	California Endangered Species Act
Conservation Strategy (or Strategy)	2016 Central Valley Flood Protection Plan Conservation Strategy
CSC	California Species of Special Concern
CVFPP	Central Valley Flood Protection Plan
Delta	Sacramento–San Joaquin Delta
ESA	Endangered Species Act
IUCN	International Union for Conservation of Nature
SB	State Bill
SPA	Systemwide Planning Area
SPFC	State Plan of Flood Control
State	State of California
Strategy (or Conservation Strategy)	2016 Central Valley Flood Protection Plan Conservation Strategy
USFWS	U.S. Fish and Wildlife Service

A.1 Introduction

The preparation of the 2016 Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy or Strategy) entailed a comprehensive review of available information and data. The purpose of that review was to identify target species and develop focused conservation plans, which are presented in Appendix G of the 2016 Conservation Strategy. This review has taken place again for the 2022 Update of the Conservation Strategy (2022 Update) to ensure the list of target species includes those that could benefit most from the implementation of the CVFPP and its Conservation Strategy through focused conservation planning.

This appendix provides the rationale for updating the list of target species, discusses the selection processes for target species and focused conservation plans, and presents four additions to the target species list for the 2022 Update. Attachment A.1 provides an update to the references listed in the 2016 Conservation Strategy for the identified target species.

A.2 Rationale for Updating the Target Species List

The list of target species has been updated for the following reasons:

- To incorporate new information and data that have become available since the 2016 Strategy.
- To include changes to species' regulatory statuses.
- To reflect changes in the conservation needs of native species that support the species' inclusion on the target species list.

Focused conservation plans have also been developed for the species added to the list of target species.

A.3 Selection of Target Species and Focused Conservation Plans

The target species identified in the 2016 Conservation Strategy were selected based on their ability to meet all three of the following criteria:

- **Sensitive or special-status.** The species is identified as sensitive or special-status in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife, National Marine Fisheries Service, or U.S. Fish and Wildlife Service (USFWS). Sensitive or special-status species include those listed as threatened or endangered under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA); species identified as candidates for listing; species identified as fully protected under the California Fish and Game Code or as California Species of Special Concern (CSC); and species with California Rare Plant Rank 1A, 1B, or 2.

- **Associated with target habitats.** The species requires riverine aquatic (including shaded riverine aquatic cover), riparian, marsh, or periodically inundated floodplain or associated habitats as the primary habitat for one or more life stages or ecological needs (e.g., reproduction or foraging).

- **Major potential CVFPP effect.** Implementing the CVFPP, including flood projects and operations and maintenance, could substantially affect the species' populations in California either temporarily or permanently, based on the species' distribution, habitat associations, and ecology (effects may be adverse or beneficial).

Additional target species identified during the 2022 Update meet these criteria based on current information and data. These species will benefit the most from the implementation of the CVFPP and its Conservation Strategy through the restoration of ecosystem processes and habitats and the reduction of flood system stressors.

Appendix G of the 2016 Conservation Strategy presented focused conservation plans prepared for target species that meet three additional criteria:

- **Existing or potential status as threatened or endangered.** The species is State-of-California (State)-listed or federally listed as threatened or endangered, or has high potential to be listed during the next five to 10 years (e.g., plant species with a California Rare Plant Rank of 1B.1, Rare or Endangered in California and elsewhere, Seriously Endangered in California).

- **Specialized or localized conservation requirements.** The species has conservation needs that are unlikely to be met without focused measures because of the species' restricted range, specialized habitat requirements, or landscape-level habitat requirements (e.g., proximity of nesting and breeding habitat, connectivity of multiple habitats). Among the species subject to these respective restrictions and requirements are riparian brush rabbit (*Sylvilagus bachmani riparius*), bank swallow (*Riparia riparia*), Swainson's hawk (*Buteo swainsoni*), and giant gartersnake (*Thamnophis gigas*).

- **Need for additional conservation planning to support the Conservation Strategy.** Other conservation plans (such as species recovery plans) do not address the relationship between the species' conservation needs and flood management activities in sufficient detail to support the implementation of the CVFPP and its Conservation Strategy.

Focused conservation plans have also been developed for new target species identified by this reevaluation, and are provided in Appendix B.

A.4 Additions to the Target Species List

The 2016 Conservation Strategy provides for amendments to the list of target species during the five-year update process to reflect changing conservation needs and habitats. The target species list in the 2016 Conservation Strategy was thoroughly reviewed and updated during development of the 2022 Update. Adopted conservation plans, status reviews and critical habitat designations, regional conservation planning references, and scientific literature were evaluated.

The four proposed additions to the target species list for the 2022 Update consist of a fish, an invertebrate, and two birds. This appendix provides rationales for their inclusion. The master list of potentially suitable animal species (Table 2-1 in Appendix G of the 2016 Conservation Strategy) that were considered for the target species list was also revised to include new species, as shown in Table A-1 (at the end of this appendix). No changes were made to the master plant table (Table 2-2 in Appendix G of the 2016 Conservation Strategy).

A.4.1 Delta Smelt

The delta smelt (*Hypomesus transpacificus*) was screened as a potential target species for the 2016 Conservation Strategy. At that time, the species was listed as endangered under CESA and threatened under ESA; however, it was not included as a target species in Appendix G of the 2016 Strategy. In the period between the completion of the 2016 Conservation Strategy and this five-year update, the delta smelt was petitioned for uplisting from threatened to endangered under ESA. USFWS issued a “warranted-but-precluded” determination for uplisting the delta smelt in 2016 (U.S. Fish and Wildlife Service 2017). The delta smelt was one of the species specifically mentioned in the 2016 Conservation Strategy for potential future inclusion as a target species.

A.4.1.1 Introduction to the Species

Delta smelt are endemic to the San Francisco Bay-Delta estuary. The Bay-Delta consists of the San Francisco Bay and the Sacramento–San Joaquin Delta (Delta), defined as the statutory delta encompassing all waters east of Chipps Island. The range of the delta smelt extends from Berkeley in San Francisco Bay to the City of Napa on the Napa River, throughout Suisun Bay and the Delta, in the Sacramento River to Knights Landing, and in the San Joaquin River to the City of Lathrop (U.S. Fish and Wildlife Service 2017).

Historically, delta smelt were widely distributed throughout the Delta, Suisun Bay, Suisun Marsh, and western San Pablo Bay (Moyle et al. 2016). The abundance of delta smelt has declined dramatically, particularly since the pelagic organism decline in the early 2000s. In 2010, population estimates for delta smelt dropped to a low of 13,000 individuals (Moyle et al. 2016; U.S. Fish and Wildlife Service 2017).

With the decline in delta smelt abundance, along with changes in habitat conditions (e.g., drought, climate change, hydrology, turbidity, harmful algal blooms), the species’ distribution became more restricted. Most delta smelt were confined to an arc of tidal habitat connected by Sacramento River flows from the Cache and Lindsay Slough Complex in the North Delta to Montezuma Slough in Suisun Marsh (Moyle et al. 2016).

A.4.1.2 Rationale

The following rationale addresses each target species criterion to further consider the delta smelt as a target species.

- **Sensitive or special-status.** USFWS considered uplisting the delta smelt from threatened to endangered status under ESA (U.S. Fish and Wildlife Service 2017). USFWS determined the uplisting of delta smelt to endangered was warranted and assigned a listing priority number of 2 based on the high magnitude and immediacy of threats, but other higher-priority actions precluded the species' reclassification (U.S. Fish and Wildlife Service 2017). Because this species was considered warranted for federal uplisting to endangered between the 2016 Conservation Strategy and this five-year update, its re-examination as a target species is merited.

- **Associated with target habitats.** Recent findings have indicated delta smelt may be food-limited, particularly in the spring and summer (Hamilton and Murphy 2018). Smelt collected in areas of greater tidal wetland influence have much greater stomach fullness than those collected in areas of little or no tidal wetland influence, suggesting food resources for delta smelt are more available when near tidal wetlands (Hammock et al. 2019). During the drought from 2012 through 2016, delta smelt were more abundant in the Yolo Bypass than in the previous 14 years, but were present in record low numbers in locations of the estuary where delta smelt were historically found. Delta smelt collected in the Yolo Bypass during the drought were compared to smelt captured elsewhere in the estuary; the findings indicated that smelt in the Yolo Bypass spawned earlier and offspring experienced both higher quality feeding conditions and faster growth rates (Mahardja et al. 2019). The aforementioned studies suggest delta smelt require a mosaic of habitat types that include inundated floodplains and wetlands, particularly because the species is experiencing serious decline. Thus, recent findings indicate a clear connection between the delta smelt and riverine aquatic habitats.

- **Potential CVFPP effect.** The ecosystem processes targeted by the Conservation Strategy are riverine geomorphic processes and floodplain inundation, which are the natural, dynamic hydrologic and geomorphic processes that sustain target habitats and species. Based on the indications that the delta smelt evolved under these natural riverine processes in the Central Valley, this threatened species appears to be a suitable candidate for inclusion as a target species that would substantially benefit from the implementation of the CVFPP and its Conservation Strategy.

A.4.1.3 Summary

The rationale for including delta smelt as a target species is based on the following conditions:

- The recent precipitous decline of this species endemic to the San Francisco Bay-Delta estuary which led to the “warranted-but-precluded” considered uplisting of the species from threatened to endangered under ESA after the completion of the 2016 Conservation Strategy.
- The demonstrated dependence of delta smelt on habitats with Central Valley riverine and bypass systems.
- The dependence of this species’ recovery on existing and additional habitat in the State Plan of Flood Control’s (SPFC’s) river corridors, sloughs, and the Yolo Bypass.

A.4.2 Monarch Butterfly

The monarch butterfly (*Danaus plexippus*) was not screened as a potential target species for the 2016 Conservation Strategy. Since that time however, the species has become a candidate for listing under ESA and classified as endangered by the International Union for Conservation of Nature (IUCN). It is also included on the California Department of Fish and Wildlife’s *Terrestrial and Vernal Pool Invertebrates of Conservation Priority* list (California Department of Fish and Wildlife 2017).

A.4.2.1 Introduction to the Species

The monarch butterfly breeds exclusively on plant species in the subfamily *Asclepiadoideae*, and the western population breeds throughout interior California and other western states (U.S. Fish and Wildlife Service 2021). Western monarchs overwinter along the coast of California, from Mendocino County south to Baja California, typically arriving at their California overwintering sites in mid-October (Hill et al. 1976). They depart from these overwintering sites in late February or March and disperse north and east across California and several other western states to breed, laying their eggs on milkweed plants (U.S. Fish and Wildlife Service, Dingle et al. 2005). Breeding occurs throughout migration; the earliest breeding events occur in areas closest to overwintering sites, and the latest breeding events occur in areas farthest from overwintering sites, resulting in multiple generations of butterflies produced annually; the fall generation migrates back to overwintering sites in California (The Xerces Society for Invertebrate Conservation 2019).

Based on annual census data, monarchs across North America have been in decline since the 1980s, losing more than 95 percent of their population (The Xerces Society for Invertebrate Conservation 2022). Population counts at overwintering sites in California indicate the western North American monarch population has experienced dramatic swings, from less than one percent of historical numbers in 2020 and 2021 (U.S. Fish and Wildlife Service 2020), then rebounding to almost 250,000 individuals in 2021–2022 (The Xerces Society for Invertebrate Conservation 2022), but with an overall severe downward trend (California Department of Fish and Wildlife 2022). This extreme population decline is likely due to multiple stressors across the monarch's range, including: the loss and degradation of overwintering groves, pesticide use (particularly insecticides), loss of breeding and migratory habitat, climate change, and parasites and diseases (U.S. Fish and Wildlife Service 2021).

A.4.2.2 Rationale

The following rationale addresses each target species criterion to further consider the monarch butterfly as a target species.

- **Sensitive or special-status.** The monarch butterfly is a candidate for listing under ESA. USFWS found the listing was warranted in December 2020, but was precluded for higher-priority listing actions. The species is currently slated to be listed in 2024 (California Department of Fish and Wildlife 2022). On July 21, 2022, IUCN classified monarch butterflies as endangered and noted the western population as having the greatest risk of extinction (International Union for Conservation of Nature 2022). Finally, although monarch butterfly does not have a state listing status, it is identified as a conservation priority by the California Department of Fish and Wildlife (2017).

- **Associated with target habitats.** Riparian and marsh habitat in the Central Valley provides critical breeding and migration habitat for monarch butterfly. During breeding and migration, adult monarch butterflies require a diversity of blooming nectar resources which they feed on throughout their migration routes and breeding grounds (U.S. Fish and Wildlife Service 2020). Monarchs also need milkweed (for both oviposition [egg-laying] and larval feeding) embedded within this diverse nectaring habitat. Milkweed may even function as the principal nectar source for monarchs in arid regions, such as California's Central Valley (Pelton et al. 2018, Robins 2020). In western North America, nectar and milkweed resources often are associated with riparian corridors (Dilts et al. 2018, Dingle et al. 2005, Rothrock 2021, Waterbury and Potter 2018). Monarchs in the west also are strongly attracted to and regularly use areas with surplus moisture, and historical records of monarch collections in western North America suggest fall migrants often followed riparian corridors, likely due to the reliable distribution of water, nectar resources, and roost trees in these landscapes (Western Association of Fish and Wildlife Agencies 2019, Robins 2020).

- **Potential CVFPP effect.** Flood control projects and operations and maintenance could permanently or temporarily affect monarch butterfly populations, based on their association with suitable habitat in the Systemwide Planning Area (SPA). In many cases, the species' conservation needs can be positively addressed by implementing management actions that integrate conservation, enhancement, and restoration elements with SPFC operations and maintenance, floodway management, and structural improvements. Specifically, the restoration of riparian SRA, as well as marsh habitat that includes native milkweed, diverse nectar plants, and shrubs for roost sites within the SPA, will provide corridors of ideal migration and breeding habitat for monarch butterflies. Implementing wildlife-friendly agricultural practices and invasive plant management will also benefit the species.

A.4.2.3 Summary

The rationale for including monarch butterfly as a target species is based on the following conditions:

- The severe population decline and overall downward trend over the last several decades, which has led to the species' consideration (and likely listing within the next year) as federal endangered and recent designation as internationally endangered.
- The critical importance of riparian corridors and marsh habitat in the Central Valley for breeding and migration.
- The opportunity to integrate conservation actions with SPFC improvements that would provide ideal migration and breeding corridors for the species.

A.4.3 Tricolored Blackbird

The tricolored blackbird (*Agelaius tricolor*) was screened as a potential target species for the 2016 Conservation Strategy. At that time, the species was a CSC, and it was not included as a target species in Appendix G of the 2016 Strategy. However, between the completion of the 2016 Conservation Strategy and this five-year update, the species was elevated from a CSC to being listed as threatened under CESA. The species was petitioned for listing as endangered under ESA in 2006 and again in 2015. The federal finding on the petition was published in 2019, and found that listing was not warranted, partly due to the listing under CESA, which is reducing the severity of some existing threats (50 Code of Federal Regulations Part 17). The tricolored blackbird was one of the species specifically mentioned in the 2016 Conservation Strategy for potential future inclusion as a target species.

A.4.3.1 Introduction to the Species

Except for small nesting colonies found locally in Oregon, Washington, Nevada, and coastal Baja California, the tricolored blackbird occurs primarily in California, with more than 90 percent of the species' population present in California's Central Valley in most years (Hamilton 2000). Historically, populations of this colonial blackbird were present along the California coast and inland in Central and Southern California; however, the agricultural and urban development of these areas has eliminated all but a few of these populations.

Historically, breeding tricolored blackbirds inhabited primarily freshwater tule (*Schoenoplectus acutus*) and cattail (*Typha* spp.) marshes, with small numbers of breeding colonies occurring in willows (*Salix* spp.), California blackberries (*Rubus ursinus*), and other dense forbs (Neff 1937). In the first half of the 20th century, much of this freshwater marsh habitat was drained and converted to urban and agricultural land uses.

Vast flocks of these birds were once present in California; however, habitat loss, poisonings and shootings of blackbirds to protect crops, pesticide use, and large, persistent, and ongoing annual losses of nests and nesting habitat through agricultural practices have contributed to rapid declines of the species in California (Center for Biological Diversity 2015). In 2014, the tricolored blackbird population was the smallest ever recorded, consisting of only 145,000 birds. By comparison, in 1934, Neff (1937) observed as many as 736,500 tricolored blackbirds from just eight Central Valley counties, and 19th century accounts described flocks of thousands "numbering so many thousands as to darken the sky for some distance by their masses" (Heermann [1859], as conveyed by Beedy 2008).

A.4.3.2 Rationale

The following rationale addresses each target species criterion to further consider the tricolored blackbird as a target species.

- **Sensitive or special-status.** The tricolored blackbird species was assigned a temporary (six-month) emergency endangered status under CESA in December 2015. The species was identified as a CSC in Appendix G of the 2016 Conservation Strategy, and it was listed as threatened under CESA on March 18, 2019. Therefore, the tricolored blackbird qualifies as a defined special-status species for a target species. Because this species was elevated from a CSC to being State-listed as threatened between the 2016 Conservation Strategy and this five-year update, the re-examination of its status as a target species is warranted.

- **Associated with target habitats.** The species' basic breeding habitat requirements are access to water and suitable nesting substrate (e.g., marsh vegetation or thorny vegetation) with access to sufficient foraging habitat within a few kilometers of the colony (Beedy and Hamilton 1999). The tricolored blackbird forms the largest breeding colonies of any North American landbird, and in the Central Valley, as many as 20,000 to 30,000 nests have been recorded in cattail marshes of four hectares or less (Beedy 2008). The species also breeds in scrubby riparian and willow riparian habitats, as well as some upland habitats. Regarding ecological dependency on riparian habitat, Beedy (2008) notes:

  "The colonial breeding system of the tricolored blackbird probably evolved in the Central Valley, where the locations of surface waters and rich sources of insect food were ephemeral and varied annually (Orians 1961). Before its rivers were dammed and channelized, the Central Valley flooded in many years, forming a vast mosaic of seasonal wetlands, freshwater marshes, alkali flats, native grasslands, riparian forests, and oak savannas. Virtually all of these habitats once supported nesting or foraging tricolored blackbirds."

  Thus, the ecological dependence of this species is probably based in its geographic isolation and evolutionary adaptation to Central Valley riverine systems in their natural state. The Central Valley supports all of the state's largest colonies (greater than 20,000 individuals) except the Toledo Pits in Riverside County (Beedy 2008). Thus, there is a clear connection between this species and dependence on the riverine-associated habitats listed in the above criterion.

- **Potential CVFPP effect.** The floodplain inundation and marsh habitats targeted by the Conservation Strategy represent the natural hydrologic process and vegetation that provide habitat for tricolored blackbirds. The restoration of, and increase in, nesting and foraging habitats for tricolored blackbirds (including marsh), as well as increased successional and scrub riparian vegetation in the flood system, would contribute to the recovery of the tricolored blackbird population. The primary conservation priorities for this species are to maintain and enhance existing habitat and to create and restore additional breeding habitats to support nesting and foraging (Tricolored Blackbird Working Group 2007).

A.4.3.3 Summary

The rationale for including the tricolored blackbird as a target species is based on the following conditions:

- The recent precipitous decline of this near-California-endemic species—of which the Central Valley holds the vast majority of the largest colonies—that led the species' status to be elevated from CSC to listed as threatened under CESA after the completion of the 2016 Conservation Strategy.
- The demonstrated dependence of the tricolored blackbird on habitats associated with Central Valley riverine systems.
- The importance to this species' recovery of existing and additional nesting habitat in the river corridors and bypasses of the SPFC.

A.4.4 Yellow-breasted Chat

The yellow-breasted chat (*Icteria virens*) was screened as a potential target species for the 2016 Conservation Strategy. The species was, and remains, a CSC, but it was not included as a target species in Appendix G of the 2016 Strategy.

A.4.4.1 Introduction to the Species

The yellow-breasted chat, a CSC, breeds in dense, shrubby, and some open habitats in North America, although the western population breeds primarily in riparian woodlands. The yellow-breasted chat winters from northern Mexico to Central America (Billerman 2020). In California, where this species occurs as a migrant and summer resident, it breeds primarily in early successional riparian habitats with a well-developed shrub layer and open canopy along the narrow borders of streams, creeks, sloughs, and rivers (Comrack 2008). This species skulks in dense vegetation and is often detected by its distinctive vocalizations.

The yellow-breasted chat has an interesting taxonomic history. The species was long considered an aberrant member of the New World warbler family, the Parulidae; however, the yellow-breasted chat has recently been recognized as a quite distinct taxon and placed in a monotypic family, *Icteriidae* (Billerman 2020).

Although still widely distributed in California, the yellow-breasted chat is now rare or absent from much of the Central Valley, as its breeding range has been reduced by approximately 35 percent (Comrack 2008). The destruction of riparian habitat has been implicated in the early decline of this species in the state (Remsen 1978).

Most yellow-breasted chat individuals in the Central Valley currently breed in the northern Sacramento Valley. The species is still considered as breeding in a few locations in the San Joaquin Valley (Comrack 2008; Dybala et al. 2017). Dybala et al. (2017) identified the population in the Sacramento Valley as small (fewer than 10,000 individuals), and the population in the Yolo-Delta region and the San Joaquin Valley as very small (fewer than 1,000 individuals). Small populations may be below a minimum viable population level and vulnerable to extirpation, and very small populations are expected to be well-below a minimum viable population level (Dybala et al. 2017). These population levels indicate likely extirpation in the Yolo-Delta and San Joaquin Valley regions, and possible extirpation in the Sacramento Valley, in the absence of additional riparian habitat.

Dybala et al. (2017) selected the yellow-breasted chat as one of seven focal species for population and habitat objectives for avian conservation in the Central Valley. This selection was based on the following species characteristics:

- The species' use of riparian vegetation as principal breeding habitat.
- Species status, as it warrants special management status or has experienced population declines or reductions in its breeding range in the Central Valley.
- The usefulness of the species for monitoring the effects of management actions in Central Valley riparian ecosystems.

Dybala et al. (2017) demonstrated the importance of increasing riparian habitat in the Central Valley to maintain a viable population of chats in the valley. The inclusion of the yellow-breasted chat as a target species in the 2022 Conservation Strategy aligns the Strategy's goals and objectives with those of the Central Valley Joint Venture regarding the conservation of riparian habitat for avian species.

A.4.4.2 Rationale

The following rationale addresses each target species criterion to further consider the yellow-breasted chat as a target species.

- **Sensitive or special-status.** As a CSC, the yellow-breasted chat meets this criterion. The research by Dybala et al. (2017) indicates that due to the small population numbers, and without additional appropriate riparian habitat, this species may be extirpated in several Central Valley regions.
- **Associated with target habitats.** The yellow-breasted chat is essentially an obligate riparian species in California. Because this species breeds primarily in early successional riparian

habitats, it depends on events that lead to riparian succession, such as periodic flooding that leads to the regeneration of riparian vegetation, a goal of the Conservation Strategy.

- **Potential CVFPP effect.** Loss of riparian habitat (caused by factors such as flood control infrastructure and management) has significantly reduced the yellow-breasted chat population in California, and particularly in the Central Valley. The dependence of the yellow-breasted chat on understory and shrubby riparian vegetation for nesting makes it vulnerable to habitat loss from vegetation removal along river channels during flood control maintenance. This species could benefit substantially from the implementation of the CVFPP and its Conservation Strategy, because it is very closely associated with riverine riparian habitat of the Sacramento and San Joaquin valleys and would benefit substantially from the addition of riparian habitat to the system (as modeled by Dybala et al. 2017). In particular, the species could benefit from the increase in successional riparian habitat associated with natural riverine processes that would be restored to the flood system.

A.4.4.3 Summary

The rationale for including the yellow-breasted chat as a target species is based on the following conditions:

- The species' status as a CSC.
- The status of the yellow-breasted chat as essentially a riparian-obligate species associated with early successional riparian habitat, which makes it a prime target species that would benefit from the implementation of the CVFPP and its Conservation Strategy. In addition, this species would be an appropriate indicator that the restoration of more natural, dynamic riverine systems has been implemented successfully, a goal of the Strategy.
- The occurrence and continuation of flood management activities that result in substantial adverse effects on this species. However, the Central Valley's yellow-breasted chat population would benefit from the implementation of the CVFPP and its Conservation Strategy, which is anticipated to result in a significant net positive outcome for the species and contribute to the recovery of this population.

Table A-1. Screening of Animal Species Potentially Affected by the CVFPP (including the Conservation Strategy) for Target Species and Focused Conservation Planning

Species	Common Name and Scientific Name	Regional Distribution in SPA [a]	Habitats	Status FED/CA [b]	Associated with Target Habitat [c]	Major Potential CVFPP Effect [d]	Potential Target Species [e]	T/E Listed or Potential for T/E Listing [f]	Focused Conservation Needs [g]	Target Species Chosen for Focused Conservation Planning [h]
Invertebrates	Conservancy fairy shrimp *Branchinecta conservatio*	USR, LSR, LSJR, USJR	Vernal pools, swales, and other ephemeral wetlands	E/None	No	No	No	Yes	Yes	No
	Lange's metalmark butterfly *Apodemia mormo langei*	LSR	Sand dunes	E/None	No	No	No	Yes	Yes	No
	Longhorn fairy shrimp *Branchinecta longiantenna*	USJR	Vernal pools, swales, and other ephemeral wetlands	E/None	No	No	No	Yes	No	No
	Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	USR, LSR, FR, LSJR, USJR	Elderberries in riparian woodlands or savannas	T/None	Yes	Yes	Yes	Yes	Yes	Yes
	Vernal pool fairy shrimp *Branchinecta lynchi*	USR, LSR, FR, LSJR, USJR	Vernal pools, swales, and other ephemeral wetlands	T/None	No	No	No	Yes	No	No
	Vernal pool tadpole shrimp *Lepidurus packardi*	USR, LSR, LSJR, USJR	Vernal pools, swales, and other ephemeral wetlands	E/None	No	No	No	Yes	No	No
	Crotch's bumblebee *Bombus crotchii*	USR, LSR, FR, LSJR, USJR	Grasslands and open oak woodlands; may occasionally forage in riparian areas with floral resources, but because species is ground-nesting, typically would nest outside flood zones; foraging habitat best characterized by upland grasslands in untilled areas with diverse or abundant floral resources	None/C	No	No	No	Yes	No	No
	Monarch butterfly *Danaus plexippus*	USR, LSR, FR, LSJR, USJR	Habitat with nectar flowers, milkweed plants, roosting sites, and access to water; riparian habitat with grassland openings is especially important in the Central Valley	C/None	Yes	Yes	Yes	Yes	Yes	Yes
Fish	California Central Valley steelhead DPS *Oncorhynchus mykiss*	USR, FR, LSJR, LSJR, USJR	Requires cold, freshwater streams with suitable gravel for spawning; rears seasonally in inundated floodplains, rivers, tributaries, and the Delta	T/None	Yes	Yes	Yes	Yes	Yes	Yes
	Central California coast steelhead DPS *Oncorhynchus mykiss*	LSR	Spawns in freshwater streams; adults live and forage in oceanic waters	T/T	Yes	No	No	Yes	Yes	No
	Chinook salmon—Central Valley fall-/late fall-run ESU *Oncorhynchus tshawytscha*	USR, LSR, FR, LSJR, USJR	Requires cold, freshwater streams with suitable gravel for spawning; rears seasonally in inundated floodplains, rivers, tributaries, and the Delta	None/CSC	Yes	Yes	Yes	Yes	Yes	Yes
	Chinook salmon—Central Valley spring-run ESU *Oncorhynchus tshawytscha*	USR, LSR, FR, LSJR	Spawns in freshwater streams and rivers; smolts mature in freshwater streams and later estuarine areas; adults live and forage in oceanic waters and hold in cool, freshwater streams and rivers before spawning	T/T	Yes	Yes	Yes	Yes	Yes	Yes

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Fish	Chinook salmon—Sacramento River winter-run ESU *Oncorhynchus tshawytscha*	LSR, USR	Spawns in freshwater streams and rivers; smolts mature in freshwater streams and later estuarine areas; adults live and forage in oceanic waters and hold in cool, freshwater streams and rivers before spawning	E/E	Yes	Yes	Yes	Yes	Yes	Yes
	Delta smelt *Hypomesus transpacificus*	LSR, LSJR	Spawns in shallow, fresh, or slightly brackish water upstream of the mixing zone (saltwater-freshwater interface); adults live along the freshwater edge of the mixing zone when not spawning; before spawning, adults disperse widely into river channels and tidally influenced backwater sloughs	T/E	Yes	Yes	Yes	Yes	Yes	Yes
	North American green sturgeon—Southern DPS *Acipenser medirostris*	USR, FR, LSR, LSJR	Spawns in deep pools in large, turbulent, freshwater mainstem rivers; adults live and forage in oceanic waters, bays, and estuaries when not spawning	T/CSC	Yes	Yes	Yes	Yes	Yes	Yes
	White Sturgeon *Acipenser transmontanus*	USR, LSR, FR, LSJR, USJR	Spawns on deep gravel or rock substrate in moderate to fast currents in mainstem rivers; adults and subadults most abundant in brackish portions of the San Francisco Bay -Delta; adult long-distance marine migrations into estuary and river habitats in WA, OR, and northern CA sometimes occurs.	None/CSC	Yes	Yes	Yes	No	Yes	No
	Hardhead *Mylopharodon conocephalus*	USR, LSR FR, LSJR, USJR	Spawns in pools and side pools of rivers and creeks; juveniles rear in pools of rivers and creeks, and shallow to deeper water of lakes and reservoirs	None/CSC	Yes	No	No	Yes	No	No
	Longfin smelt *Spirinchus thaleichthys*	LSR, LSJR	Typically spawns in freshwater and moves downstream to brackish water to rear, but tolerant of highly saline water and known to spawn in the southern San Francisco Bay	None/T	Yes	No	Yes	Yes	No	No
	Sacramento splittail *Pogonichthys macrolepidotus*	FR, USR, LSR, LSJR	Generally lives in areas of low to moderate current; uses floodplain habitat for feeding and spawning	None/ None	Yes	Yes	Yes	No	No	No
	Central California roach *Lavinia symmetricus*	USR, LSR, FR, LSJR, USJR	Spawns in pools and side pools of small rivers and creeks; juveniles rear in pools of small rivers and creeks	None/CSC	Yes	No	No	Yes	No	No
Amphibians	California red-legged frog *Rana draytonii*	LSJR	Permanent or ephemeral water sources, including lakes, ponds, reservoirs, slow streams, marshes, bogs, and swamps from sea level to 5,000 feet in woodlands, grasslands, and riparian areas	T/CSC	Yes	No	No	Yes	No	No

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Amphibians	California tiger salamander *Ambystoma californiense*	LSR, FR, LSJR, USJR	Restricted to vernal pools and seasonal ponds, including many constructed stock ponds, in grassland and oak savanna plant communities, predominantly from sea level to 2,000 feet in elevation	T/T	No	No	No	Yes	Yes	No
	Foothill yellow-legged frog *Rana boylii*	USR	Streams and rivers with rocky substrate and open, sunny banks, in forests, chaparral, and woodlands from sea level to 6,700 feet; sometimes found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools	None/T	Yes	No	No	Yes	No	No
	Northern leopard frog *Lithobates pipiens*	USJR	Grasslands, wet meadows, potholes, forests, woodland, brushlands, springs, canals, bogs, marshes, and reservoirs from sea level to 11,000 feet; generally prefers permanent water with abundant aquatic vegetation	None/CSC	Yes	No	No	Yes	No	No
	Shasta salamander *Hydromantes shastae*	USR	Mixed conifer, woodland, and chaparral habitats, especially near limestone	None/T	No	No	No	Yes	No	No
	Western spadefoot *Spea hammondii*	USR, LSR, FR, LSJR, USJR	Grasslands, scrub, chaparral, and occasionally oak woodlands near aquatic habitat such as vernal pools, wetlands, and low-gradient streams	None/CSC	No	No	No	Yes	No	No
Reptiles	Alameda whipsnake *Masticophis lateralis euryxanthus*	LSJR	Chaparral (northern coastal sage scrub and coastal sage), up to 500 feet into adjacent habitats, including grassland, oak savanna, and occasionally oak-bay woodland	T/T	No	No	No	Yes	No	No
	Blunt-nosed leopard lizard *Gambelia sila*	USJR	Semi-arid grasslands, alkali flats, and washes of the San Joaquin Valley and foothills	E/E, FP	No	No	No	Yes	No	No
	Coast horned lizard *Phrynosoma blainvillii*	LSR, FR, LSJR, USJR	Grasslands, brushlands, woodlands, and open coniferous forests	None/CSC	No	No	No	Yes	No	No
	Giant gartersnake *Thamnophis gigas*	USR, LSR, FR, LSJR, USJR	Marshes, sloughs, drainage canals, and irrigation ditches, especially around rice fields, and occasionally in slow-moving creeks from sea level to 400 feet; prefers locations with vegetation close to the water for basking	T/T	Yes	Yes	Yes	Yes	Yes	Yes
	San Joaquin coachwhip *Masticophis flagellum ruddocki*	USR, LSR, LSJR, USJR	Open, dry vegetation in valley grasslands and saltbush scrub	None/CSC	No	No	No	Yes	No	No
	Silvery legless lizard *Anniella pulchra*	LSJR, USJR	Moist, warm, loose soil with plant cover in sparsely vegetated areas of beach dunes, chaparral, woodlands, desert scrub, sandy washes, and stream terraces	None/CSC	Yes	No	No	Yes	No	No

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Reptiles	Western pond turtle *Actinemys marmorata*	USR, LSR, FR, LSJR, USJR	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with abundant vegetation and either rocky or muddy bottoms, in woodland, forest, and grassland	None/CSC	Yes	Yes	Yes	Yes	No	No
Birds	American peregrine falcon *Falco peregrinus anatum*	USR, LSR, FR, LSJR, USJR	*Foraging:* A variety of open habitats, particularly marshes and other wetlands *Nesting:* High rocky cliffs or other high structures	D/D, FP	Yes	No	No	No	No	No
	Bald eagle *Haliaeetus leucocephalus*	FR	*Foraging:* Large bodies of water or free-flowing rivers with abundant fish and adjacent snags or other perches *Nesting:* Large, old-growth trees or snags in remote, mixed stands near water	D/E, FP, EPA	Yes	No	No	Yes	No	No
	Bank swallow *Riparia*	USR, LSR, FR	*Foraging:* Open riparian areas, grassland, wetlands, water, and cropland *Nesting:* Vertical banks and cliffs with fine-textured or sandy friable soils near streams, rivers, ponds, and lakes	None/T	Yes	Yes	Yes	Yes	Yes	Yes
	Black swift *Cypseloides niger*	FR, LSR, LSJR	*Foraging*: Over a wide variety of habitats, sometimes far from nests *Nesting:* Canyon walls near water and sheltered by overhanging rock or moss, preferably near waterfalls	None/ CSC	Yes	No	No	Yes	No	No
	Black tern *Chlidonias niger*	LSR, LSJR, USJR	*Foraging and nesting:* Freshwater emergent wetlands, marshes, lakes, ponds, moist grasslands, and agricultural fields	None/ CSC	Yes	No	No	Yes	No	No
	California black rail *Laterallus jamaicensis coturniculus*	LSR, LSJR	*Foraging and nesting:* Tidal emergent wetlands dominated by pickleweed, in the high wetland zones near the upper limit of tidal flooding, or in brackish marshes supporting bulrushes and pickleweed; in freshwater, usually found in bulrushes, cattails, and saltgrass adjacent to tidal sloughs	None/T, FP	Yes	Yes	Yes	Yes	Yes	Yes
	Ferruginous hawk (wintering) *Buteo regalis*	USR, LSR, FR, LSJR, USJR	*Foraging:* Open grasslands and agricultural fields *Nesting:* Does not breed in the SPA	None/ CSC	No	No	No	Yes	No	No
	Golden eagle *Aquila chrysaetos*	USR, LSR, FR, LSJR, USJR	*Foraging*: open shrublands, grasslands, and oak woodlands *Nesting*: forests, open valleys, oak savannah with large trees, cliffs	None/FP	No	No	No	No	No	No
	Grasshopper sparrow *Ammodramus savannarum*	USR, LSR, FR, LSJR, USJR	*Foraging and nesting:* Short to middle-height, moderately open grasslands with scattered shrubs	None/ CSC	No	No	No	Yes	No	No

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Birds	Greater sandhill crane *Grus canadensis tabida*	USR, LSR, FR, LSJR, USJR	*Foraging:* Open grasslands, grain fields, and open wetlands for roosting *Roosting:* In flocks standing in moist fields or in shallow water *Nesting:* Does not breed in the SPA	None/T, FP, EPA	Yes	Yes	No	Yes	Yes	Yes
	Least Bell's vireo *Vireo bellii pusillus*	USR, LSR, FR, LSJR, USJR	*Foraging and nesting:* Low, dense riparian growth along water or along dry parts of intermittent streams	E/E	Yes	No	Yes	Yes	Yes	Yes
	Least bittern *Ixobrychus exilis*	LSJR, LSR, USJR, USR	*Foraging and nesting:* Freshwater and brackish marshes with tall, dense emergent vegetation and clumps of woody plants over deep water	None/ CSC	Yes	Yes	Yes	Yes	No	No
	Lesser sandhill crane *Grus canadensis*	LSJR, LSR, FR, USJR, USR	*Foraging:* Pastures, moist grasslands, alfalfa and grain fields, and shallow wetlands for roosting *Nesting:* Does not breed in California	None/ CSC	Yes	Yes	Yes	Yes	Yes	No
	Little willow flycatcher *Empidonax traillii brewsteri*	FR, USR	*Foraging:* Willow thickets and adjacent meadows *Nesting:* Extensive thickets of low, dense willows at edge of wet meadows, ponds, or backwaters	None/E	Yes	Yes	Yes	Yes	No	No
	Loggerhead shrike *Lanius ludovidianus*	USR, LSR, FR, LSJR, USJR	*Foraging:* Grasslands and agricultural fields *Nesting:* Scattered shrubs and trees	None/ CSC	No	No	No	Yes	No	No
	Mountain plover *Charadrius montanus*	USR, LSR, USJR	*Foraging*: Fallow, grazed, or burned fields with short and sparse vegetation cover *Nesting:* Does not breed in California	None/ CSC	No	No	No	Yes	No	No
	Northern harrier *Circus cyaneus*	USR, LSR, FR, LSJR, USJR	*Foraging and nesting:* Tall grasses and forbs in emergent wetland, along rivers or lakes, grasslands, grain fields, or on sagebrush flats several miles from water	None/ CSC	Yes	No	No	Yes	No	No
	Purple martin *Progne subis*	LSJR, LSR	*Foraging:* Conifer, woodland, and riparian habitats *Nesting:* Snags in old-growth, multilayered, open forests and woodlands	None/ CSC	Yes	No	No	Yes	No	No
	Redhead *Aythya americana*	LSR, LSJR, USJR	*Nesting:* Freshwater emergent wetlands where dense stands of cattails and tules are interspersed with areas of deep, open water *Foraging:* Large, deep bodies of water	None/ CSC	Yes	Yes	Yes	Yes	No	No
	Short-eared owl *Asio flammeus*	USR, LSR, FR, LSJR, USJR	*Foraging and nesting:* Open prairies, coastal grasslands, marshes, bogs, savanna, and dunes	None/ CSC	Yes	No	No	Yes	No	No

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Birds	Suisun song sparrow *Melospiza melodia maxillaries*	LSJR, LSR	*Foraging:* Bare surface of tidally exposed mud among tules and along slough margins in brackish marshes *Nesting:* Along edges of tidal sloughs and bays supporting mixed stands of bulrush, cattail, and other emergent vegetation	None/ CSC	Yes	No	No	Yes	Yes	No
	Swainson's hawk *Buteo swainsoni*	USR, LSR, FR, LSJR, USJR	*Foraging:* Open desert, grassland, or cropland containing scattered large trees or small groves *Nesting:* Open riparian habitat, in scattered trees or small groves in sparsely vegetated flatlands and agricultural areas; often found near water in the Central Valley	None/T	Yes	Yes	Yes	Yes	Yes	Yes
	Tricolored blackbird *Agelaius tricolor*	USR, LSR, FR, LSJR, USJR	*Foraging:* On ground in croplands, grassy fields, flooded land, and along edges of ponds *Nesting:* Dense	None/T	Yes	Yes	Yes	Yes	Yes	Yes
	Western burrowing owl *Athene cunicularia hypugaea*	USR, LSR, LSJR, USJR	*Foraging and nesting*: Grasslands and agricultural fields	None/ CSC	No	No	No	Yes	No	No
	Western snowy plover *Charadrius alexandrinus nivosus*	LSR, USJR	*Foraging and nesting:* Above high-tide line on coastal beaches, sand spits, dune-backed beaches, sparsely vegetated dunes, beaches at creek and river mouths, and salt pans at lagoons and estuaries	T/CSC	Yes	No	No	Yes	No	No
	Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	USR, LSR, FR, LSJR, USJR	*Foraging and nesting:* Extensive deciduous riparian thickets or forests with dense, low-level, or understory foliage adjacent to slow-moving watercourses, backwaters, or seeps; willow is almost always a dominant component of the vegetation. In the Sacramento Valley, also rarely uses adjacent walnut orchards; prefers sites with a dominant cottonwood overstory for foraging. Occurs primarily in riparian habitat in migration in California, although can occur in a wider variety of habitats (e.g., gallery and secondary forests) in migration and winter in the neotropics	T/E	Yes	Yes	Yes	Yes	Yes	Yes
	White-tailed kite *Elanus leucurus*	USR	*Foraging:* Undisturbed, open grasslands, meadows, farmlands, and emergent wetlands *Nesting:* Large groves of dense, broad-leafed deciduous trees close to foraging areas	None/FP	Yes	No	No	No	No	No
	Yellow-breasted chat *Icteria virens*	USR, LSR, FR, LSJR, USJR	*Foraging and nesting:* Early successional thickets of willow and other brushy habitat near rivers, streams, or other watercourses	None/ CSC	Yes	Yes	Yes	Yes	Yes	Yes

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Birds	Yellow-headed blackbird *Xanthocephalus*	LSR, LSJR, USJR	*Foraging:* Freshwater emergent wetland and sometimes along shorelines and in nearby open fields, preferably on moist ground *Nesting:* Dense emergent wetland of cattails and tules, often along borders of lakes or ponds	None/ CSC	Yes	Yes	Yes	Yes	No	No
	Yellow warbler *Dendroica petechia*	USJR, USR, LSR, [i] FR, LSJR, USJR [i]	*Foraging and nesting*: Low- to mid-story, open-canopy riparian deciduous woodlands with a heavy brush understory; sometimes in montane shrubbery in open conifer forests	None/ CSC	Yes	Yes	Yes	Yes	No	No
Mammals	American badger *Taxidea taxus*	USR, LSR, FR, LSJR, USJR	Drier open states of most scrub, forest, and herbaceous habitats with friable soils	None/ CSC	No	No	No	Yes	No	No
	Fresno kangaroo rat *Dipodomys nitratoides exilis*	USJR	Alkali desert scrub habitats between 200- and 300-feet elevation	E/E	No	No	No	Yes	No	No
	Giant kangaroo rat *Dipodomys ingens*	USJR	Annual grasslands and shrub habitats with sparse vegetative cover	E/E	No	No	No	Yes	No	No
	Hoary bat *Lasiurus cinereus*	USR, LSR, FR, LSJR, USJR	*Foraging:* Over open forested and riparian areas *Roosting:* In the foliage of trees, prefers woodlands and coniferous forests; noncolonial	None/ None	Yes	No	No	No	No	No
	Nelson's antelope squirrel *Ammospermophilus nelsoni*	USR	Arid grasslands with loamy soils and moderate shrub cover	None/T	No	No	No	Yes	No	No
	Pallid bat *Antrozous pallidus*	USR, LSR	*Foraging:* On bare ground and in short grasses in a variety of habitats including chaparral, oak woodland, grassland, ruderal, and agricultural habitats *Roosting:* In crevices of rocky outcrops, hollow trees, cliffs, bridges, barns, and other anthropogenic structures	None/ None	Yes	No	No	No	No	No
	Ringtail *Bassariscus astutus*	FR, USR, LSR	Prefers riparian habitats in many situations, rocky talus slopes, and brushy habitats in most forests	None/FP	Yes	No	No	No	No	No
	Riparian brush rabbit *Sylvilagus bachmani riparius*	LSJR	Riparian woodlands dominated by oaks with a dense understory of wild roses, grapes, and blackberries	E/E	Yes	Yes	Yes	Yes	Yes	Yes
	Riparian (= San Joaquin Valley) woodrat *Neotoma fuscipes riparia*	LSJR	Riparian habitats with associated evergreen and deciduous oak with dense understories; willow thickets	E/CSC	Yes	Yes	Yes	Yes	Yes	Yes
	Sacramento Valley red fox *Vulpes patwin*	FR, USR	Grasslands	None/ None	No	No	No	No	No	No

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Mammals	San Joaquin kit fox *Vulpes macrotis mutica*	USJR, LSJR	Saltbush scrub, grasslands, oak savannas, and freshwater scrub	E/T	No	No	No	Yes	No	No
	Salt-marsh harvest mouse *Reithrodontomys raviventris*	LSR, LSJR	Salt marsh dominated by pickleweed and saltgrass; requires non-submerged, salt-tolerant vegetation for escape during high tides	E/E, FP	Yes	No	No	Yes	No	No
	Spotted bat *Euderma maculatum*	USR, USJR	*Foraging:* Over water and along washes in deserts, grasslands, and mixed conifer forests from below sea level to above 10,000 feet *Roosting:* In rock crevices in cliffs	None/CSC	Yes	No	No	Yes	No	No
	Townsend's big-eared bat *Plecotus townsendii*	USR, LSR, FR, LSJR, USJR	*Foraging:* Along edges of a variety of habitats *Roosting:* In caves, tunnels, mines, cavernous trees, and buildings	None/C	Yes	No	No	Yes	No	No
	Western mastiff bat *Eumops perotis californicus*	USR, USJR	*Foraging:* Open aerial forager over many habitats and landscapes *Roosting:* In crevices of exposed vertical cliffs of any rock type, and rarely in bridges or tall buildings	None/CSC	Yes	No	No	Yes	No	No
	Yuma myotis *Myotis yumanensis oxalis*	LSR, LSJR	*Foraging:* On flat fresh and brackish waters, mostly in open areas *Roosting:* In tree cavities and in bridges, barns, and other anthropogenic structures	None/ Under State review	Yes	Yes	No	Yes	No	No
	Western red bat *Lasiurus blossevillii*	USR, LSR, FR, LSJR, USJR	*Foraging:* Includes oak woodlands, coniferous forest (at low elevations), along riparian corridors, among non-native trees in urban and rural residential areas, and within mature orchards *Roosting:* Maternity roosts in foliage of mostly old-growth riparian trees; distribution limited mostly to the edges of the mainstems of river systems and Delta waterways; winter roosts are often under leaf litter	None/ CSC	Yes	Yes	Yes	Yes	No	No

Sources: California Interagency Wildlife Task Group 2008; Shuford and Gardali 2008; California Department of Fish and Wildlife 2019.

[a] **Regional Distribution in SPA:**

FR = CVFPP Feather River Implementation Region
LSJR = Mid–San Joaquin River, Lower San Joaquin River, and Delta South CVFPP Implementation Regions
LSR = Lower Sacramento River and Delta-North CVFPP Implementation Regions
USJR = Upper San Joaquin River CVFPP Implementation Region
USR = Upper Sacramento River and Mid-Sacramento River CVFPP Implementation Regions
Distribution in upstream SPA aquatic and floodplain habitats is included in immediately downstream CVFPP Implementation Region.

[b] **Status FED/CA:**

Federal:
None = No listing
C = Candidate for listing under the federal ESA
E = listed as endangered under ESA
T = Listed as threatened under ESA
D = Delisted under ESA
California:
None = No listing
C = Candidate for listing under the CESA
E = Listed as endangered under CESA
T = Listed as threatened under CESA
FP = Fully protected under the California Fish and Game Code
CSC = California Species of Special Concern
D = Delisted under CESA

[c] **Associated with Target Habitat:**

Yes = Species is associated with riverine aquatic (including shaded riverine aquatic), riparian, perennial wetland, or periodically inundated floodplain habitats.
No = Species is not associated with any of these target habitats.

[d] **Major Potential CVFPP Effect:**

Yes = Implementation of the CVFPP (flood management and conservation actions) could substantially affect California populations of this species, based on distribution, habitat associations, and ecology of species. Effects may be adverse or beneficial.
No = Implementation of the CVFPP would not substantially affect California populations of this species.

[e] **Target Species:**

Yes = Species both associated with a target habitat and could be substantially affected by CVFPP implementation.
No = Species either not associated with a target habitat or not substantially affected by CVFPP implementation. Target species are species with greatest potential to benefit from or be adversely affected by CVFPP implementation.

[f] **Potential for T/E Listing:**

Yes = Species is currently State- or federally listed as threatened or endangered, or has high potential of being listed during the next five to 10 years.
No = Species is not State- or federally listed.

[g] **Focused Conservation Needs:**

Yes = Species has restricted distribution in SPA, requires habitat elements with restricted distribution (e.g., cut banks), or requires large-scale connectivity of habitat features for completion of life cycle.
No = Species does not have focused conservation needs.

[h] **Focused Conservation Planning:**

Yes = Species is a target species with listing potential and focused conservation needs.
No = Species is not a target species, or does not have listing potential or focused conservation needs. Focused conservation planning addresses specific conservation needs that otherwise may not be met by restoration of ecological processes and habitats within each region.

[i] **Potential distribution is based on historic records or poorly known.**

Notes:
CA = California
DPS = Distinct Population Segment
EPA = Bald and Golden Eagle Protection Act
ESU = Evolutionarily Significant Unit
FED = federal
SPA = Systemwide Planning Area

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A.5 References

Beedy EC. 2008. "Tricolored Blackbird." In: Shuford WD, Gardali T, editors. California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies in Western Birds 1. Camarillo and Sacramento (CA): Western Field Ornithologists and California Department of Fish and Game.

Beedy EC, Hamilton WJ III. 1999. "Tricolored Blackbird (*Agelaius tricolor*)." In: Poole A, Gill F, editors. *The Birds of North America* No. 423. Philadelphia (PA): Birds of North America.

Billerman SM. 2020. "Yellow-Breasted Chat (*Icteriidae*)," version 1.0. In: Billerman SM, Keeney BK, Rodewald PG, Schulenberg TS, editors. *Birds of the World.* Ithaca (NY): Cornell Lab of Ornithology.

California Department of Fish and Wildlife. 2019. About the CNDDB. Viewed online at: www.wildlife.ca.gov. Accessed on: January 11, 2021.

California Department of Fish and Wildlife. 2017. Terrestrial and Vernal Pool Invertebrates of Conservation Priority.

California Department of Fish and Wildlife. 2022. "Monarch Butterfly." Viewed online at: www.wildlife.ca.gov. Accessed on: June 30, 2022.

California Interagency Wildlife Task Group. 2008. California Wildlife Habitat Relationships version 8.2 personal computer program. Sacramento, CA.

Center for Biological Diversity. 2015. Petition to List the Tricolored Blackbird (Agelaius tricolor) as an Endangered Species and to Designate Critical Habitat Concurrent with Listing. Oakland (CA): Center for Biological Diversity.

Center for Biological Diversity. 2020. "Tricolored Blackbird." Tucson (AZ): Center for Biological Diversity. [Website.] Viewed online at: www.biologicaldiversity.org. Accessed: June 30, 2020.

Comrack LA. 2008. "Yellow-Breasted Chat." In: Shuford WD, Gardali T, editors. California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies in Western Birds 1. Camarillo and Sacramento (CA): Western Field Ornithologists and California Department of Fish and Game.

Dilts, T. E., M. Steele, S. Black, D. Craver, J. Cruz, E. Engler, S. Jepsen, A. Jones, S. McKnight, A. Pelton, E. Taylor, and M. Forister. 2018. Western monarch and milkweed habitat suitability modeling project Version 2 – Maxent Model outputs. The Xerces Society for Invertebrate Conservation, U.S. Fish and Wildlife Service, and University of Nevada, Reno. Viewed online at: www.monarch-milk-weed.com. Accessed September 20, 2021.

Dingle, H., M. P. Zalucki, W. A. Rochester, and T. Armijo-Prewitt. 2005. Distribution of the monarch butterfly, *Danaus plexippus* (L.) (Lepidoptera: Nymphalidae), in western North America. Biological Journal of the Linnean Society 85(4):491–500.

Dybala KE, Clipperton N, Gardali T, Golet GH, Kelsey R, Lorenzato S, Melcer R Jr, Seavy NE, Silveira JG, Yarris GS. 2017. “Population and Habitat Objectives for Avian Conservation in California’s Central Valley Riparian Ecosystems.” San Francisco Estuary & Watershed Science Volume 15 (Issue 1), Article 5. California Digital Library, University of California.

Hamilton SC, Murphy DD. 2018. “Analysis of Limiting Factors across the Life Cycle of Delta Smelt (*Hypomesus transpacificus*).” Environmental Management Volume 62: Pages 365 to 382.

Hamilton WJ. 2000. “Tricolored Blackbird 2000 Breeding Season Census and Survey—Observations and Recommendations.” The Condor Volume 100: Pages 218 to 226. Available from Division of Environmental Studies, University of California, Davis.

Hammock BG, Hartman R, Slater SB, Hennessy A, Teh SJ. 2019. “Tidal Wetlands Associated with Foraging Success of Delta Smelt.” Estuaries and Coasts Volume 42: Pages 857 to 867. Accessed: July 1, 2020.

Heermann AL. 1859. “Report upon Birds Collected on the Survey.” Zoological Report No. 2. In: Williamson RS, editor. Report of Explorations in California for Railroad Routes near the Thirty-fifth and Thirty-second Parallels in 1853: Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi to the Pacific Ocean, 1853–6, Volume 10. Washington, DC: Beverley Tucker, Printer. Pages 29 to 80.

Hill, H. F., Jr., A. M. Wenner, and P. H. Wells. 1976. Reproductive behavior in an overwintering aggregation of monarch butterflies. American Midland Naturalist 95(1):10–19.

International Union for Conservation of Nature. 2022. www.iucn.org.

Mahardja B, Hobbs JA, Ikemiyagi N, Benjamin A, Finger AJ. 2019. “Role of Freshwater Floodplain-Tidal Slough Complex in the Persistence of the Endangered Delta Smelt.” PLoS ONE Volume 14 (Issue 1): e0208084. Viewed online at: Endangered-Smelt. Accessed: July 1, 2020.

Moyle PB, Brown LR, Durand JR, Hobbs JA. 2016. “Delta Smelt: Life History and Decline of a Once-Abundant Species in the San Francisco Estuary.” San Francisco Estuary and Watershed Science Volume 14 (Issue 2), Article 7. Viewed online at: Delta-Smelt. Accessed: July 1, 2020.

Neff JA. 1937. “Nesting Distribution of the Tri-colored Red-Wing.” The Condor Volume 39 (Issue 2): Pages 61 to 81.

Orians GH. 1961. The Ecology of Blackbird (Agelaius) Social Systems. Ecological Monographs Volume 31: Pages 285t o 312.

Pelton, E., S. McKnight, C. Fallon, A. Code, J. Hopwood, S. Hoyle, S. Jepsen, and S. H. Black. 2018. Managing for monarchs in the West: Best management practices for conserving the monarch butterfly and its habitat. The Xerces Society for Invertebrate Conservation. Portland, OR. Viewed online at: www.monarchbutterflies.com. Accessed August 16, 2022

Remsen JV Jr. 1978. *Bird Species of Special Concern in California: An Annotated List of Declining or Vulnerable Bird Species.* Nongame Wildlife Investigations, Wildlife Management Branch Administration, Report 78-1. Sacramento (CA): California Department of Fish and Game.

Robins, B. 2020. Rivers are for Monarchs: Healthy River Ecosystems are Essential to the Monarch's Survival. May 14. Viewed online at: www.riverpartners.org. Accessed September 27, 2021.

Rothrock, L. 2021. "Revitalizing Rivers for Monarchs." November 16. Viewed online at:. Accessed July 8, 2022.

Shuford WD, Gardali T, editors. 2008. California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Intermediate Conservation Concern in California. Studies of Western Birds No. 1. Camarillo and Sacramento (CA): Western Field Ornithologists and California Department of Fish and Game.

The Xerces Society for Invertebrate Conservation. 2019. A quick guide to monarch habitat on farms in California's Central Valley. Viewed online at: www.xerces.org. Accessed August 18, 2022.

The Xerces Society for Invertebrate Conservation. 2022. "Western monarchs rebound to final tally of nearly 250,000 butterflies." www.xerces.org. Accessed July 8, 2022.

Tricolored Blackbird Working Group. 2007. *Conservation Plan for the Tricolored Blackbird (Agelaius tricolor)*. Kester S, editor. San Francisco (CA): Sustainable Conservation.

U.S. Fish and Wildlife Service. 2020. Monarch *(Danaus plexippus)* species status assessment report, version 2.1. September. Viewed online at: www.fws.gov. Accessed August 18, 2022.

U.S. Fish and Wildlife Service. 2021. Western Monarch Butterfly Conservation Recommendations. August 31. Viewed online at: www.xerces.org. Accessed August 18, 2022.

U.S. Fish and Wildlife Service. 2017. Species Assessment and Listing Prioritization Assignment Form. Delta Smelt (*Hypomesus transpacificus*). October 13, 2017.

Waterbury, B., and A. Potter. 2018. Integrating strategic conservation approaches for the monarch butterfly in the State Wildlife Action Plans of Idaho and Washington. Final report. June. Prepared for the U.S. Fish and Wildlife Service.

Western Association of Fish and Wildlife Agencies. 2019. Western monarch conservation plan, 2019–2069. www.wafwa.org.

Attachment A.1
Reference Update for the 2016 Conservation Strategy's Target Species

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ATTACHMENT A.1

Reference Update for the 2016 Conservation Strategy's Target Species

Acronym	Definition
CCV	California Central Valley
Conservation Strategy (or Strategy)	Conservation Strategy (or Strategy)
Delta	Sacramento–San Joaquin Delta
DPS	Distinct Population Segment
ESU	Evolutionarily Significant Unit
Strategy (or Conservation Strategy)	2016 Central Valley Flood Protection Plan Conservation Strategy

Introduction

The development of the 2016 Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy or Strategy) entailed a comprehensive review and the synthesis of key reference materials used to inform its Appendix G, Identification of Target Species and Focused Conservation Plans, and Appendix L, Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities. This attachment summarizes the relevant reference materials that have become available for the target species listed in the 2016 Strategy since its publication (the updated reference materials).

This information can help determine whether the 2016 Conservation Strategy's measurable objectives need to be updated, and whether the existing measures for multi-benefit projects to restore or enhance habitat for target species should be modified. Appendix G of the 2016 Strategy lists potentially suitable species that were considered for inclusion in the Strategy, and describes the evaluation process and criteria for selecting target species. The 2016 Strategy includes provisions for amending the list of target species as part of the five-year update process, to reflect changing conservation needs and habitats. Therefore, this update to the reference material also considered the potentially suitable species that were not selected as target species in the 2016 Strategy (i.e., non-target species) but were considered for inclusion in the five-year update.

As part of the Conservation Strategy 2022 Update, four additional species are being added to the list of 17 target species:

- Delta smelt (*Hypomesus transpacificus*).
- Tricolored blackbird (*Agelaius tricolor*).
- Yellow-breasted chat (*Icteria virens*).
- Monarch butterfly (*Danaus plexippus*).

Reference materials are included for these species in addition to references cited in the individual conservation plans (Appendix B). This attachment also lists updated reference materials for selected non-target species associated with target habitats.

Target Species References

The updated reference materials for target species are summarized as follows and organized into four categories:

1. **Adopted Conservation Plans.** Conservation plans adopted by government agencies may focus on one or more of the following areas: recovering species, managing land, or supporting an incidental take authorization or permit. Plans adopted since 2016 have been grouped into three categories: recovery plans, habitat conservation plans and natural community conservation plans, and regional conservation investment strategies. Noother types of conservation plans applicable to the Conservation Strategy have been updated since 2016. Plans adopted since 2016 have been grouped into three categories: recovery plans, habitat conservation plans and natural community conservation plans, and regional conservation investment strategies.

2. **Status Reviews and Critical Habitat Designations.** Agency reviews of the status of listed species frequently update the recommended actions or other content of recovery plans, and critical habitat designations add to federal agencies' recovery planning efforts. These references are grouped by target species.

3. **Regional Conservation Planning References.** Publications regarding conservation of species groups in the Sacramento and San Joaquin valleys and the Sacramento–San Joaquin Delta (Delta) address multiple target species and recommend actions based on recent science.

4. **Other Target Species References.** These references consist of scientific literature relevant to the conservation of target species and not included in one of the preceding categories. These references are grouped by target species.

Adopted Conservation Plans

The following conservation plans have been developed for target species since the release of the 2016 Strategy.

Recovery Plans

National Marine Fisheries Service. 2018. *Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (Acipenser medirostris).* Sacramento (CA): National Oceanic and Atmospheric Administration. August 8, 2018.

- Lists criteria for demographic and threat-based recovery.
- Presents 20 recovery actions aiming to restore passage and habitat; reduce mortality from fisheries, entrainment, and poaching; and address threats resulting from contaminants, climate change, predation, sediment loading, and oil and chemical spills.
- Contains 17 priority recovery actions and three secondary priority actions.
- Identifies 16 research priorities.
- Proposes monitoring and education and outreach programs.

U.S. Fish and Wildlife Service. 2017. *Recovery Plan for the Giant Gartersnake (*Thamnophis gigas*).* Sacramento (CA). September 28, 2017.

- Focuses on identifying and protecting areas for habitat restoration, enhancement, or creation, including connectivity between populations.
- Defines nine recovery units corresponding with geographically and genetically distinct populations: the Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin, Delta Basin, Cosumnes-Mokelumne Basin, San Joaquin Basin, and Tulare Basin.
- Defines three objectives and criteria for achieving objectives:
  - Establish and protect self-sustaining populations.
  - Restore and conserve healthy Central Valley wetland ecosystems.
  - Ameliorate or eliminate current and future threats.
- Proposes 10 recovery actions.

U.S. Fish and Wildlife Service. 2019. *Revised Recovery Plan for Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus).* Sacramento (CA). October 4, 2019.

- Focuses on loss and degradation of habitat.
- Defines three management units: Sacramento River, San Joaquin River, and Putah Creek.
- Describes two recovery objectives: preserve resilient populations across the historical range by maintaining occupancy in at least 80 percent of major river system subbasins; and protect and manage a system of connected habitat patches along each river or major drainage within subbasins.
- Presents five recovery criteria.
- Identifies two priority recovery actions, one secondary priority recovery action, and two tertiary priority recovery actions.

Habitat Conservation Plans and Natural Community Conservation Plans

U.S. Fish and Wildlife Service. 2018. Biological and Conference Opinion, Issuance of a Section 10(a)(1)(B) Permit for the Yolo County Habitat Conservation Plan and Natural Community Conservation Plan. File Number 08ESMF00-2017-F-3219-1. Sacramento (CA). August 2, 2018.

ICF International. 2018. *Yolo Habitat Conservation Plan and Natural Community Conservation Plan*. Volume I and Volume II. Prepared for Yolo Habitat Conservancy. Sacramento (CA). April 2018.

- This document and the U.S. Fish and Wildlife Service (2018) document address six of the Conservation Strategy's target species: valley elderberry longhorn beetle, giant gartersnake, bank swallow (*Riparia riparia*), least Bell's vireo (*Vireo bellii pusillus*), Swainson's hawk (*Buteo swainsoni*), and western yellow-billed cuckoo (*Coccyzus americanus*).

County of Sacramento, City of Rancho Cordova, City of Galt, Sacramento County Water Agency, Sacramento Regional County Sanitation District, and the Southeast Connector Joint Powers Authority. 2018. *Final South Sacramento Habitat Conservation Plan.* Volumes I and II. Sacramento (CA). January 2018.

- This document addresses five of the Conservation Strategy's target species—giant gartersnake, Swainson's hawk, valley elderberry longhorn beetle, greater sandhill crane, and tricolored blackbird—and several potential suitable non-target species.

Status Reviews and Critical Habitat Designations

The following status review reports and critical habitat designations have been developed for target species since the release of the 2016 Strategy.

California Central Valley Steelhead–Distinct Population Segment

National Marine Fisheries Service. 2016. *5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment.* Sacramento (CA): National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

- Recommends that California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) remain listed as threatened.
- Gives an overview of listing history and determinations.
- Increases the recovery priority number from 7 to 5 because of an increase in recovery potential.
- Recommends adding the Mokelumne River Hatchery to the CCV steelhead DPS because of the near-identical genetic relationship with Feather River Hatchery fish, which are considered native and part of the DPS.
- Outlines the recovery plan, including success criteria, and discusses progress toward achievement.
- Summarizes relevant new information and presents new data on population trends and abundance.
- Reports an increase in hatchery returns from wild fish salvage; however, all concerns from the previous status review remain.
- Discusses genetic structure and population dynamics (including hatchery data), but with a caveat that there is a general lack of data on the status of wild populations.
- Conducts a five-factor analysis, including threats, conservation measures, and regulatory mechanisms. One major factor contributing to the species' threatened status remains a reduction in habitat quality or quantity caused by anthropogenic changes to the river systems.
- Describes restoration projects that have benefited and are expected to benefit habitat in the future.
- Discusses direct human impacts (e.g., commercial, recreational, scientific, or educational), disease and predation impacts, and the inadequacies of existing regulatory mechanisms.
- Details hatchery and harvest effects on the species' continued survival.
- Includes an extensive discussion of climate change, precipitation and drought, and oceanic conditions.

- Summarizes how each ESA listing factor has changed since the 2011 status review and lists eight recommendations for future actions.

Chinook Salmon–Central Valley Spring-run Evolutionarily Significant Unit

National Marine Fisheries Service. 2016. *5-Year Review: Summary and Evaluation of Central Valley Spring-run Chinook Salmon Evolutionarily Significant Unit.* April. Sacramento (CA): National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

- Recommends that Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*) Evolutionarily Significant Unit (ESU) remain listed as a threatened species; however, the review suggests that its status has improved as a result of extensive restoration projects.
- Explains that drought conditions raise the level of concern for the species.
- Gives an overview of listing history and determinations.
- Describes critical habitats for the species, and outlines the recovery plan and criteria.
- Summarizes relevant new information regarding the ESU delineation, and presents new data on population trends and abundance.
- Conducts a five-factor analysis including threats, conservation measures, and regulatory mechanisms. Examines the effects of traditional habitat loss and remaining habitat degradation, particularly associated with dams and water projects.
- Summarizes several restoration and monitoring projects and touches upon flood management and the effects of “self-mitigating” levee maintenance.
- Discusses direct human impacts (e.g., commercial, recreational, scientific, or educational).
- Includes an extensive discussion on climate change, precipitation and drought, and oceanic conditions.
- Summarizes changes to ESA listing factors since the last review.
- Presents four priority near-term drought actions.
- Presents 11 priority actions for the recovery of Central Valley spring-run Chinook salmon.

Chinook Salmon–Sacramento River Winter-run Evolutionarily Significant Unit

National Marine Fisheries Service. 2021. *Species in the Spotlight Priority Actions 2021–2025*. Sacramento River Winter-Run Chinook Salmon (*Oncorhyncus tshawytscha*). March 2021. www.noaa.gov

Identifies key actions needed from 2021 to 2025:

- Improve management of Shasta Reservoir cold water storage.
- Restore and reintroduce winter-run Chinook salmon into Battle Creek.
- Reintroduce winter-run into historical habitats above Shasta Dam.
- Improve Yolo Bypass fish habitat and passage.
- Manage winter and early-spring Delta conditions to improve juvenile survival.
- Establish collaborative science and fostering partnerships.

National Marine Fisheries Service. 2016. *5-Year Status Review: Summary and Evaluation of Sacramento River Winter-Run Chinook Salmon ESU.* Sacramento (CA): National Oceanic and Atmospheric Administration, U.S. Department of Commerce. December 2016.

- Recommends that Sacramento River winter-run Chinook salmon ESU remain listed as an endangered species.
- Gives an overview of listing history and determinations.
- Describes critical habitats for the species, and outlines the recovery plan and criteria.
- Summarizes relevant new information regarding the ESU delineation, and presents new data on population trends and abundance.
- Discusses current threats to habitat and range, including the effects of flood management, Central Valley restoration project efforts, and climate change.
- Discusses seven recommendations for future actions.

Green Sturgeon

National Marine Fisheries Service. 2021. *Southern Distinct Population Segment of North American Green Sturgeon (Acipenser medirostris) 5-Year Review: Summary and Evaluation.* Sacramento (CA): National Oceanic and Atmospheric Administration, U.S. Department of Commerce. November 2021.

- Gives an overview of listing, rulemaking, and review history.
- Summarizes new information for the species including confirmed spawning in the Feather and Yuba rivers, and confirmed detection in the Stanislaus River and San Joaquin River at the mouth of the Merced River.
- Lists recovery criteria and discusses how each have or have not been met.
- Describes species ecology and status including new information since 2015 review.
- Presents five-factor analysis of threats, conservation measures and regulatory mechanisms including a discussion of the effects of barriers and flow in the Sacramento River system, levee projects, diversions, and climate change.

- Recommends no change to species status and lays out five recommendations to assist in improving the status of and available information about the species.

U.S. Fish and Wildlife Service. 2020. "Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews for Eulachon, Yelloweye Rockfish, Bocaccio, and Green Sturgeon." Federal Register Volume 85: Page 12,905–12,906.

- Presents a notice of the initiation of reviews and a request for information.

Giant Gartersnake

U.S. Fish and Wildlife Service. 2020. *Giant Gartersnake (Thamnophis gigas) 5-Year Review: Summary and Evaluation*. Sacramento (CA). June 2020.

- Gives an overview of listing history and determinations, and recommends no change to the species' status.
- Describes spatial distribution and abundance, including information for each recovery unit. Includes the notable discovery of giant gartersnakes at Liberty Farms in the Yolo Basin, where the population was previously presumed extirpated.
- Identifies four ongoing giant gartersnake studies being conducted by the U.S. Geological Survey.
- Discusses threats and conservation efforts, including habitat conservation plans.
- Outlines progress toward recovery criteria identified in the species recovery plan.

Halstead, BJ, P Valcarcel, R Kim, AC Jordan, JA Rose, SM Skalos, GA Reyes, JSM Ersan, ML Casazza, AM Essert, and AM Fulton. 2021. "A Tale of Two Valleys: Endangered Species Policy and the Fate of the Giant Gartersnake." California Fish and Wildlife Special CESA Issue: Page 264–283.

- Provides an assessment of how effective listing and protection under CESA and FESA has been at achieving the goal of giant gartersnake recovery.
- Reviews the relevant aspects of giant gartersnake ecology and illustrates how the listing has benefited giant gartersnakes and what challenges have been faced related to slowing declines and recovering populations.
- Charts a course toward improved conservation, management, and recovery of this species.
- Concludes that although recovery has not yet been achieved, the increased knowledge gained and mechanisms for protecting giant gartersnake habitat on private and public lands developed over the past 50 years has improved conservation of this species.

Riparian Brush Rabbit

California Department of Fish and Wildlife. 2020. *5-Year Status Review of Riparian Brush Rabbit (Sylvilagus bachmani riparius).* Report submitted to the California Fish and Game Commission. Sacramento (CA). February 21, 2020.

- Recommends no change to the species' status.
- Describes the species' life history, trends in abundance, threats and survival factors, distribution (current and historical), and habitat.
- Examines the degree and immediacy of threats.
- Discusses flood control projects (e.g., Paradise Cut) and effects on riparian brush rabbit in Lathrop, California.
- Discusses the effects of flooding on population and includes maps.
- Contains a large section on management activities and species recovery that includes recommendations (e.g., establishment of additional flood-secure populations, and the filling of data gaps).

U.S Fish and Wildlife Service. 2020. *Final Species Status Assessment for the Riparian Brush Rabbit (*Sylvilagus bachmani riparius*), Version 4.* June 2020. Environmental Conservation Online System, U. S. Fish and Wildlife Service. Viewed online at: www.fws.gov. Accessed August 18, 2022.https://ecos.fws.gov/ServCat/DownloadFile/171805

- Summarizes the results of the Species Status Assessment for the riparian brush rabbit based on assessing the species' viability at an individual, population, and species level.
- In the first part of the report, focuses on this taxon's ecology.
- In the second part of the report, evaluates the current condition of the species, including the significant past, current, and future influences affecting riparian brush rabbit viability. The most important factors include habitat loss and degradation, flooding, drought, predation, and various conservation efforts.
- In the third part of the report, forecasts the changes in species viability under probable future scenarios.
- Based on the results of the Species Status Assessment, identifies that the levels of stressors and conservation efforts are important in determining the future viability of the riparian brush rabbit, for which the current viability is very low. However, with increased conservation efforts, the viability of this species has the potential to improve, even in the face of stressors that are intensifying in response to climate change.

Riparian Woodrat

U.S. Fish and Wildlife Service. 2020. *5-Year Review Riparian Woodrat (*Neotoma fuscipes riparia*).* Sacramento (CA). July 8, 2020.

- Retains the species' endangered status.
- Discusses the status, abundance, and taxonomy of two known populations of riparian woodrats.
- Presents current threats to the species.
- Describes current conservation efforts and mechanisms.

Valley Elderberry Longhorn Beetle

U.S. Fish and Wildlife Service. 2020. "Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 66 Species in California and Nevada." Federal Register Volume 85: Page 4,692–4,694.

- Presents a notice of the initiation of reviews and a request for information for 66 species, including valley elderberry longhorn beetle.

Western Yellow-billed Cuckoo

U.S. Fish and Wildlife Service. 2020. "Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Western Distinct Segment of the Yellow-Billed Cuckoo." *Federal Register* Volume 85: Page 11,458–11,594.

- Documents the current best assessment of the areas that meet the definition of critical habitat for western yellow-billed cuckoo.
- Presents a conservation strategy focused on breeding habitat including areas for nesting, foraging, and dispersal when breeding or food resources may not be optimal.
- Discusses how the determination was focused on areas known to have breeding or suspected breeding habitat.
- Describes the species' life history and habitat associations.
- Discusses climate change and hydrologic processes.
- Reduces the August 15, 2014, area of proposed critical habitat of 546,335 acres in 80 units to 493,665 acres in 72 units.
- Describes Unit 63, CA–1 Sacramento River: Colusa, Glenn, Butte, and Tehama counties.

U.S. Fish and Wildlife Service. 2021. "Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Segment of the Yellow-Billed Cuckoo." *Federal Register* Volume 85: Page 11,458–11,594. Final Rule published April 21 2001, effective May 21, 2001. Federal Register Volume 85: Page 20,798–21,005.

- Provides the final rule to designate critical habitat, which includes addressing and incorporating comments and materials USFWS received on the proposed revised proposal rule of February 27, 2020.
- Identifies that approximately 298,845 acres (120,939 hectares) are now being designated as critical habitat in Arizona, California, Colorado, Idaho, New Mexico, Texas, and Utah.
- Extends the federal Endangered Species Act's (ESA's) protections to critical habitat for this species.

Regional Conservation Planning References

The following conservation planning references for the Sacramento–San Joaquin Valley and Delta have been published since 2016.[1]

Dayer A, Meyers R. 2016. *Central Valley Joint Venture Human Dimensions Chapter Manuscript*. December 20, 2016.

- Assesses priority areas for the human dimensions inquiry for the Central Valley Joint Venture.
- Presents a literature review to identify and summarize the human dimensions research relevant to wildlife conservation, with an emphasis on the Central Valley.
- Provides recommendations to inform the revision of the Implementation Plan.
- Provides cross-over content related to flooding or flood control.

Dahm C, Kimmerer W, Korman J, Moyle PB, Ruggerone GT, Simenstad CA. 2019. *Developing Biological Goals for the Bay-Delta Plan: Concepts and Ideas from an Independent Scientific Advisory Panel.* A Final Report to the Delta Science Program. Prepared for Delta Stewardship Council, Delta Science Program. April 2019.

- Provides biological goals for:
  - Ecosystem structure and function.
  - Native fish species.

[1] Several sections of the Delta Stewardship Council's 2013 Delta Plan (https://deltacouncil.ca.gov/delta-plan/) have been updated since 2016; however, those sections are not relevant to the Conservation Strategy.

  - Salmonids.
- Uses a geographic scope that includes the following areas:
  - San Joaquin River and its major tributaries (including the Merced, Tuolumne, and Stanislaus rivers).
  - Sacramento River including Sacramento River tributaries and Delta eastside tributaries (Mokelumne, Cosumnes, and Calaveras rivers).
  - Delta and Suisun Marsh.

Dybala, KE, Clipperton N, Gardali T, Holet GG, Kelsey R, Lorenzato S, Melcer R Jr., Seavy NE, Silveira JG, Yarris GS. 2017. "Population and Habitat Objectives for Avian Conservation in California's Central Valley Riparian Ecosystems." San Francisco Estuary & Watershed Science Volume 15 (Issue 1): Article 5. Viewed online at: AvianConservation. Accessed: March 25, 2020.

- Defines the long-term conservation goal of establishing riparian ecosystems that provide sufficient habitat to support genetically robust, self-sustaining, and resilient bird populations.
- Selects 12 riparian landbird focal species as ecosystem indicators in four Central Valley Joint Venture planning regions.
  - Focal species include six Appendix G species (including three target species): western yellow-billed cuckoo, bank swallow, least Bell's vireo, yellow-breasted chat, yellow warbler (*Setophaga petechia*), and song sparrow (*Melospiza melodia*).
- Defines long-term (100-year) population objectives.
- Estimates long-term species density and riparian restoration objectives required to achieve long-term population objectives.
- Proposes short-term (10-year) objectives to track progress toward the long-term objectives.

National Marine Fisheries Service. 2019. *Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations, Sacramento River Bank Protection Project Post Authorization Change Report*. Action Agency, U.S. Army Corps of Engineers. National Marine Fisheries Service Environmental Consultation Organizer Number: WCRO-2019-01893. Sacramento (CA). August 30, 2019.

- Describes proposed levee protection measures and flood risk management improvements under the Sacramento River Bank Protection Project Post Authorization Change Report that encompass levees and weirs within the Sacramento River Flood Control Project.

- Covers 20,535 linear feet at 35 identified potential future erosion repair sites within Economically Justified Basins.

- Does not restrict the number of repair sites covered by the biological opinion, but limits linear footage to 30,000 linear feet.

- Identifies a framework for site selection and implementation.

- Describes five bank protection measures and designs:

  1. Setback levees.
  2. Bank fill stone protection with no on-site vegetation.
  3. Adjacent levee.
  4. Riparian benches with revegetation.
  5. Bank fill stone protection with on-site vegetation.

- Presents operations and maintenance measures, a compensation strategy, and conservation measures.

- Defines the biological opinion and incidental take assessment approach and rangewide status of the affected species and their designated critical habitat for:

  – Central Valley spring-run Chinook salmon ESU.
  – CCV steelhead DPS.
  – Southern DPS of North American green sturgeon.
  – Sacramento River winter-run Chinook salmon ESU.

- Establishes an environmental baseline including current land cover types, previous flood management actions, species and critical habitat status within the Action Area, and approved mitigation banks.

- Describes direct and indirect effects of the proposed action on the species and critical habitat, and discusses cumulative effects.

  – Cumulative effects include agricultural practices, aquaculture and fish hatcheries, increased urbanization, nonfederal and illegal rock revetment, and levee repair projects.

- Provides a synthesis of the effects, environmental baseline, cumulative effects, and status of the species and critical habitat.

- Indicates the proposed action is not likely to jeopardize the continued existence of the affected species or destroy or adversely modify its designated critical habitat.

- Provides 15 conservation recommendations.

- Recommends that U.S. Army Corps of Engineers complete a study of potential rock revetment removal sites on the Sacramento River where rock revetment does not serve a flood risk reduction purpose and can be removed to enhance green sturgeon and salmonid shoreline habitat.

National Marine Fisheries Service. 2021. *Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the American River Watershed Common Features General Reevaluation Report Reinitiation 2020*. Action Agency, U.S. Army Corps of Engineers. National Marine Fisheries Service Environmental Consultation Organizer Number: WCRO-2020-03082. Sacramento (CA). May 12, 2021.

- Analyzes the effects of the American River Watershed Common Features General Reevaluation Report based on the final biological assessment for the project and the best available science for:
  - Sacramento River winter-run Chinook salmon ESU.
  - Central Valley spring-run Chinook salmon ESU.
  - Southern DPS of North American green sturgeon.
  - CCV steelhead DPS.
  - The designated critical habitats of these species.
  - Essential fish habitat for Pacific Coast salmon.
- Summarizes the background and consultation history, and the proposed federal action to reduce flood risk caused by release of 160,000 cubic feet per second from Folsom Dam to the City of Sacramento, by adding support to the surrounding levees. Includes CVFPB and SAFCA as the project’s nonfederal sponsors.
- Discusses designs, processes, and construction methods for American River, Natomas East Main Drain Canal and Arden Creek, Sacramento River, and Sacramento Weir and Fish Passage Facility infrastructure improvements.
  - Includes design, construction methods, and conservation measures for the Arden Pond mitigation site, which is intended to provide compensatory mitigation for impacts to salmonid species resulting from the Proposed Action.
- Requires the development and implementation of the Green Sturgeon Habitat, Mitigation, and Monitoring Plan (HMMP) to minimize adverse effects to green sturgeon habitat.
  - Provides a purpose, framework, and goals by which the HMMP will be developed.
- Lists 30 general minimization measures to be applied to the entire project, specific species, and/or specific locations within the project area.

- Includes an estimated three- to five-year maintenance schedule for riparian habitat mitigation.
- Requires compensatory mitigation for construction effects on listed species and their critical habitat and discusses on- and off-site compensatory mitigation associated with the Proposed Action.
- Provides Section 7 Biological Opinion.
  - Describes the Section 7 approach.
  - Reviews and analyzes the current status of the listed species and critical habitat; environmental baseline within action area; effects of the Proposed Action; effects of other activities caused by the proposed action; and cumulative effects.
  - Concludes with the biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, DPS North American green sturgeon, and CCV steelhead or destroy or adversely modify their designated critical habitat.
- Provides Incidental Take Statement
  - Defines take, harm, and incidental take and how each will be determined within the Action Area and the thresholds for allowable take.
  - Includes five “Reasonable and prudent measures” that are nondiscretionary and necessary or appropriate to minimize the impact of the amount or extent of incidental take.
  - Recommends eight conservation measures.
- Describes the purpose of consultation under the Magnuson-Stevens Fishery Conservation and Management Act regarding conservation of Essential Fish Habitat.
- Defines Essential Fish Habitat affected by the Project and the aspects of the Proposed Action that are expected to have adverse effects within the Action Area.
- Recommends 13 conservation measures to avoid and minimize adverse effects.

Pandolfino ER, Handel CM. 2018. “Population Trends of Birds Wintering in the Central Valley of California.” In Shuford WD, Gill RE Jr., Handel CM (eds.), *Trends and Traditions: Avifaunal Change in Western North America*. Studies of Western Birds 3. Camarillo (CA): Western Field Ornithologists.

- Documents the population trends for Central Valley wintering birds through the analysis of Christmas bird counts.

Shuford WD, Dybala KE. 2017. “Conservation Objectives for Wintering and Breeding Waterbirds in California’s Central Valley.” San Francisco Estuary & Watershed Science Volume 15 (Issue 1): Article 4. Viewed online at: Breeding-Birds. Accessed: March 25, 2020.

- Builds on previous efforts in the Central Valley Joint Venture to establish specific, quantitative population and habitat objectives for Central Valley waterbirds.
- Estimates the current extent, temporal availability, and distribution of suitable waterbird habitat in the Central Valley; describes the selection of 10 focal species; and summarizes new estimates of current population sizes.
  - Focal species include two Appendix G target species: California black rail (*Laterallus jamaicensis coturniculus*) and greater sandhill crane (*Antigone canadensis*).
- Defines short-term (10-year) and long-term (100-year) population objectives for each species and the corresponding habitat objectives to meet overarching waterbird needs in the Central Valley over these time frames.
- Recognizes fine-scale habitat needs and limiting factors of each focal species.
- Makes specific conservation recommendations to benefit focal species and a wide range of other waterbirds that breed or winter in the Central Valley.

Shuford WD, Hertel M. 2017. “Bird Species at Risk in California’s Central Valley: A Framework for Setting Conservation Objectives.” San Francisco Estuary & Watershed Science Volume 15 (Issue 1): Article 7. Viewed online at: Article7. Accessed: March 25, 2020.

- Identifies 38 at-risk species, subspecies, or distinct populations of birds that warrant heightened conservation efforts in the Central Valley.
- Contains the following six Appendix G target species: bank swallow, California black rail, greater sandhill crane, least Bell’s vireo, Swainson’s hawk, and western yellow-billed cuckoo.
- Includes non-target species identified in Appendix G:
  - Tricolored blackbird and yellow-breasted chat (both now included as target species).
  - Burrowing owl, bald eagle (*Haliaeetus leucocephalus*).
  - Black tern (*Chlidonias niger*).
  - Grasshopper sparrow (*Ammodramus savannarum*).
  - Lesser sandhill crane (*Antigone canadensis canadensis*).
  - Redhead (*Aythya americana*).
  - Suisun song sparrow (*Melospiza melodia maxillaris*).
  - Mountain plover (*Charadrius montanus*).
  - Western snowy plover (*Charadrius alexandrinus*).

- Loggerhead shrike (*Lanius ludovicianus*).
- Short-eared owl (*Asio flammeus*).
- Yellow-headed blackbird (*Xanthocephalus xanthocephalus*).
- Northern harrier (*Circus cyaneus*).
- Purple martin (*Progne subis*).

- Evaluates subregional distribution, habitat, and threats in the Central Valley.
- Assesses the adequacy of approaches taken to establish conservation objectives.
- Discusses a conceptual framework for determining population or habitat objectives.

Bureau of Reclamation and U.S. Fish and Wildlife Service. 2020. *Near-term Restoration Strategy for the Central Valley Project Improvement Act Fish Resource Area FY2021–FY2025*. Prepared for Reclamation and U.S. Fish and Wildlife Service. Sacramento (CA).

- Develops priorities to form a strategy to double anadromous fish populations in the Central Valley through the prioritization of restoration, research, and monitoring efforts that will be implemented during the 2021–2025 fiscal year cycle.
- Outlines focused prioritizations for the investment of restoration funds.
- Intended to facilitate the planning, design, and implementation of large-scale restoration efforts and the documentation of population-level effects on multiple anadromous fish species.
- Describes current efforts and future efforts, including restoration projects, monitoring programs, and targeted research, and provides an organizational framework to record, analyze, and repeat beneficial efforts toward increasing anadromous fish populations in the Central Valley.

Bureau of Reclamation. 2020. *Record of Decision: Reinitiation of Consultation on the Coordinated Long-Term Modified Operations of the Central Valley Project and State Water Project*. February. Region 10 – California Great Basin, Sacramento (CA).

- Approves the Bureau of Reclamation’s preferred alternative, Alternative 1, to better integrate ESA compliance actions and water supply operations through an operational plan that improves its flexibility in managing the Central Valley Project, and best meets the authorized project purposes.
- Includes a significant commitment to improved coordinated operations with California Department of Water Resources to meet ESA requirements for Delta Smelt, North American green sturgeon, CCV steelhead, Central Valley spring-run Chinook salmon, and Sacramento winter-run Chinook salmon and their habitat.

- Describes the alternatives and the key considerations for the decision to approve Alternative 1, the preferred alternative.

Bureau of Reclamation. 2021. *Public Draft Workplan: Fiscal Year 2021 Obligation Plan for CVPIA Authorities, Central Valley Project, California*. February. Region 10 – California Great Basin, Sacramento (CA).

- Describes the Bureau of Reclamation's Fiscal Year 2021 planned obligations using the authorities provided by the Central Valley Improvement Act, the Central Valley Project Restoration Fund, and other Federal appropriations.

U.S. Fish and Wildlife Service. 2017. *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle*. Sacramento (CA).

Williams TH, Spence BC, Boughton DA, Johnson RC, Crozier LG, Mantua NJ, O'Farrell MR, Lindley ST. 2016. *Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Southwest*. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-564.

- Suggests the extinction risk for the CCV steelhead DPS has not changed since 2010, but the extinction risk has increased for Sacramento River winter-run Chinook salmon ESU and Central Valley spring-run Chinook salmon ESU.
- Provides an overview of new information for consideration of boundary delineations for listed California ESUs and DPSs of Chinook salmon, coho salmon (*Oncorhynchus kisutch*), and CCV steelhead DPS.
  - Climate and ocean conditions.
  - Central Valley recovery domain.
  - Sacramento River winter-run Chinook salmon ESU.
  - Central Valley spring-run Chinook salmon ESU.
  - CCV steelhead DPS.
- Provides the following information for each species subsection:
  - DPS and ESU boundary delineation.
  - Summary of previous assessments.
  - Brief review of technical recovery team documents and previous findings.
  - New data and updated analyses; harvest impacts; summary and conclusions.

DiGaudio RT, Dybala KE, Seavy NE, Gardali T. 2017. "Population and Habitat Objectives for Avian Conservation in California's Central Valley Grassland–Oak Savanna Ecosystems." San Francisco

Estuary & Watershed Science Volume 15 (Issue 1): Article 6. Viewed online at: Article6. Accessed: March 25, 2020.

- Lists 12 focal species that include four of the non-target species in Appendix G: western burrowing owl, grasshopper sparrow, loggerhead shrike, and northern harrier.

Regional Conservation Investment Strategies

ICF International Inc. 2020. *Yolo Regional Conservation Investment Strategy/Local Conservation Plan*. Final. (ICF 00723.16.) Sacramento, California. Prepared for Yolo Habitat Conservancy, Woodland (CA). October 2020.

- Provides mitigation and stewardship-driven conservation in Yolo County; describes the existing condition for the amount, location, and type of natural communities and focal species habitat in the document's strategy area.
- Recommends conservation actions to address land cover types, and focal species to direct project planning and conservation efforts.
- Includes 40 focal species and 97 conservation species. The focal species list includes 13 of the 2016 Strategy's target species, and the three new target species; multiple non-target species are identified as either focal or conservation species.

ICF International. 2020. Final Draft Mid-Sacramento Valley Regional Conservation Investment Strategy. (ICF 00428.17.) Sacramento (CA). Prepared for Reclamation District 108, Grimes, (CA). December 2020.

- Based primarily on the Mid- and Upper Sacramento Regional Flood Management Plan and the Feather River Regional Flood Management Plan, which provide regional frameworks for integrating conservation into the flood management system and operations.
- Identifies conservation and habitat enhancement actions that can be used to provide compensatory mitigation for flood management and other infrastructure projects in the regions.
- Identifies 12 focal species; of those, 10 overlap with the 2016 Strategy's target species, tricolored blackbird is a new target species, and western pond turtle (*Actinemys marmorata*) is a non-target species.

Other Reference Materials for Target Species

Updated reference materials are available for many of the target species, which are listed in this section.

Delta Button-celery

No updated reference materials have become available for Delta button-celery (*Eryngium racemosum)* since the release of the 2016 Strategy.

Slough Thistle

No updated reference materials have become available for slough thistle (*Cirsium crassicaule*) since the release of the 2016 Strategy.

Valley Elderberry Longhorn Beetle

Within this attachment, "Adopted Conservation Plans," and "Regional Conservation Planning References," provide more details.

Dobbins MT, Holyoak M. 2021. "Population Viability and Management of the Valley Elderberry Longhorn Beetle." Biodiversity and Conservation Volume 30: Pages 481–496. Viewed online at: Longhorn-Beetle. Accessed: October 2021.

- Investigates the valley elderberry longhorn beetle population's viability and sensitivity to environmental and anthropogenic stochasticity across five major Central Valley Rivers with known populations: American River, Cache Creek, Sacramento River, Cosumnes River, and Putah Creek.
- Assesses the effects of increased habitat loss, more frequent drought and wildfires, and increased juvenile mortality due to invasive predators.
- Finds that across all scenarios, the region-wide metapopulation was more robust to extinction than individual rivers, and that extinction probabilities were lower for larger rivers than smaller ones.
- Finds that modest increases in the annual probability of drought or wildfires and juvenile mortality greatly reduced population persistence at all spatial scales, often leading to rapid within-river extinctions, while increases in habitat loss had moderate impacts.
- Finds that increases in dispersal rates among rivers had negligible effects on improving population viability.
- Highlights the vulnerability of the species to further environmental and anthropogenic disturbance and emphasizes the importance of maintaining a healthy metapopulation structure with large tracts of suitable habitat for long-term valley elderberry longhorn beetle viability.

Rayburn AP, Rogner M, Frank P. 2018. "Abundance and Distribution of Blue Elderberry (*Sambucus nigra* ssp. *caerulea*) on Lower Cache Creek: Implications for Adaptive Floodplain Management." San Francisco Estuary & Watershed Science Volume 16 (Issue 3): Article 7. Davis (CA). Accessed: March 2020.Viewed online at: Blue-Elderberry. Accessed: March 2020.

- Describes a comprehensive field survey to map elderberry shrubs (the valley elderberry longhorn beetle's host plant) across the 904-hectare Cache Creek Resource Management Plan area, and to collect spatially explicit abundance and distribution data.
- Analyzes shrub distribution relative to floodplain inundation zones and associated vegetation, slope, and aspect.

California Central Valley Steelhead–Distinct Population Segment

Within this attachment, "Status Reviews and Critical Habitat Designations," and "Regional Conservation Planning References," provide more details.

Beakes M, Phillis C. 2021. "Monitoring Steelhead Populations in the San Joaquin Basin – Life-History Variation in *Oncorhynchus mykiss*." ResearchGate. Viewed online: Steelhead-Populations. Accessed: October 2021.

- Describes 14 alternative life-history pathways for Oncorhynchus mykiss and the complex interactions in the genetic makeup and internal conditions of individual fish.
- Discusses knowledge gaps in patterns and process related to Oncorhynchus mykiss life -history variations.
- Identifies the following knowledge gaps:
  - Importance of non-natal habitats in supporting divergent life-history types (e.g., intermittent streams and the Bay-Delta).
  - Genetics as a tool for management and predicting anadromy.
  - The effects of water management, salmon management, and climate change on the environmental and genetic controls of steelhead life-history diversity.

Buchanan RA, Buttermore E, Israel J. 2021. "Outmigration Survival of a Threatened Steelhead Population Through a Tidal Estuary." Canadian Journal of Fisheries and Aquatic Sciences (Author's Accepted Manuscript). Viewed online: Threatened-Steelhead. Accessed October 2021.

- Uses acoustic telemetry with multistate release-recapture models to investigate survival patterns during a key stage of the juvenile emigration of anadromous steelhead through the Delta over multiple years, including three drought years.
- Designed to address uncertainties in San Joaquin River steelhead survival through the Delta and its relationship with the seasonal water management strategies used by federal and state agencies in the Delta.

- Presents six year migration survival results, spatial patterns in survival estimates, survival patterns compared to water management and environmental conditions, and drought effects on survival modeling.
- Finds steelhead survival through the Delta varies considerably both between and within years.
- Suggests combination of habitat loss, reduced river flows, increased resource use, warming temperatures, and non-native aquatic community structure is intensified in the Delta because of its southern latitude in the steelhead range and because of human development of the region.
- Discusses in detail water management in the San Joaquin River and its tributaries as it enters the Delta, and the way it affects steelhead movement and survival.
- Suggests the results have implications for management designed to support emigrant survival in the Delta, including timing the reservoir releases from the multiple tributaries to coincide with the juvenile migration, manipulating flow regimens, and restoring Delta habitat.
- Identifies the following factors for future investigation:
  - Factors driving route selection at various junctions in the Delta.
  - Juvenile steelhead residence time and the propensity of Delta rearing.
  - Reach-specific flow-survival relationships.
  - Survival differences between hatchery and run-of-river steelhead and between steelhead and Chinook salmon.
  - The role of non-native predators and non-native vegetation on survival patterns in different regions of the Delta.
  - The sensitivity of adult returns to estuarine and early marine survival.
- Identifies the need to estimate steelhead survival further downstream through the bays.

Moniz PJ, Pasternack GB, Massa DA, Stearman LW, Bratovich PM. 2019. "Do Rearing Salmonids Predictably Occupy Physical Microhabitat?" Journal of Ecohydraulics Volume 5 (Issue 2): Page 132–150. Viewed online: Rearing-Salmonids. Accessed: April 2020.

- Further develops and applies a generalized bioverification framework to salmonid microhabitat suitability models.

- Develops water depth and velocity habitat suitability criteria functions for two size classes of rearing *Oncorhynchus tshawytscha* and *O. mykiss* using three years of snorkel survey data from the lower Yuba River.

- Accurately predicts both preferred and avoided habitat, using microhabitat suitability levels.

- Provides a generalized bioverification framework recommended for evaluating and comparing the accuracy and reliability of ecohydraulic models.

Chinook Salmon—Central Valley Fall and Late Fall-run Evolutionarily Significant Unit

Within this attachment, “Regional Conservation Planning References,” provides more details.

Iglesias SI, Henderson MJ, Michel CJ, Ammann AJ, Huff DD. 2017. *Chinook Salmon Smolt Mortality Zones and Influence of Environmental Factors on Out-Migration Success in the Sacramento River Basin*. Prepared for D. Meier, U.S. Fish and Wildlife Service Anadromous Fish Screen Program Agreement Number F15PG00146. Sacramento (CA). April 2017.

- Incorporates a breadth of individual fish attributes, environmental covariates, and reach--specific habitat types into mark-recapture survival models to determine which factors are most influential to outmigration success for hatchery-origin, late fall-run yearling smolts.

- Examines the relationship of smolt survival to environmental factors influenced by broad-scale, basin-wide-level dynamics, as well as smaller-scale, reach-specific habitat features.

- Finds that mortality during outmigration is spatially heterogeneous, with a general trend of increased survival through lower reaches.

- Among the factors evaluated, correlates diversion density (structures for refugia), off--channel habitat availability, and sinuosity with survival; however, increased flow, smolt condition, swim speed, and release strategy exhibited the strongest correlations with outmigration success.

- Discusses limitations to the model and acknowledges that other variables not included in the model, such as turbidity, predation, and availability of large wood debris, could have improved the model fit-to-survival data and better explain the biological mechanisms causing mortality during outmigration.

- Cautions that results should be viewed in the context of a highly altered river system with severe reductions in historical flows and the elimination of vast expanses of rearing habitat, and that the study used hatchery-origin Chinook salmon, which may differ from natural-origin smolts in their behavior and vulnerabilities.

Chinook Salmon—Central Valley Spring-run Evolutionarily Significant Unit

Within this attachment, "Status Reviews and Critical Habitat Designations," and "Regional Conservation Planning References," provide more details.

Notch JJ, McHuron AS, Michel CJ, Cordoleani F, Johnson M, Henderson MJ, Ammann AJ. 2020. "Outmigration Survival of Wild Chinook Salmon Smolts through the Sacramento River during Historic Drought and High Water Conditions." Environmental Biology of Fishes Volume 103: Page 561–576.

- Describes the decline of wild spring-run Chinook salmon in the Central Valley and risks to outmigrating smolts associated with current conditions.
- Measures the movement and survival rates of acoustic-tagged wild Chinook salmon smolts from Mill Creek at fine spatial scales throughout Mill Creek and the Sacramento River over five consecutive years (2013 to 2017).
- Includes a research period of three consecutive years of drought, followed by an extremely wet year.
- Finds that higher flows resulted in increased survival rates.
- Suggests that supplying enough water instream for smolts during the critical migration window can lead to higher outmigration survival and increased returns of spawning adults.
- Proposes that managers consider tradeoffs between streamflows for agriculture and fisheries needs, with an emphasis on maintaining adequate streamflows during critical stages of the salmon life cycle and synchronizing managed flow increases with natural flow events occurring in natal tributaries.

Chinook Salmon—Sacramento River Winter-run Evolutionarily Significant Unit

Within this attachment, "Status Reviews and Critical Habitat Designations," and "Regional Conservation Planning References," provide more details.

National Marine Fisheries Service. 2016. *Species in the Spotlight: Priority Actions 2016–2020, Sacramento River Winter-Run Chinook Salmon 5-Year Action Plan*. January 1, 2016. Chinook-Salmon. Accessed: January 2021.

- Summarizes status of Sacramento River winter-run Chinook salmon and key conservation efforts and challenges.
- Lays out five key actions needed for 2016 to 2020 and describes background, expected benefits, sources defining actions (e.g., recovery plans), and the current status of progress.
- Discusses improvements to Yolo Bypass fish habitat and passage.

- Provides options for the management of winter and early-spring Delta conditions to improve juvenile survival.

National Marine Fisheries Service. 2021. *Species in the Spotlight: Sacramento River Winter-run Chinook Salmon, Priority Actions 2021–2025.* Viewed online: [Chinook-Salmon](). Accessed: October 2021.

- Summarizes the progress made on five major actions identified in the 2016 to 2020 action plan.
- Lays out six key actions needed for 2021 to 2025 and describes background, expected benefits, sources defining actions (e.g., recovery plans), and the current status of progress.

Phillis CC, Sturrock AM, Johnson RC, Webber PK. 2018. "Endangered Winter-Run Chinook Salmon Rely on Diverse Rearing Habitats in a Highly Altered Landscape." Biological Conservation Volume 217: Page 358–362.

- Uses otolith strontium isotope ratios to reconstruct juvenile habitat use by winter-run Chinook that survived to adulthood.
- Finds that 44 to 65 percent of surviving adults reared in non-natal habitats, most of which are not designated as critical habitat.
- States that most non-natal habitats were not previously known to be demographically important.
- Suggests that non-natal habitats likely provide suitable growth and survival benefits and contribute to the adult population in demographically relevant numbers.
- Reports that all winter-run juveniles at the freshwater exit were comparable in size regardless of the type of rearing habitat.
- Concludes that diverse juvenile rearing habitats promote phenotypic diversity, but that the relative importance of non-natal rearing habitats to the population may fluctuate with California's hydraulic extremes.
- Proposes that protecting a diversity of habitat options can buffer against extinction risks and that failure to do so limits recovery opportunities and may increase extinction risk.

Chinook Salmon (General)

Dusek Jennings, E. and Hendrix, AN. 2020. "Spawn Timing of Winter-Run Chinook in the Upper Sacramento River." San Francisco Estuary and Watershed Science Volume 18 (Issue 2). www.chinook-salmon.com

Hellmair M, Peterson M, Mulvey B, Young K, Montgomery J, Fuller A. 2018. “Physical Characteristics Influencing Nearshore Habitat Use by Juvenile Chinook Salmon in the Sacramento River, California.” North American Journal of Fisheries Management Volume 38 (Issue 4): Page 959–970.

- Analyzes associations between environmental characteristics and habitat occupancy in the lower Sacramento River.
- Evaluates habitat use by emigrating juvenile Chinook salmon relative to three different shoreline types:
    1. Rock revetment, defined as armored with rock and lacking additional features to enhance habitat.
    2. Mitigated, characterized by contoured, gradually sloping banks with a substrate of soil or fine sediment, deliberately planted vegetation, and anchored or embedded large wood debris.
    3. Natural, defined as not engineered, devoid of revetment, and dominated by native, naturally established vegetation.
- Finds that habitat use was significantly higher at natural shorelines and at those with mitigation features than those consisting of rock revetment.
- Explains that inundated terrestrial vegetation was associated with substantial increases in the probability of occupancy, presumably by providing cover and foraging. Shallow seasonally inundated habitat is often associated with high-quality nursery habitat and increased juvenile abundance.
- Discloses that Chinook salmon occupancy was lower in areas with large, rocky substrate and increased depth, and higher for non-native predators.
- Notes that lateral bank slope was also an important predictor of juvenile Chinook salmon presence while steep banks are less likely to be occupied.
- States that although higher mean velocity was associated with a decrease in occupancy, an increasing velocity gradient also increased habitat use, suggesting juvenile Chinook salmon preferentially occupy habitat that provides refuge from fast current, but is in proximity, to enable more efficient feeding.
- Explains that although the habitat value of mitigated shoreline habitats may be lower than that of large, seasonally inundated floodplains, nearshore habitats in the main channel are available to emigrating Chinook salmon year-round, in all years. By contrast, floodplains are only accessible for rearing in some years for relatively short periods of time, and therefore, are accessible to a comparatively small fraction of the overall juvenile salmonid population.

Lehman B, Huff DD, Hayes SA, Lindley ST. 2017. “Relationships between Chinook Salmon Swimming Performance and Water Quality in the San Joaquin River, California.” Transactions of the American Fisheries Society Volume 146 (Issue 2): Page 349–358.

- Quantifies the swimming performance of juvenile hatchery-reared Chinook salmon in relation to water quality variables in controlled laboratory and field environments.
- Explains that trials were conducted during a six-week period that coincided with peak smolt outmigration. Water quality covariates included water temperature, turbidity, dissolved oxygen, and conductivity.
- Notes that the trials found negative relationships between maximum swim speeds and both temperature and turbidity.
- Acknowledges that other environmental factors likely influence the swimming performance of juvenile salmon in the San Joaquin River system that the researchers either did not measure or could not isolate.
- Recognizes that hatchery smolts were released in excellent health condition, but wild fish may travel longer distances with variable health conditions.
- Suggests that Delta water quality cannot be managed for salmon health solely by setting threshold temperatures, but freshwater turnover may be just as important for salmonid health.
- Proposes strategies to manage temperatures and concentrations of suspended sediment, such as coordinating dam and pump operations or restoring habitat structure, thereby improving water quality to optimize smolt swimming capacity.

Nobriga, ML, CJ Michel, RC Johnson, and JD Wikert. 2021. “Coldwater fish in a warm water world: Implications for predation of salmon smolts during estuary transit.” Ecology and Evolution Volume 11 (Issue 15). Page 10,381–10,395.

Sabal M, Hayes S, Merz J, Setka J. 2016. “Habitat Alterations and a Nonnative Predator, the Striped Bass, Increase Native Chinook Salmon Mortality in the Central Valley, California.” North American Journal of Fisheries Management Volume 36 (Issue 2): Page 309–320.

- Assesses how striped bass and habitat alterations interact to influence the mortality of native juvenile Chinook salmon during their emigration from the lower Mokelumne River.
- Assesses aggregative responses of striped bass by their relative abundance and diet surveys across natural and human-altered habitats.
- States that per capita consumption of juvenile salmon and behavioral aggregation were elevated at a small diversion dam (Woodbridge Irrigation District Dam).

- Uses experimental striped bass removal, diet energetic analysis, and a before and after impact assessment to estimate the consumption of emigrating juvenile salmon by striped bass.
- Results illustrate how the synergistic relationship between habitat modification and non-native predators can exacerbate juvenile salmon mortality during emigration.
- Highlights the importance of considering interactions among stressors when planning local management strategies and assessing population-level impacts on salmon.

Sturrock AM, Carlson SM, Wikert JD, Heyne T, Nusslé S, Merz J, Sturrock HJW, Johnson R. 2020. “Unnatural Selection of Salmon Life Histories in a Modified Riverscape.” Global Change Biology Volume 26: pages 1,235–1,247.

- Quantifies the expression and ultimate success of diverse salmon emigration behaviors in the Stanislaus River.
- Analyzes two decades of Chinook salmon monitoring data to explore the influence of regulated flows on juvenile emigration phenology, abundance, and recruitment.
- Follows seven cohorts into adulthood using otolith (ear stone) chemical archives to identify patterns in time- and size-selective mortality along the migratory corridor.
- Suggests management actions favoring any single phenotype could have negative evolutionary and demographic consequences, potentially reducing adaptability and population stability.
- Suggests that mimicking the natural hydrograph with flow variability should increase trait diversity and juvenile distribution, and that increased flow and habitat restoration should enhance productivity and phenological extremes among other benefits.

Green Sturgeon—Southern Distinct Population Segment

Within this attachment, “Adopted Conservation Plans,” and “Regional Conservation Planning References,” provide more details.

Anderson, J. T., G. Schumer, P. J. Anders, K. Horvath, and J. E. Merz. 2018. Confirmed Observation: A North American Green Sturgeon Acipenser Medirostris Recorded in the Stanislaus River, California. Journal of Fish and Wildlife Management Volume 9 (Issue 2): Page 624–630.

- Describes evidence of North American green sturgeon in the Stanislaus River based on visual and eDNA evidence.

Ulaski ME, Quist MC. 2021. “Filling Knowledge Gaps for a Threatened Species: Age and Growth of Green Sturgeon of the Southern Distinct Population Segment.” Journal of Fish and Wildlife Management Volume 12 (Issue 1): Page 234–240. Fish-Wildlife.

- Analyzes fin rays collected from the Sacramento–San Joaquin River basin, San Francisco Bay, and surrounding area, archived from 1984 to 2016, to explore age structure and growth; finds highly variable growth among individuals.
- Finds growth rates were similar to northern populations and detected age classes from 0 to 26 years.
- Compares age class structure with the Klamath and Oregon Coast River systems.
- Analysis reveals significant information gaps. Suggested research needs included estimating natural mortality, monitoring year-class strength and recruitment, and assessing trends in population abundance.
- Suggests that a lack of basic population information represents a barrier to effective management and recovery of the species.

Giant Gartersnake

Within this attachment, “Adopted Conservation Plans,” “Status Reviews and Critical Habitat Designations,” and “Regional Conservation Planning References,” provide more details.

Halstead BJ, Valcarcel P, Wylie GD, Coates PS, Casazza ML. 2016. “Active Season Microhabitat and Vegetation Selection by Giant Gartersnakes Associated with a Restored Marsh in California.” Journal of Fish and Wildlife Management Volume 7 (Issue 2): Page 391–407.

- Examines the selection of microhabitats and vegetation composition by adult female giant gartersnakes (19 radio-tracked females) in restored marshes and rice agriculture in and around Gilsizer Slough, Sutter County.
- Finds that litter, emergent vegetation, terrestrial vegetation, and submerged vegetation microhabitats were positively selected and rock and rice were avoided.
- Finds that aquatic vegetation types were selected more strongly than terrestrial vegetation types. Tules, duckweed, water primrose, forbs, and grasses were positively selected and rice was avoided. Discusses various habitat and vegetation types and their relationships to selection by giant gartersnake and rice cultivation and its relationship to giant gartersnake.
- Lays out five aspects of the relationship between rice cultivation and giant gartersnake in need of future study.

- Suggests that maintaining a mosaic of cover and water is likely beneficial to giant gartersnakes during the active season including:
  - Promoting clumps of and maintaining emergent vegetation along canal and wetland margins; managing for tules; and managing primrose and cattails as habitat but preventing the formation of monocultures.

Halstead JB, Rose JP, Reyes GA, Wylie GD, Casazza ML. 2019. “Conservation Reliance of a Threatened Snake on Rice Agriculture.” Global Ecology and Conservation Volume 19: e00681.

- Examines the extent to which giant gartersnakes use rice fields and whether the survival of adult giant gartersnakes was influenced by the amount of rice grown near their home ranges and daily movements.
- Suggests that understanding how surface water distribution in the Sacramento Valley, driven largely by changes in rice agricultural practices, will affect giant gartersnakes is the most pressing concern for the conservation of the species.
- Explains how radio telemetry was used to track 58 snakes at 11 locations on private rice farms in the Colusa, Butte, and Sutter basins.
- Discusses the benefits and detriments of rice cultivation and the rice agroecosystem on giant gartersnakes.
- Discusses the complex nature of rice as a commodity crop and fluctuating water supplies in California and the challenges this presents related to giant gartersnake conservation.
- Suggests that although giant gartersnakes are reliant on the rice agroecosystem, rice agriculture is likely suboptimal habitat for giant gartersnakes. However, the reduction of rice would likely be detrimental to giant gartersnake populations.
- Suggests there may be scenarios that benefit giant gartersnakes and rice farmers.

Halstead BJ, Valcarcel P, Kim R, Jordan AC, Rose JP, Skalos SM, Reyes GA, Ersan JSM, Casazza ML, Essert AM, Fulton AM. 2021 “A Tale of TWO Valleys: Endangered Species Policy and the Fate of the Giant Gartersnake.” California Fish and Wildlife Special CESA Issue: Page 264–to 283.

- Reviews giant gartersnake population, ecology, past and present habitat and conservation status.
- Discusses the influence of listing on giant gartersnake conservation.
- Lays out remaining challenges for protection and recovery.
- Compares and contrasts the Sacramento and San Joaquin Valleys.

- Describes a path forward for giant gartersnake conservation and recovery.

Hansen EC, Schere RD, Fleishman E, Dickson BG, Krolick D. 2017. "Relations between Environmental Attributes and Contemporary Occupancy of Threatened Giant Gartersnakes (*Thamnophis gigas*)." Journal of Herpetology Volume 51 (Issue 2): Page 274–283.

- Explains that the study's objective was to evaluate hypothesized associations between the probability that a waterbody is occupied by giant gartersnake and the attributes of the waterbody and adjacent lands.
- States that the study sampled 159 sites in the American, Yolo, and southern Sutter basins with live traps and characterized the land cover, land use, and soil type at each site.
- Evaluates whether distance to historic tule marsh was associated with occupancy and assesses the strength of support for other hypotheses about components of habitat quality and selection for giant gartersnake.
- Uses statistics to predict the occupancy of giant gartersnake across a large portion of the northern Central Valley at a spatial extent consistent with regional management of the species and agricultural and urban expansion and operations.
- Contains color-coded maps for predicted occupancy and presence of giant gartersnake in the northern Central Valley.
- States that occupancy of giant gartersnake was strongly and negatively associated with elevation and strongly and positively associated with canal density and the proportion of rice and perennial wetland.
- Finds a strong and previously undescribed association between occupancy and soil order.
- Analysis results do not support the hypothesis that the estimated extent of historic tule marsh was the variable most strongly associated with giant gartersnake occupancy. At a finer scale, canal density, the proportion of adjacent rice agriculture and wetlands, and underlying soils appeared to be stronger drivers of occupancy.
- Suggests that the predictions made by the analysis be evaluated with additional data because of some inconsistencies and data gaps.
- Suggests that future work emphasize identification of soil-chemistry metrics, which could facilitate rapid assessment in the field to predict occupancy.

Reyes GA, Halstead BJ, Rose JP, Ersan JSM, Jordan AC, Essert AM, Fouts KJ, Fulton M, Gustafson KB, Wack RF, Wylie GD, Casazza ML. 2017. "Behavioral Response of Giant Gartersnakes (Thamnophis gigas) to the Relative Availability of Aquatic Habitat on the Landscape."

U.S. Geological Survey Open-File Report 2017-1141. Viewed online at: Giant-Gartersnake. Accessed: December 30, 2020.

- Examines the relationship between rice fallowing, water availability, and the ecology of giant gartersnakes.
- States that the study aimed to determine how the extent of rice agriculture in the Central Valley landscape affects the spatial ecology (home range area, movement frequency, and movement rate) of radio-tagged giant gartersnakes, their selection of habitat components, health, and survival.
- Goes into great detail in its analysis of methods, statistics, and results.
- Indicates that giant gartersnakes make little use of rice fields themselves and avoid cultivated rice relative to its availability on the landscape, but suggests that rice is a crucial component of the modern landscape for giant gartersnakes.
- Finds that giant gartersnakes are strongly associated with the canals that supply water to and drain water from rice fields—providing a more stable habitat than rice fields because water is maintained longer and they support marsh-like conditions during most of the active giant gartersnake season.
- Suggests that maintaining canals without neighboring rice would be detrimental to giant gartersnake.
- States that rice may provide increased productivity of prey populations, dispersion of potential predators, and more secure water supply.
- Indicates that identifying how rice benefits giant gartersnakes in canals and the extent to which the rice agro-ecosystem could provide these benefits when rice is fallowed would inform the use of water for other purposes without harm to giant gartersnakes.
- Suggests that without this understanding, maintaining rice and associated canals is critical for sustainability of giant gartersnake populations in the Sacramento Valley.

Rose JP, Halstead BJ, Wylie GD, Casazza ML. 2018. “Spatial and Temporal Variability in Growth of Giant Gartersnakes: Plasticity, Precipitation, and Prey.” Journal of Herpetology Volume 52 (Issue 1): Page 40–49.

- Analyzes a long-term dataset on the growth of giant gartersnakes to characterize spatial and temporal variability and evaluate potential environmental predictors of growth.
- States that data were collected on snout-vent length over 22 years from eight sites throughout the Sacramento Valley.
- Finds that growth was positively related to the amount of precipitation that fell during the prior water year and the abundance of anurans at a site.

- Finds that fish and frog abundance interacted to affect snake growth.
- Results highlight the plasticity of growth in giant gartersnake, point to potential environmental drivers of growth, and provide valuable data for demographic modeling.

Rose JP, Ersan JSM, Reyes GA, Gustafson KB, Fulton AM, Fouts KJ, Wack RF, Wylie GD, Casazza ML, Halstead BJ. 2018. “Findings from a Preliminary Investigation of the Effects of Aquatic Habitat (Water) Availability on Giant Gartersnake (Thamnophis gigas) Demography in the Sacramento Valley, California, 2014–17.” U.S. Geological Survey Open-File Report 2018-1114. Viewed online at: Giant-Gartersnake. Accessed: December 30, 2020.

- Summarizes the methods and findings of a study conducted by the U.S. Geological Survey, in cooperation with the California Department of Water Resources, to investigate the effect of the availability of aquatic habitat on the demography of giant gartersnakes inhabiting rice growing areas in the Sacramento Valley, California.
- Presents estimates of the abundance, somatic growth, fecundity, and survival of giant gartersnakes from eight sites in the Sacramento Valley studied in 2014 to 2017.
- Presents data on the area of rice growing at each of the eight sites in 2014 to 2017.

Rose, JP, Ersan JSM, Wylie GD, Casazza ML, Halstead BJ. 2018. “Construction and Analysis of a Giant Gartersnake (Thamnophis gigas) Population Projection Model.” U.S. Geological Survey Open-File Report 2017-1164. Viewed online at: Gartersnake-Population. Accessed: December 30, 2020.

- Summarizes the methods and findings of a study conducted by the U.S. Geological Survey, in cooperation with the California Department of Water Resources, to investigate the demography of giant gartersnakes in the Sacramento Valley from 1995 to 2016. The report presents vital rate models of growth, fecundity, and survival of giant gartersnakes, as well as an Integral Projection Model that integrates these component models into a demographic population model.

Schumer G., Hansen EC, Anders PJ Blankenship SM. 2019. “Development of a quantitative polymerase chain reaction assay and environmental DNA sampling methods for Giant Gartersnake (*Thamnophis gigas*).” PLOS ONE. Viewed online at: journals.plos.org/plosone/article?id=10.137/journal.pone.0222493.

- Identifies that the giant gartersnake is a low-density, visually evasive species with a low detection probability, based on standard field survey methods (e.g., traps, visual census).
- Discusses that uncertainty regarding its current distribution and occupancy presents management challenges for the species.

- Discusses enhancing survey sensitivity through development of eDNA methods would improve compliance monitoring under the ESA, recovery planning for giant gartersnake, and evaluation of California's Central Valley tule marsh habitat on which this species depends.
- Describes that to address these needs, the authors designed and validated diagnostic quantitative Polymerase Chain Reaction assays for identifying portions of the Cytochrome B and the Nicotinamide adenine dinucleotide dehydrogenase subunit 4 genes of the giant gartersnake mitochondrial genome.
- Establishes that the technique confirmed giant gartersnakes were still present at some sites where physical trapping failed to identify presence.
- Confirms that eDNA sampling methods provides an effective means to obtain critical population metrics from this otherwise cryptic, federally protected, and hard to study organism, offering great promise for elucidating patterns of occupancy with greater efficiency and at far less cost than trapping methods, particularly where detection probabilities are low.

Scherer RD, Hasen EC, Joseph M, Wack RF. 2019. "Estimating Relationships Between Size and Fecundity in the Threatened Giant Garter Snake in Seminatural and Agricultural Wetlands." Population Ecology Volume 61: Page 141–149.

- Estimates the probability of being pregnant for female giant gartersnakes and tests for differences in these demographic parameters between populations in seminatural wetlands and wetlands in areas dominated by rice agriculture.
- Analyzes data on the giant gartersnake fecundity from 9 years using a Bayesian hurdle model and finds no evidence of variation in the probability of being pregnant or in the number of fetuses given pregnancy in the two environments.
- Establishes need for inferences from their analyses for subsequent population modeling, which will guide planning and decision-making for giant gartersnakes.

Ersan JSM, Halstead BJ, Wildy EL, Casazza ML, Wylie GD. 2020. "Intrinsic Prey Preference and Selection of the Giant Gartersnake: A Threatened Predator in a Nonnative Prey-Dominated Community." Journal of Fish and Wildlife Management Volume 11 Number 1: Page 164–173.

- Identifies that in addition to the conversion of wetland habitats to agriculture, another anthropogenic factor contributing to the snake's changing ecology is the introduction of non-native prey into the species' habitats.
- Discusses that these introduced species have resulted in a prey community that is almost completely composed of exotic species and have the potential for considerable effects.
- To assess prey preference and selection, performed three sets of behavioral trials on neonates by examining neonate prey preference in response to olfactory cues of prepared

prey extracts, neonate consumption of different live prey items presented simultaneously; and terrestrial feeding behavior or latency to successful attack (or both).

- States the results from the olfactory study suggest that native Sierran treefrogs, *Pseudacris sierra*, are preferred by neonates. Results from consumption trials suggest that neonates are more likely to select frog species than fish species.
- Serves as the first study that examines prey selection of this threatened species and serves to inform its conservation and management.

Within this attachment, “Adopted Conservation Plans,” and “Regional Conservation Planning References,” provide more details.

California Black Rail

Within this attachment, “Regional Conservation Planning References,” provides more details.

Evens J. 2020. “Temporal Response of California Black Rails to Tidal Wetland Restoration.” Western Birds Volume 51: Page 111–121.

- Reports that the study monitored three sites that were formerly isolated from tidal influence and converted to farmland that were restored to tidal wetlands.
- Finds that black rails colonized all three sites within 3 to 10 years.
- Finds that all three sites had sources of prospective colonists adjacent to the restored sites.

Tsao DC, Melcer RE Jr., Bradbury M. 2015. “Distribution and Habitat Associations of California Black Rail (*Laterallus jamaicensis cortuniculus*) in the Sacramento–San Joaquin Delta.” San Francisco Estuary and Watershed Science Volume 13 (Issue 4).

- Recognizes the lack of California black rail surveys in the Delta.
- States that call–playback surveys were conducted to assess the status of the taxon within a wide range of wetland habitats of the central Delta region.
- Explains that black rails were detected at 21 of 107 discrete wetland habitats in the Delta.
- States that the study developed a model of habitat suitability and a fine-scale vegetation and land use dataset.
- Finds that black rail presence differed from other regions in California, in that it was positively associated with tall (1- to 5-meter) emergent vegetation interspersed with riparian shrubs.

Haverland AA, Green MC, Weckerly, F, Wilson, JK. 2021. “Eastern Black Rail (*Laterallus jamaicensis jamaicensis*) Home Range and Habitat Use in Late Winter and Early Breeding Season in Coastal Texas, USA.” Waterbirds Volume 44: Page 222–233.

- Discusses that although this subspecies of black rail is outside the range of the California black rail, the ecological requirements of these birds in coastal Texas is similar to those in the Delta in that they use brackish high tidal marsh; thus, this study has potential relevance to habitat preservation and management of California black rail in the Delta.
- Presents a mean home range size of 0.98 hectare with a mean core area of 0.12 hectare.
- Specifies that home ranges contained a gently sloping elevation gradient, suggesting the importance of on-foot access to higher ground.

Hand, EC, Gabel W, Dipetto, GR, Bonafilia, RE, Thibault, JM, Znidersic, E. 2021.“A Window into the Breeding Ecology and Molt of the Eastern Black Rail (*Laterallus jamaicensis jamaicensis*).” Waterbirds Volume 44: Page 207–221.

- Although this study also involves eastern birds, serves as a useful reference for California black rails given the similarities in ecology and behavior. It also provides methodologies for similar studies on California black rails in the Delta.
- Discusses that camera trapping methods facilitated the first study of black rail breeding phenology and chick development, courtship and brood rearing behaviors, and flightless molt phenology and duration.
- Identifies behavioral observations combined with phenology data provided evidence of pairs raising two or more broods during a breeding season.
- States that flightless molt was initiated as early as August 15, and completed as late as October 11 (n=10 adults).
- Suggests conservation and management strategies should consider periods of vulnerability, which coincide with increasingly severe flooding events.
- Specifies the need to understand factors key to fecundity and survival, to effectively develop conservation strategies for this species.

Greater Sandhill Crane

Within this attachment, “Regional Conservation Planning References,” provides more details.

Donnelly JP, King SL, Knetter J, Gammonley JH, Dreitz VJ, Grisham BA, Nowak MC, Collins DP. 2021. “Migration Efficiency Sustains Connectivity Across Agroecological Networks Supporting Sandhill Crane Migration.” Ecosphere Volume 12 (Issue 6): e03543. 10.1002/ecs2.3543.

- Examines flyway connectivity and monitors long-term trends in agricultural resources and wetland stopover networks with remote sensing, to identify important ownership and landscape factors structuring bird distributions.

Ivey GL, Herziger CP, Hardt DA, Golet GH. 2016. “Historic and Recent Winter Sandhill Crane Distribution in California.” Proceedings of the North American Crane Workshop Volume 13: Page 54–66. Accessed: March 2020.Viewed online at: Sandhill-Crane. Accessed: March 2020.

- Maps the observed flock and night roost locations and reviews records of historical occurrences of cranes in California.
- Discusses the expansion and contraction of the crane’s range and the contributing factors.
- Suggests that the primary cause of site abandonment is loss of suitable foraging habitat (small grain crops) and that range expansion is principally attributable to expansion of public wildlife refuges, private sanctuaries, and improvement of management.
- Recommends management actions to improve habitat conditions for cranes across the Central Valley wintering range and lists four priority conservation strategies.

Least Bell’s Vireo

Within this attachment, “Adopted Conservation Plans,” and “Regional Conservation Planning References,” provide more details.

Dybala KE, Walsh RG, Seavy NE. 2016. “Monitoring Least Bell’s Vireo and Comparing Breeding Landbird Populations at the Dos Rios Ranch Restoration Site and San Joaquin River National Wildlife Refuge 2015–2016.” Point Blue Contribution No. 2101. Petaluma (CA): Point Blue Conservation Science.

- Describes monitoring objectives, methods, and results for bird surveys and vegetation monitoring at point count stations; riparian landbird response to restoration; and least Bell’s vireo monitoring.
- Offers seven recommendations for riparian restoration and evaluation and the management and monitoring of least Bell’s vireo and other species at Dos Rios Ranch.

Preston KL, Kus BE, Perkins E. 2021. *Modeling Least Bell's Vireo Habitat Suitability in Current and Historical Ranges in California.* U.S. Geological Survey Open-File Report 2020-1151. [Least-Bell-Vireo].

- Develops habitat suitability model for least Bell's vireo across its current and historical range in California.
- Constructs models based on the current range to predict suitable habitat in historical range; constructs alternative models with different combinations of important environmental variables; and selects best-performing models to predict suitable riparian habitat.

Jung, JF, Hertz S, Fischer RA. 2021. "Summary of Collaborative Wildlife Protection and Recovery Initiative (CWPRI) Conservation Workshop: Least Bell's Vireo." U. S. Army Corps of Engineers Environmental Laboratory, U.S. Army Engineer Research and Development Center. Accessed online at: www.erdc-library.erdc.dren.milhttps://erdc-library.erdc.dren.mil/jspui/bitstream/11681/42102/1/ERDC-EL SR-21-4.pdf.

- Summarizes the regional workshop held April 24 to 26, 2018, at the USFWS Ecological Services Office in Carlsbad, California, about the importance of collaboration among federal, state, and nongovernmental agencies to facilitate the recovery of the least Bell's vireo.
- Identifies that the main objective of the workshop was to assemble an interagency and interdisciplinary group of wildlife biologists and managers to detail how the Section 7(a)(1) conservation planning approach can assist in the recovery of the least Bell's vireo on federal, state, and private lands.
- States that the goals of the workshop were to: review Section 7(a)(1); outline least Bell's vireo ecosystem processes, life history, threats, and conservation solutions; and develop and organize agency commitments to collaborative conservation practices.

Griffith, JT, Griffith, JC. 2021. "Cowbird Control and the Endangered Least Bell's Vireo: A Management Success Story." In *Ecology and Management of Cowbirds and Their Hosts: Studies in the Conservation of North American Passerine Birds.* Smith James NM, Cook Terry L, Rothstein Stephen I, Robinson Scott K, and Sealy, Spencer G. New York, USA: University of Texas Press, 2021. Page 342–356. https://doi.org/10.7560/777385.

- Identifies that cowbird control has been a very important management tool in the ongoing recovery of this subspecies and will likely continue to be in the SPA if the species is to recover there.
- States that cowbirds colonized California about 1890 and soon became abundant. In the early 1980s, between 47 percent and 100 percent of all vireo nests contained cowbird eggs.
- Maintains that persistent parasitism has caused the extirpation of vireos from thousands of acres of apparently suitable habitat throughout their historical and current ranges.

- States that cowbird trapping began at Camp Pendleton in 1983 and was extended throughout the current range of the vireo in 1986 through 1992.
- Discusses that in trapped areas, cowbird parasitism of the vireo and other host species was significantly reduced or eliminated. Vireo reproductive success at Camp Pendleton increased by 129 percent from 1982 to between 1988 and 1991, and populations first stabilized and then grew, expanding into existing habitat.
- Identifies that since cowbird control began, the numbers of singing male least Bell's vireos have increased from 60 to 902 at Camp Pendleton, from 19 to 249 at the Santa Ana River, from 9 to 50 at the San Luis Rey River West, and from 13 to 142 at the Tijuana River. No factor other than cowbird control changed significantly during the same period.

Swainson's Hawk

Within this attachment, "Adopted Conservation Plans," and "Regional Conservation Planning References," provide more details.

Fleishman E, Anderson J, Dickson BG, Krolick D, Estep JA, Anderson RL, Elphick CS, Dobkin DS, Bell DA. 2016. "Space Use by Swainson's hawk (*Buteo swainsoni*) in the Natomas Basin, California." Collabra Volume 2 (Issue 1): Page 1–12.

- Describes how satellite-based remote sensing was used to estimate the home ranges of 23 Swainson's hawks on Natomas Basin breeding grounds.
- Evaluates whether the species' space use intensity was associated with land cover, sex, reproductive success, or life stage of offspring.

Airola DA, Estep JA, Krolick DE, Anderson RL, Peters JR. 2019. "Wintering Areas and Migration Characteristics of Swainson's Hawks in the Central Valley of California." Journal of Raptor Research Volume 53 (Issue 3): Page 237–252.

- Uses satellite telemetry during 2011 through 2015 to identify and characterize winter areas and migration patterns of Swainson's hawks that breed in the Central Valley of California.
- States twenty tracked hawks wintered across 7,500 km from western Mexico to central South America.
- Identifies that all the birds followed similar migration routes through the interior of California, Sonoran Desert, and western Mexico, with some continuing through Central America to South America.
- States that most migratory stopover areas were dominated by agriculture and shrub-scrub.
- Discusses that the uses of varied wintering areas that have been altered from native habitat may indicate that migratory and wintering patterns have changed for this population.

- States the diversity of wintering areas may provide resilience from anthropogenic effects compared to collectively wintering in a single area.

- States Central Valley Swainson's hawks migration routes and wintering areas differ markedly from those of the rest of the North American population.

Battistone CL, Furnas BJ, Anderson RL, Dinsdale JL, Cripe KM, Estep JA, Chun CSY, Torres SG. 2019. "Population and Distribution of Swainson's Hawks (*Buteo swainsoni*) in California's Great Valley: A Framework for Long-Term Monitoring." The Journal of Raptor Research Volume 53, Issue 3: Page 253–265.

- Summarizes that in 2005 and 2006, the authors conducted surveys to estimate the abundance and density of Swainson's hawk breeding pairs in California's Great (Central) Valley, using a random sampling design stratified across dense, medium, and sparse nesting density strata. The sampling units comprised 2.59-km^2 (1-mile^2) U.S. Public Land Survey System Sections, and the 2-year survey covered an aggregate total of 682 sampling units (268 in 2005, and 414 in 2006).

- Discusses that after applying a detection probability correction and using generalized linear modeling of habitat associations to extrapolate density estimates throughout the study area, the authors estimated that the Great Valley supported 3218 (95 percent confidence interval: 2271 to 4165) breeding pairs of Swainson's hawks in 2005 and 2006.

- Uses modeling of habitat associations to show crop diversity, alfalfa, and native vegetation as positively associated with the density of Swainson's hawk breeding pairs, and orchards/vineyards negatively associated with the breeding pairs. Counts of breeding pairs were also highest in the middle latitudes of the Great Valley, which spans approximately 660 km from north to south.

- To monitor the population status of this species throughout California, recommends this 2-year sampling approach be expanded throughout the state and repeated every 5 to 10 years.

Furnas BJ, Wright DH, Tennant EN, O'Leary RM, Kuehn MJ, Bloom PH, Battistone CL. 2022. "Rapid growth of the Swainson's Hawk Population in California 2005." Ornithological Applications Volume 124: Page 1–12.

- Identifies that by 1979, Swainson's hawks had declined to as low as 375 breeding pairs in California.

- To evaluate the population trend since 1979, analyzes data from 1,038 locations surveyed throughout California from 2005 through 2018.

- Estimates a total of 18,810 pairs statewide.

- Finds that alfalfa cultivation, agricultural crop diversity, and the occurrence of non-agricultural trees for nesting were positively associated with hawk density.

- Estimates that the California population of Swainson's hawks increased rapidly between 2005 and 2008 at a rate of 13.9% per year.

- Recommends more frequent surveys to monitor the stability of the species' potential recovery to better understand the factors involved in the recovery.

Western Yellow-billed Cuckoo

Within this attachment, "Adopted Conservation Plans"; "Status Reviews and Critical Habitat Designations"; and "Regional Conservation Planning References," provide more details.

Johnson JJ, Hatten JR, Holmes JA, Shafroth PB. 2017. "Identifying Western Yellow-billed Cuckoo Breeding Habitat with a Dual Modelling Approach." Ecological Modelling Volume 347: Page 50–62. Viewed online at: yellow-billed cuckoo. Accessed: March 27, 2020.

- Investigates yellow-billed cuckoo habitat on the Lower Colorado River with aerial- and satellite-based models.

- Uses a dual modeling approach to provide a more complete picture of habitat requirements.

- Discusses the benefits and shortcomings of a satellite-based approach.

Wohner PJ, Laymon SA, Stanek JE, King SL, Cooper RJ. 2020. "Challenging our understanding of western Yellow-billed Cuckoo Habitat Needs and Accepted Management Practices." Restoration Ecology Volume 28 (Issue 3): Page 1–12.

- Notes that territory densities of yellow-billed cuckoo and other California species of greatest conservation need are associated with vertical vegetation structure in the low and mid-canopy and have a height threshold characteristic of early successional stage forest.

- Identifies that in the absence of flooding and gap-forming disturbance, planted forests often senesce without further young tree recruitment. This has largely been the case in California riparian systems that historically supported state-endangered western yellow-billed cuckoo.

- Notes that a decline in cuckoo population numbers in the past 30 years has been associated with forest maturation.

- Positively associates cuckoo densities with increased vertical vegetative structure 1 to 5 m above ground.

- Notes that manipulations of canopy and naturalization of the hydrograph would likely create the conditions necessary to encourage the natural regeneration of cottonwood and willow and the resulting low to mid-canopy layers used by this species.

- States that adaptive management could be used to experimentally determine best practices for restoring mature sites where water can be diverted and the canopy can be partially removed in gap sizes from a single mature tree up to 4.5 ha on an asynchronous 10-year-or-less rotation.

Stanek JA, Mcneil SE, Tracy D, Stanek JR, Manning JA, Halterman MD. 2021. "Western Yellow-billed Cuckoo Nest-Site Selection and Success in Restored and Natural Riparian Forests." The Journal of Wildlife Management Volume 85, Issue 4: Page 782–793.

- Conducts an empirical, multi-scale field investigation from 2008 to 2012 to identify habitat characteristics selected by nesting cuckoos along the Lower Colorado River.

- Used multiple logistic regression models to reveal that western yellow-billed cuckoos selected nest sites characterized by increased densities of small, native, early successional trees measuring 8 to 23 centimeters in diameter at breast height and lower diurnal temperature than available habitat in natural and restored forests.

- States that nesting cuckoos selected nest sites are characterized with increased percent canopy closure, which was important for nesting success.

- Concludes that these results show habitat components selected by nesting cuckoos in restoration and natural riparian forests can help guide the creation, enhancement, and management of riparian forests with habitat conditions necessary to promote nesting by western yellow-billed cuckoos.

Wohner PJ, Laymon SA, Stanek JE, King SL, Cooper RJ. 2021. "Early Successional Riparian Vegetation is Important for Western Yellow-billed Cuckoo Nesting Habitat." Restoration Ecology Volume 29 (Number 5): Page 1–12.

- Notes that a decline in western yellow-billed cuckoo population numbers the past 30 years has been associated with riparian forest maturation.

- Identifies that few intensive cuckoo datasets exist to test hypotheses about breeding habitat quality due to extremely low populations in remaining occupied sites.

- Uses a spot mapping dataset (1986 to 1996) from the South Fork Kern River Valley, California, to identify vegetation characteristics related to cuckoo territory densities.

- States that cuckoo densities were positively associated with increased vertical structure and started to decline with stand height greater than 6-8m.

- Concludes that naturally regenerated sites had higher densities than planted sites.

Riparian Brush Rabbit

Within this attachment, “Status Reviews and Critical Habitat Designations,” provides more details.

Kelly PA. 2018. “Reintroduction of the Riparian Brush Rabbit in the San Joaquin Valley, California, USA.” Pages 210–215 *in* Soorae PS (ed.), *Global Reintroduction Perspectives: 2018, Case Studies from Around the Globe.* Gland, Switzerland, and Abu Dhabi, United Arab Emirates: IUCN/SSC Reintroduction Specialist Group and Environment Agency–Abu Dhabi.

- Summarizes the species’ history and the captive-breeding and reintroduction program.
- Summarizes major difficulties faced by the captive-breeding and reintroduction program including vulnerability to flooding. Describes measures implemented to reduce threats from flooding: construction and vegetation of 34 flood refugia, and vegetation of 19.3 kilometers of river levees formerly kept free of vegetation other than grasses.
- States that the species easily breeds in large seminatural outdoor enclosures; a quantitative habitat suitability assessment is warranted before initiating reintroduction; an adaptive management approach should be adopted; the need exists to plan for the long term; and it is necessary to involve all stakeholders.
- Discusses the availability of a second population as a captive-breeding source; the cooperative nature of the effort; the availability of public land to anchor reintroduction program (San Joaquin River National Wildlife Refuge [NWR]); the availability of major funding from supportive programs and agencies; the hard work and dedication by team members and California State University, Stanislaus staff, and the support of the Endangered Species Recovery Program.

Matocq M, Kelly P, Rippert J, Phillips S. 2017. *Population Genetic Structure of the Riparian Brush Rabbit (*Sylvilagus bachmani riparius*): Using Multiple Marker Systems to Gain Insight into Historic and Ongoing Genetic Connectivity*. Prepared for the CVPIA Habitat Restoration Program. Grant Agreement Award F13AP00564. Stanislaus (CA) and Reno (NV). May 15, 2017.

- Identifies the genetic diversity and population genetic structure of four natural remnant populations of riparian brush rabbit and evaluates structural and functional connectivity across the species’ range.
- Finds that management and recovery efforts are increasing both structural and functional connectivity for the species.
- Suggests approaches to measure progress toward the recovery goal of re-establishing connectivity and inform planning.

Rippert J. 2017. Population Genetics and Functional Connectivity of the Riparian Brush Rabbit (*Sylvilagus bachmani riparius*): Implications for the Conservation of an Endangered Lagomorph. Thesis. University of Nevada, Reno.

- Assesses genetic diversity, population genetic structure, and structural and functional connectivity of riparian brush rabbits.
- Presents findings that suggest the presence of three genetic clusters within the subspecies corresponding to geographic locations, indicating limited gene flow caused by habitat fragmentation.
- Finds that the augmented population at San Joaquin River NWR retained high levels of diversity and functional connectivity.
- Discusses the value of patch connectivity and wildlife corridors, and restoration implications as they relate to gene flow between populations of riparian brush rabbit.

Tarcha CM. 2020. Behavior and Ecology of the Riparian Brush Rabbit at the San Joaquin River National Wildlife Refuge as Determined by Camera Traps. Master's thesis, California State University Stanislaus. May 2020.

- States that camera traps were monitored from February to August 2017.
- Investigates activity patterns, behavior, and resource use of riparian brush rabbit at restored plant communities and artificial feed sites.
- Discusses effects of flooding on riparian brush rabbit.

Riparian (San Joaquin Valley) Woodrat

Tarcha CM. 2020. Behavior and Ecology of the Riparian Brush Rabbit at the San Joaquin River National Wildlife Refuge as Determined by Camera Traps. Master's thesis, California State University Stanislaus. May 2020.

- States that more than 300 pictures of riparian woodrats were obtained at six locations on the San Joaquin River NWR.

New Target Species for the Conservation Strategy Update

These references for delta smelt, monarch butterfly, tricolored blackbird, and yellow-breasted chat are in addition to the references cited in the focused conservation plans prepared for each of these species as part of the 2022 Strategy Update.

Delta Smelt

California Natural Resources Agency. 2016. "Delta Smelt Resiliency Strategy 2016." Viewed online at: Delta-Smelt. Accessed: October 26, 2021.

Davis BE, Cocherell DE, Sommer T, Baxter RD, Hung T-C, Todgham AE, Fangue NA. 2019. "Sensitivities of an endemic, endangered California smelt and two non-native fishes to serial increases in temperature and salinity: implications for shifting community structure with climate change." Conservation Physiology Volume 7: Page 1–16. www.oup.com.

FLOAT-MAST (Flow Alteration – Management, Analysis, and Sythesis Team). 2020. *Synthesis of Data and Studies Relating to Delta Smelt Biology in the San Francisco Estuary, Emphasizing Water Year 2017.* IEP Technical Report 95. Interagency Ecological Program, Sacramento (CA).

Hamilton SA, Murphy DD. 2020. "Use of affinity analysis to guide habitat restoration and enhancement for the imperiled delta smelt." Endangered Species Research Volume 43: Page 103–120. www.abstracts.org.

Hobbs JA, Moyle PB, Fangue N, Connon RE. 2017. "Is Extinction Inevitable for Delta Smelt and Longfin Smelt? An Opinion and Recommendations for Recovery." San Francisco Estuary and Watershed Science Volume 15 (Issue 2): Article 2. Viewed online at: https://doi.org. Accessed: March 25, 2020.

Moyle PB, Brown LR, Durand JR, Hobbs JA. 2016. "Delta Smelt: Life History and Decline of a Once-Abundant Species in the San Francisco Estuary." San Francisco Estuary and Watershed Science Volume 14 (Issue 2): Article 6. Viewed online at: Delta-Smelt. Accessed: March 25, 2020.

Moyle PB, Hobbs JA, Durand JR. 2018. "Delta Smelt and Water Politics in California." Fisheries Volume 43: Page 42–51.

Moyle P, Bork K, Durand J, Hung T-C, Rypel A. 2019. "Futures for Delta Smelt." Davis (CA): University of California, Davis, Center for Watershed Sciences. December 2019. Viewed online at: Delta-Smelt. Accessed: March 25, 2020.

Sommer T, Hartman R, Koller M, Koohafkan M, Conrad JL, MacWilliams M, Bever A, Burdi C, Hennessy A, Beakes M. 2020. "Evaluation of a large-scale flow manipulation to the upper San Francisco Estuary: Response of habitat conditions for an endangered native fish." PLoS ONE Volume 15 (Issue 10): e0234673. www.plos.org.

Tempel TL, Malinich TD, Burns J, Barros A, Burdi CE, Hobbs JA. 2021. "The Value of Long-term Monitoring of the San Francisco Estuary for Delta Smelt and Longfin Smelt." California Fish and Wildlife Special CESA Issue: Page 148–171. www.doi.org.

Monarch Butterfly

Leone JB, Larson DL, Larson JL, Pennarola N, Oberhauser K. 2019. "Adult Monarch (*Danaus plexippus*) Abundance Is Higher in Burned Sites Than in Grazed Sites." Frontiers in Ecology and Evolution Volume 7.

Monarch Joint Venture. 2022. Mowing and Management: Best Practices for Monarchs. www.monarch.org

Oberhauser KS, Nail KR, Altizer S (eds.). 2015. Monarchs in a changing world: Biology and conservation of an iconic butterfly. Cornell University Press, Ithaca, New York.

Tricolored Blackbird

Within this attachment, "Regional Conservation Planning References," provides more details.

Barr K, Beichman AC, Kalhori P, Rajbhandary J, Bay RA, Ruegg K, Smith TB. 2021. "Persistent Panmixia Despite Extreme Habitat Loss and Population Decline in the Threatened Tricolored Blackbird (*Agelaius tricolor*)." Evolutionary Applications Volume 14: Page 674–684.

Belenky L, Bond M. 2015. A Petition to List the Tricolored Blackbird as Endangered under the California Endangered Species Act and Request for Emergency Action to Protect the Species.

Submitted to California Fish and Game Commission. Oakland (CA): Center for Biological Diversity. August 19, 2015.

California Department of Fish and Wildlife. 2018. *A Status Review of the Tricolored Blackbird in California.* Report to the Fish and Game Commission. Sacramento (CA). February 2018.

California Fish and Game Commission. 2018. *Notice of Findings: Tricolored Blackbird.* Sacramento (CA).

Meese RJ. 2017. *Results of the 2017 Tricolored Blackbird Statewide Survey*. California Department of Fish and Wildlife, Wildlife Branch, Nongame Wildlife Program Report 2017-04. Sacramento (CA). November 8, 2017.

U.S. Fish and Wildlife Service. 2019. "Endangered and Threatened Wildlife and Plants; 12-Month Findings on Petitions to List Eight Species as Endangered or Threatened Species." Federal Register Volume 84: Page 41,694–41,699.

U.S. Fish and Wildlife Service. 2019. *Special Status Assessment for the Tricolored Blackbird (Agelaius tricolor), Version 1.1.* February 2019. Sacramento (CA).

U.S. Fish and Wildlife Service. 2019. "Species Assessment and Listing Priority Assignment Form." Region 8, Pacific Southwest Region, Sacramento (CA).

Yellow-Breasted Chat

Mancuso KA, Hodges KE, Alexander JD, Grosselet M, Bezener AM, Morales L, Martinez SC, Castellanos-Labarcena J, Russello MA, Rockwell SM, Bieber ME, Bishop CB. 2022. "Migration and Non-breeding Ecology of the Yellow-breasted Chat *Icteria virens*" Journal for Ornithology Volume 163: Page 37–50.

Non-target Species

Because the conservation needs of sensitive species change, as do the habitats on which they depend, the 2016 Strategy included provisions for amending the list of target species as part of the five-year update process, using the same criteria as described in Appendix G. Therefore, the potentially suitable species that were not selected as target species (i.e., non-target species) for the 2016 Strategy have been considered for the 2022 Update if they met the criteria in Appendix G of the 2016 Strategy. These species include but are not limited to the delta smelt, western pond turtle, tricolored blackbird, western red bat (*Lasiurus blossevillii*), yellow-breasted chat, and western burrowing owl. As noted above, four additional species have been added to the list of target species for the 2022 Strategy Update. Updated reference materials for non-target species are provided in the following sections.

Western Pond Turtle

Within this attachment, "Regional Conservation Planning References," provides more details.

Davidson KA, Alvarez JA. 2020. "A Review and Synopsis of Nest Site Selection and Site Characteristics of Western Pond Turtles." Western Wildlife Volume 7: Page 42–49.

Thomson RC, Wright AN, Shaffer HB. 2016. *California Amphibian and Reptile Species of Special Concern.* Oakland (CA): University of California Press.

Burrowing Owl

Within this attachment, "Regional Conservation Planning References," provides more details.

Ocken MA. 2017. Seasonal Habitat Requirements and Use by the Western Burrowing Owl (*Athene cunicularia hypugaea*) in the Northern Sacramento Valley, Chico. Thesis. California State University, Sacramento.

Other Non-target Species

Literature searches were conducted for the following non-target species that were designated in Appendix G as “associated with target habitat” and “major potential CVFPP effect.” Other than those included in the documents described in the “Regional Conservation Planning References,” section of this report, no updated reference materials for these species have become available since the release of the 2016 Strategy:

- Western red bat.
- Redhead.
- Yellow warbler.
- Least bittern (*Ixobrychus exilis*).
- Little willow flycatcher (*Empidonax traillii*).

Appendix B
Focused Conservation Plans for New Target Species

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APPENDIX B

Focused Conservation Plans

Acronym	Description
°F	degree(s) Fahrenheit
CESA	California Endangered Species Act
Conservation Strategy	Central Valley Flood Protection Plan Conservation Strategy
CPA	Conservation Planning Area
CVFPP	Central Valley Flood Protection Plan
Delta	Sacramento–San Joaquin Delta
ESA	Endangered Species Act
FR	*Federal Register*
mm	millimeter(s)
SAV	submerged aquatic vegetation
SPA	Systemwide Planning Area
SPFC	State Plan of Flood Control
SRA	shaded riverine aquatic
State	State of California
USFWS	U.S. Fish and Wildlife Service

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Appendix B.1
Focused Conservation Plan: Delta Smelt

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APPENDIX B.1

Focused Conservation Plan: Delta Smelt

Source: *California Department of Water Resources*

B1.1 Conservation Status

As part of the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy Update, this focused conservation plan addresses needs and opportunities to conserve delta smelt (*Hypomesus transpacificus*) in the Systemwide Planning Area (SPA). Within the SPA, delta smelt occupy the Lower Sacramento River Conservation Planning Area (CPA) and the Lower San Joaquin River CPA.

In 1993, delta smelt were State-of-California (State)- and federally listed as threatened under the California Endangered Species Act (CESA) and federal Endangered Species Act (ESA) (58 *Federal Register* [FR] 12854, March 5, 1993). In 2010, the State elevated the species' CESA status to endangered. That same year, the U.S. Fish and Wildlife Service (USFWS) determined that delta smelt should be reclassified from threatened to endangered under the ESA, but higher-priority actions precluded the promulgation of a formal rulemaking for such a reclassification (75 FR 17667, April 7, 2010).

Recently, USFWS again considered uplisting delta smelt from threatened to endangered status under the ESA. As it had done previously, USFWS determined that delta smelt was warranted for uplisting, but this was precluded by higher-priority actions. The species was assigned a listing priority number of 2, based on the high magnitude and high imminence of threats the species faced rangewide, resulting in mortality or a significant reduction in reproductive capacity (85 FR 73164, November 16, 2020).

Critical habitat for Delta smelt was designated in 1994 (59 FR 65256, December 19, 1994). The designated critical habitat includes the following areas:

- The mainstem Sacramento River downstream of Sacramento.
- All of the Yolo Bypass.
- The mainstem San Joaquin River downstream of the San Joaquin County line.
- All river reaches and estuarine areas of the Sacramento–San Joaquin Delta (Delta) (in the Sacramento Delta and San Joaquin Delta hydrologic units).
- All waters of Suisun Bay, including Honker Bay, Grizzly Bay, and connected sloughs.

The following primary constituent elements are considered essential to conserve delta smelt:

- Freshwater or slightly brackish-water spawning sites.
- Larval and juvenile transport from spawning to rearing habitat.
- Rearing habitat.
- Adult migration to spawning habitat.

USFWS developed the *Recovery Plan for Sacramento–San Joaquin Delta Native Fishes* in 1996; however, in its most recent five-year review (2010), USFWS indicated the recovery plan was outdated and was being revised (75 FR 17667, April 7, 2010). The five-year review led to a 12-month finding for a delta smelt uplisting petition. USFWS concluded that changing the status from threatened to endangered was warranted (but precluded), and "that the biological status of this ESU [*sic*] has worsened since the last status review and therefore, we recommend that its status be reassessed in 2–3 years if it does not respond positively to improvements in environmental conditions and management actions" (75 FR 17667, April 7, 2010).

In 2020, USFWS stated the following (85 FR 73164, November 16, 2020):

> "*The primary rationale for reclassifying delta smelt from threatened to endangered was the significant decline in species abundance that have [sic] occurred since 2001, and the continuing downward trend in delta smelt abundance indices supports that finding. Fourteen of the last 15 years have seen fall abundances that have been the lowest ever recorded. 2015 to 2019 results from all four of the surveys analyzed in this review have been the lowest ever recorded for the delta smelt. Delta smelt abundance in fall was exceptionally low between 2004 and 2010, increased during the wet year of 2011, and decreased again to very low levels at present. The latest 2018 and 2019 fall surveys did not detect a single delta smelt, resulting in an abundance index of 0, and the latest 2019 spring survey resulted in an abundance index of 0.4, all of which are the lowest on record*."

B1.1.1 Status and Trends

B1.1.1.1 Historical Distribution

Historically, delta smelt were abundant throughout much of their range in San Francisco Bay and the Delta, from San Pablo Bay upstream to Sacramento (on the Sacramento River) and Mossdale (on the San Joaquin River) (75 FR 17667, April 7, 2010).

B1.1.1.2 Current Distribution

Figure B.1-1 illustrates the range of delta smelt as determined by the Interagency Ecological Program and Regional Monitoring Program. Delta smelt's extant distribution is mostly restricted to west of the Sacramento and San Joaquin River confluence, although they are found year-round—and sometimes in high numbers—in the North Delta, within the Lower Sacramento River CPA. In particular, the Cache Slough Complex and Liberty Island (downstream portions of the Yolo Bypass) appear to provide important year-round habitat for delta smelt of all life stages (Merz et al. 2011; Sommer et al. 2011; Sommer and Mejia 2013). Delta smelt are found infrequently in the southern and eastern portions of the Delta (i.e., the Lower San Joaquin River CPA) and are largely absent from these areas in summer and fall (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015).

Based on captures of newly hatched larvae and post-spawn adults, the following are known spawning locations in the Lower Sacramento River and Lower San Joaquin River CPAs:

- The Yolo Bypass, Cache and Lindsey sloughs in the lower Sacramento River.
- Between Sherman Island and Venice Island in the lower San Joaquin River.
- The lower Mokelumne River.
- The South Delta.
- The West Delta.

However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough and Sacramento Deep Water Ship Channel complex in the North Delta (U.S. Fish and Wildlife Service 2017).

Additional spawning locations occur downstream of these CPAs and include Suisun Bay and Suisun Marsh, and in wet years the Napa River (U.S. Bureau of Reclamation 2007; U.S. Fish and Wildlife Service 2017). The most significant downstream habitat for delta smelt is the lower Napa River (a tributary of San Pablo Bay), although it is typically used only in wet years (Hobbs et al. 2007; Merz et al. 2011; Sommer and Mejia 2013).

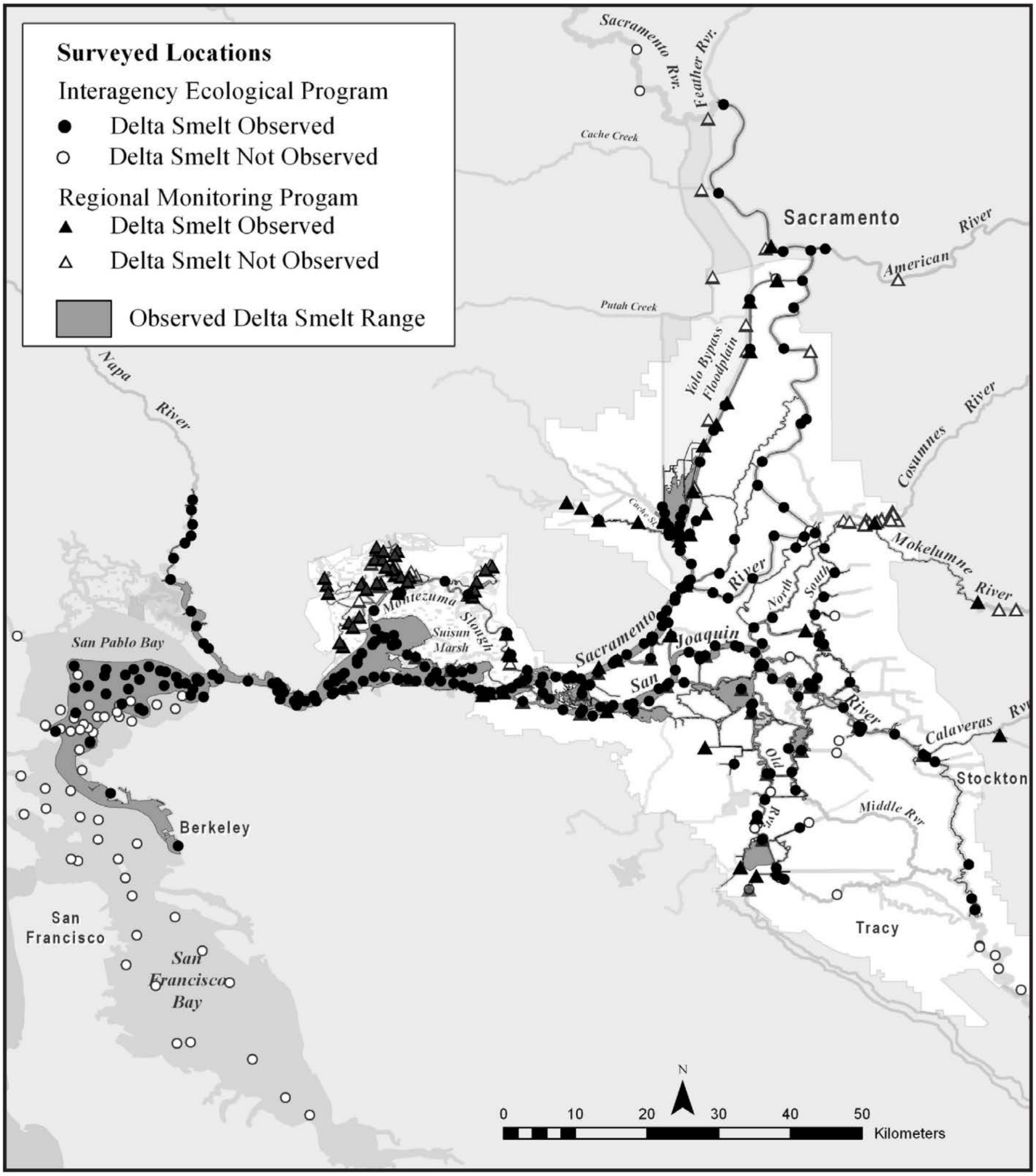
B1.1.2 Population Trends

Delta smelt were once abundant in San Francisco Bay and the Delta (Moyle 2002; Bennett 2005). Their abundance abruptly decreased in the early 1980s, apparently independent of previous or subsequent changes in abundance trends. A stronger negative trend began in the early 2000s; this abundance trend also was observed in other pelagic fishes of the San Francisco

Bay estuary, coinciding with the pelagic organism decline (Nobriga and Herbold 2009; Thomson et al. 2010). Notably, however, catch index values in the Yolo Bypass and Cache Slough Complex portions of the Lower Sacramento River CPA have increased substantially since 2008 while continuing to decrease elsewhere (California Department of Water Resources n.d.).

Much of what is known about abundance and trends in delta smelt populations is based on indices derived from regular sampling conducted by several federal and State agencies (e.g., Bennett 2005; Thomson et al. 2010; Sommer et al. 2011; Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015; and U.S. Fish and Wildlife Service 2017).

Figure B.1-1. Observed Range of Delta Smelt and Species Occurrence at Interagency Ecological Program and Regional Monitoring Survey Stations



Source: Merz et al. 2011; reproduced with permission.

Delta smelt abundance indices for four different life stages (post-larval, juvenile, subadult, and adult) were derived from data collected by the five California Department of Fish and Wildlife fish monitoring programs that differ in terms of their duration, time of year (and thus, life stage sampled), sampling intensity, and net type (Polansky et al. 2019). The surveys include the 20 millimeter (mm), which has the smallest (i.e., 20-mm) mesh size; Summer Townet; Fall Midwater Trawl; Spring Midwater Trawl; and Spring Kodiak Trawl (Polansky et al. 2019) (Figure B.1-2). Figure B.1-2 shows a series of four line graphs depicting indices of delta smelt abundance between 1990 and 2015. In order from first to last, these graphs show the respective abundance indices as determined by the 20-mm survey, Summer Townet survey, Midwater Trawl, and Spring Midwater Trawl and Spring Kodiak Trawl. These surveys reflect conditions in May, July and August, October and November, and February and March, respectively.

The best data on the annual abundance of adult delta smelt began to be collected in 2002 with the initiation of the Spring Kodiak Trawl survey, from which an abundance index has been developed. As the last line graph on Figure B.1-2 shows, the values of this index were highest in 2012 and lowest in 2016.

However, an abundance index for juveniles based on the Fall Midwater Trawl survey indicates abundance levels since 2002 are still well-below the levels that were typical before the declining trend of the early 2000s, and particularly well-below abundance levels before the abrupt decrease in the early 1980s (Figure B.1-2) (Polansky et al. 2019). The recent (2018 and 2019) fall surveys detected no delta smelt, resulting in an abundance index of 0, and the latest 2019 spring survey resulted in an abundance index of 0.4; these abundance indices are the lowest on record (85 FR 73164, November 16, 2020).

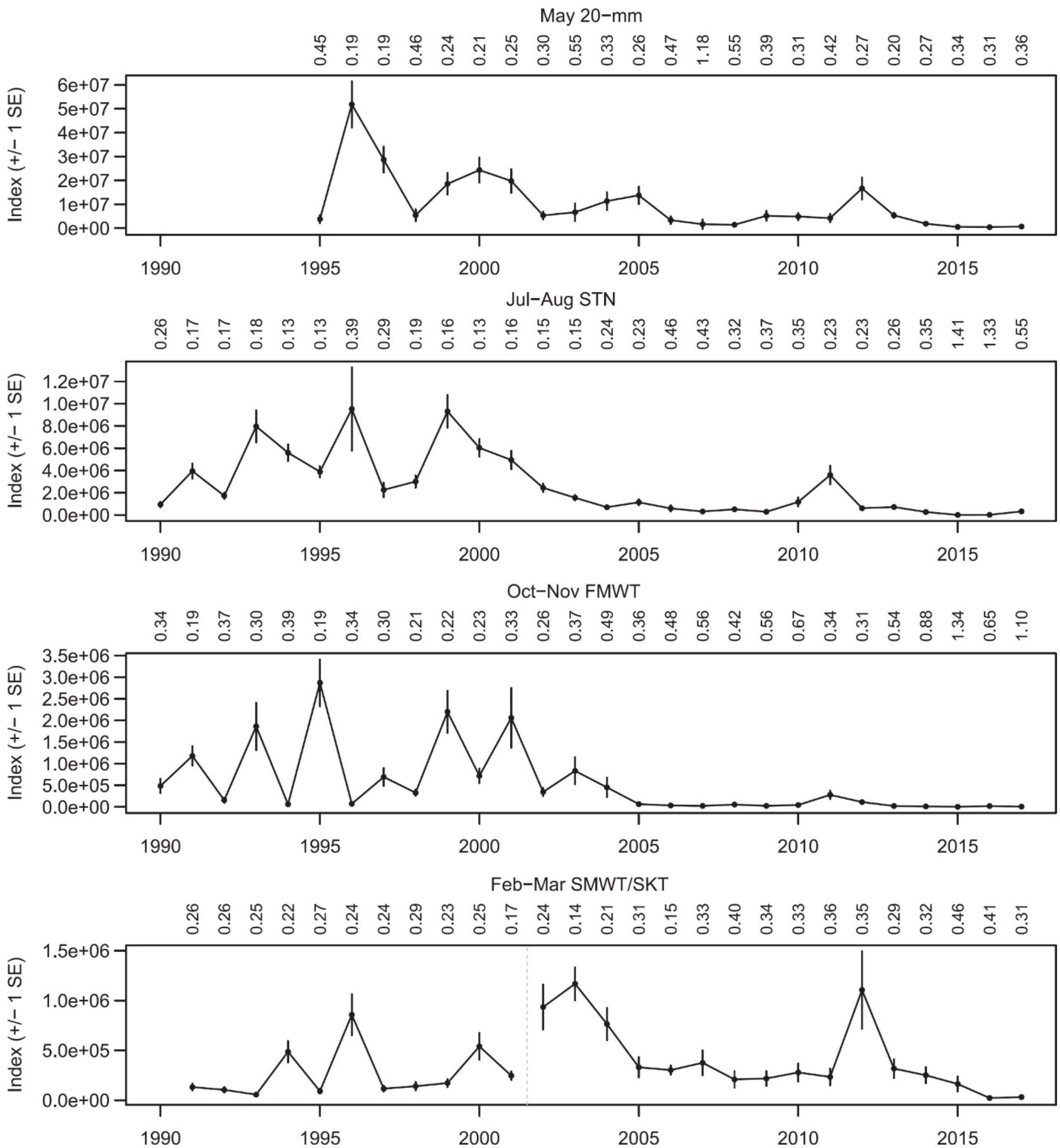
USFWS developed a procedure for estimating delta smelt abundance that is based on Spring Kodiak Trawl data. USFWS's resulting estimates of historical delta smelt abundance in January and February indicate the 2016 population is the lowest between 2002 and 2017, with only 16,000 individuals (95-percent confidence intervals 7,000 to 31,000 individuals) (U.S. Fish and Wildlife Service 2017).

B1.1.3 Life History

Delta smelt are an annual estuary-dependent species endemic to San Francisco Bay and the Delta. Adults begin migrating upstream to freshwater spawning grounds with the first flow events in winter. Migration takes one to four weeks, at a rate of approximately 1.1 to 3.9 miles per day, for an average of 2.2 miles per day. Adults appear to hold in the spawning grounds for perhaps one month before initiating spawning (Sommer et al. 2011).

Figure B.1-2. Annual Abundance Indices for Delta Smelt Life Stages

Index of abundance with standard errors are derived for each year from data from five survey types: 20-mm, STN = Summer Townet, FMWT = Fall Midwater Trawl, SMWT = Spring Midwater Trawl, and SKT = Spring Kodiak Trawl.



Source: Polansky et al. 2019.

Most delta smelt spawning occurs in the Lower Sacramento River and Lower San Joaquin River CPAs, in the lower Sacramento River, Yolo Bypass, and San Joaquin River; however, spawning also occurs broadly throughout the Delta, in marsh channels of Suisun Bay, and in wet years in the Napa River (Moyle et al. 1992; Bennett 2005).

Although spawning generally occurs in upstream reaches during dry years, post-spawn adults have been observed in the Sacramento River in at least one wet year (Souza 2002; Bennett 2005). Larval, juvenile, and adult delta smelt have been observed in the Yolo Bypass (California Department of Water Resources n.d.). These observations indicate either some juveniles remain there instead of emigrating to brackish water in the West Delta and Suisun Bay, or fish movement occurs year-round, causing them to be present in the bypass all year (Sommer et al. 2011).

Female delta smelt were thought to spawn only once during their lifetimes; however, recent evidence from laboratory experiments suggests they are capable of spawning multiple clutches within a spawning season, and in the wild they may do so when conditions remain suitable for spawning for a longer period (Bureau of Reclamation 2007; Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015; USFWS 2017). Although delta smelt are generally considered to be an annual species, a small number of fish may live for two years and either do not spawn in their first year or spawn in both their first and second years (Moyle 2002; Bennett 2005; Bureau of Reclamation 2007).

Spawning occurs between late February and June, although most occurs from mid-April through May (Bennett 2005). Some evidence exists that delta smelt may spawn primarily below the low-tide level during spring tides, behavior that has been hypothesized to protect eggs from desiccation or to take advantage of enhanced aeration provided by higher tidal velocities.

Spawning during spring tides would also mean that eggs hatch during neap tides when tidal velocities are at a minimum, reducing the chance of larvae displacement (Bennett 2005). Adults mature at 1.97 to 2.76 inches (55 to 70 mm) fork length and rarely grow larger than 3.15 inches (80 mm) fork length. Although fecundity is relatively low, it does increase with size (Bennett 2005).

Eggs have not been collected in the wild; however, laboratory experiments and information from closely related species suggest delta smelt are broadcast spawners that deposit eggs on sandy or gravelly substrate (Bennett 2005; Bureau of Reclamation 2007; Lindberg et al. 2020). Eggs form a stalk that attaches to substrate, and the eggs hatch in nine days at 59.0 to 69.8 degrees Fahrenheit (°F) (Bureau of Reclamation 2007; U.S. Fish and Wildlife Service 2017).

Much of the current knowledge about the developmental biology of larval delta smelt comes from observations made under laboratory conditions, although field observations have helped biologists to determine the timing and location of rearing larvae. After hatching, larvae likely drift downstream and quickly settle to the bottom of the river. They begin feeding after five to six days, likely remaining bottom-oriented for up to 65 days before developing into juveniles at approximately 0.8 inch in total length (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015). However, they may quickly move or be displaced from unsuitable habitat before becoming fully developed (Hobbs et al. 2007). Larval delta smelt less than 0.8 inch long are generally found in tidally influenced freshwater habitat, but move downstream toward the low-salinity zone in late spring (Nobriga and Herbold 2009).

Juvenile delta smelt are most associated with the low-salinity zone (less than 3 practical salinity units), and are thus less widely distributed than adults. Nobriga and Herbold (2009) describe a shift in distribution from the Delta in early summer to the Sacramento River and San Joaquin River confluence as the summer progresses, indicating juveniles escape unfavorable temperatures and seek turbid water. This shift is thought to be a response to changes in habitat quality from historical conditions, because historically, juveniles were found throughout the Delta (Nobriga et al. 2008; Nobriga and Herbold 2009). Juvenile delta smelt spend summer and early fall feeding and growing until the first winter storms trigger the upstream spawning migration of maturing adults (Bennett 2005; Nobriga and Herbold 2009; Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015).

B1.1.4 Habitat and Ecological Process Associations

Delta smelt are pelagic (that is, they live near the water surface) and associated with tidally influenced, turbid, low-salinity, and low-velocity water within a moderate temperature range (Swanson et al. 2000; Bennett 2005; Feyrer et al. 2007; Nobriga et al. 2008; Sommer and Mejia 2013; Bennett and Burau 2015; Bever et al. 2016).

Turbidity has been hypothesized to play a role in predator avoidance by concealing smelt, and in enhanced feeding opportunities by increasing background contrast and thus improving the visual identification of prey (Sommer and Mejia 2013). Natural sources of turbidity include streambank erosion from channel meander, upslope erosion from rainfall, and primary production. A strong shift toward lower turbidity in the Sacramento River and San Francisco Bay estuary in the late 1990s (Jassby et al. 2002; Glibert 2010; Schoellhamer 2011) has raised concerns regarding effects on habitat conditions for delta smelt (Feyrer et al. 2007; Nobriga et al. 2008).

This species is most often captured when water temperatures are less than 71.6°F, and temperatures above 68°F in spring can increase larval mortality rates (Bennett 2005). The upper temperature threshold is generally considered to be 77°F (Swanson et al. 2000; Nobriga et al. 2008), and capture rates decrease rapidly at temperatures above 75.2°F (Nobriga et al. 2008). Delta smelt are rarely captured when water temperatures are less than 44.6°F, although water temperatures in the Delta seldom become this low (Kimmerer 2004). Delta smelt have lower temperature tolerances than non-native fishes, and may currently be occupying habitats approaching their upper temperature tolerance limits (Davis et al. 2019).

Delta smelt have been captured across a range of salinities, from freshwater to brackish water (0 to 18 practical salinity units), and have an upper lethal limit of 19 practical salinity units (Swanson et al. 2000). They are most associated with the low-salinity zone (less than approximately 2 practical salinity units) (Bennett 2005; Feyrer et al. 2007; Nobriga et al. 2008).

Targeted flow manipulations directing low-salinity water into Suisun Marsh increased the area of low-salinity habitat for delta smelt, and improved habitat conditions (Sommer et al. 2020). Thus, the location of the largest fish concentrations in the nonspawning season varies as a function of the water year (Sommer and Mejia 2013). Delta smelt are distributed more downstream at locations such as the Napa River and Suisun Bay in wet years, and farther upstream in dry years. They likely take advantage of tidal movements to migrate (i.e., they “surf the tide”) (Bennett and Burau 2015).

The delta smelt’s upstream migration appears to be triggered by attraction flows, particularly “first-flush” events, resulting in a somewhat coordinated migration strategy (Sommer et al. 2011). Average upstream migration rates are approximately 3.6 kilometers per day, and rates are uncorrelated with Delta flow (Sommer et al. 2011).

Typically, December to March flow pulses trigger upstream migration, but spawning typically peaks from March through May, suggesting adult delta smelt hold for periods of at least a month before spawning (Sommer et al. 2011). Delta smelt have three different distinct life-history phenotypes based on otolith microchemistry: freshwater resident, brackish-water resident, and semi-anadromous fish (Hobbs et al. 2019).

Larval and post-larval delta smelt feed almost exclusively on two species of calanoid copepods (Moyle et al. 1992; Nobriga 2002; Slater and Baxter 2014). As delta smelt grow, they expand their diet to include other copepod species, mysid shrimp, cladocerans, and amphipods (Moyle et al. 1992; Slater 2012; Slater and Baxter 2014). The decreased abundance of copepods and mysids in the upper estuary has caused food limitation to be a major stressor for adult delta smelt (Baxter et al. 2010).

Recent findings have indicated delta smelt may be food-limited, particularly in the spring and summer (Hamilton and Murphy 2018). Smelt collected from areas where the influence of tidal wetlands is greater have much greater stomach fullness than smelt collected from areas with little or no tidal wetland influence, suggesting that food resources for delta smelt are more available when near tidal wetlands (Hammock et al. 2019).

The North Delta supports a year-round presence of delta smelt, and has been suggested as a priority subregion for restoration (Hamilton and Murphy 2020). Freshwater-tidal wetlands in the Yolo Bypass may provide a refuge for the delta smelt population during drought conditions, functioning as a critical nursery habitat; particularly when delta smelt are facing serious decline (Mahardja et al. 2019). Delta smelt collected from the Yolo Bypass during the drought were compared to smelt captured elsewhere in the estuary. Smelt from the Yolo Bypass spawned earlier and offspring experienced a higher quality of both feeding conditions and growth rates (Mahardja et al. 2019). During the drought (2012 to 2016), delta smelt abundance in the Yolo Bypass was higher than during the previous 14 years of fish monitoring there, and was at record lows in locations within the estuary where delta smelt were historically found (Mahardja et al. 2019). Delta smelt do not appear to strongly prefer aquatic vegetation or any particular substrate type, although they may avoid concrete structures such as boat ramps (Sommer and

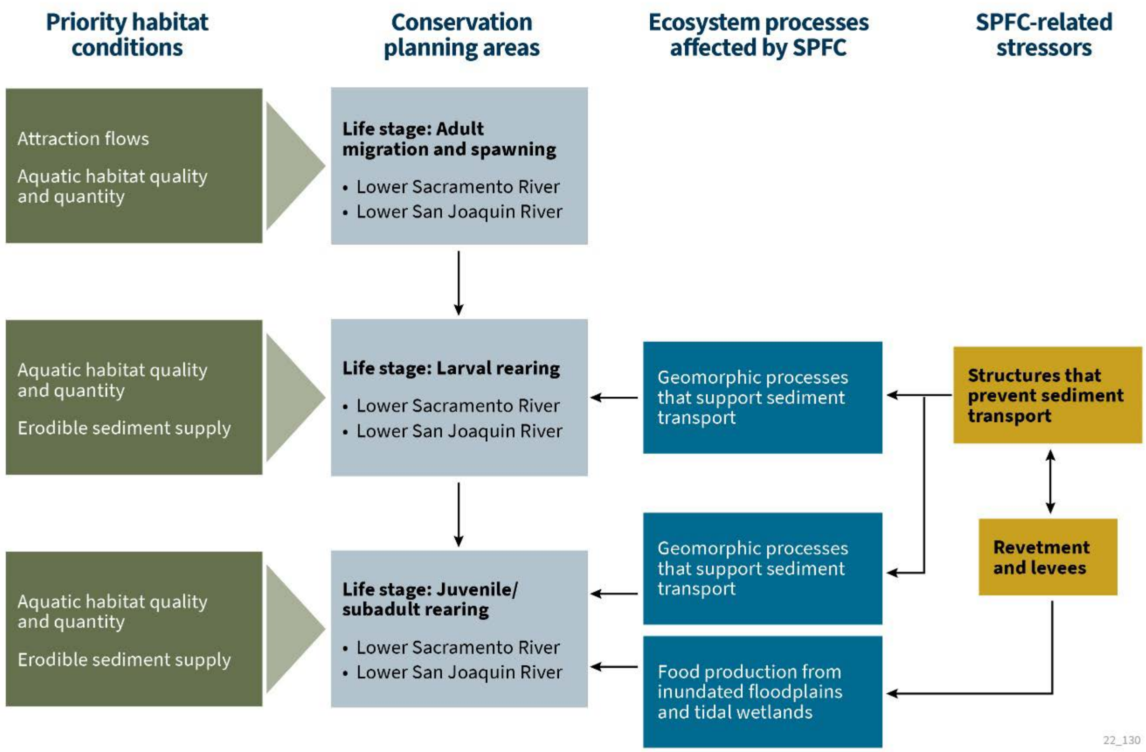
Mejia 2013). Even though spawning has not been observed in the wild, many other smelt species are known to use sandy substrate for spawning (Bennett 2005).

B1.1.5 Conceptual Models

A conceptual model has been developed to assist in the development of a targeted conservation strategy for delta smelt within the SPA (Figure B.1-3). This model is not intended to be a comprehensive model of all ecological processes, stressors, and other factors that could be relevant for this species. Rather, as Figure B.1-3 shows, the conceptual model specifically depicts all of the following considerations:

- Habitat conditions required by delta smelt within the SPA: attraction flows, and the quantity and quality of aquatic habitat.
- The specific CPAs within which these habitat conditions occur: the Lower Sacramento River and Lower San Joaquin River CPAs.
- Ecosystem processes that are key for riverine systems within the SPA, and thus may be affected by actions that could be implemented as part of the CVFPP and Conservation Strategy. These include flows that attract upstream migration, flows that improve habitat conditions, geomorphic processes that support sediment transport, floodplain inundation, food production from inundated floodplains and tidal wetlands.
- Stressors related to State Plan of Flood Control (SPFC) facilities and their operations and maintenance. These indirect factors include structures that prevent sediment transport, revetment (lack of shaded riverine aquatic [SRA] cover), and levees.
- Numerous conceptual models have been developed for delta smelt. These conceptual models focus on the “habitat conditions and ecosystem drivers affecting each delta smelt life stage across seasons and how the seasonal effects contribute to the annual success of the species stressors affecting survival from one life stage to the next.” The models were used to generate hypotheses about the factors contributing to changes in delta smelt abundance, and to identify important information gaps (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015).

Figure B.1-3. Conceptual Model for the Delta Smelt within the Systemwide Planning Area



The CVFPP's potential influences on delta smelt and its habitat include:

- Bank protection, which reduces habitat such as SRA; and lack of sediment inputs to the Delta, which affect habitat quality for delta smelt by decreasing turbidity (Feyrer et al. 2007).
- Changes to the Delta's food web that affect delta smelt growth and survival (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015).
- Flood structures that alter shorelines and adjacent bottom substrates, which could affect spawning habitat for delta smelt (Sommer and Mejia 2013).
- Flood structures that decrease mosaics of floodplain tidal slough habitat that can provide a refuge for delta smelt during drought conditions (Mahardja et al. 2019).

B1.1.6 Management Issues

B1.1.6.1 Threats and Sensitivities Rangewide

Historically, the following factors, listed in order of importance, were the causes of decline in delta smelt abundance (58 FR 12854, March 5, 1993):

- Reduced river outflows from the Sacramento and San Joaquin rivers and their tributaries.
- Extreme high outflows in years with unusually high rainfall.
- Entrainment mortality at water diversions.
- Perturbations, both human and natural, to the smelt's food web.
- Presence of toxic substances.
- Loss of genetic integrity because of small population size.

The USFWS 2020 review of delta smelt (85 FR 73164, November 16, 2020) identifies the following primary threats to the delta smelt:

- Direct entrainments by federal and State water export facilities.
- Reduction of suitable habitat by summer and fall increases in salinity and water clarity, resulting from decreases in freshwater flow into the estuary.
- Effects of introduced species.

Other potentially significant threats include ammonia in the form of ammonium, which destabilizes cell membranes, resulting in sublethal effects; predation by striped and largemouth bass and inland silversides; contaminants; climate change; and small population size. Changes to the importance of threats to the decline of delta smelt are associated with advancements in the understanding of effects of human activities on the ecosystem supporting delta smelt, as described here.

Water clarity has increased in the Delta since at least 1975 (Jassby et al. 2002). This increase has been identified as a major stressor for delta smelt (Nobriga and Herbold 2009; 75 FR 17667, April 7, 2010). Decreases in turbidity are strongly correlated with decreases in delta smelt distribution (Feyrer et al. 2007; Nobriga et al. 2008; Bever et al. 2016) and abundance (Thomson et al. 2010; Bever et al. 2016). Nobriga and Herbold (2009) summarized the primary hypothesized causes of this increase in water clarity as follows:

- Sediment has been increasingly trapped behind dams and levees (Jassby et al. 2002; Wright and Shoellhamer 2004).
- Sediment was lost from below dams and between levees as a result of high flows during the 1982 to 1983 El Niño event (Jassby et al. 2005), and presumably to a lesser extent, during less extreme high flows in other years.
- More abundant submerged aquatic vegetation (SAV), such as Brazilian waterweed (*Egeria densa*), filters the water (Feyrer et al. 2007).

Levee maintenance and bank protection activities may adversely affect critical habitat for delta smelt (59 FR 65256, December 19, 1994), in part by affecting the natural recruitment of sediments to the stream channel. Channelization within levees has caused a lack of channel meander and associated natural bank, and has converted natural banks with vegetated cover to hardened or revetted banks.

Reduced natural bank erosion in all river reaches upstream of delta smelt habitat likely reduces suspended sediment and turbidity in areas where delta smelt occur. Increases in water clarity may also be attributed to decreases in primary productivity (Jassby et al. 2002), and to a shift from diatoms to cyanobacteria and flagellates in response to increases in ammonium and a shift in the balance of nitrogen and phosphate (Glibert 2010).

Threats from climate change include increases in water temperature and the number of days when mean daily water temperatures exceed 77°F, increased salinity and an eastward shift of the low-salinity zone, and an increase in water clarity (Feyrer et al. 2010; Cloern et al. 2011; Wagner 2012). Greenberg et al. (2012) modeled the influence of riparian habitat on mediating water temperatures in the Lower Sacramento and Lower San Joaquin River CPAs, stressing the importance of maintaining and enhancing riparian habitat on channel banks on a Delta-wide scale to buffer the effects of climate change, especially SRA habitat that may moderate water temperatures.

Delta smelt are vulnerable to entrainment in water diversions, most notably the State Water Project and Central Valley Project diversions; such entrainment has been identified as a major stressor affecting all life stages (Nobriga and Herbold 2009; 75 FR 17667, April 7, 2010). Adults are vulnerable during their winter-spring spawning migrations, and larvae and juveniles are vulnerable from spring to early summer, primarily from March through June (Kimmerer and Nobriga 2008; Nobriga and Herbold 2009). Larvae are most vulnerable in the spring of low-flow years when the low-salinity zone retreats upstream (Kimmerer and Nobriga 2008).

Additional causes of mortality related to human-altered hydrodynamics in the Delta include potential habitat displacement associated with the operation of the Suisun Marsh Salinity Control Gates and entrainment with water used to cool the Mirant power plants (Nobriga and Herbold 2009). However, recently the gates were re-operated to test efficacy of a managed flow pulse into Suisun Marsh, which resulted in benefits to delta smelt and its habitat (Sommer et al. 2020). Also, decreases in abundance index values have been attributed to reduced freshwater outflows associated with statewide water conveyance (Feyrer et al. 2007; Thomson et al. 2010; 75 FR 17667, April 7, 2010).

The introduction of the invasive overbite clam (*Corbula amurensis*) in 1986 substantially reduced phytoplankton biomass throughout the estuary (Jassby et al. 2002; Glibert 2010). The clam affects delta smelt directly by competing with it for food resources (copepods), and indirectly by changing food web dynamics (reduced phytoplankton) (Nobriga and Herbold 2009). The primary food source for larval and juvenile delta smelt, the calanoid copepod (*Eurytemora affinis*), has declined in response to increased predation and competition for food resources (invasive overbite clam), and has been displaced by increasingly abundant non-native copepods of lesser food value (Kimmerer et al. 1994; Bennett 2005; Baxter et al. 2010; Glibert 2010; Winder and Jassby 2011).

The increased occurrence and magnitude of algal blooms (*Microcystis aeruginosa*) have decreased food abundance for delta smelt because the fish's primary prey, the copepods *Pseudodiaptomus forbesi* and *E. affinis*, are highly sensitive to the toxin produced by *M. aeruginosa* (Microcystin) (Ger et al. 2009; Nobriga and Herbold 2009). Further, Microcystin may be more concentrated in prime habitat for delta smelt because *M. aeruginosa* dies at low salinity. However, *M. aeruginosa* blooms occur in the summer and early fall, and thus poses a threat to delta smelt only during that time (Nobriga and Herbold 2009).

Predation by introduced striped bass has also been identified as a stressor for delta smelt (Nobriga and Herbold 2009); however, predation by invasive fish species in general poses only a low to moderate threat to delta smelt (U.S. Fish and Wildlife Service 2010).

The following stressors are attributable to water toxicity:

- The direct and indirect effects (e.g., zooplankton mortality) of pesticides, particularly because pesticide concentrations and delta smelt occurrence are both positively correlated to turbidity.
- The physiological effects of metal toxicity.
- The effects of wastewater and urban runoff (e.g., ammonia and endocrine-disrupting chemicals).
- The effects of toxic algal blooms (Nobriga and Herbold 2009; Sommer and Mejia 2013).

These stressors likely have not directly caused population declines (Sommer and Mejia 2013).

B1.1.6.2 Ongoing and Future Impacts

Ongoing impacts on delta smelt in the SPA include further reductions of the quality and availability of suitable habitat; the effects of climate change, which will likely include degradation of water quality and habitat suitability; and ongoing water diversions that entrain all life stages and affect habitat quality.

- The availability of suitable habitat will likely continue to be the most critical factor for delta smelt. Changes to the species' historical habitat caused by anthropogenic modification of the landscape, alterations to the natural flow regime and water clarity, the introduction of invasive aquatic species, and several other factors have reduced habitat availability and compromised remaining habitat. Substantial reversals of these negative effects are unlikely in the foreseeable future, so these factors will continue to compromise the ability of delta smelt to survive and thrive.

- Climate change will affect delta smelt habitat in the future, but the rate of climate change is uncertain. Many climate change projections predict increases in water temperature, the eastward migration of the low-salinity zone, and increases in water clarity within the species' habitat. Delta smelt show an abrupt negative response to water temperatures above 77°F, have a narrow tolerance for salinity, and are strongly associated with turbid water, all factors that make them particularly vulnerable to these predicted changes to their habitat.

- Because of their small size and the difficulty of screening large diversions to protect small fish, delta smelt remain vulnerable to entrainment at all life stages. Further, delta smelt are much more vulnerable to mortality than some other fishes, so once entrained, they seldom survive.

B1.1.6.3 Key Information Gaps or Uncertainties

To better understand how current and future CVFPP activities affect the conservation and potential recovery of delta smelt, and to help guide future actions of the CVFPP and Conservation Strategy, the following information is needed:

- A better understanding of the scale of tidal marsh and floodplain restoration and SAV removal needed to improve habitat suitability.

- Data on the effects of invasive aquatic plants on delta smelt survival and habitat.

- Data on the effects of predation on delta smelt populations.

Because CVFPP activities are likely to indirectly affect delta smelt and their habitat, these uncertainties focus largely on "bigger-picture" questions, rather than on specific actions taken under the CVFPP during normal operations and maintenance. The data gaps are discussed here.

Scale of Restoration Efforts

The scale of restoration efforts, such as reconnecting floodplains and tidal marshes, that is necessary to effect observable changes in delta smelt population parameters (e.g., abundance) is currently unknown. Recent studies have suggested that tidal wetlands do not contribute significantly to adjacent pelagic food webs (Lehman et al. 2010). However, the ratio of tidal wetland area to open-water area in the Delta has decreased approximately 80-fold since historical times, from 14 to 1 historically, to 1 to 6 today (Whipple et al. 2012). It is possible that the massive loss of habitat has reduced or eliminated the capacity of tidal wetlands to support pelagic food webs, rather than some inherent lack of connectivity between tidal wetlands and open water. Lehman et al. (2008) found that water passing through the Yolo Bypass contributed more and higher quality phytoplankton than water passing through the mainstem Sacramento River, indicating that large-scale floodplain inundation can have measurable effects on the pelagic food web. Also, recent research has demonstrated that delta smelt benefit more substantially from freshwater-tidal slough complexes such as the Yolo Bypass than from other parts of the Delta, particularly during drought conditions (Mahardja et al. 2019), suggesting that large-scale connectivity to floodplains or tidal marshes may indeed reconnect these habitats to pelagic food webs. Research that can identify the scale of restoration efforts necessary to affect delta smelt through positive contributions to their food web will help inform long-term planning of mitigation efforts.

Invasive Aquatic Plants

Invasive aquatic plants, especially SAV (e.g., *Egeria densa*), have been implicated in the decline of delta smelt because of their contribution to increased water clarity (the plants trap sediment) (Hestir et al. 2015) and increased predation risk (the plants provide cover for predators) (Ferrari et al. 2014). However, the extent to which removing these plants will have a population-level effect on smelt abundance is unknown; similarly, it is not known what level of invasive-plant management would be needed to benefit delta smelt.

Predation Risk

Predators' distribution and diet, as well as the amount of overlap between the habitats of predators and delta smelt, are poorly understood (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015). In particular, data are lacking for some life stages of striped bass and largemouth bass. Further studies are needed to identify the life stage–specific spatial and temporal habitat overlap of these predators with all life stages of delta smelt. Placing these overlaps in context with key habitat variables (such as temperature, salinity, and turbidity) would provide a link between environmental drivers and predation risk (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015). Understanding predator and prey interactions would also enable actions that allow the CVFPP to avoid inadvertently enhancing the habitat of any life stage of these predators, which could indirectly affect delta smelt.

B1.2 Conservation Strategy

B1.2.1 Conservation and Recovery Opportunities

The integration of environmental stewardship into all flood management activities (by the California Department of Water Resources and Local Maintaining Agencies) during project planning, design, operations, and maintenance provides an excellent opportunity for the conservation and recovery of sensitive species that are intimately tied to Central Valley riverine ecosystems and the SPFC. The most viable way to support the recovery of delta smelt is to improve habitat for all life stages by encouraging riverine processes that improve natural river morphology and function. Improving the amount and distribution of inundated floodplain and channel-margin restoration would benefit the species. These conservation needs and opportunities are discussed in detail here.

B1.2.2 Identified Conservation Needs

1. **Increase the amount and distribution of inundated floodplain habitat throughout the Delta region of the Lower Sacramento River CPA and Lower San Joaquin River CPA:** Inundated off-channel floodplain and tidal slough habitats increase food production rates locally and downstream compared to mainstem channels (Lehman et al. 2008). Such habitats may also contribute to higher growth and survival rates for delta smelt (Mahardja et al. 2019). Patterns of delta smelt occurrences indicate that habitat is found in subregions where channels of intermediate depth adjoin shallow water (Hamilton and Murphy 2020). For delta smelt, inundating the Yolo Bypass more frequently could particularly improve habitat quality in the North Delta. In addition to the more frequent inundation of the Yolo Bypass, floodplain habitat improvements to increase phytoplankton production (Lehman et al. 2008), increase residence time, and improve connectivity through the bypass would benefit delta smelt (Mahardja et al. 2019). Improving the quantity of floodplain and tidal slough habitats would require large-scale restoration actions that include providing connectivity to historical freshwater-tidal habitats that were reclaimed (Mahardja et al. 2019). Increasing the quantity and quality of floodplain and tidal slough habitats in the Lower Sacramento River and Lower San Joaquin River CPAs would improve habitat quality for all life stages of delta smelt.

2. **Improve natural river morphology and function:** Flood control measures downstream of dams, such as bank protection, have affected riparian and instream habitats, particularly in the Lower Sacramento River and Lower San Joaquin River CPAs. Constructed levees that narrow channels have increased flow velocities and channelized rivers so natural geomorphic processes (e.g., channel meander, connectivity to floodplains) are no longer possible. Improving geomorphic processes to support natural bank erosion, sediment deposition, and floodplain inundation is essential for providing habitat for delta smelt.

3. **Decrease the amount of non-native SAV throughout the Delta region of the Lower Sacramento River CPA and Lower San Joaquin River CPA:** SAV affects habitat quality for delta smelt by providing habitat for non-native predators such as largemouth bass and by decreasing turbidity (Hestir et al. 2015). *Egeria densa*, the dominant SAV species, is distributed throughout the Delta; its distribution is affected by light availability, water depth, substrate type, and water velocity (Hestir et al. 2015). Removing or reducing the extent of SAV would improve habitat conditions for delta smelt.

4. **Improve the distribution and quality of marsh and channel-margin habitat in tidally influenced waterways throughout the Delta region of the Lower Sacramento River CPA and Lower San Joaquin River CPA:** Marsh and channel-margin habitats, including SRA habitat, may provide important food resources for delta smelt and may affect the quality of spawning and larval rearing habitat (Mahardja et al. 2019; Greenberg et al. 2012). The historical reclamation of wetlands and construction of levee systems in the Delta region of the Lower San Joaquin River and Lower Sacramento River CPAs removed most of this habitat. Large-scale restoration of the distribution and amount of tidally influenced

channel-margin habitat, particularly in floodplain habitat complexes of the Yolo Bypass, may provide habitat benefits (Herbold et al. 2014; Mahardja et al. 2019).

B1.2.3 Integration of Conservation and Restoration in Flood Management

As identified in Table B.1-1, CVFPP management actions have the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the delta smelt. In many cases, the species' conservation needs can be addressed by implementing management actions that integrate conservation and restoration elements with SPFC operations and maintenance, floodway management, and structural and nonstructural improvements to facilities. The ability to implement some of these actions would depend on operations, maintenance, and floodway management actions and improvements (as described in the following section) to resolve constraints, such as the floodway's existing capacity to convey flood flows, or revetment removal at a site that may depend on levee relocation to allow bank erosion. Wherever feasible, conservation objectives and indicators will inform management actions for adaptive, responsive, and sustainable implementation that avoids and minimizes impacts on species and ecosystems.

B1.2.3.1 Operations, Maintenance, and Floodway Management

Floodwater storage and reservoir forecasting, operations, and coordination: Modifying and coordinating flood operations could include the limited reoperation of reservoirs and weirs.

The reoperation of these facilities could provide flow releases that would improve aquatic habitat conditions by changing the timing and amount of releases and ramping rates from November and early December until the end of April. These modifications could initiate upstream adult migration and generate other environmental benefits, including promoting floodplain connectivity, enhancing meander migration rates, and improving conditions to promote the development of SRA habitat.

Table B.1-1. Summary of the Contributions of CVFPP Management Actions to Identified Conservation Needs of the Delta Smelt

SPFC Activity	Management Actions	Conservation Need 1. Increase Inundated Floodplain	Conservation Need 2. Improve Natural River Function	Conservation Need 3. Decrease Non-native SAV	Conservation Need 4. Increase or Improve Marsh and Channel-margin Habitat
Operations, Maintenance, and Floodway Management	Floodwater storage and reservoir forecasting, operations, and coordination	Positive	Positive	Neutral	Neutral
	Facility maintenance	Neutral	Neutral	Positive	Neutral
	Levee vegetation management	Negative	Neutral	Neutral	Neutral
	Floodway maintenance	Neutral	Neutral	Positive	Neutral
	Floodplain topography modification	Positive	Positive	Positive	Neutral
	Invasive-plant management	Neutral	Positive	Positive	Positive
	Riparian, SRA, and marsh habitat restorations	Neutral	Positive	Positive	Positive
Structural and Nonstructural Improvements	Levee and revetment removal	Positive	Positive	Neutral	Positive
	Levee relocation	Positive	Positive	Positive	Positive
	Bypass expansion and construction	Positive	Neutral	Positive	Positive
	Levee construction and improvement	Neutral	Neutral	Neutral	Neutral
	Flood control structure reconfigurations	Neutral	Neutral	Neutral	Neutral

Notes:
CVFPP management actions are designated as having the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the species.

SAV = submerged aquatic vegetation

Modifying the operation of weirs that spill floodwater into the bypasses is also being evaluated as a CVFPP management action. For example, lowering the crests of overflow weirs and modifying operations so that bypasses carry flows earlier and longer during high river stages would activate the floodplain more frequently and for longer durations. Such floodplain activation could contribute to food web productivity and improve habitat conditions.

Levee vegetation management: The 2012 CVFPP introduced an interim vegetation management strategy, under which levee vegetation in the vegetation management zone is managed for visibility and accessibility, and to reduce threats to levee integrity (Figures 2-1 and 2-2 in Appendix D of the 2012 Conservation Strategy). Consequently, levee riparian vegetation in the vegetation management zone has been significantly trimmed or removed, reducing inputs of terrestrial insects and leaf litter and thereby reducing food availability and nutrient input. Trimming and removal of waterside vegetation also may have detrimental effects on water temperature (Poole and Berman 2001; Greenberg et al. 2012; Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015).

On the whole, levee vegetation management is likely to negatively affect habitat for delta smelt. However, lower waterside vegetation could be retained below the vegetation management zone of levees when it did not present an unacceptable threat to levee integrity. Allowing vegetation to grow on the waterside of levees where levees are adjacent to the river does not compensate for the lack of fully functioning riparian habitat, but does provide some minimal benefits for aquatic species. In the near term, this approach would also preserve other vegetation within the vegetation management zone that does not impair visibility and accessibility.

Floodway maintenance: Floodway maintenance actions could sustain or improve the existing mosaic of floodplain habitats. At selected locations, maintenance practices could be changed to facilitate the restoration of riparian habitat, or to otherwise provide greater ecological benefits than found under existing conditions. Native vegetation could be planted after sediment is removed, and large woody material that is cleared from levees could be stockpiled and used to enhance habitat (e.g., during levee erosion repairs). For example, fill-placement and rock-repair projects could incorporate SRA elements, where relevant.

Floodplain topography modification: Floodway topography modifications could increase floodway capacity and the frequency and duration of inundation. Floodplain elevations could be lowered to provide more frequent and sustained inundation. Elevations could also be modified to increase topographic and hydrologic diversity (by creating or opening secondary channels or overflow swales). These actions would increase riverine and floodplain habitat values (e.g., potentially increase turbidity and food production in downstream Delta habitats).

Invasive-plant management: Non-native invasive plants that may be removed from lands and facilities operated and maintained by the State could include SAV (e.g., *Egeria* and parrot's feather [*Myriophyllum aquaticum*]) and terrestrial vegetation that affects river geomorphology (e.g., *Arundo* and saltcedar). Aquatic habitats dominated by non-native SAV generally support non-native fishes such as centrarchids (Grimaldo et al. 2012), particularly in the Lower Sacramento and Lower San Joaquin River CPAs; these fish may be predators of delta smelt.

Established non-native terrestrial vegetation in riparian areas displaces important native plants (e.g., willows and cottonwoods) that facilitate river meander and natural geomorphic processes. The removal of non-native invasive plants could therefore benefit delta smelt by improving habitat and reducing predation by non-native fishes.

Riparian, SRA, and marsh habitat restoration: Riparian and marsh habitats could be restored at selected locations in the floodway to benefit delta smelt. Opportunities for riparian restoration would generally be found in non-riparian land cover in the floodway, particularly as part of other management actions to increase floodway capacity. Riparian, SRA, and marsh habitat restoration would be most beneficial in areas where restoration expands or connects existing habitat patches in the Delta. In the bypass system, marsh restoration would generally be beneficial to delta smelt and would be implemented in conjunction with bypass expansion and construction.

B1.2.3.2 Structural and Nonstructural Improvements

Levee and revetment removal: Removing levees and revetment that provide little value to local and systemwide flood management would reduce operations and maintenance costs while improving natural geomorphic and inundation processes in the riverine and floodplain environments. This action would have greater ecological benefits if implemented along or upstream of waterways used by delta smelt, and where removal contributes to a larger zone of active river meander migration.

Levee relocation: Relocating levees farther from rivers (i.e., constructing setback levees) is an important approach to increasing floodway capacity, creating space for river meanders, reconnecting floodplains, allowing the transport and deposition of sediment, supporting natural ecosystem disturbance processes, and increasing the diversity of riverine and floodplain habitats. Levee relocation would also provide opportunities to hydraulically connect river systems to mitigation plantings associated with the vegetation management zone, and to improve habitat for delta smelt in the Lower Sacramento River and Lower San Joaquin River CPAs.

Bypass expansion and construction: Bypass expansion could enhance delta smelt habitat (e.g., food resources) by increasing the connectivity of the floodplain to the Delta, thus restoring floodplain ecosystems that contribute to food web productivity. However, bypasses are flooded irregularly. To benefit delta smelt, bypass flooding needs to occur morefrequently (e.g., annually), with the appropriate timing and duration to provide suitable habitat. Modifying bypass weirs (e.g., those in the Yolo Bypass and at Paradise Cut) could improve the timing and duration of inundation to benefit fish, especially if coupled with large-scale restoration efforts to increase habitat complexity.

Levee construction and improvement: One levee construction and reconstruction objective that would benefit the delta smelt is restoring geomorphic processes. In addition, new levees could be designed to accommodate hydrologic changes expected to result from climate change.

Flood control structure reconfiguration: A priority action for State-operated and -maintained diversions in the SPA is to reconfigure the Fremont and Sacramento weirs in the Yolo Bypass (in the Lower Sacramento River CPA) and the weir at Paradise Cut (in the Lower San Joaquin River CPA) to increase floodplain inundation (California Department of Water Resources 2012). As discussed, improved floodplain inundation would benefit the delta smelt.

B1.2.4 Recovery Plan Alignment

USFWS developed the *Recovery Plan for Sacramento–San Joaquin Delta Native Fishes* in 1996; however, in its most recent five-year review, USFWS indicated the recovery plan is outdated (U.S. Fish and Wildlife Service 2010). The five-year review included actions that could prevent extinction of the species. Table B.1-2 lists examples of specific near- and long-term restoration and conservation actions identified in the five-year review that could be partially implemented through the CVFPP.

Table B.1-2. Examples of Near- and Long-term Restoration and Conservation Actions, by Region, that Could Be Implemented through the CVFPP

CPA	Restoration Action
Lower Sacramento River	• Increase the area of suitable spawning habitat. • Improve freshwater-tidal slough complexes in the Yolo Bypass and Delta. • Improve connectivity in low-flow channels within the Yolo Bypass.
Lower San Joaquin River	• Increase the area of suitable spawning habitat. • Improve freshwater-tidal slough complexes in the Delta.

Source: U.S. Fish and Wildlife Service (2010)

Notes:
CPA = conservation planning area

B1.2.5 Measures of Positive Contribution

A primary goal of the Conservation Strategy is to contribute to the recovery and stability of native species populations and overall biotic community diversity. The objective for this goal is a measurable contribution to the conservation of target species, including the delta smelt.

Therefore, building on the preceding discussion, this section of the delta smelt conservation plan provides measures (i.e., metrics or indicators) that will be used to determine how effectively CVFPP management actions contribute to the conservation needs of this species.

Measures for each target threatened or endangered species are organized around indicators of progress toward the Conservation Strategy's process, habitat, and stressor objectives (Table B.1-3 and Table B.1-4). The species-specific measures provide additional detail on geographic location, habitat structure, and other attributes important to conservation of the species.

Table B.1-3. Measures of the Contribution of CVFPP Actions to Conservation of the Delta Smelt

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Riverine Geomorphic Processes	Natural Bank—total length (miles)	Yes	Not applicable.
	River Meander Potential—total amount (acres)	Yes	Not applicable.
SRA Cover	SRA Cover and Bank and Vegetation Attributes of SRA Cover—total length (miles)	Yes	SRA cover in the Lower Sacramento River and Lower San Joaquin River CPAs may help moderate local temperatures by providing shade; therefore, the more shading of aquatic habitat, the greater benefit is likely to be accrued.
	Total Length and Percentage of Bank Affected by Flood Projects that Incorporate SRA Attributes	Yes	Not applicable.
Riparian	Habitat Amount—total amount and total amount on active floodplain (acres)	No	Not applicable.
	Habitat Connectivity—median patch size (acres)	No	Not applicable.
Marsh	Habitat Amount—total amount and total amount on active floodplain (acres)	Yes	Providing marsh habitat that does not include, and minimizes the likelihood of establishment of, non-native SAV is considered an important element for improving growth and survival.
Revetment	Revetment Removed to Increase Meander Potential or Natural Bank—total length (miles)	Yes	Decreasing turbidity in the Delta is considered detrimental to delta smelt. Increasing or restoring erodible banks, particularly in the tidally influenced habitats in the Lower Sacramento River and Lower San Joaquin River CPAs, would provide benefits.

SRA = shaded riverine aquatic

Table B.1-4. Measures of the Contribution of CVFPP Actions to Conservation of the Delta Smelt

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Levees	Levees Relocated to Reconnect Floodplain or Improved to Eliminate Hydraulic Constraints on Restoration—total length (miles)	Yes	Improving food production for delta smelt is considered an important element for improving growth and survival. Increasing floodplain connectivity, especially in the Yolo Bypass and in tidally influenced habitats of the Lower Sacramento River and Lower San Joaquin River CPAs, may improve system productivity in the Delta.
Fish Passage Barriers	Fish Passage Barriers—remediated or removed	No	Not applicable.
Invasive Plants	Invasive-plant-dominated Vegetation—total area reduced (acres)	Yes	Remove or decrease populations of non-native invasive aquatic plants (e.g., *Egeria* sp. and *Myriophyllum aquaticum*) that affect fish habitat, in addition to terrestrial plant species that affect river geomorphology and habitat quality (e.g., *Arundo* and saltcedar).

Note:
Floodplain inundation potential is the potential of an area to be inundated by a particular flow (e.g., a flow event that occurs about once every two years, or a “50-percent-chance event”). Expected annual habitat units represent the annual average of the area expected to be inundated in general or by flows meeting defined criteria for timing and duration (e.g., sustained spring flows).

Table B.1-3 lists the process, habitat, and stressor targets of the Conservation Strategy; identifies those used to measure the contribution to conservation of delta smelt; and provides additional specificity as necessary to measure this contribution. Management actions intended to benefit delta smelt may simultaneously affect the conservation of other species in the SPA. For this reason, these measures of contribution have been incorporated into each CPA’s objectives for the conservation of target species, which are provided in the Conservation Strategy Update. The target species objectives cover multiple species and reflect the interrelated nature of CVFPP flood management and conservation actions.

B1.3 References

Baxter R, Breuer R, Brown L, Conrad L, Feyrer F, Fong S, Gehrts K, Grimaldo L, Herbold B, Hrodey P, Mueller-Solger A, Sommer T, Souza K. 2010. *Interagency Ecological Program 2010 Pelagic Organism Decline Work Plan and Synthesis of Results*. December 2010. Sacramento (CA): Interagency Ecological Program for the San Francisco Estuary.

Bennett WA. 2005. "Critical Assessment of the Delta Smelt Population in the San Francisco Estuary, California." San Francisco Estuary and Watershed Science Volume 3 (Issue 2).

Bennett WA, Burau JR. 2015. "Riders on the Storm: Selective Tidal Movements Facilitate the Spawning Migration of Threatened Delta Smelt in the San Francisco Estuary." Estuaries and Coasts Volume 38 (Issue 3): Pages 826 to 835.

Bever AJ, MacWilliams ML, Herbold B, Brown LR, Feyrer FV. 2016. "Linking Hydrodynamic Complexity to Delta Smelt (*Hypomesus transpacificus*) Distribution in the San Francisco Estuary, USA." San Francisco Estuary and Watershed Science Volume 14 (Issue 1).

California Department of Water Resources. n.d. "Guess Who's Coming to Dinner: Evidence for Increasing Delta Smelt Utilization of the Yolo Bypass" [poster]. Prepared by: Mahardja B, Ikemiyagi N, Schreier B, Aquatic Ecology Section.

California Department of Water Resources. 2012. *Central Valley Flood Management Planning Program: Public Draft Conservation Framework*. Attachment 9C, "Fish Passage Assessment."

Cloern JE, Knowles N, Brown LR, Cayan D, Dettinger MD, Morgan TL, Shoellhamer DH, Stacey MT, van der Wegen M, Wagner RW, Jassby AD. 2011. "Projected Evolution of California's San Francisco Bay-Delta-River System in a Century of Climate Change." PLoS ONE Volume 6 (Issue 9):e24465.

Ferrari MCO, Ranåker L, Weinersmith KL, Young MJ, Sih A, Conrad JL. 2014. "Effects of Turbidity and an Invasive Waterweed on Predation by Introduced Largemouth Bass." Environmental Biology of Fishes Volume 97: Pages 79 to 90.

Feyrer F, Newman K, Nobriga M, Sommer T. 2010. "Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish." Estuaries and Coasts Volume 34: Pages 120 to 128.

Feyrer F, Nobriga ML, Sommer TR. 2007. "Multidecadal Trends for Three Declining Fish Species: Habitat Patterns and Mechanisms in the San Francisco Estuary, California, USA." Canadian Journal of Fisheries and Aquatic Science Volume 64: Pages 723 to 734.

Ger KA, Teh SJ, Goldman CR. 2009. "Microcystin-LR Toxicity on Dominant Copepods *Eurytemora affinis* and *Pseudodiaptomus forbesi* of the Upper San Francisco Estuary." Science of the Total Environment Volume 407: Pages 4,852 to 4,857.

Glibert PM. 2010. "Long-Term Changes in Nutrient Loading and Stoichiometry and Their Relationships with Changes in Food Web and Dominant Pelagic Fish Species in the San Francisco Estuary, California." Reviews in Fisheries Science Volume 18 (Issue 2): Pages 211 to 232.

Greenberg JA, Hestir EL, Riano D, Scheer GJ, Ustin SL. 2012. "Using LiDAR Data Analysis to Estimate Changes in Insolation under Large-Scale Riparian Deforestation." Journal of the American Water Resources Association Volume 48: Pages 939 to 948.

Grimaldo L, Miller RE, Peregrin CM, Hymanson Z. 2012. "Fish Assemblages in Reference and Restored Tidal Freshwater Marshes of the San Francisco Estuary." San Francisco Estuary and Watershed Science Volume 10 (Issue 1).

Hamilton SC, Murphy DD. 2018. "Analysis of Limiting Factors across the Life Cycle of Delta Smelt (*Hypomesus transpacificus*)." Environmental Management Volume 62: Pages 365 to 382.

Hamilton SA, Murphy DD. 2020. "Use of affinity analysis to guide habitat restoration and enhancement for the imperiled delta smelt." Endangered Species Research 43:103-120 www.abstracts.org .

Hammock BG, Hartman R, Slater SB, Hennessy A, Teh SJ. 2019. "Tidal Wetlands Associated with Foraging Success of Delta Smelt." Estuaries and Coasts Volume 42: Pages 857 to 867. Viewed online at: Delta-Smelt. Accessed: July 1, 2020.

Herbold B, Baltz DM, Brown L, Grossinger R, Kimmerer W, Lehman P, Simenstad CS, Wilcox C, Nobriga M. 2014. "The Role of Tidal Marsh Restoration in Fish Management in the San Francisco Estuary." San Francisco Estuary and Watershed Science Volume 12 (Issue 1). Viewed online at: Fish-Management. Accessed: December 23, 2015.

Hestir EL, Schoellhamer DH, Greenberg J, Morgan-King T, Ustin SL. 2015. "The Effect of Submerged Aquatic Vegetation Expansion on a Declining Turbidity Trend in the Sacramento–San Joaquin River Delta." Estuaries and Coasts Volume 39: Pages 1,100 to 1,112.

Hobbs JA, Bennett WA, Burton J. 2007. "Classification of Larval and Adult Delta Smelt to Nursery Areas by Use of Trace Elemental Fingerprinting." Transactions of the American Fisheries Society Volume 136: Pages 518 to 527.

Hobbs, JA, Lewis LS, Willmes M, Denny C, Bush E. 2019. "Complex Life Histories Discovered in a Critically Endangered Fish." Scientific Reports Volume 9: Article Number 16772. Viewed online at: Endangered-Fish. Accessed: July 1, 2020.

Interagency Ecological Program, Management, Analysis, and Synthesis Team. 2015. *An Updated Conceptual Model of Delta Smelt Biology: Our Evolving Understanding of an Estuarine Fish.* Technical Report 90. January 2015.

Jassby AD, Cloern JE, Cole BE. 2002. "Annual Primary Production: Patterns and Mechanisms of Change in a Nutrient-Rich Tidal Ecosystem." Limnology and Oceanography Volume 47 (Issue 3): Pages 698 to 712.

Jassby AD, Mueller-Solger AB, Vayssieres M. 2005. "Subregions of the Sacramento–San Joaquin Delta: Identification and Use." Interagency Ecological Program Newsletter Volume 18 (Issue 2): Pages 68 to 75.

Kimmerer WJ. 2004. "Open Water Processes of the San Francisco Estuary: From Physical Forcing to Biological Responses." San Francisco Estuary and Watershed Science Volume 2 (Issue 1).

Kimmerer WJ, Gartside E, Orsi JJ. 1994. "Predation by an Introduced Clam as the Likely Cause of Substantial Declines in Zooplankton of San Francisco Bay." Marine Ecology Progress Series Volume 113: Pages 81 to 93.

Kimmerer WJ, Nobriga ML. 2008. "Investigating Particle Transport and Fate in the Sacramento–San Joaquin Delta Using a Particle Tracking Model." San Francisco Estuary and Watershed Science Volume 6 (Issue 1).

Lehman PW, Sommer T, Rivard L. 2008. "The Influence of Floodplain Habitat on the Quantity and Quality of Riverine Phytoplankton Carbon Produced during the Food Season in San Francisco Estuary." Aquatic Ecology Volume 42: Pages 363 to 378.

Lehman PW, Mayr S, Mecum L, Enright C. 2010. "The Freshwater Tidal Wetland Liberty Island, CA Was Both a Source and Sink of Inorganic and Organic Material to the San Francisco Estuary." Aquatic Ecology Volume 44: Pages 359 to 372.

Lindberg JC, Tsai YJJ, Kammerer BD, Baskerville-Bridges B, Hung TC. 2020. "Spawning Microhabitat Selection in Wild-Caught Delta Smelt *Hypomesus transpacificus* under Laboratory Conditions." Estuaries and Coasts Volume 43: Pages 174 to 181.

Mahardja B, Hobbs JA, Ikemiyagi N, Benjamin A, Finger AJ. 2019. "Role of Freshwater Floodplain-Tidal Slough Complex in the Persistence of the Endangered Delta Smelt." PLoS ONE Volume 14 (Issue 1): e0208084. Viewed online at: Freshwater-Floodplain. Accessed: July 1, 2020.

Merz JE, Hamilton S, Bergman PS, Cavallo B. 2011. "Spatial Perspective for Delta Smelt: A Summary of Contemporary Survey Data." California Department of Fish and Game Volume 97 (Issue 4): Pages 164 to 189.

Moyle PB. 2002. *Inland Fishes of California*. Berkeley (CA): University of California Press.

Moyle PB, Herbold B, Stevens DE, Miller LW. 1992. "Life History and Status of Delta Smelt in the Sacramento–San Joaquin Estuary, California." Transactions of the American Fisheries Society Volume 121: Pages 67 to 77. Nobriga M, Herbold B. 2009. T*he Little Fish in*

California's Water Supply: A Literature Review and Life-History Conceptual Model for Delta Smelt (Hypomesus transpacificus) *for the Delta Regional Ecosystem Restoration and Implementation Plan (DRERIP)*. Sacramento–San Joaquin Delta Regional Ecosystem Restoration Implementation Plan.

Nobriga ML. 2002. "Larval Delta Smelt Diet Composition and Feeding Incidence: Environmental and Ontogenetic Influences." California Fish and Game Volume 88 (Issue 4): Pages 149 to 164.

Nobriga ML, Sommer TR, Feyrer F, Fleming K. 2008. "Long-Term Trends in Summertime Habitat Suitability for Delta Smelt (*Hypomesus transpacificus*)." San Francisco Estuary and Watershed Science Volume 6 (Issue 1).

Polansky L, Mitchell L, Newman KB. 2019. "Using Multistage Design-Based Methods to Construct Abundance Indices and Uncertainty Measures for Delta Smelt." Transactions of the American Fisheries Society Volume 148: Pages 710 to 724.

Poole GC, Berman CH. 2001. "An Ecological Perspective on In-Stream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation." Environmental Management Volume 27 (Issue 6): Pages 787 to 802.

Schoellhamer DH. 2011. "Sudden Clearing of Estuarine Waters upon Crossing the Threshold from Transport to Supply Regulation of Sediment Transport as an Erodible Sediment Pool is Depleted: San Francisco Bay, 1999." Estuaries and Coasts Volume 34: Pages 885 to 899.

Slater SB. 2012. "Delta Smelt Regional Feeding Patterns in Fall 2011." Interagency Ecological Program for the San Francisco Estuary Newsletter Volume 25 (Issue 2): Pages 36 to 42.

Slater SB, Baxter RD. 2014. "Diet, Prey Selection, and Body Condition of Age-0 Delta Smelt, *Hypomesus transpacificus*, in the Upper San Francisco Estuary." San Francisco Estuary and Watershed Science Volume 12 (Issue 3).

Sommer T, Hartman R, Koller M, Koohafkan M, Conrad JL, MacWilliams M, Bever A, Burdi C, Hennessy A, Beakes M. 2020. "Evaluation of a large-scale flow manipulation to the upper San Francisco Estuary: Response of habitat conditions for an endangered native fish." Flow-Manipulation. Accessed: October 19, 2021.

Sommer T, Mejia F. 2013. "A Place to Call Home: A Synthesis of Delta Smelt Habitat in the Upper San Francisco Estuary." San Francisco Estuary and Watershed Science Volume 11 (Issue 2).

Sommer T, Mejia FH, Nobriga ML, Feyrer F, Grimaldo L. 2011. "The Spawning Migration ofDelta Smelt in the Upper San Francisco Estuary." San Francisco Estuary and Watershed Science Volume 9 (Issue 2).

Souza K. 2002. "Revision of California Department of Fish and Game's Spring Midwater Trawl and Results of the 2002 Spring Kodiak Trawl." Interagency Ecological Program for the San Francisco Estuary Newsletter Volume 15 (Issue 3): Pages 44 to 47.

Swanson C, Reid T, Young PS, Cech JJ. 2000. "Comparative Environmental Tolerances of Threatened Delta Smelt (*Hypomesus transpacificus*) and Introduced Wakasagi (*H. nipponensis*) in an Altered California Estuary." Oecologia Volume 123: Pages 384 to 390.

Thomson JR, Kimmerer WJ, Brown LR, Newman KB, MacNally R, Bennett WA, Feyrer F, Fleishman E. 2010. "Bayesian Change Point Analysis of Abundance Trends for Pelagic Fishes in the Upper San Francisco Estuary." Ecological Applications Volume 20 (Issue 5): Pages 1,431 to 1,448.

U.S. Bureau of Reclamation. 2007. *Spawning, Early Life Stages, and Early Life Histories of the Osmerids Found in the Sacramento–San Joaquin Delta of California*. Mid-Pacific Region, Technical Service Center. Prepared by: Wang JCS, National Environmental Science, Byron (CA). October 2007.

U.S. Fish and Wildlife Service. 2010. *5-Year Review on Delta Smelt (Hypomesus transpacificus). Current Classification: Threatened.* Prepared by: Poage V, Bay-Delta Fish and Wildlife Office.

U.S. Fish and Wildlife Service. 2017. Species Assessment and Listing Prioritization Assignment Form: Delta Smelt (*Hypomesus transpacificus*). October 13, 2017.

U.S. Fish and Wildlife Service. 2020. Candidate Notice of Review. *Federal Register*. Volume 85, No. 221. Proposed Rules. November 16, 2020.

Wagner RW. 2012. *Temperature and Tidal Dynamics in a Branching Estuarine System.* Dissertation. Berkeley (CA): University of California, Berkeley.

Whipple AA, Grossinger RM, Rankin D, Stanford B, Askevold RA. 2012. *Sacramento–San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process.* Prepared for the California Department of Fish and Game and Ecosystem Restoration Program. A Report of SFEI-ASC's Historical Ecology Program, Publication #672. Richmond (CA): San Francisco Estuary Institute–Aquatic Science Center.

Winder M, Jassby AD. 2011. "Shifts in Zooplankton Community Structure: Implications for Food Web Processes in the Upper San Francisco Estuary." Estuaries and Coasts Volume 34: Pages 675 to 690.

Wright SA, Shoellhamer DH. 2004. "Trends in the Sediment Yield of the Sacramento River, California, 1957–2001." San Francisco Estuary and Watershed Science Volume 2 (Issue 2).

Appendix B.2
Focused Conservation Plan:
Tricolored Blackbird

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APPENDIX B.2

Focused Conservation Plan: Tricolored Blackbird

Source: H. T. Harvey & Associates

B2.1 Conservation Status

As part of the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy Update, this focused conservation plan addresses needs and opportunities to conserve the tricolored blackbird (*Agelaius tricolor*) and its habitat in the Systemwide Planning Area (SPA).

Except for small nesting colonies found locally in Oregon, Washington, Nevada, and Baja California, the tricolored blackbird is restricted to California (Beedy 2008). The global population was estimated at approximately 163,000 adults in 2000 (Beedy 2008), with more than 99 percent in California (Hamilton 2000). A recent Tricolored Blackbird Statewide Survey counted a total of 177,656 birds in 37 counties from 44 counties surveyed (Meese 2017).

As indicated in the 2016 CVFPP Conservation Strategy (Conservation Strategy) (California Department of Water Resources 2016), because the conservation needs of species change, additional species may be added to the list of target species during the five-year update process. When the tricolored blackbird was screened as a potential target species in the first iteration of the Conservation Strategy, it was a California Species of Special Concern and was not included as a target species (Appendix G of the 2016 Conservation Strategy). However, on March 18, 2019, the species was subsequently elevated from a Species of Special Concern to a threatened species under the California Endangered Species Act (CESA) due to the precipitous population decline (nearly 90 percent since the 1930s).

In 1991, the U.S. Fish and Wildlife Service (USFWS) included the tricolored blackbird as a candidate (Category 2) for listing as either threatened or endangered (59 *Federal Register* 58990, November 15, 1994) under the federal Endangered Species Act (ESA). USFWS policy changes in 1995 eliminated the Category 2 candidate designation nationwide, and because of this policy change, the species was removed from candidacy.

In 2006, USFWS rejected the petition to list the tricolored blackbird as threatened or endangered. This finding was based on a USFWS 90-day review, which determined that the scientific and commercial information presented in the petition did not warrant listing (Tricolored Blackbird Working Group 2007). On August 15, 2019, USFWS again published a finding that listing the tricolored blackbird under ESA was not warranted, because of “high nesting success in both small and large colonies” and existing regulatory mechanisms, including CESA, that “are currently acting to ameliorate the severity of some existing threats.” (Meese 2019).

Thus, the tricolored blackbird is not listed under ESA; however, in addition to its listing under CESA (14 California Code of Regulations Section 670.5), this species is also protected by the federal Migratory Bird Treaty Act and California Fish and Game Code (Sections 3503, 3503.5, and 3513).

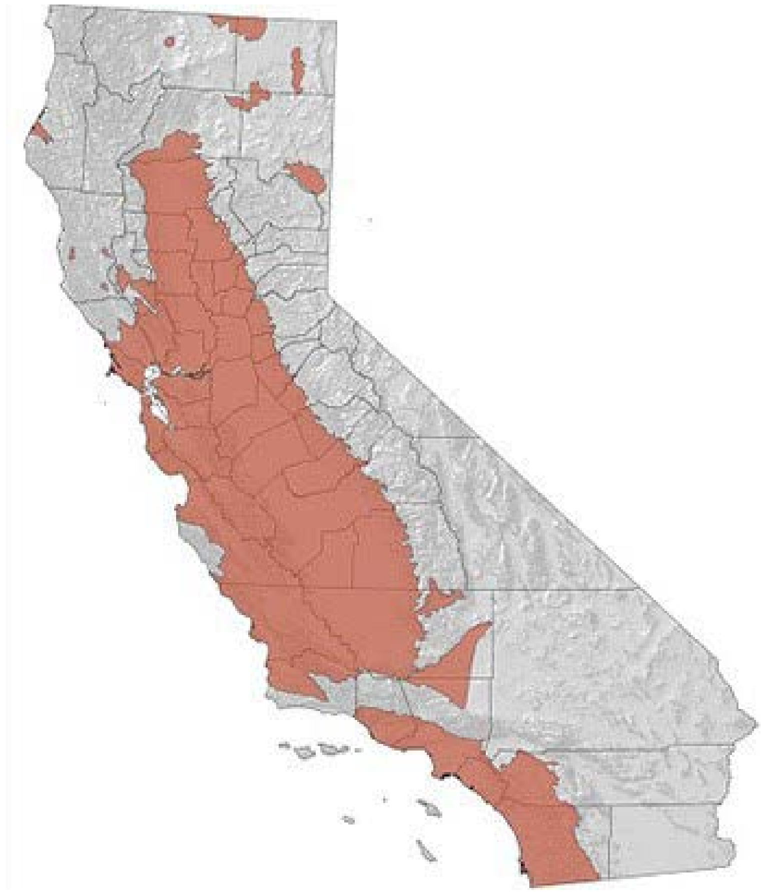
B2.1.1 Status and Trends

B2.1.1.1 Distribution

Figure B.2-1 shows the known distribution of tricolored blackbird in California. This species is restricted to California’s Central Valley and surrounding foothills and coastal and inland localities in Southern and Central California, with local populations in northeastern California, Oregon, central Washington, western Nevada, and northwestern Baja California (Beedy et al. 2020). The global population was estimated at approximately 163,000 adults in 2000 (Beedy 2008), with more than 99 percent in California and, in most years, 90 percent of the breeding population occurring in the Central Valley (Hamilton 2000). A recent Tricolored Blackbird Statewide Survey counted a total of 177,656 birds in 37 counties from 44 counties surveyed (Meese 2017).

Tricolored blackbirds also breed locally in other lowland areas west of the Sierra and Cascade Ranges and in northeastern California. During winter, most of the population remains within California, where they are joined by the birds that breed north of the state (Beedy 2008).

Figure B.2-1. Known Tricolored Blackbird Distribution in California



Source: California Department of Fish and Wildlife 2020

As a species, tricolored blackbirds are resident throughout the year in California, but individual birds migrate and move extensively within the range (Beedy 2008).

B2.1.1.2 Population Trends

Vast flocks of these birds once occurred in California; however, habitat loss, poisonings and shootings of blackbirds to protect crops, pesticide use, and large, persistent, and ongoing annual losses of nests and nesting habitat have contributed to rapid declines of the species in California (Center for Biological Diversity 2015). Virtually all suitable habitats formerly supported foraging and nesting tricolored blackbirds, including marshlands and riparian woodlands in the Central Valley (Beedy et al. 2020). The most common form of destruction of large nesting colonies (more than 50,000 nests) in the San Joaquin Valley, particularly in the early 1990s, was from harvesting grain and discing weeds on fields that supported nesting colonies of tricolored blackbirds (Beedy et al. 2020).

Recent surveys, combined with historical information, indicate the tricolored blackbird has undergone a long-term population decline (Tricolored Blackbird Working Group 2007). In 2014, the population of this species was the smallest number ever recorded, at only 145,000 birds, and the 2017 Tricolored Blackbird Statewide Survey recorded a total of 177,656 birds from 37 counties. By comparison, in 1934, Neff (1937) observed as many as 736,500 from just eight Central Valley counties, and 19th century accounts described flocks of thousands "numbering so many thousands as to darken the sky for some distance by their masses" (Heermann [1859] as conveyed by Beedy 2008). From 1931–1936, Neff (1937) found 252 colonies in 26 California counties, with the largest colony estimated to contain more than 200,000 nests and several others with more than 100,000 (Beedy 2008).

Statewide censuses have revealed steep declines in tricolored blackbird numbers in the Central Valley (Beedy and Hamilton 1997; Hamilton et al. 1999; Hamilton 2000; Green and Edson 2004; Cook and Toft 2005; Meese 2017). Studies conducted in the 1970s revealed that the overall population decreased substantially from the 1930s; more recently, intensive surveys identified a decline of 37 percent between 1994 and 1997 and a 63-percent decline between 2008 and 2014, followed by an increase of 22 percent in 2017 (Beedy et al. 2020).

B2.1.2 Life History

The tricolored blackbird diverged from its closest related taxon, the red-winged blackbird (*A. phoeniceus*), more than 3 million years ago (Yasukawa and Searcy 1995). As is the case with red-winged blackbirds, tricolored blackbirds are sexually dimorphic in plumage and size, with males being the larger sex. However, contrary to the variation in California populations of the red-winged blackbird, tricolored blackbirds do not vary in either plumage or body size across the breeding range, and their vocalizations are not regionally distinct (Beedy et al. 2020).

Tricolored blackbirds are colonial breeders, forming the largest colonies of any North American songbird, and breeding colonies have historically consisted of tens to hundreds of thousands of birds (Beedy et al. 2020). Males defend the immediate nesting area and territory size ranges from 6 to 11.5 square feet (Orians 1961). Like red-winged blackbirds, tricolored blackbirds have a polygynous breeding system; one study reported two to three females per territorial male (Collier 1968).

The basic requirements for tricolored blackbird breeding habitat are open, accessible water; a secure nesting substrate; and close foraging habitat with adequate food resources. All of these elements must be present for successful breeding (Beedy and Hamilton 1999; Meese and Beedy 2015). Historically, most colonies were located in freshwater marshes dominated by cattails (*Typha* spp.) or tules (*Schoenoplectus* spp.), with some in nettles (*Urtica* spp.), thistles (*Cirsium* spp.), and willows (*Salix* spp.) (Tricolored Blackbird Working Group 2007). This species also nests in riparian scrub and forests (Beedy and Hamilton 1999); for example, a large colony currently breeds in riparian scrub in the Panoche Valley (Shearwater pers. comm. May 23, 2020). In recent years, large numbers of tricolored blackbirds have also bred in agricultural (e.g., silage) fields.

Nesting tricolored blackbirds prefer large, continuous blocks of cattails and tules (often in the first or second year of growth), and optimal marsh conditions include emergent vegetation at least 4.3 feet high and submerged in shallow water 6 to 18 inches deep (Meese and Beedy 2015). Cattail stands must be at least 50 feet wide to support successful nesting (Meese and Beedy 2015).

With the loss of natural flooding processes and the riparian succession and wetlands sustained by such processes, tricolored blackbirds in the Central Valley forage primarily in managed habitats, including agricultural crops, such as alfalfa, irrigated pastures, grain fields; and in other areas, such as annual grassland, cattle feedlots, and dairies (Tricolored Blackbird Working Group 2007). Tricolored blackbirds continue to forage in remnant native habitats, including riparian scrub, open marshes, and seasonal wetlands.

Typically, tricolored blackbirds forage within approximately 3 to 4 miles of the nesting colony (Orians 1961; Beedy and Hamilton 1997; Tricolored Blackbird Working Group 2007; Beedy et al. 2020). The proximity to suitable foraging habitat appears to be extremely important in establishing breeding colony sites.

The following prey items are important for feeding nestlings (Crase and DeHaven 1977; Tricolored Blackbird Working Group 2007):

- Beetles (Coleopterans).
- Grasshoppers and locusts (Orthopterans).
- True bugs (Hemipterans).
- Spiders (Arachnids).
- Larval insects.

Nest heights typically range from a few inches to about 5 feet above water or ground level in freshwater marshes, and up to 10 feet in the canopies of willows and other riparian trees (Neff 1937; Beedy 2008).

Tricolored blackbirds can attempt to breed more than once per season. Many birds appear to exhibit this behavior by breeding early in the season in the San Joaquin Valley, and then moving to the Sacramento Valley to breed later in the season (Tricolored Blackbird Working Group 2007).

During the non-reproductive season, tricolored blackbirds form huge mixed-species flocks that include red-winged blackbirds, Brewer's blackbirds (*Euphagus cyanocephalus*), European starlings (*Sturnus vulgaris*), and brown-headed cowbirds (*Molothrus ater*). These mixed-species flocks forage in grasslands, in agricultural fields with low-growing vegetation, and at dairies and feedlots (Meese and Beedy 2015). In February, tricolored blackbirds segregate into pure tricolored blackbird flocks before the breeding season (Beedy 2008). Figure B.2-2 shows the *Birds of The World* annual cycle for the tricolored blackbird. As the figure shows, peak molting occurs between the latter part of June and early to mid-September; peak breeding occurs between late March and late June; and peak migration occurs from late March through mid-June.

B2.1.3 Habitat and Ecological Process Associations

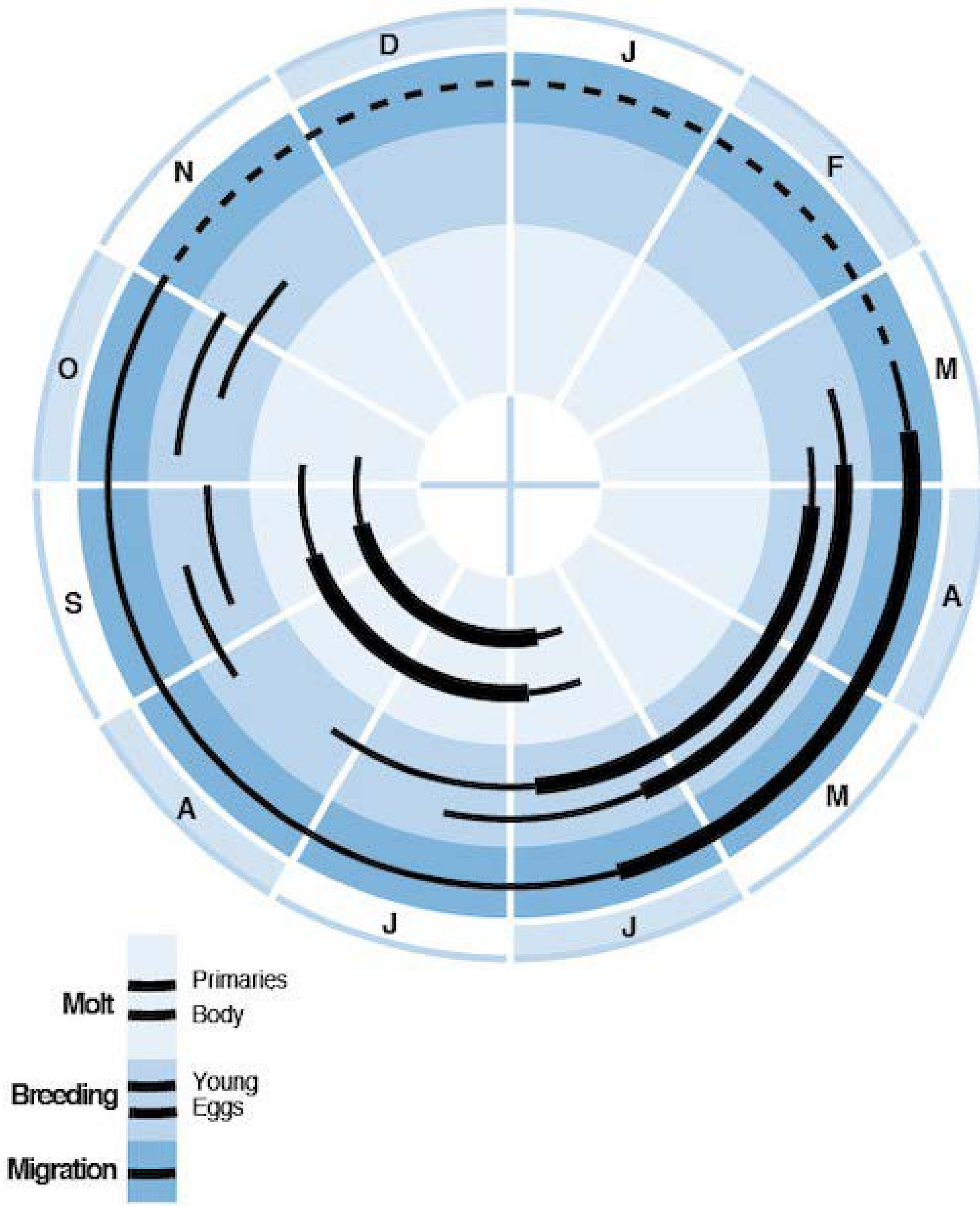
B2.1.3.1 Conceptual Models

A conceptual model has been designed to assist in the development of a targeted conservation strategy for the tricolored blackbird within the SPA (Figure B.2-3). This model is not intended to be a comprehensive model of all ecological processes, stressors, and other factors that could be relevant for this species. Rather, as Figure B.2-3 shows, the conceptual model specifically depicts all of the following considerations:

- Habitat conditions required by tricolored blackbirds within the SPA: early successional marsh and riparian habitat, open accessible water, protected nesting substrate (thorny or flooded vegetation), and adequate insect prey within a few kilometers.
- The specific Conservation Planning Areas (CPAs) within which tricolored blackbirds breed: The Upper and Lower Sacramento and San Joaquin River CPAs and the Feather River CPA.
- Key ecosystem processes of riverine systems within the SPA potentially affected by actions associated with the CVFPP and Conservation Strategy: Riverine geomorphic processes and floodplain inundation that sustains and renews marsh and riparian habitat; loss of the nesting colony or nesting habitat; and herbicide impacts.
- Stressors related to State Plan of Flood Control (SPFC) facilities and their operations and maintenance: Revetment and levees, floodway management and maintenance, and agricultural operations.

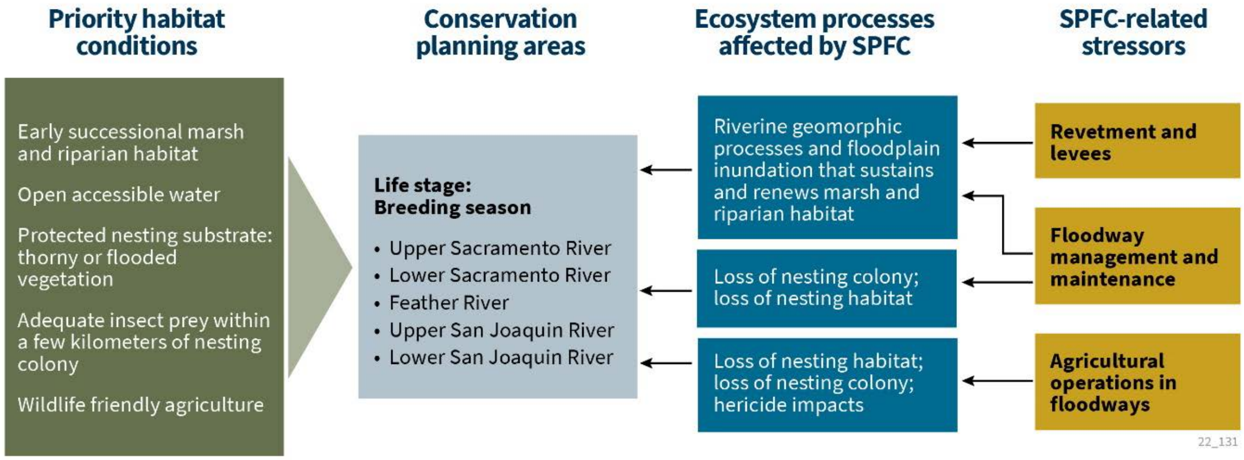
Figure B.2-2. Annual Cycle of the Tricolored Blackbird in California's Central Valley

Thick lines show peak activity; thin lines, off-peak.



Source: Beedy et al. 2020; reproduced with permission.

Figure B.2-3. Conceptual Model for the Tricolored Blackbird within the Systemwide Planning Area



B2.1.4 Management Issues

B2.1.4.1 Threats and Sensitivities Rangewide

The greatest effects of anthropogenic activity on tricolored blackbirds are related to habitat loss and the direct disturbance of active nest colonies (Beedy et al. 2020). Suitable habitats in the Central Valley (riparian habitat, marshlands, and perennial grasslands) formerly supported nesting and foraging tricolored blackbirds, but most of the valley has been converted to agriculture and urban development.

The historical—and still preferred—breeding habitat for tricolored blackbirds is freshwater emergent wetland vegetation (Neff 1937; DeHaven et al. 1975; Beedy and Hamilton 1999; Tricolored Blackbird Working Group 2007). In the past, most nesting colonies were in freshwater marshes (Beedy 2008). Water diversions and the loss of natural riverine processes have resulted in the large-scale loss and fragmentation of preferred breeding and foraging habitat for the tricolored blackbird; most researchers consider losses of natural breeding and foraging habitats to be the most important causes of the documented population declines (Tricolored Blackbird Working Group 2007). Before damming, water diversion, and flood control infrastructure and management were implemented, the Central Valley flooded during many years, forming a vast mosaic of riparian forests, freshwater marshes, seasonal wetlands, alkali flats, and upland habitats (including native grasslands and oak savannas) that supported large numbers of tricolored blackbirds (Beedy 2008).

The small percentage of California's original freshwater wetlands remaining in the Central Valley often occurs in small, isolated patches that also support high densities of predators (Tricolored Blackbird Working Group 2007). The shift in the Central Valley during the past century from marsh nesting to silage and rice field nesting is likely related to the loss of freshwater marshes.

Based on the importance of foraging habitat close to potential breeding sites, land uses within 3–4 miles of a breeding colony site—which in turn influences the local prey base—determine colony occupation and reproductive success at the particular potential breeding site (Tricolored Blackbird Working Group 2007). Agricultural crops not favorable for foraging tricolored blackbirds (e.g., vineyards and nut trees) have replaced, and continue to replace, grasslands and other more favorable crops (e.g., row and field crops) throughout the Central Valley. This conversion has resulted in decreased foraging opportunities for tricolored blackbirds near otherwise favorable breeding locations, reducing the number of nesting locations and overall foraging area.

Many of the Central Valley's freshwater marshes are managed for waterfowl and other marsh-dependent species. For tricolored blackbirds, water levels need to be deep enough to deter predators, but not deep enough to flood nests—both of which lead to nest loss (Tricolored Blackbird Working Group 2007). Frequent disturbances by predators during nesting may cause mass desertions of breeding colonies at sensitive phases of the breeding cycle; thus, marsh management that does not address the tricolored blackbird's nesting requirements is also a threat.

A major deleterious, rangewide, population-level impact has resulted from agricultural land uses involving grain harvesting and discing in fields occupied by breeding colonies of tricolored blackbirds, causing the loss of some of the largest colonies in California (Beedy et al. 2020).

Because this species nests in large, dense colonies, it is more vulnerable to nest failures that can affect large numbers of nests in a single colony. Large colonies (more than 50,000 nests) in the San Joaquin Valley were destroyed in the 1990s and the first decade of the 2000s. Shooting by farmers attempting to reduce crop damage has been documented in the Sacramento Valley since 2007 (Beedy et al. 2020). Although tricolored blackbirds are listed as threatened under CESA, other blackbird species exempted from protection under federal and state law are often shot in large numbers when depredating rice. During that time of year (autumn), tricolored blackbirds occur in mixed blackbird flocks, and thus, an unknown number of tricolored blackbirds is shot each fall (Meese and Beedy 2015).

Pesticides and other contaminants also affect, or may affect, tricolored blackbirds. For example, selenium contamination is known to decrease hatchability in the closely related red-winged blackbird; and in 1986, nearly complete nesting failure was observed at Kesterson Reservoir in Merced County, which contained water contaminated by high concentrations of selenium from agricultural drainwater (Beedy et al. 2020). Other examples include eggs sprayed with mosquito abatement oil that have failed to hatch and loss of colonies because of the aerial application of herbicides (Beedy et al. 2020).

Concerns have arisen regarding the effects of newly developed water-soluble pesticides targeting insect populations—neonicotinoids and pyrethroids—on the availability of insect food required to raise tricolored blackbird young, and recent declines in tricolored blackbirds breeding in the Sacramento Valley (Beedy et al. 2020).

With respect to overall tricolored blackbird population management issues and approach, a recent study (Barr et al. 2021) on genetic diversity within the breeding range of tricolored blackbirds found that genetic diversity is low and homogenous across breeding colonies and that these results indicate that the species as a whole may be justifiably considered a single management unit. Thus Barr et al. (2021) conclude that tricolored blackbirds may be managed without concern for gene flow or maintaining particular breeding populations to preserve genetic diversity.

B2.1.4.2 Ongoing and Future Impacts

- Losses of breeding and foraging habitat related to conversion of agricultural and urban land uses in the Central Valley has resulted in significant negative impacts on the tricolored blackbird population, and continues to do so. This is considered the most significant factor in the long-term reduction of this species' population (Beedy and Hamilton 1997; Hamilton et al. 1999; Hamilton 2000; Tricolored Blackbird Working Group 2007).

- Direct impacts of anthropogenic activities, including harvesting, plowing, burning, andwater management, have included the loss of nesting substrate and nests. (In some cases, large numbers of nests have been lost in a single event.) In the SPA, ongoing floodway maintenance, weed eradication, and other ground-disturbing activities can destroy or degrade nesting substrate or result in the loss of active nesting colonies. Ground disturbance can also degrade tricolored blackbird foraging habitat by disrupting soils and reducing prey availability. The use of revetment and other bank protection measures may eliminate the species' habitat.

- Urbanization, agricultural expansion, and other land conversion practices are increasing the abundance of predators by providing anthropogenic food sources and increasing the suitability of habitat for predatory species. Also, the presence of infrastructure such as roadways facilitates predator access into wetland areas.

- The burning and discing of marshes at Central Valley ranches and duck clubs during the spring decreases the number of suitable spring breeding sites for tricolored blackbird, resulting in a temporary loss of breeding habitat in those areas. Water management at freshwater marshes managed for species other than tricolored blackbirds can result in a loss of nests and nesting habitat.

B2.1.4.3 Key Information Gaps or Uncertainties

- **Breeding biology.** Many aspects of tricolored blackbird breeding biology require further study (Beedy et al. 2020). Of these aspects, perhaps most relevant to this focused conservation plan is the need to more precisely determine the factors that lead to nest-site selection, especially the roles of nest-substrate characteristics versus insect abundance in local foraging areas. Another prioritized research area is an assessment of relationships between habitat suitability, foraging ecology, and site philopatry (the tendency of a species to stay in or regularly return to a particular habitat). Further research needs also include assessing the effects of land use characteristics on colony size and reproductive success within colonies, and identifying the ecological factors responsible for multiple breeding attempts in a single breeding season and the relative reproductive success of those attempts.

- **Foraging ecology and pesticides.** Further research is needed on foraging ecology, including quantifying the food supply; identifying the environmental factors that result in an abundance of grasshoppers and other large insect prey in grasslands; and assessing their variability in time and space (Beedy et al. 2020). Also necessary are associated assessments of the relative abundance of insects in organic (unsprayed) versus conventional (sprayed) fields of alfalfa, rice, and sunflowers, and of the potential effects of different pesticides on prey availability.

- **Habitat and predation impacts.** Significant land use changes in the Central Valley have not only led to large-scale losses of breeding and foraging habitats, but also have increased both numbers of tricolored blackbird predators and their access to tricolored blackbird colonies. Research priorities include quantifying recent and projected habitat losses from shifts in agriculture from row crops to orchards and vineyards, or other land uses such as urban (Beedy et al. 2020). Data gaps to close involve prioritizing and managing nesting habitat; assessing the best means to establish alternative freshwater breeding habitat to draw birds away from nesting in silage fields; and comparing differential predation rates by nesting substrate.

B2.2 Distribution and Population Status

Monitoring the population trends and distribution of the tricolored blackbird will enable researchers to determine relative contributions of habitat loss and degradation, and to relate changes in population size and locations of tricolored blackbirds to landscape-level changes in habitats. Documenting the effects of restored natural river system dynamics, marshes, and riparian habitats on tricolored blackbirds will further inform ongoing and future implementation and management strategies. Understanding these dynamics is important for identifying and prioritizing sites for conservation and management of this species.

B2.2.1 Conservation and Recovery Opportunities

A primary conservation priority for tricolored blackbirds is to create new areas of appropriate habitat and to maintain, enhance, and protect existing habitat suitable for nesting, foraging, and wintering (Tricolored Blackbird Working Group 2007). In the CPAs, the most viable way to increase the population of this species is to create and maintain shallowly inundated emergent wetland habitat and riparian scrub and woodland with native vegetation suitable for foraging and nesting by tricolored blackbirds, and to maintain practices that do not result in nest destruction in agricultural lands in the floodplain.

Nesting colonies can be protected by harvesting crops outside the nesting season or conducting nesting surveys just before harvest to ensure that no nesting tricolored blackbirds are present. The same approach should be applied to vegetation management on levees and within the floodplain. (For example, tricolored blackbirds have nested in thistle on flood control levees in the South Bay region of the San Francisco Bay Area [personal observations by Scott Terrill, principal, wildlife ecology, HT Harvey & Associates, 1990s;] and in mustard, Brassicaceae, stands adjacent to the South Bay Aqueduct [D. Tsao pers. comm. February 10, 2021]). In the CPAs, this species would benefit from management and restoration activities that encourage the expansion of emergent wetlands and riparian habitats, and agricultural practices and maintenance activities (e.g., vegetation clearing) that are modified to avoid the destruction or abandonment of nests.

Like several other target species (e.g., least Bell's vireo and yellow-breasted chat), tricolored blackbirds would benefit from the restoration of natural riverine processes that promote early successional habitat and the implementation of riparian habitat restoration to increase and sustain suitable nesting habitat throughout the SPA.

B2.2.2 Identified Conservation Needs

1. **Increase and sustain nesting habitat:** Habitat loss and degradation and nest destruction by anthropogenic activities are the primary threats to the tricolored blackbird (Beedy and Hamilton 1999). Successful nesting requires appropriate water levels and suitable nesting habitat consisting of freshwater marsh with native cattails and tules. To the extent possible, these wetlands should be placed, designed, and managed to minimize predation. In addition, riparian scrub with native willows and other vegetation should be established to provide important nesting habitat.

   Removing non-native, invasive vegetation would also improve opportunities for native vegetation to colonize these areas. However, some introduced plants do provide favorable habitat for breeding and foraging tricolored blackbirds; among these are Himalayan blackberry (*Rubus armeniacus*) and introduced thistles (Beedy 2008). Creating setback levees and facilitating natural processes that lead to relatively continuous, dynamic riparian successional stages within the system would provide opportunities to renew, expand, and sustain nesting habitats. Decommissioning levees should also contribute to geomorphic processes that create diverse riparian ecosystems including early successional habitat and marsh. Creation and expansion of both habitats would be important contributions toward increasing tricolored blackbird populations and the overall recovery of the species.

   Ideal management involves actions that return the marsh to an early stage of dense, rapidly growing stems through effective water management, coupled with the removal of dead stems through burning, grazing, discing, or masticating, or by restoring the natural floodplain conditions that lead to emergent marsh regeneration naturally. Burning is the preferred method of maintaining optimal wetland vegetation: It removes old stems while releasing nutrients supporting the growth of new stems (Meese and Beedy 2015).

   A water management approach of perennial flooding that provides optimal vegetation conditions that may last for four or five years is optimal (Meese and Beedy 2015). Seasonally flooded wetlands, must, however, be managed in an annual or biennial cycle to provide the lush, young cattails preferred by nesting tricolored blackbirds. Management, including seasonal flooding, should be timed so cattails and tules are at least 4 feet tall by April 1 in the San Joaquin Valley and by May 1 in the Sacramento Valley. This growth requires saturated soils from winter through spring that result from inundation (Meese and Beedy 2015). Management recommendations also include maintaining standing water 6 to 18 inches deep throughout the breeding season to minimize predation by mammals and to cool the microhabitat temperature around nests.

2. **Increase and sustain foraging habitat:** Increasing habitat types that expand the invertebrate prey base—especially grasshoppers, locusts, and other large insects used to raise young—is an important conservation need. Spraying crops that provide a prey base for nesting tricolored blackbirds should be avoided because it negatively affects food availability and could reduce reproductive success.

3. **Minimize nest loss associated with anthropogenic activities:** Nesting colonies could be protected by clearing potential tricolored nesting habitat outside the nesting season or by completing pre-clearing nesting surveys to ensure no nesting tricolored blackbirds are present. Other anthropogenic activities could result in nest loss, such as the inappropriate management of water levels that causes wetlands to drain or floods nests, or construction activities at or near colonies. Wetlands appropriate for breeding should not be drained during the breeding season, and water levels should be managed to avoid causing nest loss in wetlands that support breeding tricolored blackbirds.

B2.2.3 Integration of Conservation and Restoration in Flood Management

As Tables B.2-1 and B.2-2 identified, CVFPP management actions have the potential to provide positive, negative, or neutral contributions to the identified conservation needs of the tricolored blackbird. In many cases, the species' conservation needs could be positively addressed by implementing management actions that integrate conservation and restoration elements with SPFC operation and maintenance, floodway management, and other structural and nonstructural improvements. The ability to implement some of these actions would depend on operations, maintenance, and floodway management actions and other structural and nonstructural improvements (as described in the following section) to resolve constraints, such as the floodway's existing capacity to convey flood flows, or revetment removal at a site that may depend on levee relocation to allow for bank erosion. Wherever feasible, conservation objectives and indicators will inform management actions for adaptive, responsive, and sustainable implementation that avoids and minimizes impacts on species and ecosystems.

Table B.2-1. Summary of the Contributions of CVFPP Management Actions to Identified Conservation Needs of the Tricolored Blackbird

SPFC Conservation Actions – Operations, Maintenance, and Floodway Management	Conservation Need 1. Increase Inundated Floodplain	Conservation Need 2. Improve Natural River Function	Conservation Need 3. Decrease Non-native SAV
Floodwater storage and reservoir forecasting, operations, and coordination	Neutral	Neutral	Neutral
Facility maintenance	Neutral	Neutral	Neutral
Levee vegetation management	Negative	Negative	Negative
Floodway maintenance	Negative	Neutral	Negative
Modification of floodplain topography	Positive	Positive	Neutral
Support of floodplain agriculture	Negative	Negative	Negative
Invasive-plant management	Positive	Positive	Neutral
Restoration of riparian, SRA, and marsh habitats	Positive	Positive	Neutral
Wildlife-friendly agriculture	Positive	Positive	Positive

Notes:
SAV = submerged aquatic vegetation
SPFC = State Plan of Flood Control

Table B.2-2. Summary of the Contributions of CVFPP Management Actions to Identified Conservation Needs of the Tricolored Blackbird

SPFC Conservation Actions – Structural and Nonstructural Improvements	Conservation Need 1. Increase Inundated Floodplain	Conservation Need 2. Improve Natural River Function	Conservation Need 3. Decrease Non-native SAV
Levee and revetment removal	Positive	Positive	Neutral
Levee relocation	Positive	Positive	Neutral
Bypass expansion and construction	Positive	Positive	Neutral
Levee construction and improvement	Positive	Positive	Neutral
Flood control structures	Neutral	Neutral	Neutral

Notes:
CVFPP management actions are designated as having the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the species.

SAV = submerged aquatic vegetation
SPFC = State Plan of Flood Control

B2.2.4 Operations, Maintenance, and Floodway Management

Levee vegetation management: Tricolored blackbirds will nest in vegetation on flood control levees, including several types of introduced plants, if the vegetation is attractive for nesting (e.g., Himalayan blackberry, thistle). To avoid direct losses of active nests, any vegetation management of potential breeding habitat on levees should take place outside the tricolored blackbird's nesting season. If this is not possible, pre-clearing nesting surveys should be conducted immediately before the management is scheduled for implementation. If active nests are found, management efforts should be delayed until the colony has fledged.

Floodway maintenance: The floodway supports breeding habitat for tricolored blackbirds, including wetlands with emergent vegetation and riparian scrub and woodlands. Maintenance activities that result in the clearing of nesting habitat (or that otherwise substantially affect such habitat) should occur outside the tricolored blackbird's breeding season. This approach applies not only to vegetation clearing, but also to activities such as demolition or construction, and to other activities near a colony that might disturb the birds to the point of nest abandonment. To avoid direct losses of active nests, vegetation management in potential breeding habitat in the floodplain should occur outside the tricolored blackbird's nesting season. If this is not possible, pre-clearing nesting surveys should be conducted immediately before the management is scheduled for implementation. If active nests are found, management efforts should be delayed until the colony has fledged and then can begin immediately. In addition, preconstruction surveys should be conducted before the start of other types of activities during the breeding season that might result in nest abandonment if appropriate nesting habitat occurs within a given distance of the project (to be determined in consultation with the California Department of Fish and Wildlife).

Modification of floodplain topography: Floodway modifications in strategic locations may provide emergent freshwater marsh habitat and allow for greater topographic and hydrologic diversity, creating habitat conditions that support tricolored blackbirds. Floodplain surfaces could be lowered by excavating benches or swales that allow for more frequent and sustained inundation, which would facilitate marsh formation and may allow additional riparian vegetation to grow along channel margins.

Support of floodplain agriculture: Although tricolored blackbirds do nest and forage in appropriate agricultural crops (i.e., row and field crops), agriculture has replaced vast amounts of native habitat for tricolored blackbirds. However, major nesting colonies have been lost during harvesting, meaning agriculture can represent a significant population sink—and agriculture has replaced much of the historical and preferred habitats occupied by tricolored blackbirds (Beedy 2008). However, some aspects of agriculture that are "friendly" to the species can be applied to agriculture in the CPAs to benefit the species ("Wildlife-friendly agriculture," later in this section, provides more details).

Invasive-plant management: New weed infestations could negatively affect the emergent marsh and early successional riparian habitats, which are the historical and preferred nesting habitats of the tricolored blackbird. Native vegetation provides breeding habitat and is an important food source for tricolored blackbirds because it supports populations of native invertebrates. In general, invasive plants displace native plant species, often over substantial areas. Managing and controlling invasive plants would minimize these impacts. In addition, habitat restoration actions that involve planting native species have been shown to reduce colonization by invasive species in newly planted sites (McClain et al. 2011; Moore et al. 2011; Tjarks 2012). However, after losing preferred native vegetation breeding sites in marshes and riparian areas, tricolored blackbirds have increasingly switched to breeding in some types of non-native-dominated vegetation including Himalayan blackberry and introduced thistle patches, and within row crops (Beedy 2008).

Because tricolored blackbirds will nest in non-native vegetation, an important aspect of the invasive-plant management process is to avoid nest loss by clearing non-native vegetation during the nonbreeding season, or conducting pre-clearing nesting surveys during the breeding season to ensure no active nests are present. If nests are present, clearing should not occur until all nests have fledged.

Restoration of riparian, SRA, and marsh habitats: Restoring emergent marsh and riparian habitat would increase the amount of available breeding habitat for tricolored blackbirds throughout the SPA.

Wildlife-friendly agriculture: Tricolored blackbirds breed and forage in appropriate agricultural fields, such as row and field crops; however, vineyards and orchards do not provide appropriate habitat and are not considered wildlife-friendly for this species. Harvesting should occur outside the tricolored blackbird’s breeding season; or if harvesting is necessary during the breeding season, pre-harvest surveys should be conducted to ensure there are no active nests in the fields. If active nests are found, the harvest should wait until the birds are fledged and could then proceed immediately. Pesticide application should not take place near an active breeding colony.

B2.2.4.1 Structural and Nonstructural Improvements

Levee and revetment removal: Revetment removal would provide an opportunity to improve natural erosional and geomorphic processes important to sustaining and creating habitats along rivers. These processes could help create emergent marsh and riparian scrub habitats if elevations are appropriate for those habitats (e.g., by forming meander bends and cutoffs or new floodplain surfaces). Restoring natural riverine processes may also enhance existing habitat; for instance, scouring could support the regeneration of riparian scrub habitat that provides nesting and foraging habitat for tricolored blackbirds. This approach will reduce habitat fragmentation and increase the extent of early successional habitats, and overall diversity in the floodplain.

Levee relocation: Relocating levees farther from rivers (i.e., constructing setback levees) creates space for rivers to meander, reconnects floodplains, allows the transport and deposition of sediment, supports natural ecosystem disturbance processes, and increases the diversity of riverine and floodplain habitats. These processes would help create new suitable habitat for tricolored blackbirds. In newly reconnected floodplains, emergent wetland and riparian scrub habitat can be restored to provide habitat for this species. In addition, expanding floodways through levee relocation would provide opportunities to improve ecosystem function and increase the extent, quality, and connectivity of habitat.

Bypass expansion and construction: Expanding bypasses would protect large areas of land from development, add agricultural land and natural vegetation to the floodway, and result in the periodic, prolonged inundation of land that was previously isolated from the river system by levees. This agriculture should be limited to row crops favorable to tricolored blackbirds and able to withstand frequent inundation (e.g., rice), as opposed to vineyards and orchards that do not provide suitable habitat and may impede water flows. An expanded, frequently activated floodplain in the bypasses may support the restoration of floodplain ecosystems and may provide suitable habitat for the tricolored blackbird, ideally comprising target areas that are shallowly flooded and dominated by native plant species.

Levee construction and improvement: New or reconstructed levees restrict the floodway. They prevent natural geomorphic processes from creating and sustaining the marsh and early successional riparian habitats the tricolored blackbird relies on for nesting and foraging habitat. Therefore, levees should not be constructed or reconstructed where they would prevent geomorphic processes in areas with the potential to provide substantial amounts of suitable nesting habitat.

B2.2.5 Recovery Plan Alignment

There is no ESA recovery plan for tricolored blackbird because it is not federally listed; however, the Tricolored Blackbird Working Group (2007) has developed a conservation plan for this species. The fundamental elements of that plan have been incorporated into this focused conservation plan. Tricolored blackbirds are protected under the CESA and, and, like all native birds in California, are also protected under the federal Migratory Bird Treaty Act and the California Fish and Game Code. The conservation needs of this species in the SPA are addressed in previous sections of this focused conservation plan.

B2.2.6 Measures of Positive Contribution

One goal of the Conservation Strategy is to contribute to the recovery and stability of native species populations and overall biotic community diversity. The objective for this goal is a measurable contribution to the conservation of target species, including the tricolored blackbird. Therefore, building on the preceding discussion, this section of the tricolored blackbird conservation plan provides measures (i.e., metrics or indicators) that will be used to determine how effectively CVFPP management actions contribute to the conservation needs of this species.

Measures for each targeted threatened or endangered species are organized around indicators of progress toward the Conservation Strategy’s process, habitat, and stressor objectives. The species-specific measures provide additional detail on geographic location, habitat structure, and other attributes important to conserving the species. For example, the acreages of riparian and marsh restoration are an indicator of progress toward the Conservation Strategy's habitat objectives. To measure how CVFPP actions contribute to the conservation of tricolored blackbirds, requirements would be added to increase the quantity and quality of emergent wetland and appropriate riparian habitat and minimize environmental stressors, such as nesting habitat and nests from anthropogenic activities.

Tables B.2-3 through B.2-5 list the Conservation Strategy's process, habitat, and stressor targets; identify those used to measure the contribution to conservation of tricolored blackbirds; and provide additional specificity, as needed, to measure this contribution.

Because management actions intended to benefit the tricolored blackbird may simultaneously affect conservation of other species in the SPA, these measures of contribution have been incorporated into each CPA's objectives to conserve target species. The target species objectives cover multiple species and reflect the interrelated nature of CVFPP flood management and conservation actions.

Table B.2-3. Measures of the Contribution of CVFPP Actions to Conservation of the Tricolored Blackbird

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Inundated Floodplain [a]	Inundated Floodplain—total amount (acres, EAH units) with sustained spring and 50% frequently activated floodplain, and total amount of expected annual inundated floodplain habitat [a]	Yes	Saturate soil in winter and spring to achieve the target emergent vegetation height of 4 feet tall by April 1 in the San Joaquin Valley and by May 1 in the Sacramento Valley. Maintain shallow inundation (6 to 18 inches) throughout the breeding season to protect nest colonies from predators and avoid submerging nests.
Riverine Geomorphic Processes	Natural Bank—total length (miles)	No	Not applicable.
	River Meander Potential—total amount (acres)	Yes	None.

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
SRA Cover	SRA Cover and Bank and Vegetation Attributes of SRA Cover—total length (miles)	No	Not applicable.
	Total Length and Percentage of Bank Affected by Flood Projects that Incorporate SRA Attributes	No	Not applicable.
Riparian	Habitat Amount—total amount and total amount on active floodplain (acres)	Yes	Include appropriate riparian breeding habitat.
	Habitat Connectivity—median patch size (acres)	Yes	None.

[a] Floodplain inundation potential is the potential of an area to be inundated by a particular flow (e.g., a flow event that occurs about once every two years, or a “50-percent-chance event”). Expected annual habitat units represent the annual average of the area expected to be inundated in general or by flows meeting defined criteria for timing and duration (e.g., sustained spring flows).

Notes:
EAH = expected annual habitat
SRA = shaded riverine aquatic

Table B.2-4. Measures of the Contribution of CVFPP Actions to Conservation of the Tricolored Blackbird

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Marsh	Habitat Amount—total amount and total amount on active floodplain (acres)	Yes	• Maintain emergent wetlands in a state of dense stems with minimal accumulation of dead stems from previous years by restoring natural floodplain processes or by managed disturbances (fire, mastication, discing grazing) at intervals of five years for perennially flooded marshes or every one to two years for seasonal wetlands. For seasonal wetlands, sustain shallow inundation (6 to 18 inches) through April. (San Joaquin Valley) or May (Sacramento Valley) to protect nest colonies from predators while not destroying nests. • Restore patches of emergent wetland vegetation at least 50 feet wide to support successful nesting.
Floodplain Agriculture	Habitat Amount—total amount of floodplain agriculture providing habitat for target species (acres)	No	Not applicable.
Revetment	Revetment Removed to Increase Meander Potential or Natural Bank—total length (miles)	Yes	None.
Levees	Levees Relocated to Reconnect Floodplain or Improved to Eliminate Hydraulic Constraints on Restoration—total length (miles)	Yes	None.
Fish Passage Barriers	Fish Passage Barriers—remediated or removed	No	Not applicable.

Table B.2-5. Measures of the Contribution of CVFPP Actions to Conservation of the Tricolored Blackbird

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Invasive Plants	Invasive-plant-dominated Vegetation—total area reduced (acres)	Yes	When removing non-native vegetation in suitable tricolored blackbird nesting habitat (e.g., patches of Himalayan blackberry), replace with native plants that will offset the loss of nesting habitat.

B2.3 References

Barr K, Beichman AC, Kalhori P, Rajbhandary J, Bay RA, Ruegg K, Smith TB. 2021. "Persistent panmixa despite extreme habitat loss and population decline in the threatened tricolored blackbird (*Agelaius tricolor*)." Evolutionary Applications Volume 14: Pages 674–684.

Beedy EC. 2008. "Tricolored Blackbird." In: Shuford WD, Gardali T, editors. California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies in Western Birds 1. Camarillo and Sacramento (CA): Western Field Ornithologists and California Department of Fish and Game.

Beedy EC, Hamilton WJ III. 1997. *Tricolored Blackbird Status Update and Management Guidelines.* Prepared for: U.S. Fish and Wildlife Service, Migratory Birds and Habitat Program, Portland (OR), and California Department of Fish and Game, Bird and Mammal Conservation Program, Sacramento (CA).

Beedy EC, Hamilton WJ III. 1999. "Tricolored Blackbird (*Agelaius tricolor*)." In: Poole A, Gill F, editors. *The Birds of North America* No. 423. Philadelphia (PA) and Washington, DC: Academy of Natural Sciences and American Ornithologists' Union.

Beedy EC, Hamilton WJ III, Meese RJ, Airola DA, Pyle P. 2020. "Tricolored Blackbird (Agelaius tricolor)," version 1.0. In: Rodewald PG, editor. Birds of the World. Ithaca (NY): Cornell Lab of Ornithology. Viewed online at: TricoloredBlackbird. Accessed: September 2, 2020

California Department of Fish and Wildlife. 2020. "Drought Stressor Monitoring Case Study: Conserving the Tricolored Blackbird through Monitoring, Breeding Colony Protection, and Habitat Restoration." Viewed online at: TricoloredBlackbird. Accessed: September 1, 2020.

California Department of Water Resources. 2016. "Central Valley Flood Protection Plan Conservation Strategy." Sacramento (CA): California Department of Water Resources. Viewed online at: www.CVFPP.org. Accessed: September 2, 2020.

Center for Biological Diversity. 2015. Petition to List the Tricolored Blackbird (Agelaius tricolor) as an Endangered Species and to Designate Critical Habitat Concurrent with Listing. Oakland (CA): Center for Biological Diversity.

Collier G. 1968. Annual Cycle and Behavioral Relationships in the Red-Winged and Tricolored Blackbirds of Southern California. Ph.D. thesis. Los Angeles (CA): University of Southern California. Page 374.

Cook LF, Toft CA. 2005. "Dynamics of Extinction: Population Decline in the Colonially Nesting Tricolored Blackbird *Agelaius tricolor*." Bird Conservation International Volume 15: Pages 73 to 88.

Crase FT, DeHaven RW. 1977. "Food of Nestling Tricolored Blackbirds." Condor Volume 79: Page 265.

Davis BE, Cocherell DE, Sommer T, Baxter RD, Hung T-C, Todgham AE, Fangue NA. 2019. "Sensitivities of an endemic, endangered California smelt and two non-native fishes to serial increases in temperature and salinity: implications for shifting community structure with climate change." Conservation Physiology 7:1-16. www.oup.com.

DeHaven RW, Crase FT, Woronecki PP. 1975. "Breeding Status of the Tricolored Blackbird, 1969–1972." California Fish and Game Volume 61: Pages 161 to 180.

Green M, Edson L. 2004. "The 2004 Tricolored Blackbird April Survey." Central Valley Bird Club Bulletin Volume 7: Pages 23 to 31.

Hamilton WJ III. 2000. *Tricolored Blackbird 2000 Breeding Census and Survey—Observations and Recommendations*. Davis (CA): Division of Environmental Studies, University of California, Davis.

Hamilton WJ III, Cook L, Hunting K. 1999. *Tricolored Blackbird 1999 Status Report*. Davis (CA): Division of Environmental Studies, University of California, Davis.

Heermann AL. 1859. "Report upon Birds Collected on the Survey." Zoological Report No. 2. In In: Williamson RS, editor. Report of Explorations in California for Railroad Routes near the Thirty-fifth and Thirty-second Parallels in 1853: Reports of Explorations and Surveys to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi to the Pacific Ocean, 1853–6, Volume 10. Washington, DC: Beverley Tucker, Printer. Pages 29 to 80.

McClain CD, Holl KD, Wood DM. 2011. "Successional Models as Guides for Restoration of Riparian Forest Understory." Restoration Ecology Volume 19 (Issue 2): Pages 280 to 289.

Meese, R. J. 2017. “Results of the 2017 Tricolored Blackbird Survey.” Calif. Dept. of Fish and Wildlife, Wildlife Branch, Nongame Wildlife Program Report 2017-04. Sacramento (CA).

Meese, RJ. 2019. “Tricolored Blackbird Portal.” Viewed online at: Tricolored-Blackbird. Accessed: September 3, 2020.

Meese RJ, Beedy EC. 2015. “Managing Nesting and Foraging Habitats to Benefit Breeding Tricolored Blackbirds.” Central Valley Bird Club Bulletin Volume 17: Pages 79 to 96.

Moore PL, Holl KD, Wood DM. 2011. “Strategies for Restoring Native Understory Plants along the Sacramento River: Timing, Shade, Non-Native Control, and Planning Method.” San Francisco Estuary and Watershed Science Volume 9 (Issue 2).

Neff JA. 1937. “Nesting Distribution of the Tri-colored Red-Wing.” The Condor Volume 39 (Issue 2): Pages 61 to 81.

Orians GH. 1961. The Ecology of Blackbird (Agelaius) Social Systems. Ecological Monographs Volume 31: Pages 285 to 312.

Shearwater D. Owner, Shearwater Journeys, Hollister (CA). May 23, 2020—verbal personal communication with Terrill T, Vice President and Senior Ornithologist, H. T. Harvey & Associates, Los Gatos (CA), regarding tricolored blackbird riparian scrub breeding habitat in the Panoche Valley.

Tjarks H. 2012. “Using a Native Understory to Control Weeds in Riparian Restoration.” California Invasive Plant Council News Volume 20 (Issue 2): Pages 8 to 9.

Tricolored Blackbird Working Group. 2007. *Conservation Plan for the Tricolored Blackbird (*Agelaius tricolor*).* Kester S, editor. San Francisco (CA): Sustainable Conservation.

Yasukawa K, Searcy WA. 1995. “Red-Winged Blackbird (*Agelaius phoeniceus*).” In: Poole A, Gill F, editors. *The Birds of North America*, No. 184. Philadelphia (PA) and Washington, DC: Academy of Natural Sciences and American Ornithologists’ Union.

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Appendix B.3
Focused Conservation Plan: Yellow-breasted Chat

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APPENDIX B.3

Focused Conservation Plan: Yellow-breasted Chat

Source: H. T. Harvey & Associates

B3.1 Conservation Status

As part of the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy Update, this focused conservation plan addresses needs and opportunities for conserving the yellow-breasted chat (*Icteria virens*) and its habitat in the Systemwide Planning Area (SPA).

The yellow-breasted chat, a California Species of Special Concern, breeds in dense, shrubby, open habitats in North America and winters from northern Mexico to Central America (Billerman 2020). In California, where this species occurs as a migrant and summer resident, it breeds primarily in early successional riparian habitat with a well-developed shrub layer and open tree canopy bordering streams, creeks, sloughs, and rivers (Comrack 2008).

This species has an interesting taxonomic history. It was long considered an aberrant member of the New World warbler family, the Parulidae. Recently, the yellow-breasted chat has been recognized as a quite distinct taxon and placed in a monotypic family, *Icteriidae* (Billerman 2020).

Yellow-breasted chats are widespread, but between 1966 and 2014, their numbers declined throughout the range by an estimated 37 percent (Cornell Lab of Ornithology 2020). Although this species is not listed as threatened or endangered at the federal or state level, it is listed as threatened, endangered, or of special concern in multiple states and Canadian provinces. The yellow-breasted chat is still widely distributed in California but is now rare or absent from much of the Central Valley, with an approximately 35-percent reduction in its breeding range (Comrack 2008). Destruction of riparian habitat is implicated in the decline of this species in the state (Remsen 1978).

Including the yellow-breasted chat as a target species aligns the goals and objectives of the CVFPP Conservation Strategy with those of the Central Valley Joint Venture's Implementation Plan for riparian habitat avian conservation and this species (Central Valley Joint Venture 2006). The yellow-breasted chat was selected as one of seven riparian, breeding focal songbirds for the avian conservation population and habitat objectives in the Central Valley based on the species' ability to meet the following criteria:

- Uses riparian vegetation as principal breeding habitat.
- Warrants special management status or has experienced population declines or reductions in the Central Valley breeding range.
- Is useful for monitoring the effects of management actions in Central Valley riparian ecosystems.

Dybala et al. (2017) added five species to the seven focal species covered by the Central Valley Joint Venture (2006). The yellow-breasted chat was thus included as one of 12 focal species in the *Population and Habitat Objectives for Avian Conservation in California's Central Valley Riparian Ecosystems* (Dybala et al. 2017).

Dybala et al. (2017) established long-term population objectives for each focal species in each region, based on principles of conservation biology; these were intended to meet the goals of establishing genetically robust, self-sustaining, resilient populations. They considered the yellow-breasted chat population in the Sacramento Valley to be small (fewer than 10,000 individuals) and the population in the Yolo-Delta, San Joaquin, and Tulare regions to be very small (fewer than 1,000 individuals). As assessed by Dybala et al. (2017), a "small population" may be below a minimum viable population level and vulnerable to extirpation, and a "very small population" is expected to be well-below a minimum viable population level. The analysis by Dybala et al. (2017) was published after the 2016 Conservation Strategy had been completed.

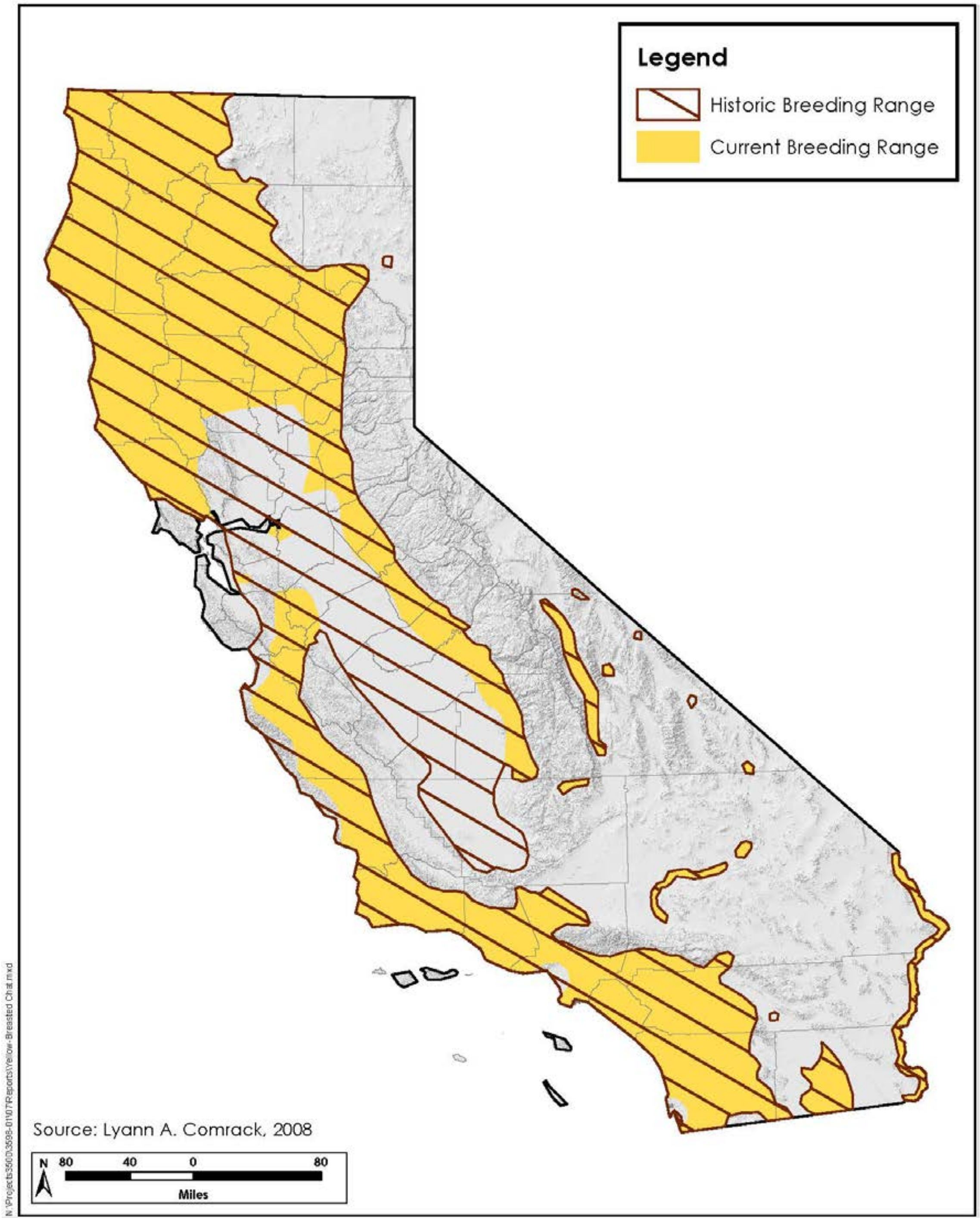
The restoration of Central Valley riparian habitat is critical to achieving the long-term goal of genetically robust, self-sustaining populations. Dybala et al. (2017) evaluated the current sizes of the Central Valley's yellow-breasted chat populations and the projected population statuses if 10-year and 100-year objectives for riparian habitat and density are reached. Riparian habitat objectives are based on the addition of restored riparian vegetation relative to existing conditions in the four planning regions, and are presented in units of thousands of hectares.

B3.1.1 Status and Trends

B3.1.1.1 Distribution

Figure B.3-1 shows the current and historical distributions in California, as well as breeding records, for the yellow-breasted chat. The yellow-breasted chat has two subspecies. The nominate subspecies, *I. v. virens*, breeds in the eastern portion of the range from the eastern Great Plains (and locally north to extreme southeastern Canada) and central Texas eastward. The western subspecies, *I. v. auricollis* (also known as the “long-tailed chat”), breeds in the western portion of the range from the western portion of the Great Plains (locally north to southwestern Canada) south through the western United States to west Texas (Eckerle and Thompson 2020); thus, this subspecies represents the taxon that breeds in California’s Central Valley. Both subspecies winter primarily from Mexico south to Central America. A global positioning system tag and light-level geolocator study on the migration and nonbreeding ecology of yellow-breasted chats found no mixing of eastern and western chats on the wintering grounds, with Pacific coastal chats wintering in western Mexico and eastern North American chats wintering in eastern Mexico, suggesting strong migratory connectivity at the subspecies level (Mancuso et al. 2022). The results of this study provided precise migratory routes and nonbreeding locations and habitat cover types for chats that may be valuable for habitat protection and conservation efforts for western chats.

Figure B.3-1. Recent and Historic Distributions in California and Locations of Breeding Records for Yellow-breasted Chat



In California, the yellow-breasted chat is a migrant and summer visitor from late March to late September, with a breeding period from late April through early August (Garrett and Dunn 1981; Eckerle and Thompson 2001; Unitt 2004). Breeding bird survey data indicate that northwestern rivers, including the Klamath, Trinity, and Eel, support the highest breeding densities in the state (Sauer et al. 2005). The yellow-breasted chat population has declined over much of the California breeding range (the following section, "Population Trends," provides more details). Winter records are quite rare in the state (eBird 2020), with the closest "normal" wintering area in central Baja California and coastal west Mexico (Dunn and Alderfer 2011).

B3.1.1.2 Population Trends

The yellow-breasted chat was formerly a fairly common to common species that bred throughout the state below elevations of approximately 5,000 feet (Grinnell and Miller 1944). Although still widely distributed in California, the yellow-breasted chat has declined significantly throughout much of the state, particularly the Central Valley and much of Southern California (Remsen 1978; Garrett and Dunn 1981; Comrack 2008). The yellow-breasted chat is now rare or absent from much of the Central Valley, with an approximately 35-percent reduction in its breeding range (Comrack 2008). The destruction of riparian habitat has been implicated in the decline of this species in the state (Remsen 1978). Most of the remaining Central Valley birds currently breed in the northern Sacramento Valley. The species is still considered to be breeding in a few locations in the San Joaquin Valley, and also breeds in the Sacramento–San Joaquin Delta (Comrack 2008; Dybala et al. 2017).

In addition to experiencing habitat loss, chats are frequent hosts to brood parasitism by the brown-headed cowbird (*Molothrus ater)* (Ehrlich et al. 1988; Comrack 2008). This is likely to have contributed to the overall reduction in California's chat population, although the actual impact of cowbirds is less well-established than for some other riparian species (e.g., least Bell's vireo). Indirect evidence of the negative relationship between cowbirds and chats includes a lack of chats in apparently suitable habitat (Comrack 2008). Chats have become quite numerous at Camp Pendleton, in San Diego County, where cowbird management has been conducted for years (Comrack 2008), indicating that cowbird management is likely to aid in increasing chat reproductive success. Cowbird management has been successfully implemented as a management strategy to reduce brood parasitism rates (Griffith and Griffith 2000; Famolaro 2006), although cowbird management can be labor-intensive and expensive (Robinson et al. 1993). However, restoring and maintaining suitable habitat and the riverine processes that renew early successional habitat may be a more sustainable method of maximizing breeding opportunities, because the yellow-breasted chat's preferred dense habitat (like the least Bell's vireo) provides a buffer from brown-headed cowbirds (Sharp and Kus 2006).

Another factor contributing to the decline in the chat population is impacts on understory and shrubby riparian habitat, caused by vegetation clearing for flood control maintenance and by urban development, agriculture, and livestock grazing (Comrack 2008).

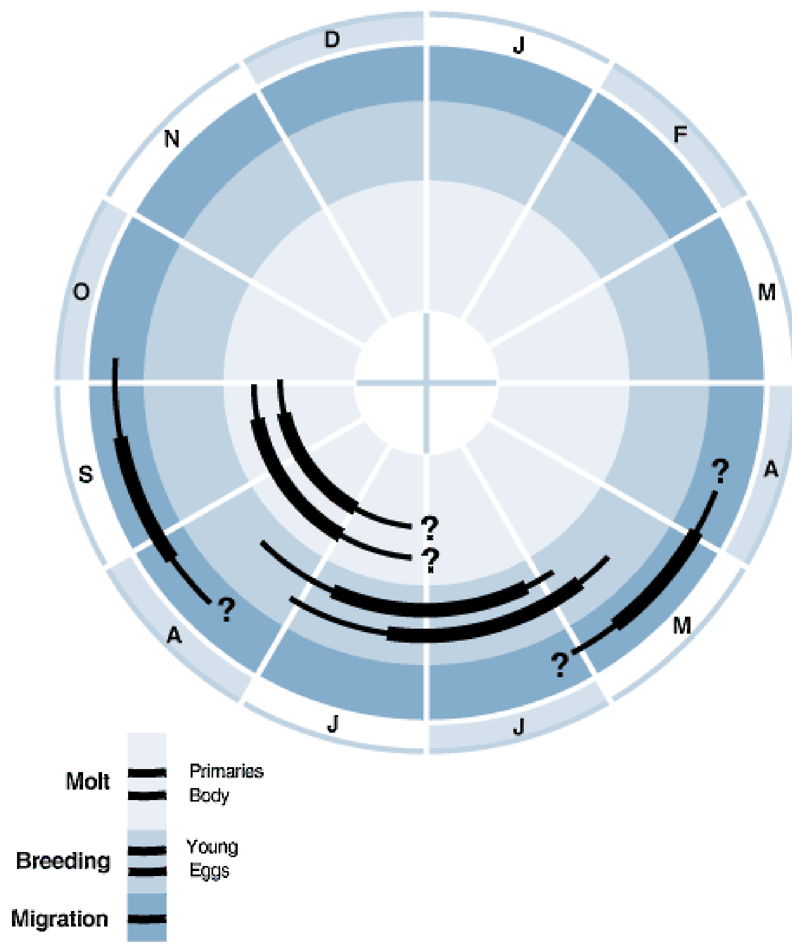
B3.1.2 Life History

The yellow-breasted chat is an entirely migratory species, with no resident populations. The species breeds from central Mexico north throughout much of North America, reaching southwestern and extreme southeastern Canada, and winters from coastal Mexico south into Central America (Eckerle and Thompson 2020).

Yellow-breasted chats are known for their extremely shy, retiring, and skulking nature, except when males sing from exposed perches or when giving display flight songs (Dunn and Garrett 1997). Foraging takes place in dense thickets and consists primarily of gleaning insects from foliage. Figure B.3-2 shows the *Birds of North America* annual cycle for the yellow-breasted chat. As the figure shows, peak molting occurs from August through mid-September; peak breeding occurs between late May and late July; and peak migration occurs in early to mid-May and late August to mid-September.

Figure B.3-2. Annual Cycle of Breeding, Molt, and Migration in the Yellow-breasted Chat

Thick lines show peak activity; thin lines, off-peak.



Source: Eckerle and Thompson 2020; reproduced with permission.

Nests are constructed 1 to 8 feet above ground level and are well concealed in dense shrubs or tangled vines. They are built of an outer base of dead leaves and weeds, with an inner cup of tightly woven vine bark, lined with fine stems and grass (Kaufman 1996). This species typically lays three or four (but up to six) creamy white eggs with brown spots. Yellow-breasted chats lay one or two broods per season, with an incubation period of 1 to 12 days and a nestling period of seven to 10 days.

B3.1.3 Habitat and Ecological Process Associations

Yellow-breasted chats occupy early successional riparian habitats with a well-developed shrub layer and an open canopy (Comrack 2008). In the western portion of the range, nesting habitat typically include riparian areas associated with the narrow borders of waterways. Early successional riparian habitats are ephemeral, productive communities and require periodic disturbance to renew and maintain the vegetative structural components and species composition used by the yellow-breasted chat. Plants typical of yellow-breasted chat habitat include blackberry, wild grape, willows, and cottonwood. A dense understory is an essential habitat requirement for the species, but as early successional habitat matures, the understory thins and does not provide adequate cover for this species. Active riverine processes, such as periodic inundation, erosion and deposition, lateral channel migration, and avulsion (i.e., channel cutoff), promote the establishment and growth of the early successional plant communities required by yellow-breasted chats. As these natural processes continue, they generate new floodplain surfaces and create a mosaic of vegetation that supports suitable nesting habitat for the species.

Yellow-breasted chats forage primarily on invertebrates, especially during the breeding season, to provide amino acids for egg formation and the growth and development of nestlings, as is the case with most birds (Eckerle and Thompson 2020). For yellow-breasted chats, these invertebrates include beetles, ants, bees, mayflies, cicadas, moths, and caterpillars (Cornell Lab of Ornithology 2020). Nestlings are fed insects, primarily; particularly, orthopterans and larval lepidopterans (Eckerle and Thompson 2020).

However, like many migrants, this species feeds largely on fruit in late summer and fall. In California, these late-summer and fall-ripening fruits include native elderberries, wild grape, honeysuckle, wild strawberry, blackberry, and chokecherry (Dunn and Garrett 1997; Cornell Lab of Ornithology 2020). Wild fruits are an important food source for many north temperate breeding birds during late-summer and fall migration. This consumption is critical for migratory birds that rely on the energy provided by fruit to store fat and fuel for migration, such as yellow-breasted chats (Gallinat et al. 2020). In turn, birds disperse seeds for the plants by consuming the fruits. Thus, the availability and synchronization of native plant species to provide fruit during the appropriate periods is critical to support local populations of migratory birds.

Many non-native invasive plant species are from different families or genera than native species and differ in many of their biochemical and structural traits. Although some non-native invasive plant species have small, fleshy fruits, they may not be as suitable as a food source as native species. In one study, Gallinat et al. (2020) found that although invasive shrubs fruited later than native plants on average, and they produced a large proportion of the total fruits available in late autumn, birds primarily consumed the fruits of native species throughout the autumn. These results and the importance of late-summer and fall fruits as a food source support the incorporation of native species with small, fleshy fruits (such as elderberry and native blackberry) into riparian habitat restoration projects in the Central Valley.

In addition, landscapes dominated by non-native plants are unlikely to support the same diversity and biomass of insect herbivores as landscapes dominated by native host plants; as such, it follows that populations of insectivores, such as birds, will be compromised (Burghardt et al. 2009).

B3.1.4 Conceptual Models

A conceptual model has been designed to assist in the development of a targeted conservation strategy for the yellow-breasted chat within the SPA (Figure B.3-3). This model is not intended to be a comprehensive model of all ecological processes, stressors, and other factors that could be relevant for this species. Rather, as Figure B.3-3 shows, the conceptual model specifically depicts the following considerations:

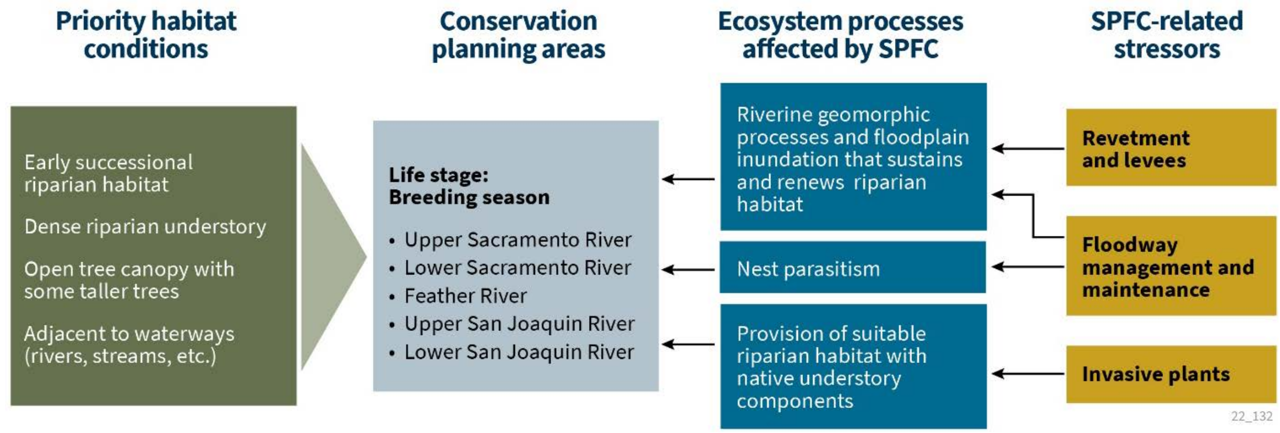
- Habitat conditions required by yellow-breasted chat within the SPA: Early successional riparian habitat, a dense riparian understory, an open tree canopy with some taller trees, and a location adjacent to a waterway. (Nesting habitat is usually restricted to the borders of streams, creeks, and rivers.) “Early successional riparian habitat” refers to a well-developed shrub layer and open canopy with taller trees such as cottonwoods for singing perches. Food includes invertebrates, especially terrestrial insects and fruit produced by native plants in the late-summer and fall.

- The specific Conservation Planning Areas (CPAs) the yellow-breasted chat may breed in, under suitable habitat conditions: The Upper and Lower Sacramento Rivers and San Joaquin River CPAs and the Feather River CPA.

- Key ecosystem processes of riverine systems within the SPA potentially affected by actions associated with the CVFPP, including the Conservation Strategy: Riverine geomorphic processes and floodplain inundation that sustains and renews riparian habitat; nest parasitism; and the provision of suitable riparian habitats with native understory components.

- Stressors related to State Plan of Flood Control facilities and their operations and maintenance: Revetment and levees, floodway management and maintenance, and invasive plants.

Figure B.3-3. Conceptual Model for the Yellow-breasted Chat within the Systemwide Planning Area



B3.1.5 Management Issues

B3.1.5.1 Threats and Sensitivities Rangewide

The population decline of yellow-breasted chats in the Central Valley and elsewhere in California is largely a function of the following factors:

- Loss and degradation of early successional riparian habitat.
- Alteration and loss of river processes that renew and maintain these habitats.
- Brood parasitism by brown-headed cowbirds.
- Habitat effects caused by invasive, exotic vegetation.

Riparian habitat is estimated to have declined in California by up to 95 percent since European contact (The Bay Institute 1998).

Dams, water diversions, levees, and other flood control structures reduce channel migration and natural disturbances, which initiate the development of early successional vegetation that provides suitable habitat. Instead, these structures lead to a predominance of mature riparian forests with dense canopies and open understories, which represent unsuitable breeding habitat for this species.

The yellow-breasted chats’ dependence on understory and shrubby riparian vegetation for nesting makes them vulnerable to habitat loss from vegetation removal along river channels during flood control maintenance, which often occurs during the breeding season (Comrack 2008). In addition to direct impacts during the breeding season, on the whole, levee and floodplain vegetation management may negatively affect habitat for chats through the direct loss of suitable riparian habitat and by fragmenting existing patches of habitat. Because early successional habitat is already greatly reduced within the SPA, maintenance activities contribute to the overall decline of this habitat-dependent bird species, such as the chat.

The conversion of riparian habitat to agriculture also contributes to habitat loss and fragmentation. In addition, riparian habitat fragmentation and the establishment of agricultural lands adjacent to yellow-breasted chat breeding sites may increase nest parasitism by brown-headed cowbirds. If agricultural land or developed areas surround suitable nesting habitat, brown-headed cowbirds can become more abundant and, consequently, lower the breeding success of riparian-breeding avian species, including the yellow-breasted chat. Another tool to reduce parasitism rates could include minimizing the availability of food sources for the brown-headed cowbird (e.g., grass seeds, crop grains, insects disturbed by domestic ungulates), especially near suitable habitat for the yellow-breasted chat, which could also serve as the primary method of controlling cowbirds. Yellow-breasted chats are also affected by grazing. Ohmart (1994) found that chat densities increased fourfold in six years in response to the removal of livestock along the San Pedro River in Arizona.

In addition to threats to their breeding grounds, migratory birds experience threats during migration and on their wintering grounds (Kirby et al. 2008). Reductions in migratory stopover habitat and habitat on the wintering grounds can contribute substantially to reductions in migratory bird populations (Bairlein 2016).

B3.1.5.2 Ongoing and Future Impacts

The most important ongoing and likely future issues for sustaining viable breeding populations of yellow-breasted chats in the Central Valley are the current low availability of suitable breeding habitat and continued loss of suitable habitat, the lack of river processes that sustain early successional habitat, and nest parasitism by brown-headed cowbirds.

B3.1.5.3 Key Information Gaps or Uncertainties

To better understand factors affecting the Central Valley's yellow-breasted chat population, more information is needed regarding the local population trends, migratory routes, and wintering areas of Central Valley breeding chats; pesticide effects; patch sizes required for breeding; and brown-headed cowbird parasitism.

- **Regional population trends.** Monitoring population trends for the yellow-breasted chat at a regional level will enable researchers to identify the sites of population increases or declines, and help determine the relative contributions of habitat loss and degradation, cowbird parasitism, and other factors that influence the population. In addition, monitoring the effects of the Conservation Strategy on yellow-breasted chats in the Central Valley related to the restoration and management of riparian habitat and the increased incorporation of natural river system dynamics will further inform ongoing and future implementation and management strategies. Understanding these dynamics will be the key to identifying and prioritizing sites for conservation and management of this species.

- **Migration and wintering grounds.** Very little information exists regarding the wintering range and migratory routes of chats that breed in California. Observations of wintering yellow-breasted chats have been recorded from Baja California Sur, Mexico, and Central America. Understanding conditions in the wintering grounds and identifying key stopover locations will help identify the habitats and threats this species may encounter during migration and on the wintering grounds, and could help determine the relative importance of management actions on the breeding grounds versus the migratory and wintering areas.

- **Pesticides**. Pesticides may affect yellow-breasted chat behavior or cause fatalities, either through direct contact or by reducing or contaminating prey populations, but the extent to which pesticides affect chat populations is unknown. Pesticide and herbicide use on agricultural lands adjacent to habitat may also reduce insect abundance in chat foraging areas.

- **West Nile virus.** West Nile virus–positive dead birds have been found in the CPAs (Wheeler et al. 2009). The yellow-breasted chat was shown to have a significant negative population interaction between the presence of West Nile virus and human land use (agricultural or urban and suburban lands near Monitoring Avian Productivity and Survivorship Program stations throughout the United States), but not a significant direct negative effect from only the presence of the virus (George et al. 2015). The authors concluded a negative interaction between land use and West Nile virus suggests the virus's effects may be amplified with increased agriculture and urban development around the habitat of species showing this negative relationship. The degree to which West Nile virus may affect yellow-breasted chats in the Central Valley is currently unknown.

- **Breeding habitat patch size**. More data on the relationship between (appropriate) habitat patch size and shape and the chats' reproductive success and breeding densities in Central Valley riparian habitat would help inform habitat restoration and management for chats.

- **Brood parasitism by brown-headed cowbirds.** Further and more detailed information regarding the impacts of brown-headed cowbirds on the reproductive success of yellow-breasted chats would help to inform the degree to which cowbird control benefits chats.

B3.2 Conservation Strategy

B3.2.1 Conservation and Recovery Opportunities

The most viable ways to support the recovery of the yellow-breasted chat are to encourage natural riverine processes that promote early native successional riparian habitat, and to restore native riparian habitat to increase and sustain suitable nesting habitat throughout the SPA, while reducing occurrences of brood parasitism by the brown-headed cowbird. Creating patches of suitable breeding habitat and connecting those patches to existing or new suitable habitat will increase opportunities for the yellow-breasted chat breeding populations to recover along waterway margins in the SPA. Connecting riparian habitat and increasing cottonwood-willow habitat between riparian forest patches may also benefit many other bird species, including special-status species (e.g., western yellow-billed cuckoo and least Bell's vireo) (Kleinschmidt Associates 2008).

Improving ecosystem function and restoring natural riverine geomorphology through the implementation of appropriate management actions would create the disturbance regimes necessary to create and maintain this suitable habitat. Incorporating early successional plant species with a dense understory into riparian restoration efforts and restoring river processes throughout the Central Valley may be the key to maximizing opportunities for the valley's yellow-breasted chat population to recover. Cowbird management could also be used as a tool to prevent nest parasitism in areas where yellow-breasted chat populations are monitored and low productivity is documented. All such conservation and restoration initiatives could incorporate the vegetative and structural components identified in the "Conceptual Models" section.

B3.2.2 Identified Conservation Needs

1. **Increase and sustain nesting habitat:** The yellow-breasted chat is a riparian obligate, dependent on early successional to mid-seral riparian habitat with a dense understory and the natural hydrologic and geomorphic processes that create and sustain it. Creating setback levees and facilitating natural flood processes that lead to relatively continuous, dynamic riparian successional stages within the system will provide opportunities to renew, expand, and sustain nesting habitat. Decommissioning levees may also contribute to geomorphic processes that create diverse riparian ecosystems, including early successional habitat. Restoring riparian habitat in core population areas would provide habitat connectivity that is important to increasing the species' numbers and facilitating colonization in the SPA. Removing exotic vegetation would also improve opportunities for native vegetation to colonize these areas, limiting the spread of undesirable species in the SPA and enhancing the outcomes of riparian restoration efforts.

2. **Reduce nest parasitism:** Brood parasitism by brown-headed cowbirds lowers the breeding success of the yellow-breasted chat. Sustaining dense, early successional habitat with a dense understory may naturally minimize rates of nest parasitism (Siegle and Ahlers 2004). Reducing cowbird food sources by reducing row-crop waste grain and reducing domestic ungulate presence, especially feedlots and dairies, near chat breeding habitat may reduce local cowbird populations, which may lower parasitism rates (Robinson et al. 1993). Conducting surveys for brown-headed cowbirds in areas where breeding populations of yellow-breasted chats occur would inform targeted conservation efforts. To ensure yellow-breasted chats have the opportunity to successfully breed and disperse, brown-headed cowbirds may need to be removed, but this should not be the primary management method. This approach to cowbird management would also significantly benefit other riparian avian species, many of which are heavily exploited by cowbird brood parasitism—especially another target species, the least Bell's vireo.

B3.2.3 Integration of Conservation and Restoration in Flood Management

As identified in Table B.3-1, CVFPP management actions have the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the yellow-breasted chat. In many cases, the species' conservation needs can be positively addressed by implementing management actions that integrate conservation and restoration elements with State Plan of

Flood Control operations and maintenance, floodway management, and structural and nonstructural improvements. The ability to implement some of these actions would depend on operations, maintenance, and floodway management actions and improvements (as described in the following section) to resolve constraints, such as the floodway's existing capacity to convey flood flows, or revetment removal at a site that may depend on levee relocation to allow bank erosion. Wherever feasible, conservation objectives and indicators will inform management actions for adaptive, responsive, and sustainable implementation that avoids and minimizes impacts on species and ecosystems.

Table B.3-1. Summary of the Contributions of CVFPP Management Actions to Identified Conservation Needs of the Yellow-breasted Chat

SPFC Activity	Management Actions	Conservation Need 1. Increase and Sustain Nesting Habitat	Conservation Need 2. Reduce Nest Parasitism
Operations, Maintenance, and Floodway Management	Floodwater storage and reservoir forecasting, operations, and coordination	Neutral	Neutral
	Facility maintenance	Neutral	Neutral
	Levee vegetation management	Neutral	Neutral
	Floodway maintenance	Neutral	Neutral
	Modification of floodplain topography	Positive	Neutral
	Support of floodplain agriculture	Neutral	Negative
Operations, Maintenance, and Floodway Management	Invasive-plant management	Positive	Positive
	Restoration of riparian, SRA, and marsh habitats	Positive	Positive
	Wildlife-friendly agriculture	Neutral	Negative

SPFC Activity	Management Actions	Conservation Need 1. Increase and Sustain Nesting Habitat	Conservation Need 2. Reduce Nest Parasitism
Structural and Nonstructural Improvements	Levee and revetment removal	Positive	Neutral
	Levee relocation	Positive	Neutral
	Bypass expansion and construction	Positive	Negative
	Levee construction and improvement	Negative	Neutral
	Flood control structures	Neutral	Neutral

Notes:
CVFPP management actions are designated as having the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the species.

SRA = shaded riverine aquatic

B3.2.3.1 Operations, Maintenance, and Floodway Management

Modification of floodplain topography: Lowering floodplain elevations would provide more frequent and sustained inundation, which may promote the growth of additional riparian vegetation (i.e., more suitable yellow-breasted chat habitat) along channel margins.

Support of floodplain agriculture: Agricultural lands provide habitat for the brown-headed cowbird. Providing scrub habitat or other vegetative buffers between agricultural lands and riparian breeding habitat for yellow-breasted chat would be important to protect and conceal nests from brown-headed cowbirds.

Invasive-plant management: New or expanded weed infestations could negatively affect the early successional riparian habitat on which the yellow-breasted chat relies during the breeding season. Native vegetation provides an important food source for yellow-breasted chats, both by supporting native invertebrate populations and by providing fruit during key periods. In general, invasive plants have been shown to significantly displace native plant species.

Managing and controlling invasive plants would minimize these impacts. In addition, habitat restoration actions that involve planting native species have been shown to reduce colonization by invasive species in newly planted sites (McClain et al. 2011; Moore et al. 2011; Tjarks 2012).

Restoration of riparian, SRA, and marsh habitats: Riparian restoration would increase the amount of riparian habitat available for yellow-breasted chats, and would be fundamental to bringing Central Valley chat populations to viable population levels throughout the SPA (Dybala et al. 2017). Providing corridors of suitable habitat throughout the SPA would maximize opportunities for this species to expand. Dense, contiguous early successional habitat would also protect nests from the brown-headed cowbird.

Incorporating a planting palette that includes Great Valley willow-scrub, cottonwood forest, and mixed riparian forest vegetation, including native fruiting riparian vegetation, would create nesting and foraging habitat for the yellow-breasted chat (U.S. Fish and Wildlife Service 2005); this diversified habitat would also provide corridors that accommodate other riparian-obligate species. Dybala et al. (2017) demonstrated the critical importance of increasing riparian habitat over existing conditions to increasing and maintaining a viable yellow-breasted chat population in the Central Valley. Further, because this species is adapted to exploiting successional habitats, it rapidly colonizes newly created habitat areas. This bodes well for positive population-level responses to management actions that create additional areas of suitable habitat (Eckerle et al. 2020).

Wildlife-friendly agriculture: Wildlife-friendly agriculture is an important conservation tool that can benefit many target species, but the brown-headed cowbird prefers expanses of open habitat. Establishing agricultural lands next to known or potential yellow-breasted chat breeding locations may inadvertently lead to nest parasitism by cowbirds.

B3.2.3.2 Structural and Nonstructural Improvements

Levee and revetment removal: Removing levees and revetment would create opportunities to improve the riverine geomorphic and floodplain inundation processes that are important to sustaining habitats along rivers. Encouraging river meander and natural erosional processes that deposit soils and facilitate the establishment of early successional riparian habitat would benefit the yellow-breasted chat by providing and maintaining suitable nesting and foraging habitats. This approach will reduce the fragmentation of riverine habitat and increase habitat succession, native plant populations, and overall diversity in the floodplain.

Levee relocation: As discussed, improving ecosystem function and restoring natural riverine geomorphology by relocating levees would create opportunities to establish and sustain early successional riparian habitat. Specifically, an expanded floodway that is reconnected to the river channel would allow for river meander, sediment erosion and deposition, and natural ecosystem disturbance processes. Each of these processes could help create new suitable habitat and renew early successional habitat that is important for sustaining populations of the yellow-breasted chat. In addition, floodways that are expanded through the relocation of levees would provide opportunities to improve ecosystem function and increase the extent, quality, and connectivity of habitat.

Bypass expansion and construction: Expanding bypasses would add agricultural land and natural vegetation to the floodway and would result in the periodic, prolonged inundation of land that was previously isolated from the river system by levees. An expanded, frequently activated floodplain in the bypasses may support some restoration of floodplain ecosystems, and may provide suitable nesting habitat for the yellow-breasted chat. However, expanding bypasses would also add agricultural land, potentially providing habitat for the brown-headed cowbird. Agricultural land should be sited away from areas that could support nesting habitat for the yellow-breasted chat.

Levee construction and improvement: New or improved levees could restrict the floodway, preventing natural geomorphic processes from creating and sustaining the early successional riparian habitat upon which the yellow-breasted chat relies as nesting habitat. New levees should not be constructed adjacent to rivers and near areas that have the potential to support suitable nesting habitat.

B3.2.4 Measures of Positive Contribution

One goal of the Conservation Strategy is to contribute to the recovery and stability of native species populations and overall biotic community diversity. The objective for this goal is a measurable contribution to the conservation of target species, including the yellow-breasted chat. Therefore, building on the preceding discussion, this section of the yellow-breasted chat conservation plan provides measures (i.e., metrics or indicators) that will be used to determine how effectively CVFPP management actions contribute to the conservation needs of this species.

Measures for each target species are organized around indicators of progress toward the Conservation Strategy's process, habitat, and stressor objectives (Table B.3-2). The species-specific measures provide additional detail on geographic location, habitat structure, and other attributes important to conservation of the species. For example, the acreage of riparian restoration is an indicator of progress toward the Conservation Strategy's riparian habitat objective. To measure the contribution of CVFPP actions to the conservation of the yellow-breasted chat, requirements would be added to increase acreage that makes a positive contribution to the early successional riparian habitat required by the species for nesting.

Table B.3-2 lists the process, habitat, and stressor targets of the Conservation Strategy; identifies those used to measure the contribution to conservation of yellow-breasted chat; and provides additional specificity as necessary to measure this contribution. Table B.3-3 provides the target, indicator, and selected measure of contribution.

Table B.3-2. Measures of the Contribution of CVFPP Actions to Conservation of the Yellow-breasted Chat

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Inundated Floodplain	Inundated Floodplain—total amount (acres, EAH units) with sustained spring and 50% frequently activated floodplain, and total amount of expected annual inundated floodplain habitat [a]	Yes	None.

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Riverine Geomorphic Processes	Natural Bank—total length (miles)	No	None.
	River Meander Potential—total amount (acres)	Yes	Nesting habitat requires adjacency to water.
SRA Cover	SRA Cover and Bank and Vegetation Attributes of SRA Cover—total length (miles)	Yes	Nesting and foraging habitats require adjacency to natural rivers or streams.
	Total Length and Percentage of Bank Affected by Flood Projects that Incorporate SRA Attributes	Yes	None.
Riparian	Habitat Amount—total amount and total amount on active floodplain (acres)	Yes	Nesting and foraging habitats require dense thickets of early successional riparian habitat (willows and other low shrubs), with a dense shrub layer, including native fruiting vegetation, and an open tree canopy with scattered tall trees, and presence of a water edge.
	Habitat Connectivity—median patch size (acres)	Yes	Nesting and foraging habitats require a tree and water edge or shrub and water edge.
Marsh	Habitat Amount—total amount and total amount on active floodplain area (acres)	No	Not applicable.

[a] Floodplain inundation potential is the potential of an area to be inundated by a particular flow (e.g., a flow event that occurs about once every two years, or a "50-percent-chance event"). Expected annual habitat units represent the annual average of the area expected to be inundated in general or by flows meeting defined criteria for timing and duration (e.g., sustained spring flows).

Notes:

EAH = expected annual habitat

SRA = shaded riverine aquatic

Table B.3-3. Target, Indicator, and Selected Measure of Contribution for the Yellow-breasted Chat

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Floodplain Agriculture	Habitat Amount—total amount (acres) of floodplain agriculture providing habitat for target species	Yes	Breeding success would be increased by reducing cowbird food sources by reducing non-native grass and row-crop seeds and reducing domestic ungulate presence, especially feedlots and dairies near chat breeding habitat.
Revetment	Revetment Removed to Increase Meander Potential or Natural Bank—total length (miles)	Yes	None.
Levees	Levees Relocated to Reconnect Floodplain or Improved to Eliminate Hydraulic Constraints on Restoration—total length (miles)	Yes	None.
Fish Passage Barriers	Fish Passage Barriers—remediated or removed	No	Not applicable.
Invasive Plants	Invasive-plant-dominated Vegetation—total area reduced (acres)	Yes	None.

Because management actions intended to benefit the yellow-breasted chat may simultaneously affect the conservation of other species in the SPA (e.g., least Bell's vireo), these measures of contribution have been incorporated into each CPA's objectives for the conservation of target species, which are provided in the Conservation Strategy Update. The target species objectives cover multiple species and reflect the interrelated nature of CVFPP flood management and conservation actions.

B3.3 References

Bairlein F. 2016. “Migratory Birds under Threat.” Science Volume 354: Pages 547 to 548.

Billerman SM. 2020. “Yellow-breasted Chat (*Icteriidae*),” version 1.0. In: Billerman SM, Keemey BK, Rodewald PG, Schulenberg TS, editors, *Birds of the World*. Ithaca (NY): Cornell Lab of Ornithology.

Burghardt KT, Tallamy DW, Shriver WG. 2009. “Impact of Native Plants on Bird and Butterfly Biodiversity in Suburban Landscapes.” Conservation Biology Volume 23: Pages 219 to 224.

Central Valley Joint Venture. 2006. “Central Valley Joint Venture Implementation Plan: Conserving Bird Habitat.” Sacramento (CA): U.S. Fish and Wildlife Service: Viewed online at: http://centralvalley.org. Accessed: August 26, 2020.

Comrack LA. 2008. Yellow-breasted Chat. In: Shuford WD, Gardali T, editors, California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies in Western Birds 1. Camarillo and Sacramento (CA): Western Field Ornithologists and California Department of Fish and Game.

Cornell Lab of Ornithology. 2020. “All About Birds.” Viewed online at: Yellow-Breasted-Chat. Accessed: October 19, 2021.

Dunn J, Alderfer J. 2011. *Field Guide to the Birds of North America*. Washington, DC: National Geographic Society.

Dunn JL, Garrett KL. 1997. *A Field Guide to the Birds of North America.* New York (NY): Houghton Mifflin.

Dybala KE, Clipperton N, Gardali T, Golet GH, Kelsey R, Lorenzato S, Melcer R Jr., Seavy NE, Silveira JG, Yarris GS. 2017. “Population and Habitat Objectives for Avian Conservation in California’s Central Valley Riparian Ecosystems.” San Francisco Estuary and Watershed Science Volume 15 (Issue 1), Article 5. California Digital Library, University of California.

eBird 2020. “Bird Observations.” Viewed online at: BirdObservations. Accessed: August 27, 2020.

Eckerle PK, Thompson CF. 2001. “Yellow-breasted Chat (*Icteria virens*).” In: Poole A, Gill F, editors, *The Birds of North America*, No. 575. Philadelphia (PA): Birds of North America.

Eckerle PK, Thompson CF. 2020. “Yellow-breasted Chat *Icteria virens.*” In: Birds of the World Online. Ithaca (NY): Cornell Lab of Ornithology. Viewed online at: www.birds.org. Accessed: August 24, 2020.

Ehrlich PR, Dobkin DS, Wheye D. 1988. The Birder’s Handbook: A Field Guide to the Natural History of North American Birds. New York: Simon and Schuster.

Famolaro P. 2006. *2005 Threatened and Endangered Species Survey Report.* Unpublished report. Prepared by: Sweetwater Authority. Prepared for: U.S. Fish and Wildlife Service, Carlsbad Field Office, Carlsbad (CA).

Gallinat AS, Primack RB, Lloyd-Evans TL. 2020. “Can Invasive Species Replace Native Species as a Resource for Birds under Climate Change? A Case Study on Bird-Fruit Interactions.” Biological Conservation Volume 241 (108268): Pages 1 to 10.

Garrett K, Dunn J. 1981. *Birds of Southern California: Status and Distribution*. Los Angeles (CA): Los Angeles Audubon Society.

George TL, Harrigan RJ, LaManna JA, DeSante DF, Saracco JF, Smith TB. 2015. “Persistent Impacts of West Nile Virus on North American Bird Populations.” Proceedings of the National Academy of Sciences Volume 112: Pages 14,290 to 14,294.

Griffith J, Griffith J. 2000. “Cowbird Control and the Endangered Least Bell’s Vireo: A Management Success Story.” In: Smith J, Cook T, Rothstein S, Robinson S, Sealy S, editors, *Ecology and Management of Cowbirds and their Hosts*. Austin (TX): University of Texas Press. Pages 342 to 356.

Grinnell J, Miller AH. 1944. *The Distribution of the Birds of California.* Cooper Ornithological Club, Pacific Coast Avifauna Number 27. Berkeley (CA).

Kaufman K. 1996. *Lives of North American Birds.* New York (NY): Houghton Mifflin Company.

Kirby JS, Stattersfield AJ, Butchart SHM, Evens MI. 2008. “Key Conservation Issues for Migratory Land and Waterbird Species on the World’s Major Flyways.” Bird Conservation International Volume 18 (S1): Pages 49 to 73.

Kleinschmidt Associates. 2008. *Cosumnes River Preserve Management Plan*. Grass Valley (CA). March 2008.

Mancuso KA, Hodges KE, Alexander JD, Grosselet M, Bezener AM, Morales L, Martinez SC, Castellanos-Labarcena J, Russello MA, Rockwell SM, Bieber ME, Bishop CB. 2022. “Migration and Non-breeding Ecology of the Yellow-breasted Chat *Icteria virens*.” Journal for Ornithology Volume 163: Pages 37 to 50.

McClain CD, Holl KD, Wood DM. 2011. “Successional Models as Guides for Restoration of Riparian Forest Understory.” Restoration Ecology Volume 19 (Issue 2): Pages 280 to 289.

Moore PL, Holl KD, Wood DM. 2011. “Strategies for Restoring Native Understory Plants along the Sacramento River: Timing, Shade, Non-native Control, and Planting Method.” San Francisco Estuary and Watershed Science Volume 9 (Issue 2), Article 1.

Ohmart RD. 1994. “The Effects of Human-Induced Changes on the Avifauna of Western Riparian Habitats.” Studies in Avian Biology Volume 15: Pages 273 to 285.

Remsen JV Jr. 1978. *Bird Species of Special Concern in California: An Annotated List of Declining or Vulnerable Bird Species*. Nongame Wildlife Investigations, Wildlife Management Branch. Administrative Report 78-1. Sacramento (CA): California Department of Fish and Game.

Robinson, S. K., J. A. Grzybowski, S. I Rothstein, M. C. Brittingham, L. J. Petit, F. R. Thompson. 1993. “Management Implications of Cowbird Parasitism on Neotropical Migrant Songbirds.” *Status and Management of Neotropical Migratory Birds*. U. S. Dept. of Agriculture, Forest Service 93-102 General Technical Report. Fort Collins (CO). September 1993.

Sauer JR, Hines JE, Fallon J. 2005. *The North American Breeding Bird Survey: Results and Analysis 1966–2004*, version 2005.2. Laurel (MD): U.S. Geological Survey Patuxent Wildlife Research Center. Viewed online at: www.mbr-pwrc.usgs.gov/bbs/bbs/html. Accessed: August 26, 2020.

Sharp BL, Kus BE. 2006. “Factors Influencing the Incidence of Cowbird Parasitism of Least Bell's Vireos.” Journal of Wildlife Management Volume 70 (Issue 3): Pages 682 to 690.

Siegle, R. and D. Ahlers. 2004. “Brown-headed Cowbird Management Techniques Manual.” U.S. Department of the Interior Bureau of Reclamation Technical Service Center Ecological Planning and Assessment Group. Denver (Co).

Tjarks H. 2012. “Using a Native Understory to Control Weeds in Riparian Restoration.” California Invasive Plant Council News Volume 20 (Issue 2): Pages 8 to 9.

The Bay Institute. 1998. From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed. Novato (CA). July 1998.

Unitt P. 2004. *The Birds of San Diego County*. San Diego Society of Natural History Memoir 13.

U.S. Fish and Wildlife Service. 2005. *Sacramento River National Wildlife Refuge Final Comprehensive Conservation Plan*. Sacramento (CA): California/Nevada Refuge Planning Office. June 2005.

Wheeler SS, Barker CM, Fang Y, Armijos MV, Carroll BD, Husted S, Johnson WO, Reisen WK. 2009. “Differential Impact of West Nile Virus on California Birds.” Condor Volume 111: Pages 1 to 20.

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Appendix B.4
Focused Conservation Plan: Monarch Butterfly

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APPENDIX B.4

Focused Conservation Plan: Monarch Butterfly

Source: River Partners

B4.1 Conservation Status

As part of the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy Update, this focused conservation plan addresses needs and opportunities for conserving the monarch butterfly (*Danaus plexippus*) and its habitat in the Systemwide Planning Area (SPA).

The monarch butterfly, a candidate for listing as threatened under the federal Endangered Species Act (ESA), breeds exclusively on plant species in the subfamily *Asclepiadoideae*. Monarch butterflies are globally distributed; there are two subpopulations of monarchs in North America, with the eastern population overwintering in Mexico and breeding in the midwestern states, and the western population overwintering in coastal California and migrating across the west from Arizona to Idaho to breed (California Department of Fish and Wildlife 2022). The taxonomy of this species is complex; several subspecies have been identified by various taxonomists, but agreement on their classifications has not been reached (Warren et al. 2013, Smith et al. 2005, Hay-Roe et al. 2007, J. Pelham pers. comm. 2017 in U.S. Fish and Wildlife Service 2020).

While most scientific papers do not recognize subspecies of monarchs that occur only in California (U.S. Fish and Wildlife Service 2020), the larger western North American population (which includes individuals that overwinter and breed in California) is recognized as a distinct phenotype by the U.S. Fish and Wildlife Service (USFWS) based on differences in migratory behavior, habitats occupied, reproductive behavior, wing morphology, flight performance, and disease and parasite resistance (U.S. Fish and Wildlife Service 2020). The western North American population makes up as much as 30 percent of the area occupied by monarch butterflies in North America (Dilts et al. 2019).

On the western coast of North America, monarchs are known to overwinter along the coast of California, from Mendocino County south to Baja California, with the largest groups typically occurring in Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara Counties. Monarchs typically begin arriving at their California overwintering sites in mid-October (Hill et al. 1976), where they form dense clusters on the branches and leaves of trees. Monarchs depart from these overwintering sites in late February or March and disperse north and east across California and several other western states to breed, laying their eggs exclusively on milkweed plants (U.S. Fish and Wildlife Service 2021, Dingle et al. 2005). Twenty-seven species of milkweeds (*Asclepias* spp.) plus a few species in closely related genera have been recorded as larval food plants (Malcolm and Brower 1986). Breeding takes place throughout migration such that the earliest breeding events occur in areas closest to overwintering sites, and the latest breeding events occur in areas farthest from overwintering sites, resulting in multiple generations of butterflies produced annually. Most adult butterflies live approximately two to five weeks during the spring and summer; however, the fall generation that migrates back to overwintering sites in California may live up to nine months (The Xerces Society for Invertebrate Conservation 2019).

Based on annual census data, monarchs across North America have been in decline since the 1980s, losing more than 95 percent of their prior recorded population (The Xerces Society for Invertebrate Conservation 2022). Population counts at overwintering sites in California indicate the western North American monarch population has experienced dramatic swings, from less than 1 percent of historical numbers in 2020 and 2021 (U.S. Fish and Wildlife Service 2020), then rebounding to almost 250,000 individuals (roughly 15 percent of historical numbers) in 2021 and 2022 (The Xerces Society for Invertebrate Conservation 2022), but with an overall severe downward trend (California Department of Fish and Wildlife 2022) (refer to the "Population Trends" section later in this document). This extreme population decline is likely due to multiple stressors across the monarch's range, including: the loss and degradation of overwintering tree groves, pesticide use (particularly insecticides), loss of breeding and migratory habitat, climate change, and parasites and diseases (U.S. Fish and Wildlife Service 2021). Owing to this population decline, the monarch butterfly was petitioned for listing under ESA in 2014. Although the USFWS found that listing was warranted, in December 2020 it determined that the listing was precluded by work on higher-priority listing actions. The monarch butterfly is currently slated to be listed by USFWS in 2024 (California Department of Fish and Wildlife 2022), and in July 2022, migratory monarchs were listed as internationally endangered by the International Union for Conservation of Nature, with the western population noted as being at the greatest risk for extinction (International Union for Conservation of Nature 2022). Monarchs are also included on the California Department of Fish and Wildlife's *Terrestrial and Vernal Pool Invertebrates of Conservation Priority* list (California Department of Fish and Wildlife 2017) and are identified as a Species of Greatest Conservation Need in California's *State Wildlife Action Plan* (California Department of Fish and Wildlife 2015).

The SPA is within the western North American monarch butterfly's early breeding zone (i.e., the geographic area where breeding occurs closest to coastal overwintering sites). The USFWS (2021) has designated the early breeding zone as a "priority #1 conservation action zone" for monarch conservation actions (refer to the "Status and Trends" section of this document). Recommended conservation actions for the priority #1 conservation action zone include the protection and planting of pesticide-free, early-season native milkweed and nectar plants. The SPA also makes up a smaller portion of the western monarch's summer breeding zone (i.e., the geographic area farther from California's coast, which subsequent generations of migrating monarchs reach later in the summer), which the USFWS (2021) has designated as a "priority #2 conservation action zone." Recommended conservation actions in the priority #2 conservation action zone include the identification and protection of existing native milkweed and nectar plants, as well as the planting of pesticide-free native milkweed and nectar plants.

The western population of the monarch butterfly meets the three criteria for inclusion as a target species in the Conservation Strategy:

1. Sensitive or special-status: the monarch butterfly is a candidate for listing as threatened under ESA.
2. Associated with target habitats: monarch breeding and migration habitat in the Central Valley includes riparian and marsh habitat associated with riverine systems (refer to the "Habitat and Ecological Process Associations" section of this document).
3. Potential CVFPP effect: flood control projects and operations and maintenance could permanently or temporarily affect monarch butterfly populations based on their association with suitable habitat in the SPA (refer to the "Integration of Conservation and Restoration in Flood Management" section of this document).

B4.1.1 Status and Trends

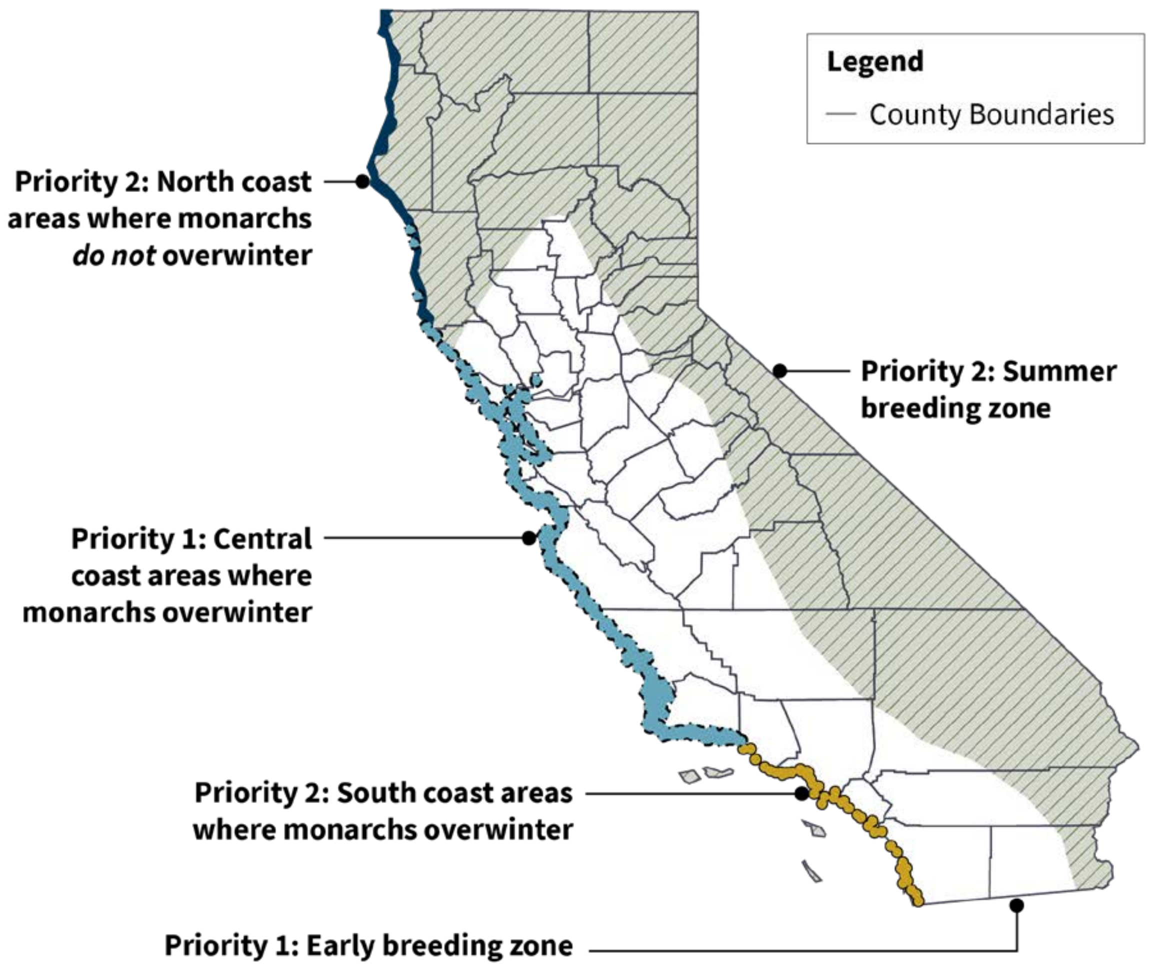
B4.1.1.1 Distribution

Figure B.4-1 shows the locations of overwintering sites, and breeding and migration zones for the monarch butterfly in California. Western North American monarchs migrate through inland areas to the California coast in the fall and cluster in a specific set of forested tree groves during the fall and winter each year (U.S. Fish and Wildlife Service 2021). Approximately 400 groves have been occupied, but only a portion of these sites is occupied in any given year (U.S. Fish and Wildlife Service 2020). These sites are scattered along approximately 620 miles of the Pacific Coast, ranging from Mendocino County, California, south into northern Baja California, Mexico (Western Monarch Milkweed Mapper 2022).

The groves are populated by a variety of evergreen tree species, including blue gum eucalyptus (*Eucalyptus globulus*), Monterey pine (*Pinus radiata*), and Monterey cypress (*Hesperocyparis macrocarpa*) (Griffiths and Villablanca 2015), all of which act as roost trees. The groves provide indirect sunlight for the overwintering monarchs, sources of moisture for hydration, protection against freezing temperatures, and protection against strong winds (Tuskes and Brower 1978, Leong 1990, Leong 1999). The close proximity to the coast (average distance of approximately 1.5 miles) also provides a mild winter climate (Leong et al. 2004).

In late winter and early spring (February through March), surviving monarchs mate and disperse from the overwintering sites across California's Central Valley and other western states to lay their eggs on milkweed plants (Leong et al. 1995, van Hook 1996, The Xerces Society for Invertebrate Conservations 2019). During their migration and breeding journey, adults rely on many different habitat types that harbor nectar plants and roosting sites (i.e., trees and shrubs) (U.S. Fish and Wildlife Service 2020). Breeding and migrating monarchs have been impacted by the loss of much of the high-quality habitat that historically was found in California's Central Valley due to the conversion of native grassland and shrubland to intensive agriculture (The Xerces Society for Invertebrate Conservation 2019). Monarch populations also have been impacted by pesticides and diseases, such as the pathogen *Ophryocystis elektroscirrha* (OE) (The Xerces Society for Invertebrate Conservation 2019), especially as breeding activity increases in urban areas where ornamental, non-native milkweed is planted in gardens and landscaping (James et al. 2021).

Figure B.4-1. Locations of Overwintering and Breeding/Migration Zones for the Monarch Butterfly in California



Source: Modified from USFWS 2021

B4.1.1.2 Population Trends

Monarchs, like many insects, are sensitive to environmental conditions (i.e., temperature and precipitation) and can experience large swings in population sizes from year-to-year in response to interannual changes in temperature and the amount and timing of precipitation (Rendón-Salinas et al. 2015, Schultz et al. 2017). During favorable conditions, monarch survival and reproductive rates are high, and population numbers increase; conversely, when environmental conditions are unfavorable, survival and reproductive rates are low, and population numbers can plummet (U.S. Fish and Wildlife Service 2020). Thus, a robust potential population growth rate (i.e., high-potential reproductive output) is necessary for monarch populations to withstand large swings in population sizes over generations and years.

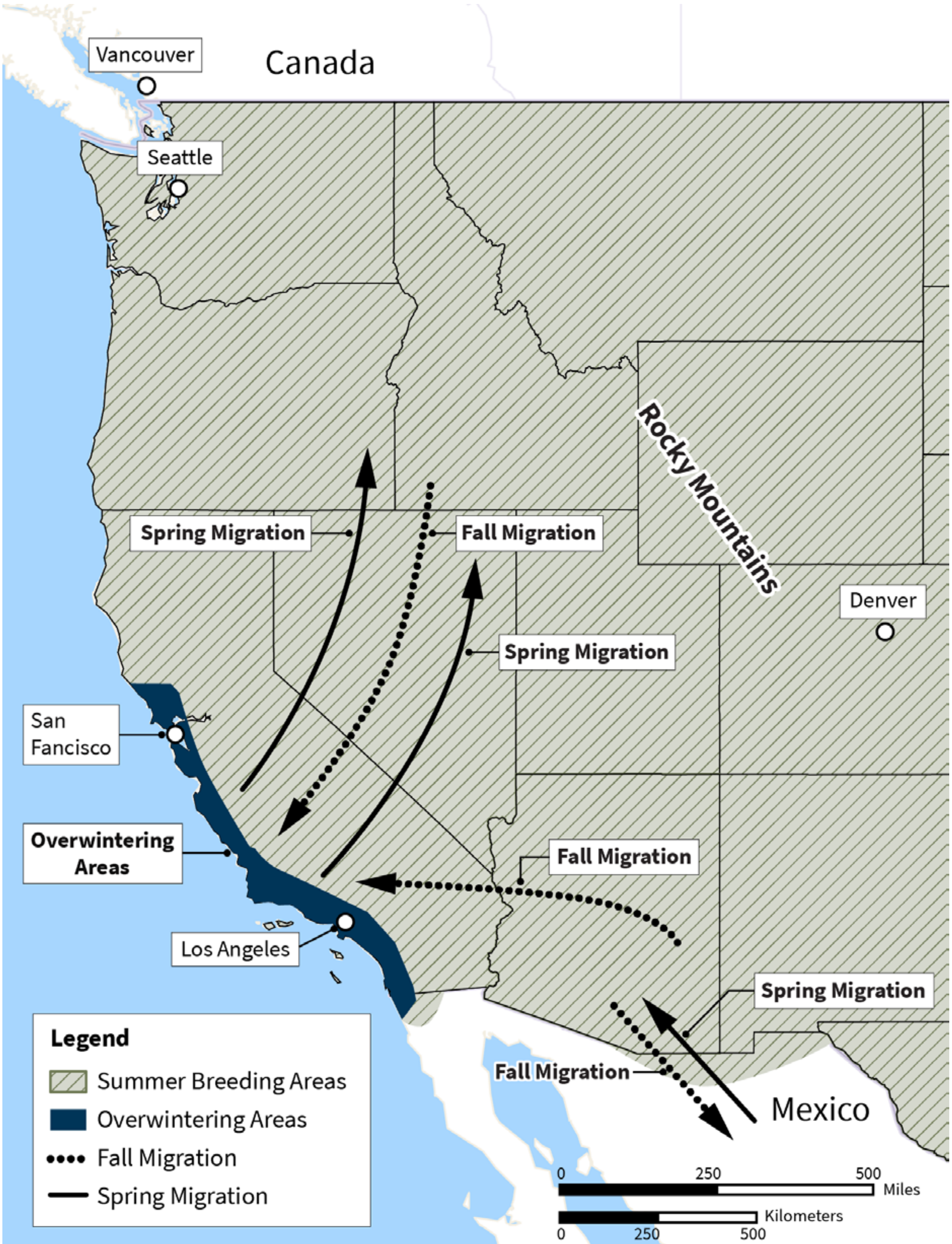
To support a strong growth rate, monarch populations require a sufficient quantity and quality of habitat to accommodate all life stages (U.S. Fish and Wildlife Service 2020). Based on the past annual censuses of California overwintering sites, the western North American population has generally been declining over the last 23 years, despite an increasing number of sites being counted (U.S. Fish and Wildlife Service 2020). Overwintering populations have declined from an estimated 4.5 million individuals in the 1980s to fewer than 2,000 butterflies in 2020, a decline of 99 percent (U.S. Fish and Wildlife Service S 2021, The Xerces Society for Invertebrate Conservation 2020). Although overwintering population counts recorded nearly 250,000 butterflies in 2021 (The Xerces Society for Invertebrate Conservation 2022), a stable population for western monarchs is likely closer to the historical averages in the 1980s (California Department of Fish and Wildlife 2022).

B4.1.2 Life History

With only a few localized exceptions (Figure B.4-2), most monarch butterfly populations in eastern and western North America undergo long-distance migration for breeding (Cockrell et al. 1993, Herman and Tatar 2001). In the fall, migrating monarchs, which are in a state of reproductive diapause, begin migrating to their respective overwintering sites. These migrations can occur over distances of more than 1,800 miles (Urquhart and Urquhart 1978) and last for more than two months (Brower 1996). Migratory individuals in western North America generally fly south and west to overwintering groves along the California coast into northern Baja California (Solensky 2004).

In late winter and early spring (February and March), surviving monarchs break reproductive diapause (i.e., become reproductively active, possibly due to a combination of hormonal and physiological factors, although this is not fully understood [Monarch Watch 2009]), and mate at the overwintering sites before dispersing east and north (Leong et al. 1995, van Hook 1996). The same individuals that undertook the initial southward migration begin flying back through the breeding grounds, and their offspring start the cycle of generational migration over again (Malcolm and Zalucki 1993). Multiple generations of monarchs are produced during the breeding season, with most adult butterflies living approximately two to five weeks before they breed and die (Cockrell et al. 1993, Herman and Tatar 2001).

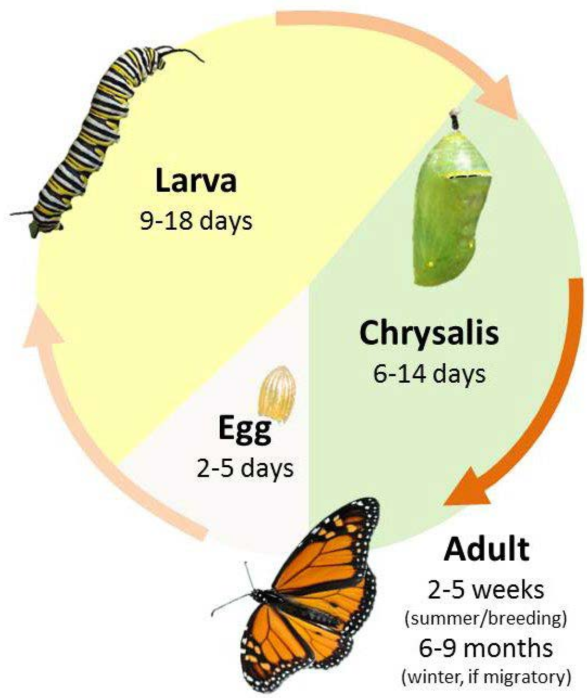
Figure B.4-2. North American Monarch Migration Patterns



Source: Modified from USFWS 2020

In California, monarchs lay their eggs on their obligate milkweed host plant, and larvae emerge after two to five days (Zalucki 1982, Secretariat of the Commission for Environmental Cooperation 2008). Larvae develop through five larval instars (intervals between molts) over a period of 9 to 18 days, feeding on milkweed and sequestering toxic cardenolides as an anti-predator defense mechanism (Parsons 1965). The larva then pupates into a chrysalis before emerging 6 to 14 days later as an adult butterfly. Multiple generations of monarchs are produced during the breeding season; as mentioned, most adult butterflies live approximately two to five weeks, but the fall generation that migrates to overwintering sites in California may live up to 9 months (The Xerces Society for Invertebrate Conservation 2019). Figure B.4-3 shows the monarch life cycle adapted from the USFWS species assessment (U.S. Fish and Wildlife Service 2020).

Figure B.4-3. Annual Cycle of Breeding, Larval Development, and Migration in the Monarch Butterfly



Source: USFWS 2020

B4.1.3 Habitat and Ecological Process Associations

During breeding and migration, adult monarch butterflies require a diversity of blooming nectar resources that bloom at different times throughout the migration period, which they feed on throughout their migration routes and breeding grounds (U.S. Fish and Wildlife Service 2020).

Monarchs also need milkweed (for both oviposition [egg-laying] and larval feeding) embedded within diverse nectaring habitat. Milkweed may function as the principal nectar source for monarchs in arid regions such as California's Central Valley (Pelton et al. 2018, Robins 2020). The correct phenology, or timing, of monarchs, nectar plants, and milkweed is important for monarch survival, as is the position of these resources on the landscape (Zalucki and Lammers 2010, Miller et al. 2012).

In western North America, nectar and milkweed resources often are associated with riparian corridors, and the restoration of river corridors is a leading strategy being undertaken to save monarchs in California's Central Valley (Dilts et al. 2018, Dingle et al. 2005, Rothrock 2021, Waterbury and Potter 2018). Historical records of monarch collections in western North America suggest fall migrants often followed riparian corridors, likely due to the reliable distribution of water, nectar resources, and roost trees in these landscapes (Western Association of Fish and Wildlife Agencies 2019). However, the specific amounts of needed habitat and its spatial distribution are unknown; more research is needed about optimal distances between habitat patches, as well as optimal patch size, milkweed density, and characteristics of patches selected by females for oviposition (Kasten et al. 2016, Stenoien et al. 2016, Grant et al. 2018, Waterbury and Potter 2018). During the long migration to overwintering sites, monarchs continue to need blooming nectar plants throughout the migratory habitat to provide sugar that is eventually stored as lipid reserves (i.e., fats that provide the butterflies with energy throughout the winter) (Brower et al. 2015).

Early-blooming milkweed plants native to the SPA include California milkweed (*A. californica*), heartleaf milkweed (*A. cordifolia*), and woolly milkweed (*A. vestita*). Late-blooming milkweed plants in the SPA include woollypod milkweed (*A. eriocarpa*), narrow-leaf milkweed (*A. fascicularis*), and showy milkweed (*A. speciosa*). Nectar plants especially favored by monarchs include some shrubs and woody forbs typical of riparian habitat, such as mulefat (*Baccharis salicifolia*), coyote brush (*B. pilularis*), buttonwillow (*Cephalanthus occidentalis*), and willows (*Salix* spp.), as well as a variety of herbaceous annuals and perennials native to the region (Robins 2020, The Xerces Society for Invertebrate Conservation 2019). Monarchs also use trees and shrubs to rest during breeding and migration, and they need regular access to water sources for hydration.

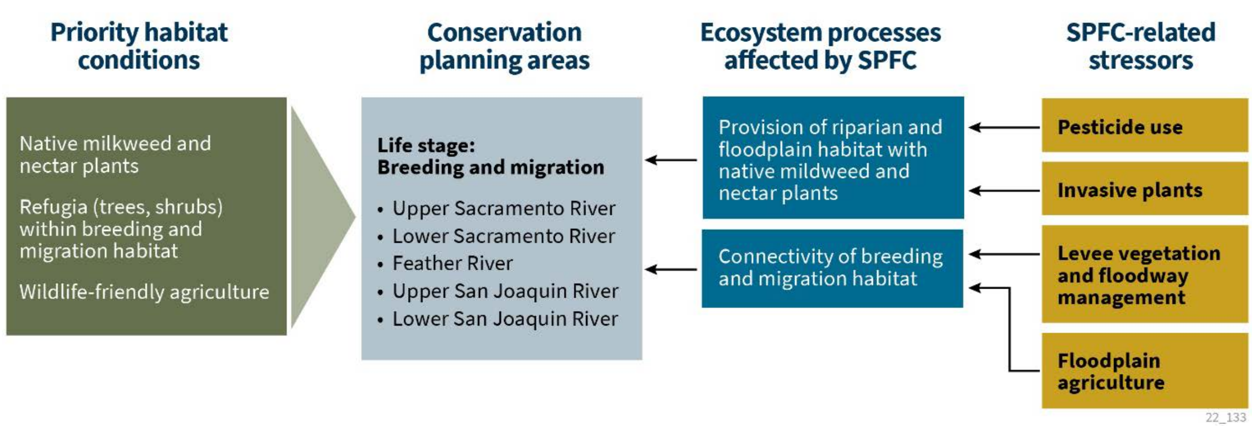
In the western United States, monarchs are observed traveling along riparian corridors and roosting in trees during the breeding and migration seasons; fall migration roosting habitat is likely important for monarchs along rivers (Dingle et al. 2005). Monarch usage of roost sites along some rivers varies by year, possibly due to weather conditions and resource availability (Western Association of Fish and Wildlife Agencies 2019). In the southwestern United States, most monarchs are detected during the summer breeding season, in riparian areas with tall trees that offer shade and cooler temperatures near milkweed and nectar plants (Robins 2020, Gail Morris pers. comm. in Western Association of Fish and Wildlife Agencies 2019). Monarch butterflies in the western United States also are strongly attracted to and regularly use areas with available moisture (Western Association of Fish and Wildlife Agencies 2019, Robins 2020).

B4.1.4 Conceptual Model

A conceptual model has been designed to assist in developing a targeted conservation strategy for the monarch butterfly within the SPA (Figure B.4-4). This model is not intended to be a comprehensive model of all ecological processes, stressors, and other factors that could be relevant for this species. Rather, as Figure B.4-4 shows, the conceptual model specifically depicts the following information:

- Habitat conditions required by monarch butterflies within the SPA; that is, areas with native milkweed and nectar plants, as well as trees and shrubs for roosting during breeding and migration periods (i.e., spring, summer, and fall) and wildlife-friendly agriculture.
- All five Conservation Planning Areas where the monarch butterfly may breed under suitable habitat conditions.
- Key ecosystem processes of riverine systems within the SPA potentially affected by actions that could be implemented as part of the CVFPP, including the Conservation Strategy; in this case, the provision of riparian and floodplain habitat with native milkweed and nectar plants and connectivity of suitable breeding and migration habitat.
- Stressors related to State Plan of Flood Control facilities and their operations and maintenance; that is, pesticide use, invasive plants, levees and floodway management and maintenance, and agricultural operations in floodways and bypasses.

Figure B.4-4. Conceptual Model for the Monarch Butterfly within the Systemwide Planning Area



B4.1.5 Management Issues

B4.1.5.1 Threats and Sensitivities Rangewide

The main influences affecting the decline of monarchs in western North America are (International Union for Conservation of Nature 2022, U.S. Fish and Wildlife Service 2020):

- The availability, spatial distribution, and quality of milkweed plants for larvae.
- The availability, spatial distribution, and quality of nectar resources in breeding habitat.
- The use of insecticides; availability and quality of overwintering habitat.
- Climate change effects on suitable habitat.
- Other climate change effects that directly affect individuals (e.g., drought, increasing temperature, large storms).

The availability of milkweed is essential to monarch reproduction and survival. Reduction in milkweed is cited as a key driver in monarch declines (Brower et al. 2012, Pleasants and Oberhauser 2013, Inamine et al. 2016, Thogmartin et al. 2017, Waterbury and Potter 2018, Saunders et al. 2019). Although milkweed is lost when native habitats are developed for urban and suburban uses (Lark et al. 2015, The Xerces Society for Invertebrate Conservation 2019), and milkweed can be displaced by invasive plants and vegetation management practices (e.g., prescribed burning, grazing, and mowing) (Electric Power Research Institute 2019), a majority of recent (i.e., since the 1990s) milkweed loss has occurred in agricultural lands, where intensive herbicide use for weed control has resulted in widespread milkweed eradication (Pleasants 2017, U.S. Fish and Wildlife Service 2020).

Glyphosate (an herbicide) used on genetically engineered glyphosate-tolerant crops has increased dramatically since the 1990s, especially within the Central Valley of California and other agricultural areas in western United States (U.S. Geological Survey National Water-Quality Assessment 2017, Waterbury and Potter 2018). Over time, weed species develop an increasing resistance to glyphosate, and other herbicide-tolerant crops are developed, which overall leads to a corresponding increase in herbicide use on crops. Accordingly, herbicide impacts to milkweed and nectar plants will continue to adversely affect monarch resources.

Insecticides are pesticides with chemical properties that are designed to kill insects; most are non-specific and broad-spectrum in nature. Furthermore, the larvae of many lepidopterans (i.e., moths and butterflies) are considered major agricultural pest species, and insecticides are tested specifically on this taxon to ensure they will effectively kill individuals at labeled application rates. In addition to direct exposure at the insecticide application point, monarchs may also be exposed to insecticides because of insecticide drift from the application point to other adjacent areas (Olaya-Arenas and Kaplan 2019, Halsch et al. 2020). Although insecticide use is most often associated with agricultural production (Atwood and Jones 2017), any habitat where monarchs are found may be subject to insecticide use. For example, homeowners and municipalities may treat yards, gardens, and landscaped areas to protect plants from pests, or they may purchase plants from nurseries or wholesalers that sell ornamental plants treated with neonicotinoids (a type of insecticide chemically similar to nicotine). The wide-scale use of insecticides for pest outbreaks and vector control (e.g., for disease-carrying mosquitos) also can adversely affect monarchs (U.S. Fish and Wildlife Service 2020).

While both herbicides and insecticides are acknowledged to affect monarchs—both directly and indirectly through loss of milkweed and nectar plants—the magnitude of risk posed by pesticides may be underestimated. Research on pesticides usually examines the effects of the active ingredient on target species (or surrogate species) alone, while many commercial pesticide formulations combine a variety of chemicals to increase treatment efficacy. Thus, studies looking specifically at dose-responses of monarchs to neonicotinoids, organophosphates, pyrethroids, or other widely used pesticides (e.g., Krischik et al. 2015, James 2019, Krishnan et al. 2020, Bargar et al. 2020) may underestimate the potential impacts of these chemicals on monarchs, when used in combination.

Losses of nectar resources during breeding and migration also have been particularly implicated as a potential key driver in monarch declines (Inamine et al. 2016, Thogmartin et al. 2017, Saunders et al. 2019). These losses are due to the same stressors that have resulted in the loss of milkweed resources. Additionally, as droughts become more severe and frequent, especially in western North America, the impacts of climate change may be a larger driver of future monarch population declines (International Union for Conservation of Nature 2022, U.S. Fish and Wildlife Service 2020).

Monarchs rely on the microclimate provided by the trees at their overwintering sites (Leong et al. 2004, Williams and Brower 2015). Western monarch overwintering habitat along the California coast has been subject to loss through various forms of development, particularly urban development (Sakai and Calvert 1991, Frey and Schaffner 2004). Habitat alteration, both natural and anthropogenic, also can alter the microclimate of the western overwintering sites, leading to less suitable habitat conditions (Jepsen et al. 2015). There are many other stressors that can work alone or in tandem on the California overwintering sites, including disease and pests that impact the trees used for overwintering, as well as tree senescence (i.e., the process of slowed growth and eventual death) and improper grove management. Wildfire is also a threat, both indirectly through habitat loss and directly to overwintering monarchs (Pelton et al. 2016).

In western North America, climate change is predicted to cause a significant change in the distribution of overwintering monarchs in coastal California. Results from climatic niche modeling by Fisher et al. (2018) suggest that climate change will result in an inland and upslope displacement of suitable overwintering conditions. Climate change impacts, particularly increasing temperatures, also may adversely affect monarch fecundity (maximum reproductive potential) (Oberhauser 1997), mating success (Solensky and Oberhauser 2009), and survival during migration and while overwintering (Masters et al. 1988, Alonso-Mejía et al. 1997). High temperatures and drought conditions may be particularly harmful during the crucial spring migration (Chip Taylor pers. comm. 2020 in U.S. Fish and Wildlife Service 2020).

Widespread drought is likely to adversely affect trees in the California overwintering areas both directly and indirectly due to increased susceptibility to pests (Paine and Millar 2002). A warming climate may influence breeding habitat by altering suitable locations for both monarchs (Batalden et al. 2007) and their milkweed host plants (Lemoine 2015). Drought may also influence the amount and availability of nectar needed for migrating butterflies (Brower et al. 2015, Stevens and Frey 2010, Espeset et al. 2016), and cause an increase in the frequency and intensity of catastrophic wildfires (International Union for Conservation of Nature 2022).

Additionally, climate change may adversely affect monarchs in ways that are more difficult to measure, such as phenological mismatch (e.g., timing of milkweed and nectar source availability not aligning with monarch migration; Thogmartin et al. 2017). Furthermore, recent research suggests that elevated carbon dioxide may reduce medicinal properties of some milkweed species, potentially leading to increased OE parasite virulence and decreased monarch tolerance of OE infections (Decker et al. 2018).

B4.1.5.2 Ongoing and Future Impacts

The most important ongoing and likely future hindrances to sustaining viable populations of monarch butterflies in the Central Valley are pesticide impacts on milkweed, nectar resources and individual monarchs; climate change effects, including drought and increasing temperatures that adversely affect both habitat and individuals; and loss of breeding and migratory monarch habitat due to a variety of mechanisms (U.S. Fish and Wildlife Service 2020). Vegetation management practices in breeding and migration habitat on managed landscapes, such as within the SPA, also will have effects on monarch butterflies, and could be either detrimental or beneficial, depending on the timing, frequency, and intensity of maintenance activities (Electric Power Research Institute 2019).

B4.1.5.3 Key Information Gaps or Uncertainties

To better understand factors affecting the Central Valley's monarch butterfly population, more information is needed regarding the following subject (U.S. Fish and Wildlife Service 2020; Western Association of Fish and Wildlife Agencies 2019):

- **Optimal patch size and connectivity of breeding and migration habitat.** The size and spatial arrangement of breeding and migration habitat patches is generally thought to be important, but specific parameters are unknown (U.S. Fish and Wildlife Service 2020). Having a better understanding of optimal size and arrangement of habitat patches would help define targets for habitat restoration and conservation projects.

- **Roosting site requirements within breeding and migration habitat.** Monarchs need places to rest during breeding and migration, but specific requirements of roosting sites in breeding and migration habitat are unknown (U.S. Fish and Wildlife Service 2020). A better understanding of roosting requirements in breeding and migration habitat would help inform habitat restoration and conservation guidelines for providing suitable roosting habitat (Western Association of Fish and Wildlife Agencies 2019).

- **Timing and locations of breeding areas and migration pathways.** While the pattern and timing of movement of the western North American monarch population generally are understood, more specific information is lacking (U.S. Fish and Wildlife Service 2019). Having more precise information about where and when monarchs are breeding and their migration pathways in the Central Valley would help prioritize where conservation areas should be located and when certain conservation actions should occur to sustain breeding and migration habitat (Western Association of Fish and Wildlife Agencies 2019), as well as when and where to implement vegetation management activities in managed landscapes (Electric Power Research Institute 2019).

- **Connectivity of North American populations.** Although monarchs in the western North American population primarily overwinter along the California coast, some individuals are known to overwinter in Mexico (Morris et al. 2015), where the majority of the eastern North American population overwinters, and some overwintering individuals from Mexico are known to migrate into California to breed (Brower and Pyle 2004, Dingle et al. 2005). Thus, there is some mixing of monarchs from the western and eastern North American populations, but the rate of exchange is unknown (U.S. Fish and Wildlife Service 2020). Understanding the immigration and emigration rates between them would provide a better estimate of population resiliency and viability (U.S. Fish and Wildlife Service 2020) and, thus, would better guide the prioritization of conservation actions.

- **Alternate overwintering strategies and locations.** While it is believed that the majority of monarchs in California overwinter in reproductive diapause, there are known exceptions, including individuals that become reproductively active and breed throughout the winter along the southern Pacific Coast (Howard et al. 2010, Satterfield et al. 2016). These monarchs are more likely to become infected with OE (Satterfield et al. 2016, 2018), and their infected offspring could emerge in reproductive diapause and continue to Mexico or California overwintering sites later in the season, spreading OE infection across overwintering sites (Batalden and Oberhauser 2015). Additionally, there are smaller overwintering areas for the western North American population, including several small sites in inland California (Figure B.4-1) (Morris et al. 2015, Pelton et al. 2016). These sites are less likely to be included in the annual population counts; therefore, population estimates in California may be low (U.S. Fish and Wildlife Service 2020). Understanding the less common overwintering strategies and locations will provide a more thorough status of the species and threats in California and thereby inform development of conservation actions.

- **Threats and population response**. The direct and causal relationships between monarch population size and certain threats are poorly understood—specifically the interactions among threats (e.g., land-use change and pesticide use), changes to threats over time (e.g., invasive species populations), and responses to climate change (International Union for Conservation of Nature 2022, U.S. Fish and Wildlife Service 2020). These uncertainties likely lead to an underestimate of the vulnerability of extinction and overestimate the resiliency and viability of monarch populations. Having a better understanding of threats and population response would help prioritize conservation actions.

- **Extinction thresholds**. Another key uncertainty regarding monarch populations is the population size in which environmental stochasticity and Allee effects (i.e., reinforcing processes that drive the population downward toward extinction) begin to override the population dynamics (U.S. Fish and Wildlife Service 2020). This uncertainty affects current estimates of monarch resiliency and possibly overestimates or underestimates the viability of the monarch as a species. Developing more precise extinction thresholds will help to prioritize conservation actions.

B4.2 Conservation Strategy

B4.2.1 Conservation and Recovery Opportunities

The most viable ways to support the recovery of the monarch butterfly in the SPA are to restore or enhance native riparian habitat that contains suitable breeding and migration habitat, promote wildlife-friendly agriculture; reduce pesticide use throughout the SPA; and control invasive plants that displace native milkweed and nectar plants. Creating patches of suitable breeding and migration habitat and connecting those patches to existing or new suitable habitat would increase opportunities for the recovery of monarch populations in the SPA. Encouraging less pesticide use in agricultural areas and timing vegetation maintenance activities carefully in the SPA—especially in the spring, summer, and fall when monarchs are present (generally mid-March through the end of October)—would reduce monarch mortality and increase breeding success. Planting native nectar plants and milkweed in agricultural areas protected from pesticide drift and controlling invasive plants in potentially suitable breeding and migration habitat would also improve connectivity between suitable habitat areas.

All such conservation and restoration initiatives could incorporate the vegetative and structural components identified in the “Conceptual Models” section of this document.

B4.2.2 Identified Conservation Needs

The following actions have been identified as being necessary to support the conservation of monarchs.

1. Reduce pesticide use: Herbicides used for weed control can kill milkweed and nectar plants, and insecticides used on agricultural lands can kill individual monarch adults and caterpillars. Reducing or eliminating the use of herbicides for levee and floodway vegetation management would reduce the loss of milkweed and nectar plants that are unintended targets of broad-spectrum herbicides (e.g., glyphosate). Using insecticides appropriately on agricultural lands so that direct contact and drift are avoided at times when monarchs are present (spring, summer, and fall) would reduce individual mortality.

2. Increase and sustain breeding and migration habitat: The loss of native milkweed and nectar plants has reduced the amount and connectivity of suitable breeding and migration habitat in the Central Valley. Restoring and enhancing this habitat could occur throughout the SPA, because monarchs will use a variety of habitat types so long as milkweed or nectar plants (or both) are present. Restoration and enhancement in the floodway provide a substantial opportunity to increase connectivity of suitable habitat throughout the Central Valley. Monarch restoration projects could be incorporated into nearly any other type of riparian and floodway restoration that includes an open herbaceous component. Migrating monarchs also need trees and shrubs for safe roost sites and water to drink, so including open areas with an abundance of native nectar plants and milkweeds in riparian forest and shrub restoration projects in the floodway would be ideal.

B4.2.3 Integration of Conservation and Restoration in Flood Management

As identified in Table B.4-1, CVFPP management actions have the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the monarch butterfly. In many cases, the species’ conservation needs can be positively addressed by implementing management actions that integrate conservation, enhancement, and restoration elements with State Plan of Flood Control operations and maintenance, floodway management, and structural improvements. The ability to implement some of these actions would depend on operations, maintenance, and floodway management actions and structural improvements (as described in the following section) to resolve constraints, such as the dominance of non-native vegetation that requires intensive maintenance practices or revetment removal at a site that may depend on levee relocation to allow bank erosion. Wherever feasible, conservation objectives and indicators will inform management actions for adaptive, responsive, and sustainable implementation that avoids and minimizes impacts on species and ecosystems.

B4.2.3.1 Operations, Maintenance, and Floodway Management

Invasive-plant management: Weed infestations negatively affect the native milkweed and nectar plants the monarch butterfly relies on during breeding and migration. Native milkweed and nectar plants provide essential food sources for monarch caterpillars and adults. In general, invasive plants have been shown to significantly displace native plant species. Managing and controlling invasive plants would minimize these impacts, so long at herbicide use is minimized and non-native floral resources are not entirely eliminated during monarch active periods (generally mid-March through the end of October).

Table B.4-1. Summary of the Contributions of CVFPP Management Actions to Identified Conservation Needs of the Monarch Butterfly

CVFPP Management Actions		Conservation Need 1. Reduce Pesticide Use	Conservation Need 2. Increase and Sustain Breeding and Migration Habitat
Operations, Maintenance, and Floodway Management	Floodwater storage and reservoir forecasting, operations, and coordination	Neutral	Neutral
	Facility maintenance	Neutral	Neutral
	Levee vegetation management	Negative	Negative
	Floodway maintenance	Negative	Negative
	Modification of floodplain topography	Neutral	Neutral
	Support of floodplain agriculture	Negative	Negative
	Invasive-plant management	Positive	Positive
	Restoration of riparian, SRA, and marsh habitats	Neutral	Positive
	Wildlife-friendly agriculture	Positive	Positive
Structural Improvements	Levee and revetment removal	Positive	Positive
	Levee relocation	Positive	Positive
	Bypass expansion and construction	Neutral	Positive
	Levee construction and improvement	Negative	Negative
	Flood control structures	Neutral	Neutral

Notes:
CVFPP management actions are designated as having the potential to provide a positive, negative, or neutral contribution to the identified conservation needs of the species.
SRA = shaded riverine aquatic

Additionally, habitat restoration actions that involve planting native species have been shown to reduce colonization by invasive species in newly planted sites and generally require less intensive management practices than sites dominated by invasive species (Electric Power Research Institute 2019, McClain et al. 2011, Moore et al. 2011, Tjarks 2012). New plants and seeds should not have been treated with neonicotinoids or other systemic insecticides at any time; non-native flowering plants should be replaced with native perennial monarch nectar or host plants with similar phenology as the invasive species targeted for removal to avoid disruption of habitat suitability in that location (Electric Power Research Institute 2019, U.S. Fish and Wildlife Service 2021).

Restoration of riparian, SRA, and marsh habitats: Riparian restoration that incorporated open areas dominated by native milkweed and nectar plants would increase the amount of breeding and migration habitat available for monarch butterflies in the Central Valley. Providing corridors of suitable habitat throughout the SPA would maximize opportunities for this species to migrate and breed. Incorporating a planting palette that includes native early-blooming (spring) to late-blooming (fall) milkweeds and a variety of nectar plants, along with native trees and shrubs for roosting, would create ideal breeding and migration habitat for monarchs (Robins 2020, Western Association of Fish and Wildlife Agencies 2019, U.S. Fish and Wildlife Service 2021, California Department of Fish and Wildlife 2022). Plant materials should not have been treated with neonicotinoids or other systemic insecticides, including coated seeds, due to their ecosystem persistence, systemic nature, and toxicity (U.S. Fish and Wildlife Service 2021). Adjacency to water sources available throughout the breeding and migration period is also important.

Wildlife-friendly agriculture: Wildlife-friendly agriculture is an important conservation tool that can benefit many target species. Conserving wild pollinators, including butterflies, in habitats adjacent to agriculture improves both the level and stability of pollination, leading to increased yields and income (Klein et al. 2003). Diversified agricultural landscapes containing flowers in bloom throughout the growing season could both increase monarch habitat and facilitate crop pollination (Western Association of Fish and Wildlife Agencies 2019). Planting hedgerows or corridors along field edges and irrigation canals with native milkweeds and nectar plants, or simply allowing native milkweeds to grow in areas that are naturally conducive to milkweed (e.g., margins of fields, runoff collection areas, wet meadows, and riparian areas) would benefit monarchs by providing additional breeding and migration habitat and connectivity between habitats (Robins 2020, Western Association of Fish and Wildlife Agencies 2019).

Limiting the use of pesticides in agricultural areas is essential to providing suitable habitat for monarchs. Pesticides should not be used on blooming flowers in monarch habitat. Herbicides can be applied during young plant phases, when plants are more responsive to treatment, and when monarchs and other pollinators are less likely to be feeding on the plants (U.S. Fish and Wildlife Service 2021). If pesticides are used, they should be applied using targeted application methods, avoiding large-scale broadcast applications, and precautions taken to limit the off-site movement of pesticides (e.g., drift from wind and discharge from surface water flows) (U.S. Fish and Wildlife Service 2021). Monarch habitat areas should be separated from areas receiving chemical treatments with a pesticide-free spatial buffer, evergreen vegetative buffer of coniferous, non-flowering trees to capture chemical drift, or both. The appropriate monarch habitat spatial buffer size depends on several factors, including weather and wind conditions; at a minimum, the habitat should be at least 40 feet from ground-based pesticide applications, 60 feet from air-blast sprayers, and 125 feet from any systemic insecticide applications or seed-treated plants (U.S. Fish and Wildlife Service 2021).

B4.2.3.2 Structural Improvements

Levee and revetment removal: Removing levees and revetment would create opportunities to improve the riverine geomorphic and floodplain inundation processes that are important to sustaining natural habitats along rivers. Removing levees and revetment reduces the need for vegetation management in these areas. Restoring land formerly covered by levees and revetment to native vegetation could provide suitable breeding and migration habitat for monarchs. Restoring habitat along former levees would also provide better connectivity between patches of suitable habitat.

Levee relocation: Similar to the restoration opportunities described, floodways that are expanded through the relocation of levees would provide opportunities to improve ecosystem function and increase the extent, quality, and connectivity of habitat. If habitat were managed to increase native milkweed and nectar plants—adjacent to riparian shrubs and trees that could provide roosting sites, as well as channels and wetlands that would provide water sources—this would provide suitable breeding and migration habitat for monarchs.

Bypass expansion: Similar to the restoration opportunities described, floodways that are expanded through bypass widening would provide opportunities to improve ecosystem function and increase the extent, quality, and connectivity of habitat. If habitat were managed to increase native milkweed and nectar plants—adjacent to riparian shrubs and trees that could provide roosting sites, as well as channels and wetlands that would provide water sources—this would provide suitable breeding and migration habitat for monarchs.

B4.2.4 Measures of Positive Contribution

One goal of the Conservation Strategy is to contribute to the recovery and stability of native species populations and overall biotic community diversity. The objective for this goal is a measurable contribution to the conservation of target species, including the monarch butterfly. Therefore, building on the preceding discussion, this section of the monarch butterfly conservation plan provides measures (i.e., metrics or indicators) that will be used to determine how CVFPP management actions contribute to the conservation needs of this species.

Measures for each target species are organized around indicators of progress toward the Conservation Strategy’s process, habitat, and stressor objectives (Table B.4-2). The species-specific measures provide additional detail on geographic location, habitat structure, and other attributes important to conservation of the species. For example, the reduction of acreage of invasive-plant-dominated area is an indicator of progress toward the Conservation Strategy’s invasive-plant objective. To measure the contribution of CVFPP actions to the conservation of the monarch butterfly, requirements would be added to replace acreage that was dominated by invasive plants with areas with an abundance of native milkweed and nectar plants.

Table B.4-2 lists the process, habitat, and stressor targets of the Conservation Strategy; identifies those used to measure the contribution to conservation of monarch butterfly; and provides additional specificity, as necessary, to measure this contribution.

Table B.4-2. Measures of the Contribution of CVFPP Actions to Conservation of the Monarch Butterfly

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Inundated Floodplain	Inundated Floodplain—total amount (acres, EAH units) with sustained spring and 50- percent frequently activated floodplain, and total amount of expected annual inundated floodplain habitat [a]	No	Not applicable.
Riverine Geomorphic Processes	Natural Bank—total length (miles)	Yes	Natural banks can support native milkweed and nectar plants.
	River Meander Potential—total amount (acres)	No	Not applicable.
SRA Cover	SRA Cover and Bank and Vegetation Attributes of SRA Cover—total length (miles)	Yes	Native trees and shrubs can provide roosting sites adjacent to water sources.
	Total Length and Percentage of Bank Affected by Flood Projects that Incorporate SRA Attributes	Yes	Native trees and shrubs can provide roosting sites adjacent to water sources.
Riparian	Habitat Amount—total amount and total amount on active floodplain (acres)	Yes	Riparian habitat with open areas that harbor an abundance of native milkweed and nectar plants provides breeding and migration habitat.
	Habitat Connectivity—median patch size (acres)	Yes	Connectivity of riparian habitat also connects suitable breeding and migration habitat.

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
Marsh	Habitat Amount—total amount and total amount on active floodplain area (acres)	Yes	Marsh habitats can support some native milkweed and nectar plants.
Floodplain Agriculture	Habitat Amount—total amount (acres) of floodplain agriculture providing habitat for target species	No	Not applicable.
Revetment	Revetment Removed to Increase Meander Potential and/or Natural Bank—total length (miles)	Yes	Less revetment reduces the need for vegetation maintenance along banks and supports riverine geomorphic processes that naturally create and sustain habitats that support nectar plants.
Levees	Levees Relocated to Reconnect Floodplain or Improved to Eliminate Hydraulic Constraints on Restoration—total length (miles)	Yes	Relocated levees (setting back) allow for establishment of suitable breeding and migration habitat.
Fish Passage Barriers	Fish Passage Barriers—remediated or removed	No	Not applicable.
Invasive Plants	Invasive-Plant-Dominated Vegetation—total area reduced (acres)	Yes	Invasive plants displace native milkweed and nectar plants.

[a] Floodplain inundation potential is the potential of an area to be inundated by a particular flow (e.g., a flow event that occurs about once every two years, or a “50-percent-chance event”). Expected annual habitat units represent the annual average of the area expected to be inundated in general or by flows meeting defined criteria for timing and duration (e.g., sustained spring flows).

Notes:
EAH = expected annual habitat
SRA = shaded riverine aquatic

Because management actions intended to benefit the monarch butterfly may simultaneously affect conservation of other species in the SPA (e.g., valley elderberry longhorn beetle), these measures of contribution have been incorporated into each Conservation Planning Area’s objectives for the conservation of target species, which are provided in the Conservation Strategy Update. The target species objectives cover multiple species and reflect the interrelated nature of CVFPP flood management and conservation actions.

B4.3 References

Alonso-Mejía, A., E. Rendón-Salinas, E. Montesinos-Patiño and L. P. Brower. 1997. Use of lipid reserves by monarch butterflies overwintering in Mexico: implications for conservation. Ecological Applications 7(3):934–947.

Atwood, D., and C. Paisley-Jones. 2017. Pesticides Industry Sales and Usage: 2008–2012 Market Estimates. Biological and Economic Analysis Division, Office of Pesticides Programs, Office of Chemical Safety and Pollution Prevention, U.S. Environmental Protection Agency. Washington, DC. www.epa.gov .

Batalden, R. V. and K. S. Oberhauser. 2015. Potential changes in eastern North American monarch migration in response to an introduced milkweed, *Asclepias curassavica*. *In* K. S. Oberhauser, K. R. Nai, and S. Altizer, editors, Monarchs in a Changing World: Biology and Conservation of an Iconic Butterfly. Cornell University Press. www.jstor.org . Accessed September 20, 2021.

Batalden, R. V., K. Oberhauser, and A.T. Peterson. 2007. Ecological niches in sequential generations of eastern North American monarch butterflies (*Lepidoptera: Danaidae*): the ecology of migration and likely climate change implications. Environmental Entomology 36(6):1365–1373.

Bargar T. A., M. L. Hladik, and J. C. Daniels. 2020. Uptake and toxicity of clothianidin to monarch butterflies from milkweed consumption. PeerJ 8:e8669. https://peerj.com/articles/8669/ .

Brower L. P. 1996. Monarch butterfly orientation: Missing pieces of a magnificent puzzle. Journal of Experimental Biology 199(1):93–103.

Brower, L. P., and R. M. Pyle. 2004. The interchange of migratory monarchs between Mexico and the western United States, and the importance of floral corridors to the fall and spring migrations. Pages 144–166 *in* G. Nabhan, editor, Conserving migratory pollinators and nectar corridors in western North America. University of Arizona Press, Tucson, AZ.

Brower, L. P., O. R. Taylor, E. H. Williams, D. A. Slayback, R. R. Zubieta, and M. I. Ramírez. 2012. Decline of monarch butterflies overwintering in Mexico: Is the migratory phenomenon at risk? Insect Conservation and Diversity 5(2):95–100.

Brower, L. P., L. S. Fink, R. J. Kiphart, V. Pocius, R. R. Zubieta, and M. I. Ramírez. 2015. Effect of the 2010-2011 drought on the lipid content of monarch butterflies migrating through Texas to their overwintering sites in Mexico. Pages 117–129 *in* K. S. Oberhauser, K. R. Nail, and S. M. Altizer, editors. Monarchs in a changing world: Biology and conservation of an iconic insect. Cornell University Press, Ithaca, NY.

California Department of Fish and Wildlife. 2015. California State Wildlife Action Plan, 2015 Update, A Conservation Legacy for Californians. September 30.

California Department of Fish and Wildlife. 2017. California Terrestrial and Vernal Pool Invertebrates of Conservation Priority. June 12.

California Department of Fish and Wildlife. 2022. "Monarch Butterfly." Available at: www.wildlife.ca. Accessed on: June 30, 2022.

Secretariat of the Commission for Environmental Cooperation. 2008. North American monarch conservation plan. Communications Department of the Center for Environmental Cooperation Secretariat. Montreal, Quebec, Canada.

Cockrell, B. J., S. B. Malcolm, and L. P. Brower. 1993. Time, temperature, and latitudinal constraints on the annual recolonization of eastern North America by the monarch butterfly. Pages 233–251 *in* S. B. Malcolm and M. P. Zalucki, editors, Biology and conservation of the monarch butterfly, Natural History Museum of Los Angeles County, Science Series 38.

https://schararegistry.gc.ca/5A471915-265F-42FB-9B8C-5B985BB4FBF4/CESCC_report_Sept_2010_E.pdfDecker, L. E., J. C. de Roode, and M. D. Hunter. 2018. Elevated atmospheric concentrations of carbon dioxide reduce monarch tolerance and increase parasite virulence by altering the medicinal properties of milkweeds. Ecology Letters 21(9):1353–1363.

Dilts, T. E., M. Steele, S. Black, D. Craver, J. Cruz, E. Engler, S. Jepsen, A. Jones, S. McKnight, A. Pelton, E. Taylor, and M. Forister. 2018. Western monarch and milkweed habitat suitability modeling project Version 2 – Maxent Model outputs. The Xerces Society for Invertebrate Conservation, U.S. Fish and Wildlife Service, and University of Nevada, Reno. www.monarch.org/ . Accessed September 20, 2021.

Dilts, T. E., M. O. Steele, J. D. Engler, E. M. Pelton, S. J. Jepsen, S. J. McKnight, A. R. Taylor, C. E. Fallon, S. H. Black, E. E. Cruz, D. R. Craver, and M. L. Forister. 2019. Host plants and climate structure habitat associations of the western monarch butterfly. Frontiers in Ecology and Evolution 7:188.

Dingle, H., M. P. Zalucki, W. A. Rochester, and T. Armijo-Prewitt. 2005. Distribution of the monarch butterfly, *Danaus plexippus* (L.) (Lepidoptera: Nymphalidae), in western North America. Biological Journal of the Linnean Society 85(4):491–500.

Electric Power Research Institute. 2019. Conservation Actions for Electric Power Companies to Support Monarch Butterflies. May. Palo Alto, California.

Espeset, A. E., J. G. Harrison, A. M. Shapiro, C. C. Nice, J. H. Thorne, D. P. Waetjen, J. A. Fordyce, and M. L. Forister. 2016. Understanding a migratory species in a changing world: Climatic effects and demographic declines in the western monarch revealed by four decades of intensive monitoring. Oecologia 181(3):819–830.

Fisher, A., K. Saniee, C. van der Heide, J. Griffiths, D. Meade, and F. Villablanca. 2018. Climatic niche model for overwintering monarch butterflies in a topographically complex region of California. Insects 9(4):167.

Frey, D., and A. Schaffner. 2004. Spatial and temporal pattern of monarch overwintering abundance in western North America. Pages 167-176 *in* K. S. Oberhauser and M. J. Solensky, editors, The monarch butterfly: Biology and conservation. Cornell University Press, Ithaca, NY.

Grant, T. J., H. R. Perry, M. P. Zalucki, and S. P. Bradbury. 2018. Predicting monarch butterfly (*Danaus plexippus*) movement and egg-laying with a spatially-explicit agent-based model: The role of monarch perceptual range and spatial memory. Ecological Modelling 374:37–50.

Griffiths, J., and F. Villablanca. 2015. Managing monarch butterfly overwintering groves: Making room among the eucalyptus. California Fish and Game 101(1):40–50.

Halsch, C. A., A. Code, S. M. Hoyle, J. A. Fordyce, N. Baert and M. L. Forister. 2020. Contamination of milkweeds across the agricultural, urban, and open spaces of low elevation northern California. Frontiers in Ecology and Evolution 8:162.

Hay-Roe, M. M., G. Lamas, and J. L. Nation. 2007. Pre- and post-zygotic isolation and Haldane rule effects in reciprocal crosses of *Danaus erippus* and *Danaus plexippus* (Lepidoptera: Danainae), supported by differentiation of cuticular hydrocarbons, establish their status as separate species. Biological Journal of the Linnean Society 91(3):445–453.

Herman, W. S., and M. Tatar. 2001. Juvenile hormone regulation of longevity in the migratory monarch butterfly. Proceedings of the Royal Society of London, Series B: Biological Sciences, 268(1485):2509–2514.

Hill, H. F., Jr., A. M. Wenner, and P. H. Wells. 1976. Reproductive behavior in an overwintering aggregation of monarch butterflies. American Midland Naturalist 95(1):10–19.

Howard, E., Aschen, H., and A. K. Davis. 2010. Citizen science observations of monarch butterfly overwintering in the southern United States. Psyche: A Journal of Entomology 2010:1–6.

Inamine, H., S. P. Ellner, J. P. Springer, and A. A. Agrawal. 2016. Linking the continental migratory cycle of the monarch butterfly to understand its population decline. Oikos 125(8):1081–1091.

International Union for the Conservation of Nature. 2022. Migratory monarch now endangered – IUCN Red List. www.iucn.org. Accessed August 8, 2022.

James, D. G. 2019. A neonicotinoid insecticide at a rate found in nectar reduces longevity but not oogenesis in monarch butterflies, *Danaus plexippus* (L.). (Lepidoptera: Nymphalidae). Insects 10(9):276.

James, D. G., M. C. Schaefer, K. K. Easton, and A. Carl. 2021. First population study on winter breeding monarch butterflies, *Danaus plexippus* (Lepidoptera: Nymphalidae) in the urban south bay of San Francisco, California. Insects 12(946):1–16.

Jepsen, S., D. F. Schweitzer, B. Young, N. Sears, M. Ormes, and S. H. Black. 2015. Conservation status and ecology of monarchs in the United States. NatureServe, Arlington, VA, and The Xerces Society for Invertebrate Conservation, Portland, OR.

Kasten, K., C. Stenoien, W. Caldwell, and K. S. Oberhauser. 2016. Can roadside habitat lead monarchs on a route to recovery? Journal of Insect Conservation 20(6):1047–1057.

Klein, A-M., I. Steffan-Dewenter, and T. Tscharntke. 2003. Fruit set of highland coffee increases with the diversity of pollinating bees. Proceedings of the Royal Society of London, Series B: Biological Sciences 270(1518):955–961.

Krischik, V., M. Rogers, G. Gupta, and A. Varshney. 2015. Soil-applied imidacloprid translocates to ornamental flowers and reduces survival of adult *Coleomegilla maculata*, *Harmonia axyridis*, and *Hippodamia convergens* lady beetles, and larval *Danaus plexippus* and *Vanessa cardui* butterflies. PLoS one 10(3):e0119133.

Krishnan, N., Y. Zhang, K. G. Bidne, R. L. Hellmich, J. R. Coats, and S. P. Bradbury. 2020. Assessing field-scale risks of foliar insecticide applications to monarch butterfly (*Danaus plexippus*) larvae. Environmental Toxicology and Chemistry 39(4):923–941.

Lark, T. J., J. M. Salmon, and H. K. Gibbs. 2015. Cropland expansion outpaces agricultural and biofuel policies in the United States. Environmental Research Letters 10(4):044003.

Lemoine, N. P. 2015. Climate change may alter breeding ground distributions of eastern migratory monarchs (*Danaus plexippus*) via range expansion of *Asclepias* host plants. PloS one 10(2):e0118614.

Leong, K. L. H. 1990. Microenvironmental factors associated with the winter habitat of the monarch butterfly (Lepidoptera, Danaidae) in central California. Annals of the Entomological Society of America 83(5):906–910.

Leong, K. L. H. 1999. Restoration of an overwintering grove in Los Osos, San Luis County, California. Pages 211–18 *in* J. Hoth, L. Merina, K. Oberhauser, I. Pisantry, A. Price, and T. Wilkinson, editors, The 1997 North American conference on the monarch butterfly. Montreal, Canada: Commission for Environmental Cooperation.

Leong, K. L. H., E. O'Brien, K. Lowerisen, and M. Colleran. 1995. Mating activity and status of overwintering monarch butterflies (Lepidoptera, Danaidae) in central California. Annals of the Entomological Society of America 88(1):45–50.

Leong, K. L. H., W. H. Saka, W. Bremer, D. Feuerstein, and G. Yoshimura. 2004. Analysis of the pattern of distribution and abundance of monarch overwintering sites along the California coastline. Pages 177–185 *in* K. S. Oberhauser and M. J. Solensky, editors, The monarch butterfly: Biology and conservation. Cornell University Press, Ithaca, NY.

Malcolm, S. B., and L. P. Brower. 1986. Selective oviposition by monarch butterflies in a mixed stand of *Asclepias curassavica* L. and *A. incarnata* L. in south Florida. Journal of the Lepidopterists' Society 40(4):255–263.

Malcolm, S. B., and M. P. Zalucki. 1993. The monarch butterfly: Research and conservation. Pages 3-8 *in* S. B. Malcolm and M. P. Zalucki, editors, Biology and conservation of the monarch butterfly, Natural History Museum of Los Angeles County, Science Series 38.

Masters, A. R., S. B. Malcolm, and L. P. Brower. 1988. Monarch butterfly (*Danaus plexippus*) thermoregulatory behavior and adaptations for overwintering in Mexico. Ecology 69(2):458–467.

McClain, C. D., K. D. Holl, and D. M. Wood. 2011. Successional models as guides for restoration of riparian forest understory. Restoration Ecology 19(2):280–289.

McCoshum, S. M., S. L. Andreoli, C. M. Stenoien, K. S. Oberhauser, and K. A. Baum. 2016. Species distribution models for natural enemies of monarch butterfly (*Danaus plexippus*) larvae and pupae: Distribution patterns and implications for conservation. Journal of Insect Conservation 20(2):223–237.

Miller, N. G., L. I. Wassenaar, K. A. Hobson, and D. R. Norris. 2012. Migratory connectivity of the monarch butterfly (*Danaus plexippus*): Patterns of spring re-colonization in eastern North America. PLoS one 7(3):e31891.

Monarch Watch. 2009. Monarch butterfly press briefing. April. www.monarch-watch.org. Accessed September 21, 2021.

Moore, P. L., K. D. Holl, and D. M. Wood. 2011. Strategies for restoring native understory plants along the Sacramento River: Timing, shade, non-native control, and planting method. San Francisco Estuary and Watershed Science 9(2):1–15.

Morris, G. M., C. Kline, and S. M. Morris. 2015. Status of *Danaus plexippus* population in Arizona. Journal of the Lepidopterists Society 69(2):91–107.

Oberhauser, K. S. 1997. Fecundity, lifespan and egg mass in butterflies: Effects of male-derived nutrients and female size. Functional Ecology 11(2):166–175.

Olaya-Arenas, P., and I. Kaplan. 2019. Quantifying pesticide exposure risk for monarch caterpillars on milkweeds bordering agricultural land. Frontiers in Ecology and Evolution 7:223.

Paine, T. D., and J. G. Millar. 2002. Insect pests of eucalyptus in California: Implications of managing invasive species. Bulletin of Entomological Research 92(2):147–151.

Parsons, J. A. 1965. A digitalis-like toxin in monarch butterfly *Danaus plexippus* L. Journal of Physiology 178(2):290–304. London.

Pelton, E., S. Jepsen, C. Schultz, C. Fallon, and S. H. Black. 2016. State of the monarch butterfly overwintering sites in California. Report to the U.S. Fish and Wildlife Service by The Xerces Society for Invertebrate Conservation. Portland, OR. www.xerces.org.

Pelton, E., S. McKnight, C. Fallon, A. Code, J. Hopwood, S. Hoyle, S. Jepsen, S. H. Black. 2018. Managing for monarchs in the West: Best management practices for conserving the monarch butterfly and its habitat. The Xerces Society for Invertebrate Conservation. Portland, OR. www.xerces.org.

Pleasants, J. M. 2017. Milkweed restoration in the Midwest for monarch butterfly recovery: Estimates of milkweeds lost, milkweeds remaining and milkweeds that must be added to increase the monarch population. Insect Conservation and Diversity 10(1):42-53.

Pleasants, J. M., and K. S. Oberhauser. 2013. Milkweed loss in agricultural fields because of herbicide use: Effect on the monarch butterfly population. Insect Conservation and Diversity 6(2):135–144.

Rendón-Salinas, E., A. Fajardo-Arroyo, and G. Tavera-Alonso. 2015. Forest surface occupied by monarch butterfly hibernation colonies in December 2014. World Wildlife Fund. www.wwf.ca

Robins, B. 2020. Rivers are for Monarchs: Healthy River Ecosystems are Essential to the Monarch's Survival. May 14. www.river-partners.org . Accessed September 27, 2021.

Rothrock, L. 2021. "Revitalizing Rivers for Monarchs." November 16. www.river-partners.org. Accessed July 8, 2022.

Sakai, W. H. and W. C. Calvert. 1991. Statewide monarch butterfly management plan for the state of California Department of Parks and Recreation. Unpublished report prepared for California Department of Parks and Recreation, Sacramento, CA.

Satterfield, D. A., F. X. Villablanca, J. C. Maerz, and S. Altizer. 2016. Migratory monarchs wintering in California experience low infection risk compared to monarchs breeding year-round on non-native milkweed. Integrative and Comparative Biology 56(2):343–52.

Satterfield, D. A., J. C. Maerz, M. D. Hunter, D. T. T. Flockhart, K. A. Hobson, D. R. Norris, H. Streit, J. C. de Roode, and S. Altizer. 2018. Migratory monarchs that encounter resident monarchs show life-history differences and higher rates of parasite infection. Ecology Letters 21(11):1670–1680.

Saunders, S. P., L. Ries, N. Neupane, M. I. Ramírez, E. García-Serrano, E. Rendón-Salinas, and E. F. Zipkin. 2019. Multiscale seasonal factors drive the size of winter monarch colonies. Proceedings of the National Academy of Sciences of the United States of America 116(17):8609–8614.

Schultz, C. B., L. M. Brown, E. Pelton, and E. E. Crone. 2017. Citizen science monitoring demonstrates dramatic declines of monarch butterflies in western North America. Biological Conservation 214(October):343–346.

Smith, D. A. S., G. Lushai, and J. A. Allen. 2005. A classification of *Danaus* butterflies (Lepidoptera: Nymphalidae) based upon data from morphology and DNA. Zoological Journal of the Linnean Society 144(2):191–212.

Solensky, M. J. 2004. Overview of monarch migration. Pages 79–83 *in* K. S. Oberhauser and M. J. Solensky, editors, The monarch butterfly: Biology and conservation. Cornell University Press, Ithaca, NY.

Solensky, M. J., and K. S. Oberhauser. 2009. Sperm precedence in monarch butterflies (*Danaus plexippus*). Behavioral Ecology 20(2):328–334.

Stenoien, C., K. R. Nail, J. M. Zalucki, H. Parry, K. S. Oberhauser, and M. P. Zalucki. 2016. Monarchs in decline: A collateral landscape level effect of modern agriculture. Insect Science 25(4):528–541.

Stevens, S. R. and D. F. Frey. 2010. Host plant pattern and variation in climate predict the location of natal grounds for migratory monarch butterflies in western North America. Journal of Insect Conservation 14(6):731–744.

The Xerces Society for Invertebrate Conservation. 2019. A quick guide to monarch habitat on farms in California's Central Valley. www.xerces.org.

The Xerces Society for Invertebrate Conservation. 2020. The Xerces Society Western Monarch Thanksgiving Count 1997–2019.www.monarch.org.

The Xerces Society for Invertebrate Conservation. 2022. "Western monarchs rebound to final tally of nearly 250,000 butterflies." www.xerces.org. Accessed July 8, 2022. Zalucki, M. P. 1982. Temperature and rate of development in *Danaus-plexippus* L. and *D. chrysippus* L. (Lepidoptera: Nymphalidae). Journal of the Australian Entomological Society 21(4):241–246.

Thogmartin, W., R. Wiederholt, K. Oberhauser, R. Drum, J. Diffendorfer, S. Altizer, O. Taylor, J. Pleasants, D. Semmens, B. Semmens, R. Erickson, K. Libby, and L. López-Hoffman. 2017. Monarch butterfly population decline in North America: Identifying the threatening processes. Royal Society open science 4(9):170760.

Tjarks. H. 2012. Using a native understory to control weeds in riparian restoration. California Invasive Plant Council News 20(2):8–9.

Tuskes, P. M., and L. P. Brower. 1978. Overwintering ecology of monarch butterfly, *Danaus plexippus* L., in California. Ecological Entomology 3(2):141–153.

Urquhart, F. A., and N. R. Urquhart. 1978. Autumnal migration routes of the eastern population of monarch butterfly (*Danaus p. plexippus* L.; Danaidae; Lepidoptera) in North America to the overwintering site in the Neovolcanic Plateau of Mexico. Canadian Journal of Zoology 56(8):1759–1764.

U.S. Fish and Wildlife Service. 2020. Monarch *(Danaus plexippus)* Species Status Assessment Report, version 2.1. September. www.fws.org. Accessed August 16, 2022.

U.S. Fish and Wildlife Service. 2021. Western Monarch Butterfly Conservation Recommendations. August 31. www.xerces.org. Accessed August 16, 2022.

U.S. Geological Survey National Water-Quality Assessment. 2017. Pesticide national synthesis project. <https://water.usgs.gov/nawqa/pnsp/usage/maps/>. Accessed September 20, 2021.

van Hook, T. 1996. Monarch butterfly mating ecology at a Mexican overwintering site: Proximate causes of non-random mating. Dissertation. University of Florida.

Warren, A. D., K. J. Davis, E. M. Stangeland, J. P. Pelham, and N. V. Grishin. 2013. Illustrated lists of American butterflies. <http://www.butterfliesofamerica.com/L/t/Danaus_plexippus_a.htm>. Accessed September 20, 2021.

Waterbury, B., and A. Potter. 2018. Integrating strategic conservation approaches for the monarch butterfly in the State Wildlife Action Plans of Idaho and Washington. Final report. June. Prepared for the U.S. Fish and Wildlife Service.

Western Association of Fish and Wildlife Agencies. 2019. Western monarch conservation plan, 2019–2069. www.wafwa.org .

Western Monarch Milkweed Mapper. 2022. Western Monarch Biology. www.monarch.org . Accessed July 8, 2022.

Williams, E. H., and Brower, L. P. 2015. Microclimatic protection of monarch butterflies provided by Mexico's high elevation Oyamel fir forests: A review. Pages 109–116 *in*

Oberhauser, K. S., Nail, K. R., Altizer, S. M., editors, Monarchs in a changing world: Biology and conservation of an iconic insect. Cornell University Press, Ithaca, NY.

Zalucki, M. P., and W. A. Rochester. 2004. Spatial and temporal population dynamics of monarch down under: Lessons for North America. Pages 219–228 *in* K. S. Oberhauser and M. J. Solensky, editors, The monarch butterfly: Biology and conservation. Cornell University Press, Ithaca, NY.

Zalucki, M. P., and J. H. Lammers. 2010. Dispersal and egg shortfall in monarch butterflies: What happens when the matrix is cleaned up? Ecological Entomology 35(1):84–91.

Appendix C
Updates to 2016 Conservation Strategy Appendix J, "Existing Conservation Objectives from Other Plans"

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APPENDIX C

Updates to 2016 Conservation Strategy Appendix J, "Existing Conservation Objectives from Other Plans"

Acronym	Acronym
BRCP	Butte Regional Conservation Plan
CCP	comprehensive conservation plan
CDFW	California Department of Fish and Wildlife
Conservation Strategy (or Strategy)	Central Valley Flood Protection Plan Conservation Strategy
CVFPP	Central Valley Flood Protection Plan
Delta	Sacramento–San Joaquin Delta
DWR	California Department of Water Resources
Flood-MAR	flood-managed aquifer recharge
HCP	habitat conservation plan
LCP	local conservation plan
NCCP	natural community conservation plan
NMFS	National Marine Fisheries Service
Portfolio	Water Resilience Portfolio
RCIS	regional conservation investment strategy
State Water Board	State Water Resources Control Board
Strategy (or Conservation Strategy)	Central Valley Flood Protection Plan Conservation Strategy
USFWS	U.S. Fish and Wildlife Service
WMA	Wildlife Management Area

C.1 Introduction

Regional planning efforts such as the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy or Strategy) are most effective when coordinated with other regional conservation plans and programs. For example, the knowledge gained by implementing existing plans has refined the Conservation Strategy's objectives and approaches. Coordination with other planning efforts during the Strategy's implementation will provide greater opportunities for effective, integrated, landscape-level conservation.

A collaborative approach will enable the Conservation Strategy to contribute to the shared objectives of other regional conservation plans and programs (e.g., improving habitat connectivity) while achieving its own specific objectives.

The 2016 Strategy, Appendix J, "Existing Conservation Objectives from Other Plans," described the completed and ongoing conservation planning efforts in the Sacramento and San Joaquin valleys that had regional, geographically based, or quantifiable conservation measures that could be relevant to the Strategy. The completed regional conservation planning efforts included several habitat conservation plans (HCPs) and natural community conservation plans (NCCPs) (e.g., Natomas Basin HCP, East Contra Costa County HCP and NCCP); large-scale conservation programs (e.g., the Ecosystem Restoration Program's Conservation Strategy for Restoration of the Sacramento–San Joaquin Valley Regions); and refuge comprehensive conservation plans (CCPs) (e.g., Sacramento River National Wildlife Refuge CCP).

When the 2016 Conservation Strategy was prepared, the ongoing conservation planning efforts included the Butte Regional Conservation Plan, California EcoRestore, Placer County Conservation Plan, South Sacramento HCP, and Yolo HCP and NCCP. This appendix provides the following information:

- Proposed modifications to the conservation plans described in Appendix J of the 2016 Strategy.
- New planning efforts undertaken since the 2016 Strategy's completion.
- An updated summary of the relationships of geographically overlapping conservation plans to the Strategy's target ecosystem processes, habitats, and species.

C.2 Modifications to Relevant Conservation Plans

C.2.1 California EcoRestore

The EcoRestore Program includes 36 projects that are at various stages of development, from conceptual to completed. The California Department of Water Resources (DWR) is the lead agency for 32 of the 36 EcoRestore projects. As of January 2021, the following progress had been made (California Department of Water Resources 2022a):

- *Fish passage improvement projects:* Three completed and two being planned or permitted.
- *Upland and riparian forest restoration:* 559 acres completed, 368 acres under construction, and 727 acres being planned or permitted.
- *Floodplain restoration:* 115 acres completed, 1,050 acres under construction, and 17,320 acres being planned or permitted.
- *Tidal and subtidal restoration:* 4,212 acres completed, 2,290 acres under construction, and 7,479 acres being planned or permitted.
- *Emergent (managed) wetland restoration:* 1,542 acres completed, 643 acres under construction, and 1,350 acres being planned or permitted.

To develop a comprehensive, science-based adaptive management approach that would support the achievement of the Sacramento–San Joaquin Delta (Delta) conservation goals, the Delta Science Program initiated the Interagency Adaptive Management Integration Team in 2016. This team serves as a technical coordinating body to strengthen interagency collaboration; it also provides resources, input, and guidance on adaptive management for current and future Delta conservation efforts. The team consists of scientific and technical staff members from federal, State of California (State), and local agencies, other interagency programs and workgroups, universities, and nongovernmental organizations, who plan, facilitate, implement, fund, or regulate habitat restoration projects in the Delta and Suisun Marsh.

C.2.2 California Water Plan

The California Water Plan was updated in June 2019 (California Department of Water Resources 2019), and is currently undergoing further updates along with the CVFPP (California Natural Resources Agency 2022a). The following goals of the updated plan are relevant to the Conservation Strategy:

- Promote climate change adaptation and resilience.
- Improve integrated watershed management.
- Restore critical ecosystem functions.
- Improve interagency alignment and address persistent regulatory challenges.
- Support real-time decision-making, adaptive management, performance tracking, and long--term planning.

C.2.3 San Joaquin River Restoration Program–Fisheries Framework

As part of the San Joaquin River Restoration Program, the Fisheries Framework was completed in 2018 (San Joaquin River Restoration Program 2018). This document provides the following information:

- An outline of the goals and objectives for establishing populations of spring-run and fall-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Restoration Area.
- The necessary habitat that will support naturally reproducing, self-sustaining salmon populations.
- The science behind these planned management actions.
- An outline of the proposed adaptive management process and implementation plan for fishery actions.

C.2.4 Central Valley Project–State Water Project Operations Plan and Associated Biological Opinions

In August 2016, the U.S. Bureau of Reclamation and DWR began to develop a new operations plan and undertake a review of that plan's effects on numerous species listed for protection under the federal Endangered Species Act, particularly delta smelt (*Hypomesus transpacificus*), green sturgeon (*Acipenser medirostris*), and salmon and steelhead species (*Oncorhynchus mykiss*). In October 2019, after conducting robust scientific reviews, the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) released biological opinions on the new Central Valley Project–State Water Project operations (U.S. Fish and Wildlife Service 2019a; National Marine Fisheries Service 2019). These opinions found the revised proposed operations would not jeopardize threatened or endangered species, or adversely modify their critical habitat. These findings were reached in large part as a result of significant investments in science, habitat restoration, conservation facilities (including hatcheries), and protective measures built into the operations plan (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2019).

C.2.5 Central Valley Project Improvement Act Programs

Enacted in response to substantial declines in populations of anadromous fish, the Central Valley Project Improvement Act provided for all reasonable efforts to double the sustainable natural production of anadromous fish stocks, including the four runs of Chinook salmon (fall, late fall, winter, and spring), steelhead trout, and green sturgeon, among others. From 2017 through 2019, under the Central Valley Project Improvement Act, the Anadromous Fish Restoration Program completed fisheries investigations of several waterways and facilities in the Strategy's Plan Area (Anadromous Fish Restoration Program 2018a, 2018b, 2019).

C.2.6 Central Valley Joint Venture

The Central Valley Joint Venture is one of 21 habitat-based Migratory Bird Joint Ventures in North America, all of which work to protect and restore bird habitat. The Central Valley Joint Venture is currently administered through a coordination office within the USFWS. It is guided by a management board that receives input and recommendations from four standing committees and a variety of working groups and ad hoc committees. Its management board is composed of representatives from 19 partner organizations, including nongovernmental organizations, State and federal agencies, and one regulated utility. The board members work cooperatively to address the habitat needs of migratory and resident bird species in California's Central Valley. Originally focused exclusively on waterfowl, the Central Valley Joint Venture's mission has expanded over time to also encompass the conservation needs of shorebirds, waterbirds, landbirds, and at-risk bird species.

The Central Valley Joint Venture released an updated implementation plan in 2020 (Central Valley Joint Venture 2020). The implementation plan builds on previous plans published in 1990 and 2006 and identifies biologically based conservation objectives for the eight bird groups, which include five target species: greater sandhill crane (*Grus canadensis tabida*), California black rail (*Laterallus jamaicensis coturniculus*), least Bell's vireo (*Vireo bellii pusillus*), western yellow-billed cuckoo (*Coccyzus americanus*), and bank swallow (*Riparia riparia*). One non-target species is also included: western burrowing owl (*Athene cunicularia hypugaea*).

C.2.7 Final Comprehensive Conservation Plan for the Butte Sink, Willow Creek–Lurline, and North Central Valley Wildlife Management Areas

The Final Comprehensive Conservation Plan for the Butte Sink, Willow Creek–Lurline, and North Central Valley Wildlife Management Areas (WMAs) guides management of these units (U.S. Fish and Wildlife Service 2020). USFWS manages the WMAs as part of the Sacramento National Wildlife Refuge Complex, which is headquartered in the Sacramento Valley, approximately 90 miles north of the city of Sacramento. The WMAs consist primarily of private lands protected by perpetual conservation easements, and also include some USFWS-owned lands.

C.2.8 Butte Regional Conservation Plan

The final Butte Regional Conservation Plan (BRCP) was submitted to USFWS, NMFS, and California Department of Fish and Wildlife (CDFW) on June 28, 2019, for final inspection (Butte County Association of Governments 2019), and has not yet been adopted by Butte County and the other plan partners. The BRCP covers 13 of the Conservation Strategy's target species: valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), Central Valley steelhead, spring-run and fall-run Chinook salmon, green sturgeon, giant gartersnake (*Thamnophis gigas*), bank swallow (*Riparia riparia*), California black rail (*Laterallus jamaicensis coturniculus*), greater sandhill crane (*Grus canadensis tabida*), Swainson's hawk (*Buteo swainsoni*), tricolored blackbird (*Agelaius tricolor*), western yellow-billed cuckoo (*Coccyzus americanus*), and yellow-breasted chat (*Icteria virens*). The BRCP also covers two non-target species considered for inclusion in the Strategy: western burrowing owl and western pond turtle (*Actinemys marmorata*).

C.2.9 Placer County Conservation Program

The updated Placer County Conservation Program was released in February 2020, and the associated final environmental impact statement and environmental impact report was released in May 2020 (Placer County 2020). The program was adopted by Placer County in September 2020, and the other plan partners (City of Lincoln, Placer County Water Agency, South Placer Transportation Agency) are also expected to adopt the plan (Placer County 2020). This program covers seven of the Conservation Strategy's target species: valley elderberry longhorn beetle, Central Valley steelhead, Central Valley fall- and late fall-run Chinook salmon, giant gartersnake, California black rail, Swainson's hawk, and tricolored blackbird. The Placer County Conservation Program also covers two non-target species: western burrowing owl and western pond turtle.

C.2.10 South Sacramento Habitat Conservation Plan

The South Sacramento HCP was adopted by the participating agencies in 2018 (County of Sacramento et al. 2018). This document covers five of the Strategy's target species: valley elderberry longhorn beetle, giant gartersnake, greater sandhill crane, Swainson's hawk, and tricolored blackbird. The South Sacramento HCP also covers three non-target species: western burrowing owl, western pond turtle, and western red bat (*Lasiurus blossevillii*).

C.2.11 Yolo Habitat Conservation Plan and Natural Community Conservation Plan

The Yolo HCP and NCCP (Yolo Habitat Conservancy 2018b) was adopted in 2018, and its implementation began on January 11, 2019 (Yolo Habitat Conservancy 2020a). USFWS issued a biological and conference opinion and Section 10(a)(1)(B) permit on August 2, 2018 (U.S. Fish and Wildlife Service 2018). This document covers seven of the Strategy's target species: valley elderberry longhorn beetle, giant gartersnake, bank swallow, least Bell's vireo, Swainson's hawk, tricolored blackbird, and western yellow-billed cuckoo. It also covers two non-target species: western burrowing owl and western pond turtle.

C.2.12 State and Regional Water Board Plans

Several State and regional water board plans have been updated since the 2016 Conservation Strategy, or are currently being updated. The *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* was updated in February 2019 (Central Valley Regional Water Quality Control Board 2019). The Wetland and Riparian Area Protection Policy was updated and adopted by the State Water Resources Control Board (State Water Board) in 2019 and became effective in May 2020 (State Water Resources Control Board 2019). Finally, the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary was amended in 2019 (State Water Resources Control Board 2018) and other amendments are being considered (State Water Resources Control Board 2020).

C.2.13 Recovery Plan for the Giant Gartersnake

The recovery plan for the giant gartersnake was released in 2017 (U.S. Fish and Wildlife Service 2017). This plan focuses on identifying and protecting areas for habitat restoration, enhancement, or creation, including connectivity between populations. Nine recovery units are defined, corresponding with geographically and genetically distinct populations: the Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin, Delta Basin, Cosumnes-Mokelumne Basin, San Joaquin Basin, and Tulare Basin. The recovery plan includes the following objectives and criteria for achieving the objectives:

- Establish and protect self-sustaining populations.
- Restore and conserve healthy Central Valley wetland ecosystems.
- Ameliorate or eliminate current and future threats.

C.2.14 Revised Recovery Plan for the Valley Elderberry Longhorn Beetle

A revised recovery plan for valley elderberry longhorn beetle was released in 2019 (U.S. Fish and Wildlife Service 2019b). The plan focuses on loss and degradation of habitat and defines three management units: Sacramento River, San Joaquin River, and Putah Creek. There are two recovery objectives: preserve resilient populations across the historical range by maintaining occupancy in at least 80 percent of major river system subbasins; and protect and manage a system of connected habitat patches along each river or major drainage within subbasins.

C.3 New Relevant Conservation Plans

C.3.1 California Biodiversity Initiative

In 2017, a group of 26 scientific experts from across the State's universities, herbaria, and conservation organizations created the "Charter to Secure the Future of California's Native Biodiversity," a call to action to secure and recover the abundance and richness of native plants and animals in California, under current and changing climate conditions. Governor Edmund G. Brown Jr. responded in 2018 by launching the California Biodiversity Initiative (California Natural Resources Agency et al. 2018). The goal of the California Biodiversity Initiative is to secure the future of California's biodiversity by integrating biodiversity protection into the State's environmental and economic goals and efforts. The following broad goals are identified as a starting point:

- Protect 20 percent of each terrestrial, freshwater, coastal, and marine ecosystem type.
- Recover and restore 15 percent of each ecosystem type from its degraded or disturbed status.

Future actions are grouped into seven focal areas:

1. Help the government coordinate on biodiversity goals.
2. Improve the understanding of California's biodiversity.
3. Improve the understanding and protection of the State's native plants.
4. Manage land and waters to achieve biodiversity goals.
5. Restore and protect lands and waters to achieve biodiversity goals.
6. Educate Californians about biodiversity.
7. Prioritize collaboration and partnership.

C.3.2 Water Resilience Portfolio

Replacing the California Water Action Plan that guided the 2016 Conservation Strategy and 2017 CVFPP Update, Executive Order N-10-19, issued by Governor Gavin Newsom on April 29, 2019, called for a portfolio of actions to ensure the State's long-term water resilience and ecosystem health. In response, State agencies have released a Water Resilience Portfolio (Portfolio) with a suite of recommended actions to help California cope with more extreme droughts and floods, rising temperatures, declining fish populations, aging infrastructure, and other challenges (California Natural Resources Agency et al. 2020). The executive order identified seven principles on which to base the Portfolio. Of those, the following principles are most relevant to the Conservation Strategy:

- Prioritize multi-benefit approaches that meet several needs at once.
- Use natural infrastructure such as forests and floodplains.

The Portfolio provided proposals that detail how State agencies can support the principles. Several of these are consistent with the Conservation Strategy:

- *"10. Reconnect aquatic habitat to help fish and wildlife endure drought and adapt to climate change.*

- *11.3. Support expansion of multi-benefit floodplain projects across the Central Valley and coastal regions, including projects that reduce flood risk and restore or mimic historical river and floodplain processes, such as the Yolo Bypass and Cache Slough Partnership program.*

- *12. Curb invasive species altering California waterways.*

- *13. Align and improve permitting to help launch and incentivize more restoration, multi-benefit, and multi-partner projects.*

- *13.1. Coordinate grant and loan programs across state agencies to make funding for multi-benefit projects, including restoration, easier to arrange and leverage.*

- *13.2. Support the development of expedited and cost-effective permitting mechanisms for common types of restoration and enhancement projects.*

- *13.3. Expand use of the Regional Conservation Investment Strategies approach established in 2017 under Assembly Bill (AB) 2087 to guide mitigation needs for water-related projects.*
- *13.4. Incorporate strategically designed conservation planning and other resource protection and recovery plans into mitigation approaches for levee modifications, operations, and maintenance.*
- *25.1. Support implementation of the Central Valley Flood Protection Plan and its "state systemwide investment approach" to protect urban areas, small communities, and rural areas; improve operations and maintenance of the flood system; better coordinate reservoir operations; improve the flood emergency response system; and integrate natural systems into flood risk reduction projects.*
- *25.2. Review state, federal, and local permitting processes for flood risk reduction projects and operations and maintenance and recommend ways to improve permitting processes.*
- *25.4. Update and refine the regional flood management strategy in the CVFPP to account for the projected impacts of climate change in order to protect vulnerable communities and infrastructure and restore floodplains along the San Joaquin River and its tributaries."*

C.3.3 Cutting the Green Tape Initiative

The California Natural Resources Agency developed the Cutting the Green Tape Initiative to help implement environmentally beneficial work more quickly, simply, and cost-effectively. Between December 2019 and April 2020, this initiative convened regulatory agency staff members, representatives from local governments and environmental conservation groups, and a range of other stakeholders and experts from across California to improve permitting and funding efficiencies for ecological restoration and stewardship projects. These roundtables developed specific recommendations to improve on existing programs and program delivery in 2020 and beyond, and the report *Cutting the Green Tape: Regulatory Efficiencies for a Resilient Environment* was released in November 2020 (California Landscape Stewardship Network 2020). In January 2021, the California Natural Resources Secretary issued an Implementation Memorandum (California Natural Resources Agency 2021) that direction entities within the California Natural Resources Agency to begin implementing the recommendations in the 2020 report, which are currently underway (California Natural Resources Agency 2022b).

C.3.4 Delta Smelt Resiliency Strategy

Under a comprehensive strategy, federal and State agencies are working to rapidly improve conditions for the endangered delta smelt, which is close to extinction (California Natural Resources Agency 2016). The strategy represents a management shift for federal and State water and wildlife agencies, which are addressing multiple stressors on delta smelt in a systematic way while studying the synergy of the actions. In total, 13 near- and mid-range actions are aimed at creating better habitat, more food, and higher turbidity, along with reduced levels of weeds, predators, and harmful algal blooms to help reduce the mortality of delta smelt and boost the rate at which the fish grow, reproduce, and survive.

C.3.5 Feather River Conceptual Plan

The Feather River Conceptual Plan identifies immediate, high-priority projects that DWR and the community may undertake cooperatively while DWR completes necessary facility repairs and improvements, and completes measures that may become part of the Federal Energy Regulatory Commission's license related to the 2017 Oroville Dam spillways emergency event (Supplemental Benefits Fund Steering Committee 2018). The following recommended projects are relevant to the Conservation Strategy.

- In Reach 3:
  - Develop in-channel morphologic features (artificial bedrock, natural boulders, and augmented wood and sediment) to improve instream habitat, increase gravel retention in riffles, and create whitewater kayak play features.
  - Improve spawning and rearing habitat with the targeted (riffle construction) and also significant (bulk) augmentation of sediment (spawning-sized, and other) to recover from the deficit caused by upstream dams and exacerbated by recent high-flow events.
  - Coordinate the design of habitat and recreation features with development of the gravel augmentation plan, the gravel budget, and the construction and maintenance of side channels.
- In Reaches 3, 4, and 5, develop floodplain and side-channel habitat on the right bank.

C.3.6 Flood-managed Aquifer Recharge

Flood-managed aquifer recharge, or Flood-MAR, is an integrated and voluntary resource management strategy that uses floodwater resulting from—or in anticipation of—rainfall or snowmelt for managed aquifer recharge on agricultural lands and working landscapes, such as refuges, floodplains, and flood bypasses (California Department of Water Resources 2022b).

Flood-MAR can be implemented at multiple scales, from individual landowners using existing infrastructure to divert floodwater, to the use of extensive detention and recharge areas and the modernization of flood management infrastructure and operations. Flood-MAR could overlap with multi-benefit flood projects, such as building setback levees where soils are suitable and flows during wet years could be stored. For example, the Merced River Flood-MAR Reconnaissance Study is studying the use of flood waters for managed aquifer recharge that can reduce flood risk, increase supply reliability, support groundwater sustainability, and enhance ecosystems in the Merced River Basin. Multiple floodplain and riparian species, including Conservation Strategy target species, could benefit by reconnecting floodplains and creating new transitory storage.

C.3.7 Sacramento Valley Salmon Resiliency Strategy

Through the Sacramento Valley Salmon Resiliency Strategy (California Natural Resources Agency 2017), State agencies have committed to a suite of actions to improve survival rates, including restoring habitat, improving streamflow, removing stream barriers, and reintroducing species to ideal habitat for California's native salmon and steelhead species.

C.3.8 Voluntary Agreements

State agencies have developed a framework for voluntary agreements outlining a multi-year program to improve environmental conditions in an adaptive way, through new flows dedicated to the environment and the most extensive habitat creation in California history (California Natural Resources Agency 2020). Building on years of work, the team has developed a science-driven framework that could improve environmental conditions and meet the State Water Board's legal requirement to provide for the reasonable protection of beneficial uses. The framework provides for up to 900,000 acre-feet of new flows for the environment above existing conditions in dry, below-normal, and above-normal wateryear types, and over 100,000 acre-feet in critical and wet years, to help recover fish populations. It also provides for thousands of acres of new habitat, from targeted improvements in tributaries to large landscape-level restoration in the Sacramento Valley. Habitat improvements include the following actions:

- The creation of spawning and rearing habitat for salmon and smelt.
- The completion of high-priority fish screen projects.
- The restoration and reactivation of floodplains.
- The initiation of projects to address predation.
- Improvements to fish passages.

The framework outlines several billion dollars in investments funded by water users and the federal and State governments to improve environmental conditions and science and adaptive management. It also establishes a governance program to strategically deploy flows and habitat, implement a science program, and develop strategic plans and annual reports.
The California Natural Resources Agency and California Environmental Protection Agency are working with water users and other participants to refine the proposed framework into a legally enforceable program. The refined document will then be submitted to the State Water Board, where it will undergo a third-party scientific review, an environmental review, and a public comment process.

C.3.9 Yolo Regional Conservation Investment Strategy and Local Conservation Plan

A draft regional conservation investment strategy (RCIS) and local conservation plan (LCP) for Yolo County was released in 2018 (Yolo Habitat Conservancy 2018a), and CDFW approved the final document was in 2020 (Yolo Habitat Conservancy 2020b). The Yolo RCIS/LCP is a regional conservation planning effort to provide mitigation and stewardship-driven conservation in Yolo County. It describes the existing condition for the amount, location, and type of natural communities and focal species habitat in the document's strategy area.

The Yolo RCIS/LCP recommends conservation actions for focal species and land cover types to direct project planning and conservation efforts. There are 40 focal species and 97 conservation species. The list of focal species includes 16 of the 2022 Conservation Strategy's target species: valley elderberry longhorn beetle, Central Valley steelhead, Central Valley spring-run and fall-run Chinook salmon, Sacramento River winter-run Chinook salmon, delta smelt, green sturgeon, giant gartersnake, bank swallow, California black rail, greater sandhill crane, least Bell's vireo, Swainson's hawk, tricolored blackbird, western yellow-billed cuckoo, and yellow-breasted chat. Six non-target species are identified as either focal or conservation species: western burrowing owl, western pond turtle, western red bat, least bittern (*Ixobrychus exilis*), redhead (*Aythya americana*), and yellow warbler (*Setophaga petechial*).

C.3.10 Mid-Sacramento Valley Regional Conservation Investment Strategy

A public draft RCIS for the Mid-Sacramento Valley was released in 2019 (Reclamation District 108 2019), and CDFW approved the final document in 2020 (Reclamation District 108 2020). The Mid-Sacramento RCIS is based primarily on the Mid- and Upper Sacramento Regional Flood Management Plan and the Feather River Regional Flood Management Plan. Those documents provide regional frameworks for integrating conservation into the flood management system and its operations. This RCIS identifies conservation and habitat enhancement actions that can be used to provide compensatory mitigation for flood management and other infrastructure projects in the regions.

The Mid-Sacramento RCIS identifies 12 focal species, 11 of which overlap the 2022 Conservation Strategy's target species: valley elderberry longhorn beetle, Central Valley steelhead, Central Valley spring-run and fall-run Chinook salmon, Sacramento River winter-run Chinook salmon, green sturgeon, giant gartersnake, bank swallow, Swainson's hawk, tricolored blackbird, and western yellow-billed cuckoo. The RCIS also identifies one non-target species: western pond turtle.

C.3.11 Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon

The recovery plan for green sturgeon was released in 2018 (National Marine Fisheries Service 2018). This plan presents 20 recovery actions aiming to restore passage and habitat; reduce mortality from fisheries, entrainment, and poaching; and address threats from contaminants, climate change, predation, sediment loading, and oil and chemical spills. The recovery plan identifies 17 priority recovery actions and three secondary priority actions, as well as 16 research priorities. It also proposes monitoring and education and outreach programs.

C.3.12 Executive Order N-82-20 ("30 by 30")

On October 7, 2020, Governor Gavin Newsom signed Executive Order N-82-20, which calls for the conservation of 30 percent of land and coastal waters by 2030 to combat climate change and protect biodiversity. The order enlists California's natural and working lands—forests, rangelands, farms, wetlands, coast, deserts, and urban greenspaces—to act as carbon storage.

It directs State agencies to implement innovative strategies to remove carbon from the atmosphere through actions such as:

- Healthy soils management, including planting cover crops, hedgerows, and compost applications.
- Wetlands restoration to protect coastal areas.
- Active forest management to reduce catastrophic risk and restore forest health.
- Green infrastructure boost (like trees and parks) in urban areas.

The executive order also directs the California Natural Resources Agency to form a California Biodiversity Collaborative to bring together experts, leaders, and communities to both pursue a unified approach to protecting biodiversity and develop strategies to support the 30 by 30 goal. A coalition of State agencies is also ordered to develop a Natural and Working Lands Climate Smart Strategy within one year of the signing of the executive order, which will serve as a framework to advance the State's carbon neutrality goal and builds climate resilience.

C.4 Summary of the Relationship of Other Conservation Plans to Conservation Strategy Targets

As described here and in Appendix J of the 2016 Conservation Strategy, multiple conservation plans overlap the Strategy, and many of the plans have addressed the Strategy's targets. Tables C-1 and C-2 summarize the relationships of these plans to the Strategy's target habitats and target species, respectively. The tables include the plans described in Appendix J of the 2016 Conservation Strategy, as well as the new plans described in this appendix.

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Table C-1. Relationship of Conservation Objectives of Other Plans to Conservation Strategy Target Habitats

Plan Type	Plan Name	Target Habitat Riparian or Shaded Riverine Aquatic	Target Habitat Wetland	Target Habitat Seasonal Floodplain	Target Habitat Riverine Aquatic	Geographic Overlap Systemwide Planning Area
Plans with Quantified Conservation Measures	Butte Regional Conservation Plan Butte Sink, Willow	Probable	Probable	Probable	Probable	Probable
	Creek–Lurline, and North Central Valley WMA CCP	Probable	Probable	None	Probable	Probable
	California EcoRestore	Significant	Significant	Significant	Significant	Significant
	California Water Action Plan	None	Significant	None	Significant	Significant
	California Water Plan	Probable	Probable	Probable	Probable	Significant
	Central Valley Joint Venture	Significant	Significant	None	None	Significant
	Central Valley Project Improvement Act Programs	Significant	None	Probable	Significant	Significant
	Central Valley Project–State Water Project OCAP and Associated BOs	Probable	None	Probable	Significant	Significant
	Cosumnes River Preserve Management Plan	Probable	Probable	Significant	Probable	Probable
	Delta Smelt Resiliency Strategy	None	Significant	None	Significant	Significant
	DWR's Oroville FERC license	Probable	Probable	Probable	Significant	Probable
	East Contra Costa County HCP/NCCP	Probable	Probable	None	None	Probable
	Ecosystem Restoration Program	Significant	Significant	Significant	Significant	Significant
	Executive Order N-82-20 ("30 by 30")	Probable	Significant	Probable	Significant	Probable
	Natomas Basin HCP	None	Probable	None	None	Significant
	PG&E O&M HCP	Probable	Probable	Probable	Probable	Significant
	Placer County Conservation Plan	Probable	Probable	None	Probable	Probable
	Recovery Plan for Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon ESUs and Central Valley Steelhead DPS	Significant	None	Significant	Significant	Significant
	Recovery Plan for the Southern DPS of North American Green Sturgeon	None	None	None	Significant	Significant
	Sacramento, Delevan, Colusa, and Sutter NWR CCP/EA	Probable	Probable	Significant	Probable	Probable
	Sacramento River NWR CCP	Significant	Probable	Probable	Probable	Probable
	Sacramento Valley Salmon Resiliency Strategy	Significant	None	Significant	Significant	Significant
	San Joaquin County Multi-Species HCP and Open Space Plan	Probable	Probable	None	None	Probable
	San Joaquin River Restoration Program– Fisheries Framework	Probable	None	Significant	Significant	Significant
	Solano Multi-Species HCP	Probable	Probable	None	Probable	Probable
	South Sacramento HCP	Probable	Probable	Probable	Probable	Probable
	Voluntary Agreements	None	None	Significant	Significant	Significant
	Yuba-Sutter Regional Conservation Plan	Probable	Probable	None	None	Probable
	Yolo HCP/NCCP	Significant	Significant	None	None	Probable

Plan Type	Plan Name	Target Habitat Riparian or Shaded Riverine Aquatic	Target Habitat Wetland	Target Habitat Seasonal Floodplain	Target Habitat Riverine Aquatic	Geographic Overlap Systemwide Planning Area
Plans without Quantified Conservation Measures	Bank Swallow Conservation Strategy for California	Probable	Probable	Probable	Probable	Significant
	Bank Swallow Recovery Plan	Probable	Probable	Probable	Probable	Significant
	California Biodiversity Initiative	None	Probable	None	Probable	Probable
	California Red-Legged Frog Recovery Plan	Probable	Probable	Probable	Probable	Probable
	CMP for the Sacramento River Wildlife Area	Significant	Significant	Significant	Significant	Significant
	Cutting the Green Tape Initiative	None	None	None	None	Probable
	Mid-Sacramento Valley RCIS/LCP	Significant	Significant	Significant	Significant	Significant
	Draft Recovery Plan for the Least Bell's Vireo	Significant	None	None	None	Probable
	Yolo RCIS/LCP	Significant	Significant	Significant	Significant	Significant
	Feather River Conceptual Plan	None	None	Significant	None	Probable
	Flood-MAR	Significant	Significant	Significant	Probable	Probable
	Recovery Plan for Upland Species of the San Joaquin Valley, California	Probable	None	None	None	Probable
	Revised Draft Recovery Plan for the Giant Gartersnake	None	Significant	None	None	Significant
	Sacramento River Conservation Area Forum	Significant	Probable	Probable	Probable	Significant
	State Water Resources Control Board Plans	None	None	None	Probable	Probable
	The Nature Conservancy Sacramento River Project	Significant	Probable	Probable	Significant	Significant
	VELB Recovery Plan	Significant	None	None	None	Significant
	Water Resilience Portfolio	None	Probable	Significant	Probable	Significant
	Yolo Bypass Wildlife Area LMP	Significant	Significant	Significant	Probable	Probable

Source: California Department of Water Resources 2016, updated with data compiled by H. T. Harvey & Associates in 2020

Notes:

The magnitude of the relationship between the CVFPP and other conservation plans or programs is specified as follows:

None = No relationship exists.

Probable = A probable or potential relationship exists. The Conservation Strategy is not likely to significantly contribute to the other conservation plan's conservation objectives, or the conservation target is a secondary focus of the conservation plan. For geographic overlap, there is a minor spatial overlap between the conservation plan area and one of the CVFPP planning boundaries.

Significant = A significant relationship exists. The Conservation Strategy could significantly contribute to the other conservation plan's conservation objectives. For geographic overlap, there is a large spatial overlap between the conservation plan and one of the CVFPP planning boundaries.

BO = Biological Opinion
CCP = comprehensive conservation plan
CMP = comprehensive management plan
CVFPP = Central Valley Flood Protection Plan
DPS = Distinct Population Segment
DWR = California Department of Water Resources
EA = Environmental Assessment
ESU = Evolutionarily Significant Unit
FERC = Federal Energy Regulatory Commission
HCP = habitat conservation plan
LMP = land management plan
NCCP = natural community conservation plan
NWR = National Wildlife Refuge
OCAP = operations criteria and plan
O&M = operations and maintenance
PG&E = Pacific Gas and Electric Company
VELB = valley elderberry longhorn beetle

Table C-2. Relationship of Conservation Objectives of Other Plans to Conservation Strategy Target Species

Plan Type	Plan Name	Target Species Delta Button-Celery	Target Species Slough Thistle	Target Species Salmonids	Target Species Green Sturgeon	Target Species Delta Smelt	Target Species Giant Gartersnake	Target Species VELB	Target Species Western Yellow-billed Cuckoo	Target Species Bank Swallow	Target Species Swainson's Hawk	Target Species Least Bell's Vireo	Target Species Greater Sandhill Crane	Target Species California Black Rail	Target Species Tricolored Blackbird	Target Species Yellow-breasted Chat	Target Species Riparian Brush Rabbit	Target Species Riparian Woodrat	Geographic Overlap Systemwide Planning Area
Plans with Quantified Conservation Measures	Butte Regional Conservation Plan	None	None	Probable	Probable	None	Probable	Probable	Probable	Probable	Probable	None	Probable	Probable	Probable	Probable	None	None	Probable
	Butte Sink, Willow Creek–Lurline, and North Central Valley WMA CCP	None	None	None	None	None	None	None	None	None	None	None	None	None	Probable	None	None	None	Probable
	California EcoRestore	Significant	Probable	Significant	Probable	Probable	Significant	Probable	Significant	Probable	Significant	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Significant
	California Water Action Plan	None	None	Significant	Probable	Probable	None	None	None	None	None	None	Probable	None	None	None	None	None	Significant
	California Water Plan	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Central Valley Joint Venture	None	None	None	None	None	None	None	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	None	None	Significant
	Central Valley Project Improvement Act Programs	None	None	Significant	None	None	Probable	Probable	Probable	Probable	Probable	Probable	None	None	None	None	Probable	Probable	Significant
	Central Valley Project–State Water Project OCAP and Associated BOs	None	None	Significant	Probable	Probable	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Cosumnes River Preserve Management Plan	None	None	Significant	None	None	Probable	Probable	None	None	Probable	Probable	Probable	None	None	None	None	None	Probable
	Delta Smelt Resiliency Strategy	None	None	Probable	Probable	Significant	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	DWR's Oroville FERC license	None	None	Significant	None	None	Probable	Probable	None	None	None	None	None	None	None	None	None	None	Probable
	East Contra Costa County HCP/NCCP	None	None	None	None	None	Probable	None	None	None	Probable	None	None	None	None	None	None	None	Probable
	Ecosystem Restoration Program	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	None	Significant	Significant	Significant
	Natomas Basin HCP	None	None	None	None	None	Probable	Probable	None	Probable	Probable	None	None	None	Probable	None	None	None	Significant
	PG&E O&M HCP	Probable	Probable	None	None	None	Probable	Probable	None	Probable	Probable	None	None	None	None	None	Probable	Probable	Significant
	Placer County Conservation Plan	None	None	Probable	None	None	Probable	Probable	Probable	Probable	Probable	None	None	Probable	Probable	None	None	None	Probable

Plan Type	Plan Name	Target Species Delta Button-Celery	Target Species Slough Thistle	Target Species Salmonids	Target Species Green Sturgeon	Target Species Delta Smelt	Target Species Giant Gartersnake	Target Species VELB	Target Species Western Yellow-billed Cuckoo	Target Species Bank Swallow	Target Species Swainson's Hawk	Target Species Least Bell's Vireo	Target Species Greater Sandhill Crane	Target Species California Black Rail	Target Species Tricolored Blackbird	Target Species Yellow-breasted Chat	Target Species Riparian Brush Rabbit	Target Species Riparian Woodrat	Geographic Overlap Systemwide Planning Area
Plans with Quantified Conservation Measures	Recovery Plan for Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon ESUs and Central Valley Steelhead DPS	None	None	Significant	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Recovery Plan for the Southern DPS of North American Green Sturgeon	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Sacramento, Delevan, Colusa, and Sutter NWR CCP/EA	None	None	Probable	None	None	Probable	None	Probable	None	Probable	None	Probable	None	Probable	None	None	None	Probable
	Sacramento River NWR CCP	None	None	Probable	None	None	Probable	Probable	Probable	Probable	Probable	Probable	None	None	Probable	Probable	None	None	Probable
	Sacramento Valley Salmon Resiliency Strategy	None	None	Significant	Probable	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	San Joaquin County Multi-Species HCP and Open Space Plan	Probable	Probable	None	Probable	Probable	Probable	Probable	Probable	Probable	Probable	None	Probable	Probable	Probable	Probable	Probable	Probable	Probable
	San Joaquin River Restoration Program–Fisheries Framework	None	None	Significant	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Solano Multi-Species HCP	None	None	Probable	Probable	Probable	Probable	Probable	None	None	Probable	None	None	Probable	Probable	None	None	None	Probable
	South Sacramento HCP	None	None	None	None	None	Probable	Probable	None	None	Probable	None	Probable	None	Probable	None	None	None	Probable
	Voluntary Agreements	None	None	Significant	Probable	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Yuba-Sutter Regional Conservation Plan	None	None	Probable	None	None	Probable	Probable	Probable	Probable	Probable	None	Probable	Probable	Probable	None	None	None	Probable
	Yolo HCP/NCCP	None	None	None	None	None	Probable	Probable	Probable	Probable	Probable	Probable	None	None	Probable	None	None	None	Probable
	Bank Swallow Conservation Strategy for California	None	None	None	None	None	None	None	None	Significant	None	None	None	None	None	None	None	None	Significant
Plans without Quantified Conservation Measures	Bank Swallow Recovery Plan	None	None	None	None	None	None	None	None	Significant	None	None	None	None	None	None	None	None	Significant
	California Biodiversity Initiative	Probable	Probable	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Probable
	California Red-Legged Frog Recovery Plan	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Probable
	CMP for the Sacramento River Wildlife Area	None	None	Probable	Probable	None	Probable	Probable	Probable	Probable	None	None	None	None	Probable	Probable	None	None	Significant

Plan Type	Plan Name	Target Species Delta Button-Celery	Target Species Slough Thistle	Target Species Salmonids	Target Species Green Sturgeon	Target Species Delta Smelt	Target Species Giant Gartersnake	Target Species VELB	Target Species Western Yellow-billed Cuckoo	Target Species Bank Swallow	Target Species Swainson's Hawk	Target Species Least Bell's Vireo	Target Species Greater Sandhill Crane	Target Species California Black Rail	Target Species Tricolored Blackbird	Target Species Yellow-breasted Chat	Target Species Riparian Brush Rabbit	Target Species Riparian Woodrat	Geographic Overlap Systemwide Planning Area
Plans without Quantified Conservation Measures	Cutting the Green Tape Initiative	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Probable
	Draft Mid-Sacramento Valley RCIS/LCP	None	None	Significant	Significant	None	Significant	Significant	Significant	Significant	Significant	None	None	None	Significant	None	None	Significant	Significant
	Draft Recovery Plan for the Least Bell's Vireo	None	None	None	None	None	None	None	None	None	None	Probable	None	None	None	None	None	None	Probable
	Draft Yolo RCIS/LCP	None	None	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	None	None	Significant
	Executive Order N-82-20 ("30 by 30")	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable	Probable
	Feather River Conceptual Plan	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Probable
	Flood-MAR	None	None	Probable	Probable	None	None	None	None	None	None	None	Probable	None	None	None	None	None	Probable
	Recovery Plan for Upland Species of the San Joaquin Valley, California	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Significant	Significant	Probable
	Revised Draft Recovery Plan for the Giant Gartersnake	None	None	None	None	None	Probable	None	None	None	None	None	None	None	None	None	None	None	Significant
	Sacramento River Conservation Area Forum	None	None	Significant	None	None	None	Significant	Significant	Significant	Probable	Significant	None	None	None	None	None	None	Significant
	State Water Resources Control Board Plans	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	Probable

Plan Type	Plan Name	Target Species Delta Button-Celery	Target Species Slough Thistle	Target Species Salmonids	Target Species Green Sturgeon	Target Species Delta Smelt	Target Species Giant Gartersnake	Target Species VELB	Target Species Western Yellow-billed Cuckoo	Target Species Bank Swallow	Target Species Swainson's Hawk	Target Species Least Bell's Vireo	Target Species Greater Sandhill Crane	Target Species California Black Rail	Target Species Tricolored Blackbird	Target Species Yellow-breasted Chat	Target Species Riparian Brush Rabbit	Target Species Riparian Woodrat	Geographic Overlap Systemwide Planning Area
Plans without Quantified Conservation Measures	The Nature Conservancy Sacramento River Project	None	None	Significant	None	None	None	Significant	Significant	Significant	Probable	Significant	None	None	Probable	Probable	None	None	Significant
	VELB Recovery Plan	None	None	None	None	None	None	Significant	None	None	None	None	None	None	None	None	None	None	Significant
	Water Resilience Portfolio	None	None	Probable	Probable	Probable	None	None	None	None	None	None	None	None	None	None	None	None	Significant
	Yolo Bypass Wildlife Area LMP	None	None	Significant	None	Probable	Significant	None	Probable	None	Significant	None	None	None	Probable	None	None	None	Probable

Source: California Department of Water Resources 2016, updated with data compiled by H. T. Harvey & Associates in 2020

Notes:

The magnitude of relationship between the CVFPP and other conservation plans or programs is specified as follows:

None = No relationship exists.

Probable = A probable or potential relationship exists. The Conservation Strategy is not likely to significantly contribute to the other conservation plan's conservation objectives, or the conservation target is a secondary focus of the conservation plan. For geographic overlap, there is a minor spatial overlap between the conservation plan area and one of the CVFPP planning boundaries.

Significant = A significant relationship exists. The Conservation Strategy could significantly contribute to the other conservation plan's conservation objectives. For geographic overlap, there is a large spatial overlap between the conservation plan and one of the CVFPP planning boundaries.

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CCP = comprehensive conservation plan
CMP = comprehensive management plan
CVFPP = Central Valley Flood Protection Plan
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EA = Environmental Assessment
ESU = Evolutionarily Significant Unit
FERC = Federal Energy Regulatory Commission
HCP = habitat conservation plan
LMP = land management plan
NCCP = natural community conservation plan
NWR = National Wildlife Refuge
O&M = operations and maintenance
OCAP = operations criteria and plan
PG&E = Pacific Gas and Electric Company
VELB = valley elderberry longhorn beetle

C.5 References

Anadromous Fish Restoration Program. 2018a. *Central Valley Project Improvement Act Fisheries Investigations: Annual Progress Report, Fiscal Year 2017*. Lodi (CA): U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office. February 2, 2018. Viewed online at: www.fws.gov. Accessed: October 26, 2021.

Anadromous Fish Restoration Program. 2018b. *Central Valley Project Improvement Act Fisheries Investigations: Annual Progress Report, Fiscal Year 2018*. Lodi (CA): U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office. December 7, 2018. Viewed online at: www.fws.gov. Accessed: October 26, 2021.

Anadromous Fish Restoration Program. 2019. *Central Valley Project Improvement Act Fisheries Investigations Annual Progress Report Fiscal Year 2019*. Lodi (CA): U.S. Fish and Wildlife Service, Lodi Fish and Wildlife Office. November 1, 2019. Viewed online at: www.fws.gov . Accessed: October 26, 2021.

Butte County Association of Governments. 2019. *Butte Regional Conservation Plan*. June 28, 2019. Viewed online at: http://www.buttehcp.com. Accessed: July 16, 2020.

California Department of Water Resources. 2016. *Central Valley Flood System Conservation Strategy*. Sacramento (CA).

California Department of Water Resources. 2019. *California Water Plan Update 2018: Managing Water Resources for Sustainability*. June 2019. Viewed online at: https://water.ca. . Accessed: October 26, 2021.

California Department of Water Resources. 2022a. "California EcoRestore." Viewed online at: https://water.ca. Accessed: August 16, 2022.

California Department of Water Resources. 2022b. "Flood-Managed Aquifer Recharge (FloodMAR)." Viewed online at: https://water.ca. Accessed: June 28, 2022.

California Landscape Stewardship Network. 2020. *Cutting the Green Tape: Regulatory Efficiencies for a Resilient Environment.* November. Viewed online at: https://landscape.ca. Accessed: March 16, 2021.

California Natural Resources Agency. 2016. *Delta Smelt Resiliency Strategy*. Sacramento (CA). July 2016.

California Natural Resources Agency. 2017. *Sacramento Valley Salmon Resiliency Strategy*. Sacramento (CA). June 2017.

California Natural Resources Agency. 2020. "Voluntary Agreements." Viewed online at: www.resources.ca. Accessed: August 16, 2022.

California Natural Resources Agency. 2021. Cutting Green Tape Report Implementation. Memorandum to Leaders of the Agency's Conservancies, Departments, and Divisions. www.crowfoot.com. From Wade Crowfoot, Secretary, Natural Resources Agency. January 7.

California Natural Resources Agency. 2022a. "California Water Plan – Update 2023." Viewed online at: www.water.ca. Accessed: June 27, 2022.

California Natural Resources Agency. 2022b. Transforming Environmental Restoration: Progress on the Cutting the Green Tape Initiative. Update to California Natural Resources. www.crowfoot.com. Secretary Wade Crowfoot. March 17.

California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency. 2016. "California Water Action Plan 2016 Update." Viewed online at: www.resources.ca. Accessed: August 16, 2022.

California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency. 2020. *Water Resilience Portfolio*. July 2020. Viewed online at: www.resources.ca Accessed: October 26, 2021.

California Natural Resources Agency, California Department of Food and Agriculture, and Governor's Office of Planning and Research. 2018. *California Biodiversity Initiative: A Roadmap for Protecting the State's Natural Heritage*. Sacramento (CA). September 2018.

Central Valley Joint Venture. 2020. "2020 Implementation Plan." Viewed online at: www.jointventure.org. Accessed: July 17, 2020.

Central Valley Regional Water Quality Control Board. 2019. waterqualityplan.org. Revised February 2019 (with Approved Amendments).

County of Sacramento, City of Rancho Cordova, City of Galt, Sacramento County Water Agency, and Southeast Connector Joint Powers Authority. 2018. *Final South Sacramento Habitat Conservation Plan*. Sacramento (CA). February 2018.

National Marine Fisheries Service. 2018. *Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*).* Prepared for National Oceanic and Atmospheric Administration, Sacramento (CA). August 8, 2018.

National Marine Fisheries Service. 2019. Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project. Consultation Number WCR-2016-00069. October 21, 2019.

Placer County. 2020. "Placer County Conservation Program." Viewed online at: www.placer.ca. Accessed: July 16, 2020.

Reclamation District 108. 2019. *Public Draft Mid-Sacramento Valley Regional Conservation Investment Strategy.* Grimes (CA): Prepared by ICF International. January 2019.

Reclamation District 108. 2020. *Mid-Sacramento Valley Regional Conservation Investment Strategy.* Final. Grimes (CA): Prepared by ICF International. December 2020.

San Joaquin River Restoration Program. 2018. *Fisheries Framework: Spring-run and Fall-run Chinook Salmon*. July 2018. Viewed online at: www.restore.org. Accessed: July 17, 2020.

State Water Resources Control Board. 2018. Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary. December 12, 2018.

State Water Resources Control Board. 2019. State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State. April 2, 2019.

State Water Resources Control Board. 2020. "San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta) Watershed Efforts." Viewed online at: www.waterboards.ca. Accessed: July 16, 2020.

Supplemental Benefits Fund Steering Committee. 2018. "Feather River Conceptual Plan. Final Plan. Oroville (CA)." Prepared by Environmental Science Associates, Sacramento (CA), and Melton Design Group, Chico (CA). September 5, 2018. Viewed online at: www.oroville.com. Accessed: July 16, 2020.

U.S. Fish and Wildlife Service. 2017. *Recovery Plan for the Giant Gartersnake (*Thamnophis gigas*).* Sacramento (CA). September 28, 2017.

U.S. Fish and Wildlife Service. 2018. Biological and Conference Opinion, Issuance of a Section 10(a)(1)(B) Permit for the Yolo County Habitat Conservation Plan/Natural Community Conservation Plan. File Number 08ESMF00-2017-F-3219-1. Sacramento (CA). August 2, 2018.

U.S. Fish and Wildlife Service. 2019a. Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project. Service File No. 08FBTD00-2019-F-0164. Sacramento (CA). October 21, 2019.

U.S. Fish and Wildlife Service. 2019b. *Revised Recovery Plan for Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*).* Sacramento (CA). October 4, 2019.

U.S. Fish and Wildlife Service. 2020. "Final Comprehensive Conservation Plan for the Butte Sink, Willow Creek–Lurline, and North Central Valley Wildlife Management Areas." Viewed online at: www.fws.com. Accessed: July 16, 2020.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 2019. "Overview of the ROC on LTO Biological Opinions." October 2019. Viewed online at: www.usbr.gov. Accessed: August 16, 2022.

Yolo Habitat Conservancy. 2018a. *Yolo Regional Conservation Investment Strategy/Local Conservation Plan*. Draft. Woodland (CA): Prepared by ICF International. March 2018.

Yolo Habitat Conservancy. 2018b. *Yolo Habitat Conservation Plan/Natural Community Conservation Plan*. Volume I & Volume II. Woodland (CA): Prepared by ICF International. April 2018.

Yolo Habitat Conservancy. 2020a. "Yolo Habitat Conservancy: Welcome." Viewed online at: YoloHabitatConservancy.org. Accessed: July 17, 2020.

Yolo Habitat Conservancy. 2020b. *Yolo Regional Conservation Investment Strategy/Local Conservation Plan*. Final. Woodland (CA): Prepared by ICF International. October 2020.

Appendix D
Updates to 2016 Conservation Strategy Appendix A, "Regulatory Setting"

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APPENDIX D

Updates to 2016 Conservation Strategy Appendix A, "Regulatory Setting"

Acronym	Definition
BO	biological opinion
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	*Code of Federal Regulations*
Conservation Strategy (or Strategy)	Central Valley Flood Protection Plan 2016 Conservation Strategy
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CWA	Clean Water Act
Delta Plan	long-term management plan for the Sacramento–San Joaquin Delta
DWR	California Department of Water Resources
EA	environmental assessment
EIR	environmental impact report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
HCP	habitat conservation plan

Acronym	Definition
MND	mitigated negative declaration
MOU	memorandum of understanding
National Register	National Register of Historic Places
NCCP	natural community conservation plan
ND	negative declaration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPPA	Native Plant Protection Act
NWPR	Navigable Waters Protection Rule
regional water board	regional water quality control board
SHA	Safe Harbor Agreement
SHPO	State Historic Preservation Officer
SLC	California State Lands Commission
State	State of California
State Water Board	State Water Resources Control Board
Strategy (or Conservation Strategy)	Central Valley Flood Protection Plan 2016 Conservation Strategy
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
WDR	waste discharge requirements

D.1 Introduction

Appendix A, “Regulatory Setting,” of the Central Valley Flood Protection Plan (CVFPP) 2016 Conservation Strategy (Conservation Strategy or Strategy) described the federal and State of California (State) regulatory approvals required to implement the CVFPP, including the Conservation Strategy. This appendix provides an updated description of these regulatory approvals. Table D-1 lists these authorizations and approval actions by agency and statute, first for federal and then for State agencies.

Table D-1. Typical Authorizations Required by Multi-Benefit Flood Projects

Agency	Agency—Statute	Authorization or Approval Action
Federal Agencies	Lead federal agency—NEPA	• Record of decision
	USACE—Section 404 of the CWA	• Individual (standard) permit • Letter of permission • General permit (nationwide, regional, or programmatic basis)
	USACE—Section 9 of the Rivers and Harbors Act of 1899	• Individual (standard) permit • General permit (nationwide, regional, or programmatic basis)
	USACE—Section 10 of the Rivers and Harbors Act of 1899	• Individual (standard) permit • Letter of permission • General permit (nationwide, regional, or programmatic basis)
	USACE—Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408)	• Letter of permission
	USFWS/NMFS—ESA, Section 7	• Biological opinion • Incidental take statement
	USFWS/NMFS—ESA, Section 10	• Incidental take permit • Enhancement of survival permit • Recovery and interstate commerce permit
	National Marine Fisheries Service—Magnuson-Stevens Fishery Conservation and Management Act [a]	• Consultation
State Agencies	Lead State or local agency—CEQA	• Notice of determination
	CDFW—Section 1600 of the California Fish and Game Code	• Lake and streambed alteration agreement • Master agreement • Routine maintenance agreement
	CDFW—CESA	• Section 2081(a) MOU • Section 2081(b) incidental take permit • Section 2080.1 consistency determination • Natural community conservation plan • Safe harbor agreement • Voluntary local program

Agency	Agency—Statute	Authorization or Approval Action
State Agencies	State Water Resources Control Board—Sections 1200 and 1201 of the California Water Code	• Water right permit
	Central Valley Regional Water Quality Control Board—Porter-Cologne Water Quality Control Act	• WDR
	Central Valley Regional Water Quality Control Board—CWA (Section 401)	• Water quality certification
	Central Valley Regional Water Quality Control Board—CWA Section 402	• NPDES permit and WDR
	California Office of Historic Preservation—Section 106 of the National Historic Preservation Act	• Consultation with the SHPO
	Central Valley Flood Protection Board—California Water Code Section 8608	• Encroachment permit
	California State Lands Commission—Public Resources Code Section 6009	• Lease
	Delta Stewardship Council—Sacramento–San Joaquin Delta Reform Act of 2009	• Certification of consistency [b]

[a] Consultations on actions that may adversely affect essential fish habitat (required by the Magnuson Stevens Fishery Conservation and Management Act) may be conducted in conjunction with NEPA compliance, ESA compliance, USACE permitting, or as a separate consultation.

[b] Filed by the lead State or local agency.

Notes:

CDFW = California Department of Fish and Wildlife
CEQA = California Environmental Quality Act
CESA = California Endangered Species Act
CFR = *Code of Federal Regulations*
CWA = Clean Water Act
ESA = Endangered Species Act
MOU = memorandum of understanding
NEPA = National Environmental Policy Act
NMFS = National Marine Fisheries Service
NPDES = National Pollutant Discharge Elimination System
SHPO = State Historic Preservation Officer
USACE = U.S. Army Corps of Engineers
USC = *United States Code*
USFWS = U.S. Fish and Wildlife Service
WDR = waste discharge requirements

D.2 Federal Authorizations

D.2.1 National Environmental Policy Act

The NEPA requires federal agencies to assess the environmental effects of their proposed actions before making decisions. The NEPA process involves three levels of analysis: categorical exemption, environmental assessment (EA), and environmental impact statement (EIS). Unless a federal action is determined to be categorically excluded, federal agencies are required to prepare an EA assessing the environmental impacts and related social and economic effects of the proposed action and alternatives. If an EA concludes with a finding of no significant impact, no further NEPA documentation is required. If the EA determines the project may result in significant environmental effects, or if significant effects are presumed initially, an EIS must be prepared to achieve NEPA compliance. The EIS process also provides opportunities for public review and comment. The EIS process ends with the issuance of a Record of Decision by the lead federal agency. Specific procedures for NEPA compliance vary by lead agency because many federal agencies have developed their own supplemental procedures that support the agency’s specific mission and activities.

D.2.2 U.S. Army Corps of Engineers

D.2.2.1 Section 404 of the Clean Water Act

Through its regulatory program, USACE administers and enforces Section 404 of the CWA. Under Section 404, a permit must be obtained to discharge dredged or fill material into waters of the United States, unless the activity is exempt (e.g., some agricultural activities).

The Navigable Waters Protection Rule (NWPR) became effective in 2020 and established the scope of federal regulatory authority under the CWA. The NWPR included four simple categories of jurisdictional waters, and provided specific exclusions for many water features that have not traditionally been regulated. In June 2021, the U.S. Environmental Protection Agency (EPA) and Department of the Army announced their intent to revise the definition of “waters of the United States” to better protect our nation’s vital water resources that support public health, environmental protection, agricultural activity, and economic growth. In September 2021, the NWPR was vacated and remanded in the case of *Pascua Yaqui Tribe v. U.S. Environmental Protection Agency*. In light of this order, EPA and USACE have halted implementation of the NWPR and are interpreting “waters of the United States” consistent with the pre-2015 regulatory regime until the definition of “waters of the United States” is revised.

USACE regulations provide for the issuance of general (nationwide, regional, or programmatic basis) and individual permits. General permits may be issued to authorize specific types of activities that would have minimal individual and cumulative adverse environmental effects or would avoid the unnecessary duplication of the regulatory control exercised by another federal, state, or local agency, provided it has been determined that the environmental consequences of the action are individually and cumulatively minor. General permits can be issued for a period of no more than five years. A letter of permission is a type of individual permit issued through an abbreviated processing procedure that includes coordination with relevant federal and state agencies. An individual (standard) permit must be obtained for a specific proposed activity that cannot be authorized under a general permit or letter of permission. These activities may have more than minimal individual or cumulative environmental impacts.

Related EPA and USACE regulations require the filling of wetlands and other waters of the United States to be avoided and minimized to the maximum extent practicable. Compensatory mitigation is required for unavoidable impacts on the waters of the United States. EPA and USACE have adopted regulations and guidelines that define compensatory mitigation and required mitigation plan contents, guide the determination of mitigation amounts, and address the timing of mitigation relative to impacts (33 CFR 332, Final Regional Compensatory Mitigation and Monitoring Guidelines of the South Pacific Division, January 12, 2015).

These regulations define "compensatory mitigation" as "the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, or, in certain circumstances, preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved." Mitigation options are preferred in the following order, from most preferred to least: mitigation bank credits, in-lieu fee program credits, and permit-responsible mitigation in consideration of a watershed approach. Compensatory mitigation should be commensurate with the amount and type of impact, and should be sufficient to replace the lost aquatic resource functions.

Mitigation plans must describe objectives, site selection criteria, site protection instruments, baseline information, credit determinations, mitigation work plan, maintenance plan, ecological performance standards, monitoring requirements, long-term management plan, adaptive management plan, and financial assurances. Generally, financial assurances are provided as either bonds or letters of credit, although other types may be acceptable. Financial assurances should in place before the permitted activity begins.

D.2.2.2 Section 9 of the Rivers and Harbors Act of 1899

Section 9 of the Rivers and Harbors Act of 1899 prohibits the construction of any dam or dike across any navigable water of the United States, without congressional consent and approval of the plans by the Chief of Engineers and the Secretary of the Army. Where the navigable portions of the waterbody lie wholly within the limits of a single state, the structure may be built under the authority of that state's legislature, if the Chief of Engineers and the Secretary of the Army approve the location and plans or any modifications. Section 9 also pertains to bridges and causeways, but the authority of the Secretary of the Army and Chief of Engineers over bridges and causeways was transferred to the Secretary of Transportation (U.S. Coast Guard) under the Department of Transportation Act of October 15, 1966.

D.2.2.3 Section 10 of the Rivers and Harbors Act of 1899

Through the regulatory program, USACE administers and enforces Section 10 of the Rivers and Harbors Act of 1899. Under Section 10, a permit is required for work or structures (e.g., levees or piers) in, over, or under navigable waters of the United States. Navigable waters of the

United States are defined as waters that have been used in the past, are now used, or are susceptible to use for the transportation of interstate or foreign commerce up to the head of navigation. Typical activities requiring a permit include the installations of piers, docks, and other structures; dredging and excavation; and bank stabilization.

D.2.2.4 Section 14 of the Rivers and Harbors Act of 1899

Section 14 of the Rivers and Harbors Act (USC Title 33, Section 408 [33 USC 408], or "Section 408") states that the Secretary of the Army may, on recommendation of the Chief of Engineers, grant permission for the alteration or permanent occupation of a public work (e.g., a levee or dam) as long as that alteration or occupation is not injurious to the public interest and will not impair the usefulness of the work. Permission for certain alterations (which include changes to the authorized purpose, scope, or functioning of a project) must be obtained from USACE Headquarters. The primary focus of USACE's Section 408 review is to ensure there will be no impacts on the flood risk reduction system. For USACE projects with a nonfederal sponsor, that sponsor must provide a written Statement of No Objection if they are not the requester. Nonfederal sponsors typically have operations and maintenance responsibilities; have a cost-share investment in the USACE project; or hold the real property for the USACE project (or a combination).

In 2019, the USACE Sacramento District established 25 "categorical permissions" to expedite the review of Section 408 requests that are similar in nature and have similar impacts. Examples of these categorical permissions include wells, ditches and canals, bridges, roads, borrow areas, seepage and stability berms, and environmental restoration (e.g., plantings or placement of spawning gravels). For an alteration to be approved through a categorical permission, it must be consistent with the category's description, have no disqualifying circumstances (e.g., inducing floodplain development or causing a net loss in riparian habitat), and adhere to a set of standard engineering and environmental conditions.

D.2.3 U.S. Fish and Wildlife Service and National Marine Fisheries Service

D.2.3.1 Endangered Species Act

The purpose of the ESA is to protect and recover imperiled species and the ecosystems they depend on. Under the ESA, species may be listed as either endangered or threatened. Once a fish or wildlife species is listed as endangered or threatened under the federal ESA, the act prohibits take of the species. To "take" a species means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." "Harm" is defined as an act that actually kills or injures wildlife, and can include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns. Listed plants are not protected from take.

In addition, the ESA prohibits the destruction or adverse modification of designated critical habitat. Designated critical habitat encompasses areas that are essential to the conservation of threatened and endangered species, and includes geographic areas "on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection" (ESA Section 3[5][A]). Generally, the USFWS (under the U.S. Department of the Interior) administers the ESA for terrestrial and freshwater species, and the NMFS (under the U.S. Department of Commerce) administers the ESA for marine and anadromous species.

D.2.3.2 Endangered Species Act Section 7

ESA Section 7(a)(2) requires federal agencies that are undertaking, funding, permitting, or authorizing actions to consult with USFWS or NMFS, or both, to ensure the action is not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat of such species. The issuance of a permit by a federal agency provides a federal nexus for a nonfederal agency action or project, thus allowing ESA compliance through Section 7 consultation. For example, when issuing a CWA Section 404 permit, which may provide a federal nexus for at least a portion of a project, USACE would initiate Section 7 consultation with both USFWS and NMFS.

Section 7 consultations lead to the following general outcomes:

- If an action has no potential to affect species listed under the ESA or critical habitat, the federal agency undertaking or permitting the action makes a "no effect" determination and is not obligated to contact USFWS or NMFS for concurrence.
- Informal consultation and a concurrence letter from USFWS and/or NMFS are needed if the action may affect but is not likely to adversely affect ESA-listed species or critical habitat.
- Formal consultation is required if adverse effects on listed species or critical habitat are expected. If based on a biological assessment or equivalent document, the action is likely to adversely affect species listed under the ESA or critical habitat, a formal consultation occurs between the federal agency proposing the action (e.g., USACE) and USFWS and/or NMFS. Formal consultation concludes within 90 calendar days after all required information is provided unless the process is extended. USFWS or NMFS issues a biological opinion (BO) within 45 calendar days of the formal consultation's completion.
  - If the BO makes a "no jeopardy" finding for the ESA-listed species considered, incidental take may be authorized through an incidental take statement that sets forth "reasonable and prudent measures" and terms and conditions to minimize the potential take. Measures are considered reasonable and prudent when they are consistent with the proposed action's basic design, location, scope, duration, and timing (50 CFR 402.14[i][v][2]).
  - If the BO makes a "jeopardy" finding for the species, the BO must identify "reasonable and prudent alternatives" to prevent jeopardy or state why there are no alternatives. The federal agency proposing the action must consider the reasonable and prudent alternatives. If no reasonable and prudent alternatives exist, the federal agency with a nexus to the action or the project proponent may apply for an exemption from the Endangered Species Committee.

A consultation can be programmatic and lead to a programmatic BO. A programmatic consultation addresses an agency's multiple actions on a program or regional basis. A programmatic approach streamlines the procedures and time involved in consultations for broad agency programs or multiple similar, frequently occurring, or routine actions with predictable effects on listed species and/or critical habitat, thus reducing the amount of time spent on individual project-by-project consultations.

D.2.3.3 Endangered Species Act Section 10

Proponents of any activity without a federal nexus (e.g., through USACE or another federal agency) cannot consult under Section 7 of the ESA. Instead, ESA compliance for incidental take needs to be achieved under ESA Section 10(a)(1)(B), primarily through the preparation of a habitat conservation plan (HCP) and subsequent issuance of an incidental take permit. An HCP is a planning document prepared by a nonfederal party as part of an incidental take permit application for incidental take authorization. An HCP must include an assessment of impacts likely to result from the proposed taking of one or more federally listed species; measures to monitor, minimize, and mitigate impacts; funding for the proposed measures; and alternatives to the take being considered.

Upon an HCP's approval, USFWS or NMFS issues an incidental take permit. In addition to issuing the incidental take permit, USFWS and NMFS prepare a BO and provide appropriate NEPA documentation. HCPs can vary in their scale and complexity, from regional conservation plans for multiple parties and projects to Low-Effect HCPs for projects involving minor or negligible direct, indirect, and cumulative effects. Low-Effect HCPs do not require a NEPA document because the project must qualify for a categorical exclusion under NEPA. Unlike the Section 7 consultation process, there are no statutory limits on the duration of steps in the HCP development process.

D.2.3.4 Safe Harbor and Conservation Agreements

A Safe Harbor Agreement (SHA) is a tool available under the ESA. An SHA is a voluntary agreement between private or nonfederal landowners whose actions contribute to the recovery of listed species and USFWS or NMFS. Because only the landowner can enter into an SHA, a maintaining agency cannot obtain such an agreement with an easement for maintenance (as is typical for the California Department of Water Resources [DWR]).

Under an SHA, participating private and nonfederal property landowners voluntarily undertake activities on their property to enhance, restore, or maintain habitat benefiting listed species. SHAs and the subsequent enhancement of survival permits that are issued encourage property owners to implement conservation efforts for listed species. They are assured they will not be subjected to increased land use restrictions as a result of their efforts to attract listed species to their property or to increase the numbers or distribution of listed species already on their property. In 2016, NMFS completed its first SHA in the United States in the Dry Creek watershed. This was a partnership among NMFS, USACE, Sonoma County Water Agency, CDFW, and private landowners in the Dry Creek Valley, and supports the recovery of endangered coho salmon, and threatened Chinook salmon and steelhead.

A candidate conservation agreement is an agreement between landowners (including federal land management agencies) and USFWS or NMFS. A candidate conservation agreement covers species that are candidates for listing or are otherwise at risk. As part of this agreement, the landowner voluntarily commits to actions that reduce threats and help stabilize or restore a species, with the goal that listing will become unnecessary. A candidate conservation agreement with assurances provides regulatory assurances that if the candidate species becomes listed, the agreement becomes a permit authorizing the landowner's incidental take of the species. In 2016, USFWS and NMFS revised the candidate conservation agreement with assurances policy, to be clearer and more transparent about the level of conservation effort required for each candidate conservation agreement, and with assurances to be approved and be consistent with the criteria used for SHAs.

D.2.3.5 Migratory Bird Treaty Act

The federal Migratory Bird Treaty Act makes it illegal to pursue, hunt, take, capture, kill, or sell birds that are listed in the act. Under certain circumstances, a waiver can be obtained that allows for these actions; for example, for hunting, scientific collection, and if required, to address a health or public safety concern.

D.3 State Authorizations

D.3.1 California Environmental Quality Act

Projects by public agencies and private entities that are subject to discretionary approvals by government agencies must go through the environmental review process required by CEQA. CEQA defines a "project" as a "whole action" that may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment. "Projects" consist of discretionary activity by a public agency, a private activity that receives public funding, or activities that involve the public agency's issuance of a discretionary approval and is not statutorily or categorically exempt (Public Resources Code Section 21065).

Flood management projects may qualify for CEQA exemptions under two categories: statutory exemptions or categorical exemptions. Statutory exemptions are created by the Legislature, and projects that fall under these are generally not subject to CEQA, regardless of their impact on the environment. Categorical exemptions are created through the regulatory process and will not apply if one of three conditions exist: there is a reasonable possibility of a significant effect on the environment; significant cumulative impacts from projects of the same type will result; or the project will impact a uniquely sensitive environment (CEQA Guidelines Sections 15300 to 15333). Projects that are exempt from CEQA are not necessarily exempt from other federal, State, or local permits and authorizations.

The following types of projects may be exempt from CEQA:

- Emergency repairs necessary to maintain service essential to the public health, safety, or welfare (Section 15269[b]).
- Maintenance dredging where the spoil is deposited in a spoil area authorized by all applicable federal and State regulatory agencies (Section 15304[g]).
- Repairs, maintenance, or minor alterations of existing public structures that involve negligible or no expansion of an existing use (Section 15301).

If a project does not qualify for an exemption, an initial study is initiated. The initial study is prepared by the lead agency (usually the city or county with primary jurisdiction over the project, but this may also be State agencies) to determine whether there may be a significant environmental impact. Depending on the initial study, a negative declaration (ND), mitigated negative declaration (MND), or environmental impact report (EIR) may be required. An ND is prepared when there is no substantial evidence that a significant effect on the environment will occur. An MND is prepared when conditions are attached to an ND stating revisions were made to the project to avoid potentially significant impacts, and there is no substantial evidence that the revised project will have a significant effect on the environment. An EIR is prepared when, based on substantial evidence, a project may have a significant environmental effect.

D.3.2 California Department of Fish and Wildlife

D.3.2.1 Lake and Streambed Alteration Agreement

Section 1600 of the California Fish and Game Code requires that project proponents (any person, State or local governmental agency, or public utility) notify the CDFW before conducting activities that will substantially obstruct or divert the natural flow of any river, stream, or lake; substantially change or use any material from the bed, channel, or bank of any river, stream, or lake; or deposit or dispose of debris, waste, or other material where it may pass into a river, stream, or lake. Following the notification, CDFW determines whether the planned activities require a lake or streambed alteration agreement (agreement) as described in California Fish and Game Code Sections 1600 to 1616. An agreement will be required if the project may substantially adversely affect an existing fish, wildlife, or plant resource, and will include measures necessary to protect those resources. There are different types of agreements depending on the type of project and duration of the agreement (e.g., standard; long-term; gravel, sand, or rock extraction; routine maintenance). A master agreement covers multiple projects where specific detailed plans have not been prepared at the time of the original notification, and describes a procedure the entity must follow for construction, maintenance, or other covered projects.

The required content of a notification (i.e., application) includes the location (including site maps and aerial photos); a detailed description of the project (including timing and duration; construction equipment, plans, and specifications; volume and area of alterations such as material fill or removal; and permanent and temporary impacts on the waterway and associated habitats and vegetation); measures to protect fish, wildlife, and plant resources (including erosion control, avoidance and minimization measures, and compensatory measures); and a copy of the project's CEQA document and any other relevant biological resource documents or permits. CDFW may also require additional information and suggest ways to modify the project that would eliminate or reduce harmful effects on fish, wildlife, and plant resources.

Statutory requirements limit the duration of standard agreement development. Once a notification and the applicable fees have been received, CDFW has 30 calendar days to determine whether it is complete and to notify the applicant either that the application is complete or that additional information is required. Upon receipt of a complete application, CDFW provides the applicant with a draft agreement within 60 calendar days (California Fish and Game Code Section 1603[a]). The applicant then has 30 calendar days to accept, reject, or negotiate revisions to the draft agreement. If CDFW determines an activity may substantially adversely affect an existing fish or wildlife resource, an agreement will include reasonable measures to protect these resources. Reasonable measures can include best management practices and avoidance, minimization, and compensatory mitigation measures.

D.3.2.2 Protection of Bird Nests, Eggs, and Birds of Prey

Under Sections 3503 and 3503.5 of the California Fish and Game Code, it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, or to do so to any birds in the orders Falconiformes or Strigiformes (birds of prey). CDFW frequently includes conditions in lake and streambed alteration agreements, or suggests specific language for a CEQA document, to protect bird nests, eggs, and birds of prey. This language usually includes avoidance and minimization measures, including specified timing for tree and shrub removal and maintenance of no-disturbance buffers, to protect all nesting birds.

D.3.2.3 Fully Protected Species

The California Fish and Game Code designates 37 fully protected species and prohibits the take or possession at any time of such species, with certain limited exceptions. State law defines "take" as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill" (California Fish and Game Code Section 86). This definition of take does not include habitat modification, harm, or harassment.

Fully protected species are described in California Fish and Game Code Sections 3511 (birds), 4700 (mammals), 5050 (reptiles and amphibians), and 5515 (fish). These code sections state that "…no provision of this code or any other law shall be construed to authorize the issuance of permits or licenses to take any fully protected [bird], [mammal], [reptile or amphibian], [fish]." Fully protected species in the Central Valley include the blunt-nosed leopard lizard, golden eagle, white-tailed kite, American peregrine falcon, bald eagle, California black rail, greater sandhill crane, and ring-tailed cat.

D.3.2.4 California Endangered Species Act

CESA states that "all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved." CDFW works with all interested persons, agencies, and organizations to protect and preserve such sensitive resources and their habitats, and prohibits activities that will result in the take of State-listed and candidate species without prior authorization. Section 86 of the California Fish and Game Code defines "take" as "hunt, pursue, catch, capture, or kill or attempt to hunt, pursue, catch, capture, or kill." CDFW may authorize the take of any such species if certain conditions are met.

CDFW may authorize the take of State-listed and candidate species by issuing an MOU, SHA, voluntary local program, incidental take permit, consistency determination, or natural community conservation plan (NCCP). These mechanisms for authorizing incidental take are described in the following sections.

D.3.2.5 Native Plant Protection Act

In addition to CESA, plants designated as endangered are also protected under the Native Plant Protection Act (NPPA). The NPPA protects plants designated as endangered or rare. There are currently 64 species, subspecies, and varieties of plants that are protected as rare under the NPPA. The NPPA prohibits the take, possession, propagation, transportation, exportation, importation, or sale of endangered or rare native plants. However, it includes some exceptions for agricultural and nursery operations, emergencies, and in certain other situations. CDFW may authorize the take of any such species by permit pursuant to the conditions set forth in Fish and Game Code Section 2081, subdivisions (b) and (c) for endangered plants or California Code of Regulations, Title 14, Section 786.9, subdivision (b) for rare plants.

D.3.2.6 California Fish and Game Code Section 2081(a): Memorandums of Understanding

California Fish and Game Code Section 2081(a) includes MOUs. An MOU authorizes individuals, public agencies, universities, zoological gardens, and scientific or educational institutions to import, export, take, or possess endangered, threatened, or candidate species for scientific, educational, or management purposes.

D.3.2.7 California Fish and Game Code Sections 2089.2 to 2089.26 Safe Harbor Agreements

SHAs authorize the incidental take of a species listed as endangered, threatened, candidate, or a rare plant, if the agreement is reasonably expected to provide a net conservation benefit to the species, among other provisions. SHAs are intended to encourage landowners to voluntarily manage their lands to benefit CESA-listed species. California SHAs are analogous to the federal SHA program, and CDFW has the authority to issue a consistency determination based on a federal SHA. The State program has the same limitations for use by DWR as described for the federal program ("Safe Harbor and Conservation Agreements" provides more details). Only a private landowner, not an easement holder, can initiate participation in the SHA program.

D.3.2.8 California Fish and Game Code Section 2081(b): Incidental Take Permit

A California Fish and Game Code Section 2081(b) incidental take permit may authorize the take of endangered, threatened, or candidate species if all of the following conditions are met:

> *"(1) the take is incidental to an otherwise lawful activity;*
>
> *(2) the impacts of the authorized take shall be minimized and fully mitigated. The measures required to meet this obligation shall be roughly proportional in extent to the impact of the authorized taking on the species, maintain the applicant's objectives to the greatest extent possible, and be capable of successful implementation;*
>
> *(3) the applicant shall ensure adequate funding to implement the minimization and mitigation measures and to monitor compliance with and effectiveness of those measures; and*
>
> *(4) [the] issuance of the permit will not jeopardize the continued existence of the species."*

CDFW may determine that permanent protection and perpetual management of compensatory habitat is necessary and required, pursuant to CESA, to fully mitigate project-related impacts of the taking on the covered species. Determinations are based on factors such as the importance of that habitat in the project area, the extent to which covered activities will impact the habitat, and CDFW's estimate of the acreage required to provide to adequately mitigate the impacts of the taking. Compensatory habitat requirements may be met by purchasing species credits from a CDFW-approved conservation bank or through purchase, transfer, and/or permanent protection of habitat lands (including funding for monitoring and management in perpetuity).

If mitigation will not be completed before the start of activities that will affect CESA-listed species, a trust account or other form of security acceptable to CDFW must be established to ensure funding is available to carry out mitigation measures and monitoring requirements in case the applicant fails to complete these activities. CDFW generally requires the performance security to be in the form of an irrevocable letter of credit, surety bond, bank trust (or escrow) account, or another form of security approved in writing in advance by CDFW's Office of General Counsel.

Once an application and the applicable fees have been received, CDFW has 30 calendar days to determine whether it is complete and notify the applicant either that the application is complete or that additional information is required. If CDFW takes no action within 30 days of receipt, the application is deemed complete. CDFW may require supplementary information during the application review process after the application is determined to be complete, or is deemed complete. Upon receipt of a complete application, CDFW issues the permit either 90 calendar days from the lead agency's approval of the activity or 90 calendar days from the time the application was deemed complete, whichever is later (14 CCR Section 783.5[c][1]). CDFW may extend application processing an additional 60 calendar days from the later of the two dates as necessary, for 150 days total from the date of a complete application. Pursuant to

State Bill (SB) 473 (Hertzberg, Ch. 329, Stats. 2018; Fish and Game Code Section 2081[e]), commencing January 1, 2019, CDFW is required to post each new incidental take permit issued on CDFW’s website on the CESA Incidental Take Permitting Documents page.

D.3.2.9 California Fish and Game Code Section 2080.1: Consistency Determination

If a species is listed by both the federal ESA and CESA, Fish and Game Code Section 2080.1 allows an applicant who has obtained a federal incidental take statement (federal Section 7 consultation) or a federal incidental take permit (federal Section 10(a)(1)(B)) to request that the Director of CDFW find the federal documents consistent with CESA. If the federal documents are found to be consistent with CESA, a consistency determination is issued and no further authorization or approval is necessary under CESA.

D.3.2.10 Natural Community Conservation Plan

CDFW administrates the NCCP program pursuant to Sections 2800 to 2835 of the California Fish and Game Code (i.e., the Natural Community Conservation Planning Act of 2003), with the primary objective of conserving natural communities at the ecosystem level while accommodating compatible land use. CDFW may issue an incidental take permit authorizing the take of species covered in an NCCP, pursuant to California Fish and Game Code Section 2835. The NCCP development and permit processing phases do not have statutory timeframes, but the time required to complete NCCPs in the Sacramento region has been longer than five years. NCCPs are developed in coordination with HCPs that authorize the same covered activities.

D.3.2.11 Fish and Game Code Section 2086: Voluntary Local Program

This program is designed to encourage farmers and ranchers that are engaged in agricultural activities to voluntarily enhance and maintain habitat for State-listed endangered, threatened, and candidate species. The regulations for implementing Voluntary Local Programs can be found in the California Code of Regulations Title 14 Section 786. The program was authorized by Senate Bill 231 (Costa 1997), which required CDFW, in cooperation with the California Department of Food and Agriculture, to adopt regulations to create locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that will encourage habitat conservation and minimize the take of threatened, endangered, and candidate species, and wildlife in general. Farmers and ranchers who follow the wildlife-friendly agricultural practices prescribed by a voluntary local program receive an exemption from CESA’s prohibition against the take of certain State-listed endangered or threatened species. They may also withdraw from the program without penalty.

D.3.3 State Water Resources Control Board and Regional Water Quality Control Boards

D.3.3.1 Water Rights

A water right is a legal entitlement authorizing water to be diverted from a specified source and put to beneficial, nonwasteful use. Under Sections 1200 and 1201 of the California Water Code, the diversion of surface water for a beneficial use is an appropriation of water and requires a water right permit. In California, water right permits or licenses are administered by the State

Water Resources Control Board (State Water Board) Division of Water Rights. An application must be filed with the Division of Water Rights specifying the proposed project's course, place of use, purpose, and point(s) of diversion, as well as the quantity to be diverted. Additionally, applicants proposing changes to current water right permits or licenses must submit a change petition to the Division of Water Rights. Some diverters claim rights to divert independent of a permit, license, registration, or certification issued by the State Water Board, such as diversions under riparian or pre-1914 rights. These types of water rights can be confirmed only by the courts.

D.3.3.2 Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act governs water quality regulation in California. It is administered regionally, through the State Water Board and California's nine regional water quality control boards (regional water boards). The State Water Board is responsible for water rights and statewide water quality control plans and policies, whereas the regional water boards develop and enforce water quality control plans, called "Basin Plans," within their boundaries. The Systemwide Planning Area for the CVFPP falls within the Central Valley Regional Water Board's authority. The regional water boards have the authority to enforce the Basin Plan objectives by issuing and enforcing permits containing WDRs, which decide when the discharge is to take place, for how long, and how much waste is released into the water. WDRs under the Porter-Cologne Water Quality Control Act are issued for discharges of dredged or fill material to waters of the State.

D.3.3.3 Clean Water Act Section 401 and Section 402

The State Water Board and the regional water boards issue CWA Section 401 water quality certifications to applicants for a federal license or permit for activities that may result in a discharge into waters of the United States, including but not limited to the discharge or dredged or fill material, to ensure that State water quality standards are met. Applications for a water quality certification must be submitted to the State Water Board for projects that meet any of the following criteria:

- Fall under the jurisdiction of more than one regional water board.
- Involve or are associated with an appropriation of water (California Water Code Part 2, Division 2, Section 1200 et seq.).
- Involve or are associated with a hydroelectric facility, and the proposed activity requires a Federal Energy Regulatory Commission (FERC) license or amendment to a FERC license.
- Involve or are associated with any other diversion of water for domestic, irrigation, power, municipal, industrial, or other beneficial use.

Applications for all other water quality certifications are submitted to the regional water boards.

In April 2019, the State Water Board adopted the State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State (formally known as the Wetland Riparian Area Protection Policy). These procedures went into effect in May 2020. The procedures consist of four major elements, including a wetland definition; a framework to determine whether a feature that meets the wetland definition is a water of the State; wetland delineation procedures; and procedures for the submittal, review, and approval of applications for water quality certifications and WDRs for dredge or fill activities.

In addition, the regional water boards have been delegated permitting authority for the NPDES permit program (i.e., CWA Section 402), which regulates point-source discharges to waters of the United States and State. "Point sources" are discrete conveyances, such as pipes or human-made ditches. Examples of pollutants include rock, sand, dirt, and agricultural, industrial, and municipal waste discharged into waters of the United States. Discharges regulated by the NPDES program include drinking water systems; stormwater discharges; sanitary sewer systems; pesticide applications; vessel discharges; and others. In California, NPDES permits are also referred to as WDRs that regulate discharges into waters of the United States.

The State Water Board also designates beneficial uses for water bodies and establishes water quality standards to protect those uses. Water quality monitoring data for California's surface waters is assessed every two years to determine whether pollutant levels violate protective water quality standards. If a pollutant exceeds the standard threshold, the waterbody and pollutant are placed on the 303(d) list. When a waterbody and pollutant are placed on the 303(d) list, a total maximum daily load is developed to address the impairment. Projects that may affect the total maximum daily load may have to comply with a regulatory program for that waterbody and pollutants. The Systemwide Planning Area includes water bodies on the 303(d) list.

D.3.4 State Office of Historic Preservation

D.3.4.1 National Historic Preservation Act

Historic properties are considered through the National Historic Preservation Act of 1966 (NHPA), as amended through 2016, and its implementing regulations. The NHPA establishes the federal government's policy on historic preservation and the programs, including the National Register of Historic Places (National Register), through which that policy is implemented. Under the NHPA, historic properties include "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register" (54 USC 300308). Types of cultural resources that may qualify as historic properties include artifacts, records, and material remains relating to the district, site, building, structure, or object.

Under Section 106 of the NHPA (Section 106), before implementing an undertaking (e.g., issuing a federal permit), federal agencies must consider the effects of the undertaking on historic properties, in consultation with the SHPO, Native American Tribes, and other interested parties (e.g., historical societies or groups with potential ties to historic properties that could be affected by an undertaking). Section 106 applies when two thresholds are met: there is a federal or federally licensed action, including grants, licenses, and permits; and the action has the potential to affect properties listed on or eligible for listing on the National Register.

In addition, the agencies must also afford the Advisory Council on Historic Preservation and the SHPO a reasonable opportunity to comment on any undertaking that would adversely affect properties eligible for listing in the National Register. Section 101(d)(6)(A) of the NHPA allows properties of traditional religious and cultural importance to a Native American Tribe or Native Hawaiian organization to be determined eligible for inclusion in the National Register.

D.3.5 Central Valley Flood Protection Board

D.3.5.1 Encroachment Permit Program

The Central Valley Flood Protection Board (CVFPB) is the regulatory agency responsible for ensuring the State and federal levees and the facilities of the State Plan of Flood Control are operated and maintained in a manner that reduces the risk of catastrophic flooding. The CVFPB is required to enforce, on behalf of the State, the erection, maintenance, and protection of levees, embankments, and channel rectification. In accordance with California Water Code Section 8608, the CVFPB is charged with establishing and enforcing standards for the operations and maintenance of levees, channels, and other flood control works of an authorized project or an adopted plan, including standards for encroachment, construction, vegetation, and erosion control.

An encroachment permit is required for any work to be done in or near a regulated stream, designated floodway, or on any federal flood control project levee to include the area 10 feet landward of the landside levee toe. As part of the permitting process, letters are sent to adjacent landowners to ensure there are no flood control concerns related to the proposed project. In addition, the permit application is sent to the USACE Levees and Channels Branch (Section 408) for their review and comment. Encroachment permits are subject to conditions the CVFPB deems reasonable and appropriate, and conditions requested by USACE or the local maintaining agency. The issuance of an encroachment permit requires review for compliance with CEQA, and no proposed project or work will be approved and issued an encroachment permit until the requirements of CEQA have been met.

D.3.6 California State Lands Commission

The California State Lands Commission (SLC) has jurisdiction and management control over certain public lands the State received from the United States. When California became a state in 1850, it acquired approximately 4 million acres of land underlying its navigable and tidal waterways. Known as sovereign or Public Trust lands, these lands include the beds of California’s navigable natural rivers, lakes, streams, bays, estuaries, inlets, and straits, as well as the State’s tidal and submerged lands along California’s more than 1,100 miles of coastline and offshore islands, from the mean high-tide line to three nautical miles offshore. A lease from the SLC is required if an action plans to use or construct any type of structure on lands under the SLC’s jurisdiction, or develop any resources or minerals located on, or otherwise occupying any lands under the SLC’s jurisdiction.

The issuance of any SLC lease, permit, or other entitlement for use of State lands, is reviewed for compliance with CEQA. Additionally, if the application involves lands found to contain “significant environmental values” within the meaning of Public Resources Code Section 6370 et seq., the consistency of the proposed use with the identified values must also be determined through the CEQA review process. Pursuant to its regulations, the SLC may not issue a lease for use of “significant lands” if such proposed use is detrimental to the identified values. In 2018, the SLC adopted a comprehensive environmental justice policy intended to improve public access to open space and recreation for disadvantaged or marginalized communities, achieve more equity in the distribution of environmental benefits and burdens, and increase inclusive decision-making.

D.3.7 Delta Stewardship Council

The Delta Stewardship Council is a State agency established by the Sacramento–San Joaquin Delta Reform Act of 2009 to create a comprehensive, long-term management plan for the Sacramento–San Joaquin Delta (Delta Plan), which was formally adopted by the Delta Stewardship Council in 2013. The Delta Plan has two co-equal goals: providing a more reliable water supply for California; and protecting, restoring, and enhancing the Sacramento–San Joaquin Delta ecosystem. The Delta Plan includes policies, recommendations, and performance measures that are enforceable through regulatory authority in the Delta Reform Act of 2009, which requires State and local agencies to be consistent with the Delta Plan. State and local agencies proposing to undertake a project covered by the Delta Plan must prepare and file a consistency determination with the Delta Stewardship Council demonstrating the project is consistent with requirements in the Delta Plan. Any person may challenge a consistency determination by bringing an appeal to the Delta Stewardship Council no later than 30 calendar days after the submission of the certification of consistency. If there are no appeals, the State or local public agency may proceed to implement the covered action.

D.3.8 Other State Authorization

In addition to obtaining State permits under the programs listed here, future projects may need to comply with other permitting requirements, including the following:

- Surface Mining and Reclamation Act.
- California Wild and Scenic Rivers Act.
- California air pollution control laws.

Flood management projects undertaken by federal entities generally are not subject to State authorizations.

D.4 Local Authorizations

Flood management activities may also require local authorizations, including the following:

- Grading permits.
- Tree removal permits.
- Burning permits.

However, flood management projects undertaken by federal or State entities generally are not subject to local authorizations.

Appendix E
Mitigation Availability

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APPENDIX E

Mitigation Availability

Acronym	Definition
CDFW	California Department of Fish and Wildlife
CVFPP	Central Valley Flood Protection Plan
DWR	California Department of Water Resources
ESU	environmentally significant unit
NMFS	National Marine Fisheries Service
PSP	proposal solicitation package
RIBITS	Regulatory In-Lieu Fee and Bank Tracking System
SJV	San Joaquin Valley
SPFC	State Plan of Flood Control
SRA	shaded riverine aquatic
SV	Sacramento Valley
TRLIA	Three Rivers Levee Improvement Authority
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VELB	valley elderberry longhorn beetle

This appendix describes the status of advance mitigation projects funded by the California Department of Water Resources (DWR) to support implementation of the Central Valley Flood Protection Plan (CVFPP) and the Conservation Strategy. It also describes the availability of compensatory mitigation at mitigation and conservation banks for the Conservation Strategy's target habitats and species.

As described in the 2016 Conservation Strategy (California Department of Water Resources 2016), when compensatory mitigation is not available, project approvals and construction can be delayed by the lengthy procedures involved in mitigation development. Such procedures can entail legal, financial, planning, and restoration implementation actions. In addition to project delays and inflated costs, habitat can be lost between the time when projects are constructed and the time when habitat is re-established. The resulting mitigation may have less long-term viability and may be more poorly integrated with regional conservation priorities than mitigation developed in advance for multiple projects.

In light of these issues related to mitigation availability, DWR funded several projects from 2012 to 2020 to mitigate the future effects of State Plan of Flood Control (SPFC) improvements, many of which have not yet been identified. DWR prepared funding guidelines for such advance mitigation projects and issued a Proposal Solicitation Package in 2012. This package solicited proposals to mitigate unavoidable impacts from the future evaluation, repair, reconstruction, or replacement of SPFC levees, weirs, bypasses, and other facilities. Four advance mitigation projects were funded. Each project was carefully selected in collaboration with the regulatory agencies to meet the expected mitigation needs for future improvements to SPFC facilities. DWR also made direct expenditures to secure mitigation credits in advance of project mitigation needs and impacts.

As Table E-1 describes, four projects were funded; mitigation credits are available from two of these four projects and are anticipated to soon be available from a third. It is uncertain when the fourth project will provide mitigation credits.

Table E-1. Advance Mitigation Projects and Mitigation/Conservation Banks Funded 2012–2020

Project Title and Applicant	Proposal Process (Total Project Cost)	Project Description and Status as of November 1, 2020
Grasslands Mitigation Bank *Westervelt Ecological Services*	Direct expenditure $4,164,000, of which $3,164,000 is from Proposition 1E [a] *($9,050,372)*	This 281-acre mitigation bank in the San Joaquin Valley is to provide 130 giant gartersnake (*Thamnophis gigas*) credits (from USFWS and CDFW), which will be used to offset impacts on giant gartersnakes from SPFC and Delta Levees Program activities. **This project is complete.** DWR has received the giant gartersnake credits, which are available for use by projects in the bank's service area.

Project Title and Applicant	Proposal Process (Total Project Cost)	Project Description and Status as of November 1, 2020
Hidden Valley Ranch Acquisition *Reclamation District 2092*	Direct expenditure $3,900,000 from Proposition 1E and direct expenditure amendment of existing agreement $2,400,000 $3,000,000 from Wildlife Conservation Board, Proposition 1E *($9,300,000)*	The acquisition of this 497-acre property in the lower San Joaquin River Conservation Planning Area adds to the flood benefits at the adjacent Dos Rios Ranch and the San Joaquin River National Wildlife Refuge. Approximately 191 acres of this property could be used for advance mitigation. Cumulatively, these properties will provide river-floodplain connectivity to more than 1,000 acres, absorb approximately 10,000 acre-feet of floodwaters, and increase flood protection for downstream communities. Phase 2 will focus on achieving mitigation. **The project is in progress.** The land acquisition is complete. It has not yet been determined how ecological enhancements at the site will be developed into mitigation credits.
Bullock Bend Mitigation Bank *Westervelt Ecological Services* [b]	State contracting process: secondary request for proposals to the original PSP $4,656,867.50 *(Unknown)*	This 119.65-acre mitigation bank along the Sacramento River created 116.15 acres of salmonid (for four evolutionarily significant units and steelhead [*Oncorhynchus mykiss*]) (NMFS and CDFW credits), floodplain (USACE, NMFS, and CDFW credits), riparian (USCACE, NMFS, and CDFW), and Swainson's hawk (*Buteo swainsoni*) foraging and nesting credits (CDFW), 57.5 credits of which are reserved for DWR to offset impacts from SPFC activities along the Sacramento River. **This project is complete.** The bank has met performance standards. DWR has received all 57.5 salmonid credits and several credits have been used by projects in the bank's service area.

Project Title and Applicant	Proposal Process (Total Project Cost)	Project Description and Status as of November 1, 2020
Feather River Conservation Bank *Three Rivers Levee Improvement Authority*	PSP (grant) of $4,440,000 and a direct expenditure from State of California General Fund *($6,482,501)*	Funding is to enhance 500 acres of a 1,600--acre levee setback area by creating riparian habitats. This project is expected to generate advance mitigation credits from CDFW (for riparian habitat and possibly for western yellow--billed cuckoo [*Coccyzus americanus*]) and USFWS (for valley elderberry longhorn beetle [*Desmocerus californicus dimorphus*] and possibly for western yellow-billed cuckoo). **Planting for this project is complete.** The 500 acres have been planted in mixed riparian forest and scrub. Discussions are ongoing with CDFW and USFWS to finalize bank documents that will provide assurances of mitigation credits at the site from CDFW and USFWS.

Source: California Department of Water Resources 2016

[a] $1 million of the $4,164,000 was provided by the Delta Levees Program

[b] Project originally approved under the PSP, but it was withdrawn and then resubmitted as a direct expenditure.

Notes:

CDFW = California Department of Fish and Wildlife
DWR = California Department of Water Resources
ESU = Evolutionarily Significant Unit
NMFS = National Marine Fisheries Service
PSP = proposal solicitation package
SPFC = State Plan of Flood Control
TRLIA = Three Rivers Levee Improvement Authority
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service

These projects represent a considerable contribution to the supply of mitigation for flood projects and operations and maintenance. Furthermore, by funding the mitigation projects in Table E-1, DWR has secured a supply of mitigation credits that is allocated and tracked by DWR staff, providing DWR project managers with certainty regarding the availability and cost of these types of mitigation.

Table E-2 provides the mitigation credits available from conservation and mitigation banks as of August 2022 for the habitats (riparian, shaded riverine aquatic, marsh, and other wetland habitats) and the federally listed or State-listed target species of this Conservation Strategy. Several different types of credits could apply to each target habitat and species; these credit types are listed in Table E-2 along with the banks that provide them. Table E-3 summarizes the available amount of compensatory mitigation by Strategy habitats and target species. These tables are based on the credits listed as available in the Regulatory In-Lieu Fee and Bank Tracking System (RIBITS) (U.S. Army Corps of Engineers 2022). Available credits change as projects purchase credits and as new banks are approved and credits released, but the credits available on August 2, 2022, summarized in Tables E-2 and E-3, indicate the general level of credit availability.

Table E-2. Available Compensatory Mitigation for Conservation Strategy Habitats and Target Species Available at Mitigation and Conservation Banks

Category	Credit Type	Credits [a]	Location
Species	Giant gartersnake	178	Colusa Basin Mitigation Bank (SV), Gilsizer Slough South Giant Gartersnake Conservation Bank (SV), Grasslands Mitigation Bank (SJV), Ridge Cut Giant Garter Snake Conservation Bank (SV), Sutter Basin Conservation Bank (SV)
	Salmonid	4	Bullock Bend Mitigation Bank (SV)
	Salmonid (preservation)	55	Liberty Island Conservation Bank (SV)
	Salmonid (restoration)	2	Liberty Island Conservation Bank (SV)
	Swainson's hawk	734	Meridian Ranch Mitigation Bank (SV) [c], Van Vleck Ranch Mitigation Bank (SV) [c]
	Swainson's hawk nesting tree use (enhanced)	1	Bullock Bend Mitigation Bank (SV)
	Tricolored blackbird (*Agelaius tricolor*)	1	Antonio Mountain Ranch Mitigation Bank (SV) [c], SMUD Nature Preserve Mitigation Bank (SV) [c]

Category	Credit Type	Credits [a]	Location
Species	Valley elderberry longhorn beetle	324	French Camp Conservation Bank (SJV), River Ranch VELB Conservation Bank (SV), Stillwater Plains Mitigation Bank (SV) [c] One credit is approximately 1,800 square feet
Habitats	Seasonal wetland [b]	10	Colusa Basin Mitigation Bank (SV), Grasslands Mitigation Bank (SJV), Stillwater Plains Mitigation Bank (SV) [c] Does not include vernal pools or seasonal wetlands of vernal pool landscapes
	Seasonal wetland (Preservation)	Less than 1	SMUD Nature Preserve Mitigation Bank (SV) [c]
	Emergent marsh (federal)	6	Stillwater Plains Mitigation Bank (SV) [c]
	Emergent marsh creation	6	Stillwater Plains Mitigation Bank (SV) [c]
	Floodplain mosaic wetland (re-establishment)	1	Cosumnes Floodplain Mitigation Bank (SV)
	Freshwater emergent marsh (preservation)	8	Elsie Gridley Mitigation Bank
	Freshwater emergent marsh	1	Seigler Valley Wetland Mitigation Bank (SV) [c]
	Freshwater marsh complex (creation)	5	River Ranch Wetland Mitigation Bank (SV)
	Open water (preservation)	4	SMUD Nature Preserve Mitigation Bank (SV) [c]
	Riparian (preservation)	5	Noonan Ranch Conservation Bank (SV), SMUD Nature Preserve Mitigation Bank (SV) [c]
	Riparian (creation)	Less than 1	Beach Lake Mitigation Bank (SV), River Ranch Wetland Mitigation Bank (SV)
	Riparian 404 (establishment)	2	Markham Ravine – Western Placer County ILF Site, Seigler Valley Wetland Mitigation (SV) [c]
	Riparian floodplain forest	15	Fremont Landing Conservation Bank (SV)
	SRA preservation	10	Cosumnes Floodplain Mitigation Bank (SV) Credit units are linear feet

Category	Credit Type	Credits [a]	Location
Groups	Swainson's hawk and western burrowing owl (*Athene cunicularia hypugaea*)	133	Alkali Sink Conservation Bank (SJV), Bryte Ranch Conservation Bank (SV), Dolan Ranch Conservation Bank (SV), Elsie Gridley Mitigation Bank (SV)
	Delta smelt (*Hypomesus transpacificus*) and longfin smelt (*Spirinchus thaleichthys*)	7	Liberty Island Conservation Bank (SV)
	Salmonid, floodplain riparian, and Swainson's hawk nest buffer (enhanced)	11	Bullock Bend Mitigation Bank (SV)
	Salmonid, floodplain riparian, and Swainson's hawk nest buffer (re-established)	8	Bullock Bend Mitigation Bank (SV)
	Salmonid and riverine riparian (enhanced)	1	Bullock Bend Mitigation Bank (SV)
	Salmonid and riverine riparian (re-established)	20	Bullock Bend Mitigation Bank (SV)
	Salmonid, riverine riparian, and Swainson's hawk nest buffer (re-established)	38	Bullock Bend Mitigation Bank (SV)
	Swainson's hawk foraging and tricolored blackbird foraging	13	Antonio Mountain Ranch Mitigation Bank (SV) [c]
	Riparian floodplain forest and off-channel SRA habitat	8	Fremont Landing Conservation Bank (SV)
	Riparian floodplain forest and riverbank SRA habitat	Less than 1	Fremont Landing Conservation Bank (SV)
	Tule marsh SRA and salmonid-smelt restoration	Less than 1	Liberty Island Conservation Bank (SV)

Source: U.S. Army Corps of Engineers 2022.

[a] Credit units are acres unless otherwise noted.
[b] Does not include seasonal wetlands of banks in vernal pool landscapes.
[c] Located outside of the Systemwide Planning Area.

Notes:
SJV = San Joaquin Valley
SRA = shaded riverine aquatic
SV = Sacramento Valley

Table E-3. Summary of Available Compensatory Mitigation Credits by Conservation Strategy Habitats and Target Species

Category	Amount or Target Species [a]	Credits [b]
Riparian Habitat	Acres	88
SRA Habitat	SRA—acres	2
	SRA—miles	Less than 1
Marsh and Other Wetlands Habitat	Marsh—acres	27
	Seasonal wetlands—acres	11
	Floodplain wetland mosaic—acres	1
Species—Acres	Delta button-celery (*Eryngium racemosum*)	0
	Valley elderberry longhorn beetle	324 [c]
	Western monarch butterfly	0
	Green sturgeon (*Acipenser medirostris*)	0
	Salmonids	140
	Delta smelt	7
	Giant gartersnake	178
	Bank swallow (*Riparia riparia*)	0
	California black rail (*Laterallus jamaicensis coturniculus*)	0
	Greater sandhill crane (*Grus canadensis tabida*)	0
	Least Bell's vireo (*Vireo bellii pusillus*)	0
	Tricolored blackbird	14
	Swainson’s hawk—nest tree and nest buffer	58
	Swainson’s hawk—foraging	880
	Western yellow-billed cuckoo	0
	Riparian brush rabbit (*Sylvilagus bachmani*)	0
	Riparian woodrat (*Neotoma fuscipes riparia*)	0

Source: U.S. Army Corps of Engineers 2022.

[a] Only federally listed or State-listed target species are included in the table.
[b] Credit types grouped at the bank are included in totals for each species or habitat in the group.
[c] Unit is approximately 1,800 square feet.

Note:
SRA = shaded riverine aquatic

Despite the mitigation provided by DWR-funded mitigation projects, there is limited mitigation available to compensate for unavoidable impacts on this Conservation Strategy's target habitats and species. As Table E-3 shows, mitigation credits are not available for half of the target species; and as Table E-2 shows, most of the available mitigation is located in the Sacramento Valley, with much less mitigation available in the San Joaquin Valley. Although many established banks have the potential to develop and release additional credits, these are at the same locations and generally of the same types as currently available credits. Therefore, future credit releases will not provide additional types or geographic availability of mitigation. Furthermore, much of the available mitigation is located relatively far from the major rivers, bypasses, and floodplains of the Sacramento and San Joaquin rivers, and thus may not be acceptable as mitigation for the impacts of flood projects.

In summary, the advance mitigation projects funded by DWR have made a considerable contribution to the supply of mitigation available for mitigating unavoidable impacts of flood projects. However, the supply remains limited and multiple types of mitigation are not available in many areas. Consequently, given the current state of mitigation availability, mitigation planning and development will likely continue to complicate project implementation, increase project costs, and lengthen project schedules. These impediments to implementing the CVFPP could be reduced by funding additional advance mitigation projects, and tracking of anticipated demand for mitigation and its supply could focus this funding on the most needed types of mitigation.

E.1 References

California Department of Water Resources. 2016. *Central Valley Flood Protection Plan Conservation Strategy*. Sacramento (CA).

U.S. Army Corps of Engineers. 2022. RIBITS: Regulatory In-Lieu Fee and Bank Tracking System. Viewed online: https://ribits.ops.usace.army.mil/. Accessed: August 2, 2022.

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Appendix F
Five-Year Implementation Summary Memorandum

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APPENDIX F

Five-year Implementation Summary Memorandum

Acronym	Definition
Conservation Strategy (or Strategy)	Central Valley Flood Protection Plan Conservation Strategy
CPA	Conservation Planning Area
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
DWR	California Department of Water Resources
NGO	nongovernmental organization
O&M	operations and maintenance
SPA	Systemwide Planning Area
SPFC	State Plan of Flood Control
State	State of California
Strategy (Conservation Strategy)	Central Valley Flood Protection Plan Conservation Strategy
TRLIA	Three Rivers Levee Improvement Authority
USACE	U.S. Army Corps of Engineers

This memorandum summarizes contributions to the measurable objectives of the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy or Strategy; California Department of Water Resources 2016) and progress toward the Strategy's goals resulting from projects implemented in the Systemwide Planning Area (SPA) between 2016, when the CVFPP Conservation Strategy was finalized, and 2021. Documenting progress toward the goals is a key part of each five-year update and will help the California Department of Water Resources (DWR) and its partners to adaptively manage implementation. This memorandum also describes actions taken between 2016 and 2021 to support the adaptive management of the Strategy's implementation. Chapter 2 of the Conservation Strategy 2022 Update also presents key information from this memorandum.

F.1 Context of the Goals and Measurable Objectives

The 2016 Conservation Strategy created the following four goals to attain the Central Valley Flood Protection Act's objectives to promote ecosystem functions by integrating recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species into flood management activities:

1. **Ecosystem Processes**. Improve dynamic hydrologic (flow) and geomorphic processes in the State Plan of Flood Control (SPFC) plan area or SPA.

2. **Habitats**. Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats.

3. **Species**. Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.

4. **Stressors**. Reduce stressors related to development and operations of the SPFC that negatively affect at-risk species.

To achieve these goals, measurable objectives were developed to target processes, habitats, and species in need of recovery, and the stressors to these processes, habitats, and species that could be addressed by flood risk management. The targets of the Conservation Strategy's measurable objectives (or the amount of restoration needed) were determined by reviewing restoration needs and opportunities across the flood system. (For further explanation of how the objectives were determined, refer to Appendix L of the 2016 Conservation Strategy.) Progress toward the measurable objectives will inform CVFPP implementation and future State of California (State) funding guidelines and grant programs.

F.2 Conservation Strategy Measurable Objectives Outcomes 2016 to 2021

The projects identified here generated outcomes that correspond to the metrics of one or more measurable objectives, and meet the following criteria:

- The project was designed after 2012 and completed between 2016 and 2021. Although planning, permitting, and funding of many projects progressed during the 2016 to 2021 period, only projects, or phases of projects, completed in this period are reported here. In addition, projects that were planned and designed before 2012 were generally considered part of baseline conditions while the measurable objectives were developed, and therefore do not represent ecosystem improvements resulting from the CVFPP's implementation.

- The project implements the CVFPP via a multi-benefit project (defined later in this section) or through a habitat enhancement project with a positive result for one or more measurable objectives as identified in the Conservation Strategy (typically through other DWR integrated watershed management programs, such as the Riverine Stewardship Program).
- The project is within the geographic scope of the CVFPP (i.e., the SPA), and within SPFC facilities or on lands protected by the SPFC.
- If an identified fish passage barrier from Appendix K of the 2016 Conservation Strategy has been removed or remediated as part of the CVFPP or any other program or project (e.g., Fremont Weir Adult Fish Passage Modification Project), it is considered resolved and thus counts toward meeting the measurable objective for this stressor, regardless of the effect on flood risk (i.e., not necessarily a multi-benefit project).

The CVFPP defines multi-benefit projects as follows (California Department of Water Resources 2017): “projects designed to reduce flood risk and enhance fish and wildlife habitat; multi--benefit projects may also create additional public benefits such as sustaining agricultural production, improving water quality and water supply reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and educational opportunities, or any combination thereof.”

The outcomes reported here are planned project outcomes as reported in environmental planning documents, permits, and spatial data provided by project managers. These outcomes will be monitored and verified so the achieved outcomes are documented accurately. The Flood Performance Tracking System will be updated once data become available for verified outcomes. When project outcomes are used to mitigate habitat loss caused by other projects, contributions to the measurable objectives will be reduced to account for the portion used as mitigation.

F.2.1 Completed Projects

The four projects summarized here were completed between 2016 and 2021, and contributed to the measurable objectives by reconnecting floodplains, restoring riparian habitats, and providing other ecosystem benefits. Components of these projects were funded through DWR’s flood management programs and meet the CVFPP criteria for a multi-benefit or habitat enhancement project:

- **The Oroville Wildlife Area Flood Stage Reduction Project (Feather River Conservation Planning Area [CPA])** reduced flood risk, increased the area of inundated floodplain, and restored riparian habitat by augmenting the existing system of inflow and outflow weirs to safely divert additional floodwaters through the Oroville Wildlife Area and by improving drainage to reduce fish stranding. The project area is approximately 1,500 acres located on the west side of State Route 70 across the Feather River from the Thermalito Afterbay outlet.

- **The Three Rivers Levee Improvement Authority (TRLIA) Feather River Conservation Bank (Feather River CPA)** restored 500 acres of a previously created levee setback area to a mosaic of mixed riparian forest and riparian scrub. This project is anticipated to be used as a bank; therefore, measurable objectives contributions will be reduced as credits are used.

- **The Southport Setback Levee Project (Lower Sacramento River CPA)** restored 120 acres of inundated floodplain and riparian habitat by constructing a setback levee along the west bank of the Sacramento River. A portion of this project may be used as mitigation in the future; however, currently it is providing temporary uplift. Therefore, contributions to measurable objectives may be reduced as credits are used.

- **The Dos Rios Ranch Floodplain Expansion and Ecosystem Restoration Project, Phase I (Lower San Joaquin River CPA)** reconnected approximately 1,000 acres of inundated floodplain by constructing notches in agricultural berms resulting in restored riparian habitat on most of the reconnected floodplain.

Multi-benefit projects being developed within the legal Sacramento–San Joaquin Delta (Delta) independent of the CVFPP before 2016 (e.g., the McCormack-Williamson Restoration Project) were excluded from the measurable objectives, and thus, are not included in this summary of multi-benefit projects implemented between 2016 and 2021. Other projects were completed during this timeframe but do not contribute to the measurable objectives because they do not meet the required criteria. Except where components of EcoRestore projects are being used to meet specific mitigation requirements, any uplift created by EcoRestore projects will count toward meeting the Conservation Strategy's measurable objectives. In addition, one project did not meet the criteria as a multi-benefit project and was not implemented under the CVFPP, but it is included because it contributed to addressing a Conservation Strategy measurable objective:

- **The Fremont Weir Adult Fish Passage Modification Project (Lower Sacramento River CPA, non-CVFPP)** was implemented as a mitigation requirement for the Central Valley Project and State Water Project operations. This project remediated a stressor (that is, a fish passage barrier) as identified in Appendix K of the Conservation Strategy. This project improved fish passage by replacing the existing fish ladder at Fremont Weir with a step pool channel leading up to the weir and gated notch through the weir. Note that only the fish passage barrier component of the project is being counted toward that stressor's measurable objective.

F.2.2 Methodology

The data reported here were acquired by reviewing project documents, collecting spatial information, and interviewing project managers. All data will also be captured and reported in the Flood Performance Tracking System for long-term storage and use.

To determine how each project contributed to the measurable objectives, project plans and environmental reports were reviewed, then compared to the descriptions of the measurable objectives in the Conservation Strategy. Some project outcomes, like riparian habitat (acres) and natural bank (linear miles), were often not reported using the same metrics as the Conservation Strategy. In these cases, the consistency between project outcomes and the Conservation Strategy's measurable objectives was determined based on the project description and the objective descriptions and definitions in the Conservation Strategy.

To quantify each project's contribution to the measurable objectives, project spatial data for pre-project and post-project conditions, and baseline datasets for the objectives were used. The project's contributions to the measurable objectives were measured as the change between pre- and post-project conditions.

DWR is developing a set of methodology sheets for future use, which will clarify how project managers can translate their project outcomes to contributions to the measurable objectives. These methodology sheets, along with the data entered into the Flood Performance Tracking System, will allow for a clear understanding of progress toward the Conservation Strategy's measurable objectives (and, potentially, the goals and objectives of other plans and programs).

F.2.2.1 Case Study: Oroville Wildlife Area Flood Stage Reduction Project

To illustrate this translation of project outcomes to project contributions to the Conservation Strategy's measurable objectives, Table F-1 displays the outcomes for the Oroville Wildlife Area Flood Stage Reduction Project, showing how they were mapped to each of the 10 measurable objectives for the Feather River CPA. The habitat types listed in Table F-1 are the restored habitats as listed in the Initial Study/Mitigated Negative Declaration for the Oroville Wildlife Area Flood Stage Reduction Project (ICF International, Inc. 2016).

Table F-1. Example Conversion from Project Habitat Types and Actions to Measurable Objectives of the Conservation Strategy

Oroville Wildlife Area Flood Stage Reduction Project Habitat Types and Actions	Quantity	Related Measurable Objective	Contribution
Riparian woodland/riparian scrub	36.3 acres	Riparian habitat	36.3 acres
Gravel understory	48.5 acres	Not applicable—no corresponding objective	Not applicable
Riparian scrub/wetland	44.3 acres	Marsh/other wetland habitat	44.3 acres
Floodplain habitat	125.8 acres	Inundated floodplain	125.8 acres
Removal of water primrose	500 acres	Not applicable—no corresponding objective	Not applicable
Removal of other invasive plant species [a]	200 acres	Not applicable—no corresponding objective	Not applicable

Oroville Wildlife Area Flood Stage Reduction Project Habitat Types and Actions	Quantity	Related Measurable Objective	Contribution
Re-grading of interior channel system	7,500 linear feet	River meander potential	Not applicable—no corresponding objective

[a] The Conservation Strategy has measurable objectives for the removal of prioritized invasive plant species; however, in this example, the removal of invasive plant species did not contribute toward the measurable objective because it did not include a prioritized invasive plant species as identified in the 2016 Conservation Strategy.

F.2.3 Project Outcomes

Table F-2 captures the outcomes of each of the aforementioned projects, allocated to the Conservation Strategy's 10 measurable objectives. As Table F-2 shows, these completed projects all contributed to one or more of the measurable objectives. However, in all five of the CPAs, only minimal progress was made toward most measurable objectives.

Tables F-3 and F-4 show each CPA's progress toward the Conservation Strategy's measurable objectives, and Figures F-1 through F-3 show progress toward each CPA's measurable objectives. Significant additional work is needed in each CPA to meet their objectives. Several additional projects are in the planning or funding stages. These in-progress projects are discussed in Attachment F-1, and will make additional contributions to the measurable objectives in the next few years as they are implemented.

Table F-2. Contributions to the Conservation Strategy's Measurable Objectives by Project

Project Name	Conservation Planning Area	Status	Funding Amount	Funding Source(s)	Inundation–Major River Reaches (acres)	Inundation–Bypasses/ Transient Storage (acres)	Natural Bank (miles)	River Meander Potential (acres)	Natural Bank (miles)	Riparian-Lined Bank (miles)	Riparian Habitat (acres)	Marsh/ Wetland (acres)	Fish Passage Barriers (number)	Invasive Plants (acres)
Oroville Wildlife Area Flood Stage Reduction	Feather River	Complete	$47,938,698	Prop. 1, WCB	125.8	0	0	0	0	0	36.3	44.3	0	0
Three Rivers Levee Authority Feather River Conservation Bank [a]	Feather River	Plantings Complete	$6,482,501	Prop. 1E, State of California General Fund	0	0	3.4	0	3.4	0	402.1	0	0	0
Fremont Weir Adult Fish Passage Modification [b]	Lower Sacramento River	Complete	$6,782,325	SWP, Reclamation, NGOs	0	0	0	0	0	0	0	0	1	0
Southport Setback Levee [c]	Lower Sacramento River	Construction Complete	$183,500,000	Prop. 1E, WSAFCA	110.2	0	4.9	0	4.9	0	107.7	13.4	0	0
Dos Rios Floodplain Expansion and Ecosystem Restoration, Phase I	Lower San Joaquin River	Complete	$53,182,575	DWR, WCB, NRCS, Prop. 1, Prop. 13, others	0	0	0.2	0	0.2	0.2	739.1	0	0	0
Total SPA					236.0	0	8.5	0	8.5	0.2	1,285.2	57.7	1	0

[a] Because this is a bank, uplift is temporary until credits are used. Acreage does not include approximately 100 acres of elderberry mitigation plantings.
[b] This project does not qualify as a multi-benefit project and was not implemented as part of the CVFPP but because it reduced a stressor as identified in the 2016 Conservation Strategy, it is included.
[c] Because portions of this project may be used as advance mitigation, uplift is temporary until credits are used.

Notes:
NGO = nongovernmental organization
NRCS = U.S. Natural Resources Conservation Service
Prop. 1/1E/13 = State of California propositions
Reclamation = U.S. Bureau of Reclamation
SPA = Systemwide Planning Area
SWP = State Water Project
WCB = Wildlife Conservation Board
WSAFCA = West Sacramento Area Flood Control Agency

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Table F-3. Contributions to the Conservation Strategy's Measurable Objectives by Conservation Planning Area: Ecosystem Processes

Conservation Planning Area	Contributions to Floodplain Inundation–Major River Reaches	Contributions to Floodplain Inundation–Bypasses/ Transient Storage Areas	Contributions to Riverine–Natural Bank	Contributions to Riverine–River Meander Potential
Feather River [a]	125.8 acres created (3.4% of target of 3,700 acres)	0 acres created (no target applicable in this CPA)	3.4 miles created (no target applicable in this CPA)	0 acres created (0% of target of 400 acres)
Upper Sacramento River	0 acres created (0% of target of 6,300 acres)	0 acres created (0% of target of 9,600 acres)	0 miles created (0% of target of 20 miles)	0 acres created (0% of target of 5,600 acres)
Lower Sacramento River [b]	110.2 acres created (1.6% of target of 7,650 acres)	0 acres created (0% of target of 7,500 acres)	4.9 miles created (122% of target of 4 miles)	0 acres created (0% of target of 1,300 acres)
Upper San Joaquin River	0 acres created (0% of target of 2,800 acres)	0 acres created (no target applicable in this CPA)	0 miles created (0% of target of 8 miles)	0 acres created (0% of target of 2,100 acres)
Lower San Joaquin River [c]	0 acres created (0% of target of 11,600 acres)	0 acres created (0% of target of 200 acres)	0.2 miles created (1.5% of target of 13 miles)	0 acres created (0% of target of 4,300 acres)

[a] Contributing projects in the Feather River CPA include the Oroville Wildlife Area Flood Stage Reduction and Three Rivers Levee Authority Feather River Conservation Bank.

[b] Contributions in the Lower Sacramento River CPA are made by the Southport Setback Levee.

[c] Contributions in the Lower San Joaquin River CPA are made by the Dos Rios Floodplain Expansion and Ecosystem Restoration, Phase I.

Notes:

% = percent

CPA = Conservation Planning Area

Table F-4. Contributions to the Conservation Strategy's Measurable Objectives by Conservation Planning Area: Habitats and Stressors

Conservation Planning Area	Contributions to Habitat Objectives—SRA Cover: Natural Bank	Contributions to Habitat Objectives—SRA Cover: Riparian-Lined Bank	Contributions to Habitat Objectives—Riparian	Contributions to Habitat Objectives—Marsh (and Other Wetlands)	Contributions to Stressor Objectives—Fish Passage Barriers	Contributions to Stressor Objectives—Invasive Plants
Feather River [a]	3.4 miles created (no target applicable in this CPA)	0 miles created (0% of target of 0 miles)	438.4 acres created (24% of target of 1,800 acres)	44.3 acres created (no target applicable in this CPA)	0 barriers remediated (0% of target of 0 barriers)	0 acres restored (0% of target of 257 acres)
Upper Sacramento River	0 miles created (0% of target of 20 miles)	0 miles created (0% of target of 8 miles)	0 acres created (0% of target of 3,400 acres)	0 acres created (0% of target of 2,400 acres)	0 barriers remediated (0% of target of 5 barriers)	0 acres restored (0% of target of 268 acres)
Lower Sacramento River [b]	4.9 miles created (122% of target of 4 miles)	0 miles created (0% of target of 3 miles)	107.7 acres created (5.6% of target of 1,900 acres)	13.4 acres created (0.4% of target of 3,500 acres)	1 barrier remediated (25% of target of 4 barriers)	0 acres restored (0% of target of 363 acres)
Upper San Joaquin River	0 miles created (0% of target of 8 miles)	0 miles created (0% of target of 2 miles)	0 acres created (0% of target of 2,100 acres)	0 acres created (no target applicable in this CPA)	0 barriers remediated (target to be determined)	0 acres restored (0% of target of 143 acres)
Lower San Joaquin River [c]	0.2 miles created (1.5% of target of 13 miles)	0.2 miles created (3.3% of target of 6 miles)	739.1 acres created (12.7% of target of 5,800 acres)	0 acres created (0% of target of 100 acres)	0 barriers remediated (target to be determined)	0 acres restored (0% of target of 34 acres)

[a] Contributing projects in the Feather River CPA include the Oroville Wildlife Area Flood Stage Reduction and Three Rivers Levee Authority Feather River Conservation Bank.

[b] Contributing projects in the Lower Sacramento River CPA include the Fremont Weir Adult Fish Passage Modification and Southport Setback Levee.

[c] Contributions in the Lower San Joaquin River CPA are made by the Dos Rios Floodplain Expansion and Ecosystem Restoration, Phase I.

Notes:

CPA = Conservation Planning Area

SRA = shaded riverine aquatic

Figure F-1. Potential Contributions of Completed Projects to Ecosystem Process Objectives

Note 1: Advance mitigation and non-mitigation are displayed separately because using restored ecosystem processes as mitigation reduces progress toward the Conservation Strategy's measurable objectives.

Note 2: Floodplain inundation was calculated using the Floodplain Restoration Opportunity Analysis, as described in Appendix I of the 2016 Conservation Strategy

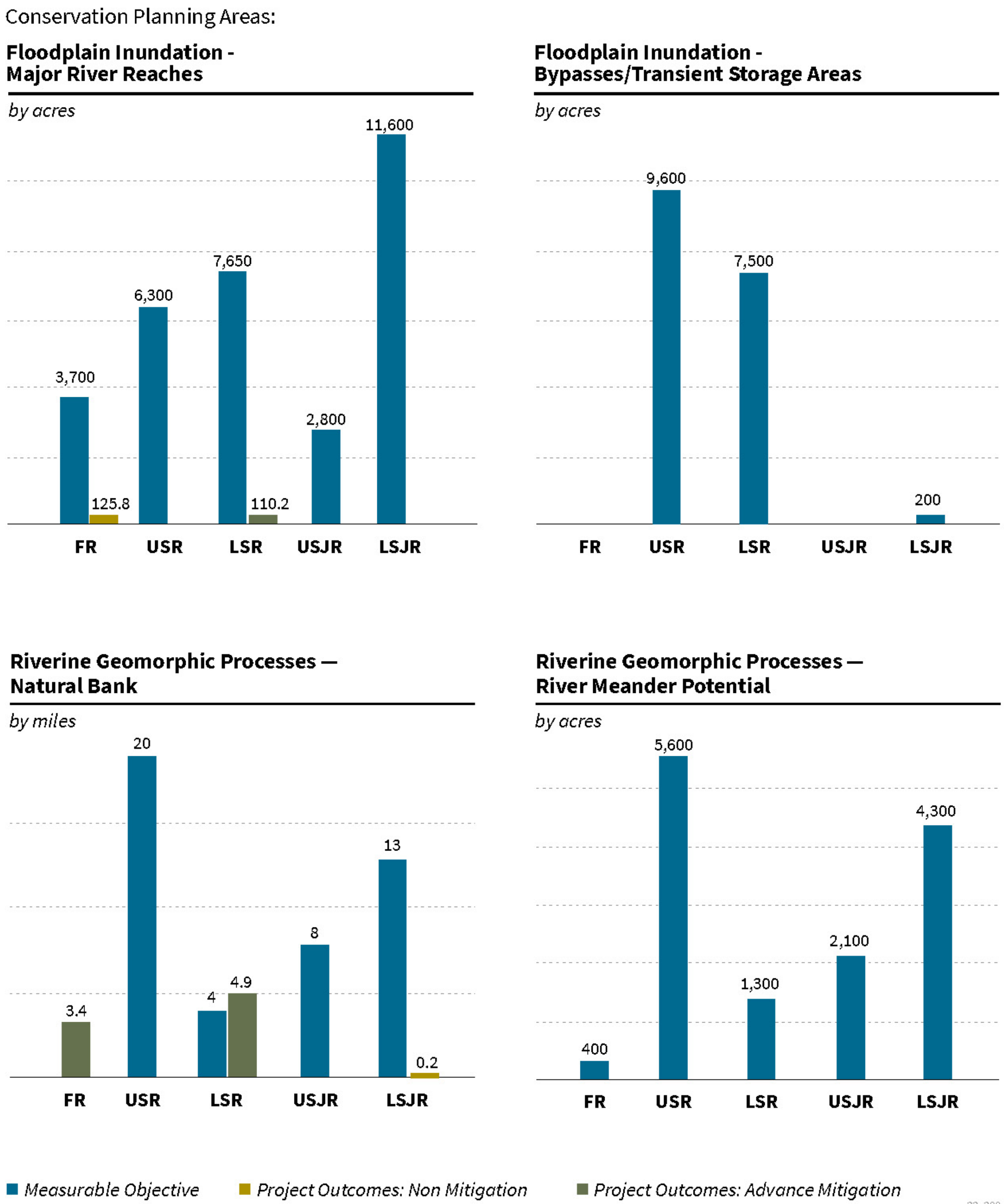


Figure F-2. Potential Contributions of Completed Projects to Habitat Objectives

Note: Advance mitigation and non-mitigation are displayed separately because using restored habitats as mitigation reduces progress toward the Conservation Strategy's measurable objectives.

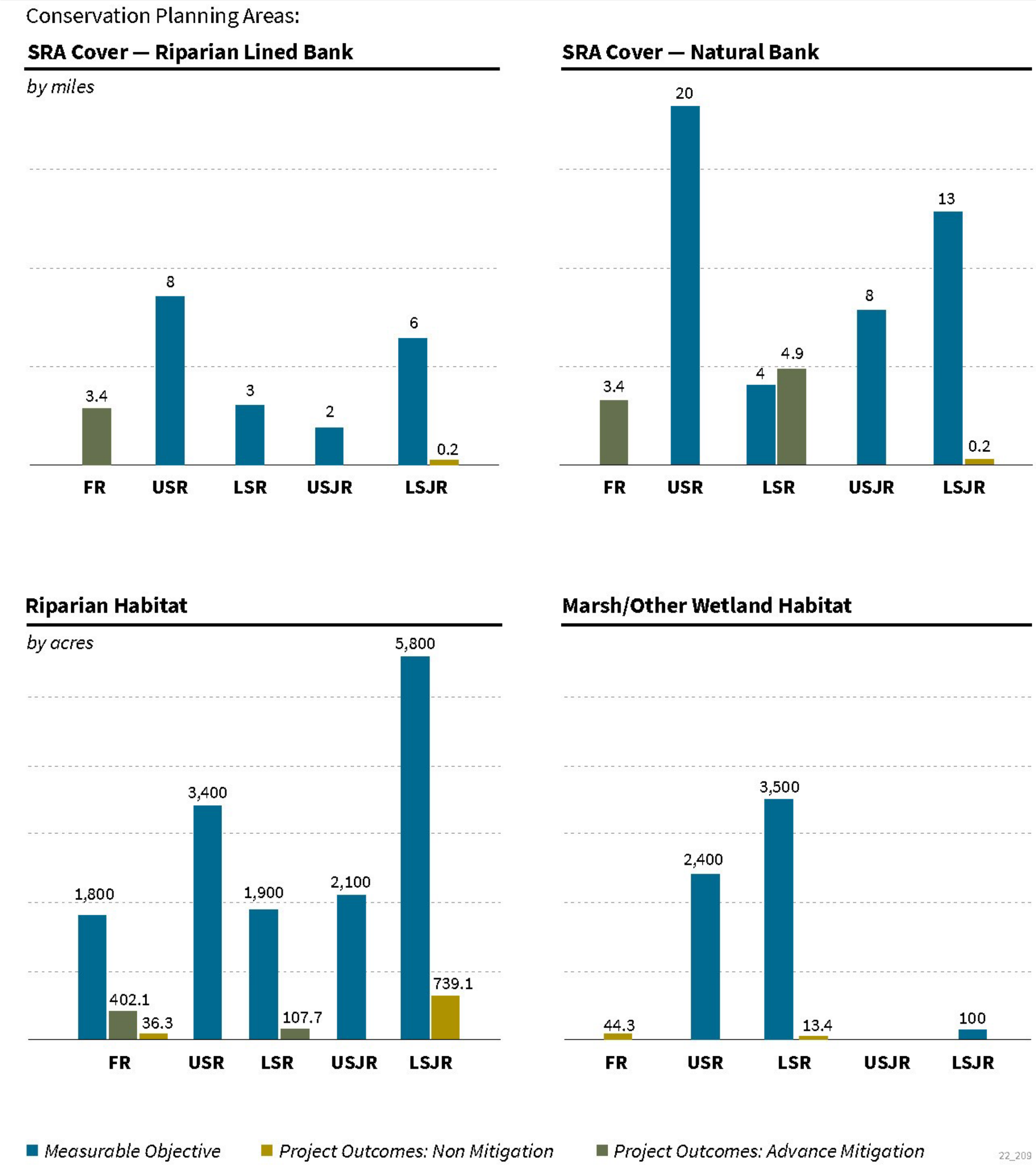
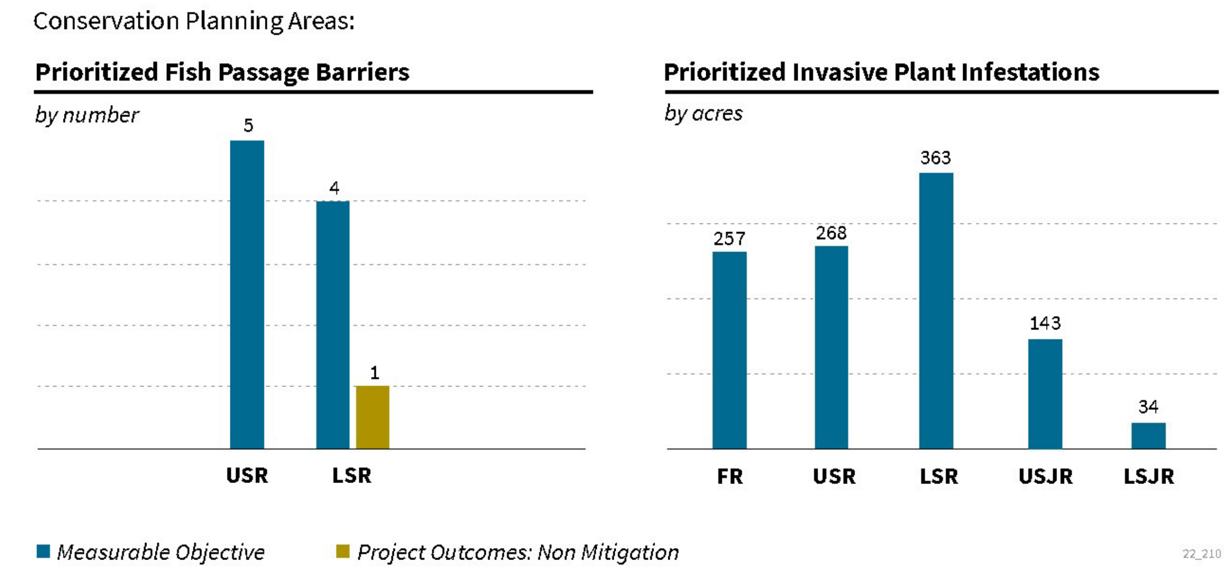


Figure F-3. Potential Contributions of Completed Projects to Stressor Objectives

Note: Advance mitigation and non-mitigation are displayed separately because using reduced stressors as mitigation reduces progress toward the Conservation Strategy's measurable objectives.



F.2.4 Funding for Multi-Benefit Projects Contributing to the Conservation Strategy's Measurable Objectives

As Table F-5 shows, the completed multi-benefit projects listed in Table F-2 received funding from multiple sources, including federal, State, and local contributions. A total of $297,886,099 was spent on these five projects. State bonds were the largest funding source.

Table F-5. Funding Sources and Amounts for Multi-benefit Projects

Source	Funding Amount
Federal Funding	**$21,079,511**
U.S. Natural Resources Conservation Service	$10,100,000
U.S. Bureau of Reclamation	$6,782,325
Central Valley Project Improvement Act	$2,775,186
U.S. Fish and Wildlife Service	$1,422,000
Local Funding	**$42,020,000**
West Sacramento Area Flood Control Agency	$40,000,000
San Francisco Public Utilities Commission	$2,000,000
Other private and local contributions	$20,000

Source	Funding Amount
State—Propositions	**$229,986,588**
Proposition 1E	$181,783,501
Proposition 84	$14,850,000
Proposition 1	$27,305,587
Proposition 13	$6,047,500
State—Other Funds	**$4,800,000**
Other State funds	$4,800,000
Total Funding	**$297,886,099**

F.2.5 Recommendations for Documenting Outcomes

The documentation of project outcomes for the Conservation Strategy 2022 Update and in the development of this memorandum has highlighted a few key processes that should be improved in the future. These improvements would promote greater understanding of floodplain progress toward the measurable objectives.

- **Project reporting guidance should be created and distributed.** Project reporting guidance would enable project managers across the flood system to know how, when, and what to report at each stage of project implementation. Such guidance would lessen the reporting burden, reduce inconsistencies, and keep DWR's records up to date. This guidance should describe how to report on funding amounts and sources, project statuses, and multi--benefit outcomes planned or achieved to date. This could be done using the methodology sheets (described in the "Methodology" section). These methodology sheets would also clarify how different project actions could contribute to the measurable objectives, which may incentivize project managers to include elements in their project design that they otherwise may not have considered, to show advance progress toward their region's measurable objective targets. These sheets also clarify the spatial analyses needed to understand contributions to the measurable objectives.
- **A central repository of information should be promoted.** An easily accessible repository for project information should be updated regularly by project managers, so DWR can keep an accurate record of current project information. This repository should also contain contact names to enable follow-up with project managers as questions arise.
- **Post-construction monitoring should occur regularly and should be reported to a centralized source**. The project outcomes reported here are planned outcomes. However, verified outcomes via monitoring are critical to ensure projects achieve their intended outcomes. Although it is easy to assume projects will produce and maintain all planned outcomes, it is difficult to understand ecological change on the ground and over time without consistent monitoring and maintenance. Monitoring can ensure projects stay on track and continue to provide both flood and habitat benefits as intended.

F.3 Adaptive Management of Implementation 2016 to 2021

The 2016 Conservation Strategy included an approach to adaptive management based on implementation tracking and data dissemination; systemwide or regional inventories of targeted ecosystem processes, habitats, and stressors; studies focused on key uncertainties; and solicited guidance. The following sections describe how these components were implemented between 2016 and 2021.

F.3.1 Implementation Tracking and Data Dissemination

The 2016 Conservation Strategy described a proposed system of tracking and data management to facilitate necessary reporting, information sharing, and adaptive management.

Since 2016, to meet these needs, DWR has been creating new, more efficient systems for data management, including two systems to manage data from the implementation of the Conservation Strategy. The Flood Performance Tracking System compiles and tracks flood management and environmental outcomes. Another system that is under development will associate these outcomes with DWR programs, and will support project prioritization and outcome-based evaluations of programs. These new, centralized systems use common data from across programs and applications while maintaining the unique functionality of existing applications. This data management infrastructure has the following characteristics:

- Relies on an integrated set of databases and applications.
- Integrates shared data across programs.
- Reduces redundancy and duplicated data management efforts by storing shared data in a single location that can be accessed across DWR.

Together, these data systems manage information about projects, funding, habitat outcomes, and ecosystem metrics across DWR programs. They are described further in Section 3.4.5, “Adaptive Management,” of the Conservation Strategy 2022 Update, which provides the updated approach to adaptive management.

F.3.2 Inventories

While developing the 2016 Conservation Strategy and 2017 CVFPP Update, DWR produced several systemwide or regional inventories of targeted ecosystem processes, habitats, and stressors. These inventories supported development of the measurable objectives and also inform project planning. As described in the 2016 Conservation Strategy, updating these datasets every 5 to 10 years would document regional changes to the amount and distribution of these targets, thereby supporting adaptive management of the Strategy’s implementation and development of multi-benefit projects (refer to Table 8-1 in the 2016 Conservation Strategy).

Between 2016 and 2021, DWR updated vegetation mapping systemwide in three separate efforts: the legal Sacramento–San Joaquin Delta, a portion of the Feather River CPA, and the rest of the SPA. These updates are based on 2016 imagery and fieldwork and validation studies conducted from 2018 until 2021. The previous map of vegetation in the SPA was based on 2009 imagery.

The datasets of channel banks (revetted and natural) were also updated for the Upper Sacramento River and Lower Sacramento River CPAs. These updates were based on 2016 aerial imagery and field work that took place during 2019 and 2020. Channel-bank data for the Feather River CPA is scheduled to be updated in 2022. The previous mapping for the Lower Sacramento River CPA was based on a U.S. Army Corps of Engineers (USACE) inventory of revetment along the Sacramento River (U.S. Army Corps of Engineers 2007). The previous mapping for the Upper Sacramento River CPA was based on 2009 imagery and field work that took place in 2014.

The updated inventory of revetted and natural banks in the Upper Sacramento River CPA illustrates the value of regional inventories for adaptively managing implementation of the Conservation Strategy. Between 2009 and 2014, revetment was eroded away from or deposited at nearly 100 locations with a combined length of nearly 3 miles. These changes resulted in a net decrease in natural bank of approximately 1 mile. Figure F-4 and Table F-6 show this net reduction in ecosystem processes and habitat does not substantially alter 2009 conditions, but continues a trend that has already dramatically reduced ecosystem processes and habitat for target species. Because revetment is placed on the most actively eroding locations along channel banks, the placement of revetment on approximately one-third of bank length has had a disproportionate impact on geomorphic processes and the regeneration of early successional vegetation (Fremier 2003).

Figure F-4. Length of Revetment and Natural Channel Bank in the Upper Sacramento River Conservation Planning Area in 2009 and 2016

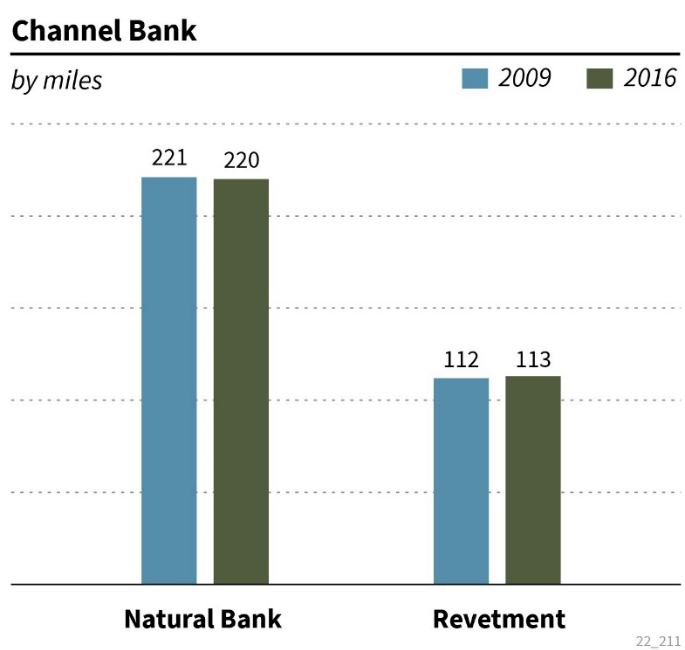


Table F-6. Length of Natural Bank and Revetment in the Upper Sacramento River Conservation Planning Area in 2009 and 2016

Year	Natural Bank (miles)	Revetment (miles)
2009	221	112
2016	220	113

Source: DWR, unpublished data

F.3.3 Focused Studies

The 2016 Conservation Strategy recommended using focused studies to complete key datasets and reduce uncertainty surrounding how targeted habitats and species would respond to management actions. The Strategy identified 17 studies as priorities (refer to Table 8-2 in the 2016 Conservation Strategy). Seven of these studies would complete regional inventories of targeted ecosystem processes or habitats, nine are focused on targeted species, and one is focused on fish passage barriers.

None of these focused studies have taken place since 2016 to support the implementation of the CVFPP or relevant conservation programs. New priorities have also been identified, particularly related to the need to update older inventories and inform climate change adaptation. These updated priorities are provided Table 3-6 of the Conservation Strategy 2022 Update.

F.3.4 Implementation Guidance

As described in the 2016 Conservation Strategy, an adaptive management approach to implementation must be guided not only by project outcomes, regional resource inventories, and focused studies, but also by input from other agencies and scientists. To obtain this guidance, an interagency advisory committee and scientific advisory committee were proposed. Neither of these committees convened during the 2016 and 2021 period, however, DWR solicited advisory input from agencies, NGOs, and project proponents.

In addition to conducting its own assessment of implementation of this Conservation Strategy, DWR solicited input regarding implementation and applied the input to this update. Input was received from the Central Valley Flood Protection Board (CVFPB), other project proponents and maintainers, regulatory agencies, NGOs, and other stakeholders.

This input was initially solicited through a survey (distributed to approximately 240 individuals, 42 of whom responded) and 16 interviews, and subsequently through participation in the CVFPB's Conservation Strategy Advisory Committee. The experience of survey recipients and interviewees represented the range of regions, roles, project types, and project phases relevant to the Conservation Strategy's implementation.

Survey respondents identified funding availability, funding-source requirements, and regulatory requirements as major factors limiting multi-benefit projects, among other factors (Figure F-5 and Table F-7). They identified funding availability and project proponent leadership as the major factors contributing to the successful implementation of multi-benefit projects (refer to Figure F-5 and Table F-8).

Figure F-5. Survey Responses regarding Factors Contributing to or Limiting Ecosystem Improvements by Multi-benefit Projects

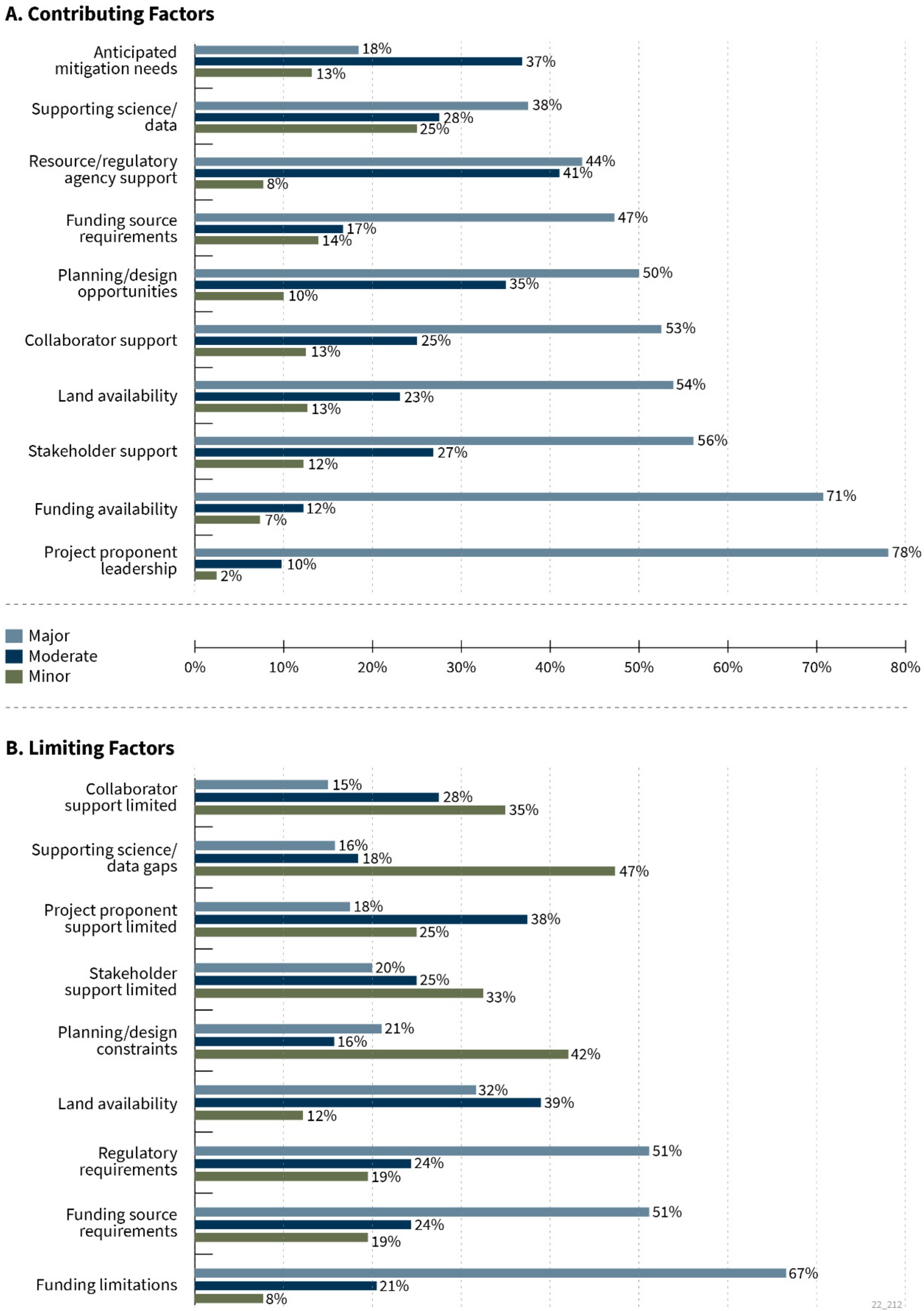


Table F-7. Survey Responses regarding Factors Limiting Ecosystem Improvements by Multi-benefit Projects

Factor	Minor (%)	Moderate (%)	Major (%)
Collaborator support limited	35	27.5	15
Supporting science/data gaps	47	18	16
Project proponent support limited	25	38	18
Stakeholder support limited	33	25	20
Planning/design constraints	42	16	21
Land availability	12	39	32
Regulatory requirements	20	24	51
Funding source requirements	20	24	51
Funding limitations	8	21	67

Table F-8. Survey Responses regarding Factors Contributing to Ecosystem Improvements by Multi-benefit Projects

Factor	Minor (%)	Moderate (%)	Major (%)
Anticipated mitigation needs	13	37	18
Supporting science/data	25	28	38
Resource agency support	8	41	44
Funding source requirements	14	17	47
Planning/design opportunities	10	35	50
Collaborator support	13	25	53
Land availability	13	23	54
Stakeholder support	12	27	56
Funding availability	7	12	71

Interview participants provided more extensive and detailed input regarding implementation needs. The interviews led to the following major findings:

- **Better alignment is needed among agency policies, funding sources, and regulatory requirements.** Participants called for better policy integration and coordination within and among agencies to facilitate the development of multi-benefit projects. Such projects are subject to the policy and regulatory requirements of fish and wildlife agencies and USACE, and to the requirements of funding sources, which often do not align well with the multi--benefit project objectives described in the CVFPP. Much of this alignment will have to occur at higher State and federal policymaking levels; however, participants also noted the need for better alignment of divisions and programs within key CVFPP agencies to support the development and implementation of multi-benefit projects.

- **CVFPP criteria are needed that define multi-benefit projects and contributions to measurable objectives.** Participants also called for clearer policy guidance in the CVFPP, particularly regarding criteria that define multi-benefit projects and determine contributions to the measurable objectives (e.g., mitigation contributions, if any).

- **The CVFPP should consider how to strike an appropriate balance between multi-benefit and single-purpose projects.** Some participants expressed concern that because of the difficulty of developing multi-benefit projects, placing substantially greater emphasis on such projects could leave important flood safety needs unaddressed. They were also concerned that it may not be feasible for every flood management project to achieve meaningful ecosystem improvements.

- **Regional planning is working well, but more early engagement is needed between project proponents, stakeholders, and regulatory agencies.** Developers of multi-benefit projects reported that early engagement with local stakeholders and State and federal agencies, particularly regulators, is essential to a successful project. Participants considered the collaborative environments established by the regional flood management plan process and the CVFPB's Advisory Committee to be effective at the planning level; however, they also identified the need for additional, earlier engagement among all stakeholders and agencies (including divisions and programs within agencies) in the project development process.

- **Funding requirements are a major constraint, including the lack of funding for monitoring and long-term operations and maintenance (O&M) associated with ecosystem improvements.** Project developers consistently cited the divergent requirements of various funding sources as a significant barrier to project development. Multi-benefit projects usually package funds from multiple sources, many of which can only be used for specified purposes, and which may have different deadlines and administrative requirements. The perennial lack of funding for post-construction O&M and monitoring is an even larger problem for restoring habitats through multi-benefit projects.

- **Improved post-construction monitoring, data management, and documentation of project outcomes are needed to adaptively manage implementation.** Participants reported that funding of post-construction activities, including monitoring, is generally inadequate. Some noted data are recorded inconsistently and project outcomes are insufficiently documented. Without more complete, consistent methods of tracking and recording project features and outcomes, it will be difficult to accurately assess progress toward this Conservation Strategy's measurable objectives, or to improve management strategies in response to ecological conditions and lessons learned from previous implementation experiences.

The CVFPB's Advisory Committee also provided recommendations. During summer 2020, the CVFPB Advisory Committee formed three stakeholder-led subgroups to provide input into the update of this Strategy and its implementation. The subgroups addressed the following topics:

- Implementation of multi-benefit projects
- Permitting
- Performance tracking

Each subgroup met multiple times between August 2020 and February 2021 to formulate recommendations. DWR requested that these recommendations be grouped to distinguish recommendations pertaining to this update of the Conservation Strategy from other recommendations. These subgroup-specific recommendations were finalized in January 2021. Cross-cutting themes (e.g., topics applicable to all three subgroups) were also identified and include: funding, O&M support, technical assistance for disadvantaged communities, and clarification on the definitions of mitigation and allocation of multi-benefit project features toward meeting the Conservation Strategy's measurable objectives. The recommendations were finalized in January 2021 and are compiled in Appendix G with a status of how their incorporation was addressed via the CVFPP planning process.

F.4 Implementation Summary

During the past five years, DWR has developed tracking systems; updated systemwide vegetation mapping; updated mapping of natural and riparian-lined banks in the Upper Sacramento River CPA; developed permitting mechanisms for O&M activities; funded and developed multi-benefit projects; aligned efforts with non-flood programs making conservation-related investments in the SPA; and sought input on the implementation of this Strategy from resource agencies, project proponents, maintainers, and other stakeholders.

Overall, completed projects have attained only a small portion of most measurable objectives (less than 5 percent). Projects under construction and proposed projects are anticipated to result in contributions to additional objectives, and for multiple objectives, cumulative contributions could exceed 20 percent of the objective by 2027. Nonetheless, for most of the objectives, the cumulative contributions of projects could still be less than 20 percent of the objective in 2027.

This level of implementation indicates that without systemic changes that expedite the development or increase the number of multi-benefit projects (particularly those analyzed in the 2017 CVFPP's Basin-Wide Feasibility Studies that expand the footprint of the flood system) multiple measurable objectives may not be attained, leaving the goals of this Conservation Strategy unfulfilled.

The input from DWR staff, survey respondents, interviewees, and the CVFPB's Advisory Committee indicated that project funding and permitting have been major impediments to the successful implementation of multi-benefit projects, and that multiple factors are important contributors to the success of these projects. The input received also includes numerous recommendations for aiding the development and implementation of multi-benefit projects, and for aligning implementation with non-flood programs making conservation-related investments in the SPA. Those recommendations have been applied to development of the updated content for the Conservation Strategy and priority actions for 2022–2027 that are provided in the Conservation Strategy 2022 Update.

F.5 References

Note: The following references are cited in the text of this appendix. For references cited in Attachment F1, "Project Descriptions," please refer to the lists in Attachment F1.

California Department of Water Resources (DWR). 2016. *Central Valley Flood Protection Plan Conservation Strategy.* Sacramento (CA).

California Department of Water Resources (DWR). 2017. *Central Valley Flood Protection Plan 2017 Update*. Sacramento (CA).

Fremier AK. 2003. *Floodplain Age Modeling Techniques to Analyze Channel Migration and Vegetation Patch Dynamics on the Sacramento River, California*. Master's thesis. Davis (CA): University of California, Davis.

ICF International, Inc. 2016. *Draft Oroville Wildlife Area Flood Stage Reduction Project, Initial Study/Mitigated Negative Declaration.* Sacramento (CA). Prepared for Sutter Butte Flood Control Agency, Yuba City (CA). May 2016. Viewed online at: Oroville_Flood_Risk_Reduction_Project. Accessed: January 2021.

U.S. Army Corps of Engineers (USACE). 2007. *Bank Revetment Inventory, Sacramento River Bank Protection Project.* Sacramento (CA). Prepared by Stillwater Sciences, Berkeley (CA).

ATTACHMENT F.1

Project Descriptions

Acronym	Definition
CDFW	California Department of Fish and Wildlife
CPA	Conservation Planning Area
DWR	California Department of Water Resources
SWP	State Water Project
TRLIA	Three Rivers Levee Improvement Authority
USFWS	U.S. Fish and Wildlife Service

This attachment describes each project completed during the 2016 to 2021 period and identifies anticipated 2022 to 2027 projects, defined as projects under construction or proposed projects that may begin construction during 2022 to 2027. Project descriptions include the project implementer, type, location, and funding sources and amounts. In the following descriptions, project funding often does not include staff time for the California Department of Water Resources (DWR) and other agencies and other in-kind costs.

Completed Projects

The following four projects were completed between 2016 and 2021. Together, they represent a diverse set of multi-benefit projects that both provide flood control benefits and improve habitat features. An additional (fifth) project is described below; although it does not qualify as a multi-benefit project, it did contribute to addressing a Conservation Strategy measurable objective (i.e., reduced a stressor).

Oroville Wildlife Area Flood Stage Reduction Project

This project improved State Water Project (SWP) operations, reconnected the Feather River floodplain, provided inundated floodplain, improved fish habitat, and remediated fish passage barriers. The project augmented the existing system of inflow and outflow weirs to safely divert additional floodwaters through the Oroville Wildlife Area and reduce flood stages in the main channel. The improvements were completed to reduce flood stages, improve SWP operations, reconnect the Feather River to its historic floodplain, provide more frequently inundated floodplain rearing habitat for juvenile salmonids, and improve drainage and fish stranding conditions. The project also incorporated removal of invasive species, new riparian restoration plantings, and construction of new recreational footbridges and grading work to provide improved river access, public parking, and site access improvements.

- **Project Implementer:** Sutter Butte Flood Control Agency
- **Project Status**: Constructed
- **Type:** Multi-benefit flood and ecosystem enhancement project
- **Location:** Feather River CPA
- **Funding:** Total cost $47,938,697
  - Proposition 1 (California Department of Fish and Wildlife and Wildlife Conservation Board): $15,217,697.81
  - Proposition 1E (DWR Emergency Levee Repair Work and Emergency Flood Fighting and Protective Measures): $29,201,000
  - Private and Local Contributions: $20,000
  - Other State Funds: $3,500,000
- **Sources:**

  - California Department of Fish and Wildlife. 2017. “California Endangered Species Act Consistency Determination No. 2080−2017−005−02.” California Regulatory Notice Register No. 26-Z (June 30, 2017): Page 947.
  - California Natural Resources Agency. 2015a. “Bond Accountability: Oroville Wildlife Area Restoration Project.” Viewed online at: Bond_Accountability_Resources. Accessed: January 2021.
  - California Natural Resources Agency. 2015b. “Bond Accountability: Oroville Wildlife Area Floodplain Reconnection and Habitat.” Viewed online at: Bond_Accountability_Resources. Accessed: January 2021.
  - ICF International. 2016. *Draft Oroville Wildlife Area Flood Stage Reduction Project, Initial Study/Mitigated Negative Declaration.* Sacramento (CA). Prepared for Sutter Butte Flood Control Agency, Yuba City (CA). May 2016. Viewed online at: Oroville_Flood_Risk_Reduction. Accessed: January 2021.
  - Sutter Butte Flood Control Agency. 2017. Lease agreement. June 22, 2017.
  - Sutter Butte Flood Control Agency. 2019. “Sutter Butte Flood Control Agency Overview of Activities.” Central Valley Flood Protection Board briefing, May 10, 2019.
  - Bureau of Reclamation. 2017. Fisheries Charters Appendix B for the 2017 Annual Work Plan. Public Final. Central Valley Project Improvement Act, Title XXXIV of Public Law 102-575.

Three Rivers Levee Improvement Authority Feather River Setback Conservation Bank

The Three Rivers Levee Improvement Authority (TRLIA) Feather River Setback Conservation Bank restored approximately 500 acres of a previously created levee setback area to a mosaic of mixed riparian forest and riparian scrub. This project is expected to generate advance mitigation credits from the California Department of Fish and Wildlife (CDFW), for riparian habitat and possibly for yellow-billed cuckoo, and the U.S. Fish and Wildlife Service (USFWS), for valley elderberry longhorn beetle and possibly for yellow-billed cuckoo.

- **Project Implementer:** TRLIA
- **Project Status:** Planting completed
- **Type:** Conservation bank (approval pending)
- **Location:** Feather River CPA
- **Funding:** $6,482,501 million
  - Proposition 1E (DWR FloodSAFE Ecosystem Stewardship and Statewide Resources Office): $5,182,501
  - State of California General Fund: $1,300,000
- **Sources**:
  - Three Rivers Levee Improvement Authority. 2016. *Final Initial Study/Mitigation Negative Declaration Feather River Setback Conservation Bank Project*. July. Marysville, California. Viewed online at: Feather-River. Accessed: July 2021.
  - Three Rivers Levee Improvement Authority. 2020. Feather River Conservation Bank – FESSRO. Viewed online at: Feather-River-Floodway. Accessed: July 2021.

Southport Setback Levee Project

This project involved constructing a setback levee along the western bank of the Sacramento River, which resulted in approximately 138 acres of inundated floodplain and riparian habitat. The setback area is a mixed floodplain and riparian habitat intended to provide floodplain restoration benefits to native fish species. The project is self-mitigating, and all habitat created is reserved for later use as mitigation for other projects under the West Sacramento Levee Improvement Program.

- **Project Implementer:** West Sacramento Area Flood Control Agency
- **Project Status:** Constructed
- **Type:** Multi-benefit flood and ecosystem enhancement project
- **Location:** Lower Sacramento River CPA, Yolo County
- **Funding:** Estimated total cost: $183,500,000
  - Proposition 1E (DWR Flood Project Office Early Implementation Projects and Urban Flood Risk Reduction Program): $143.5 million
  - Local contribution (West Sacramento Area Flood Control Agency): $40 million

- **Sources:**
  - California Natural Resources Agency. [Date unknown]. *Southport Setback Levee Project, West Sacramento, CA: Mixed Floodplain and Riparian Habitat.* Viewed online at: Southport-Setback-Levee. Accessed: January 2021.
  - Dirksen Jr. P. Flood protection planner, City of West Sacramento, West Sacramento (CA). February 9, 2021—email to Boysen K, Environmental Incentives, Denver (CO).
  - West Sacramento Area Flood Control Agency. 2020. *Draft Southport Levee Setback Implementation Report*. July 2020.

Dos Rios Floodplain Expansion and Ecosystem Restoration Project, Phase 1

River Partners' Dos Rios project provides almost 1,000 acres of floodplain reconnection and habitat restoration via a controlled breach of agricultural berms on the site, which increases floodwater storage and potentially reduces flood stages in the San Joaquin River. Dos Rios also provides extensive habitat for salmonids, migratory birds, and many other native aquatic and terrestrial species, including the endangered riparian brush rabbit. A planned second phase of Dos Rios would breach the federal project levee on the site and reconnect approximately 1,100 more acres of floodplain habitat to the San Joaquin River, ultimately providing more than 2,100 acres of total floodplain restoration, absorbing approximately 10,000 acre-feet of floodwaters, and increasing flood protection for downstream communities. Because Dos Rios is an expansive project, only a portion of the project qualifies to be included in this implementation summary. Some of the work had been done before the 2016 Conservation Strategy, and future phases, including the neighboring Hidden Valley Ranch parcel, have yet to be implemented.

- **Project Implementer:** River Partners
- **Project Status:** Constructed
- **Type:** Ecosystem enhancement project
- **Location:** Lower San Joaquin River CPA
- **Funding:** $53,182,575 million
  - Proposition 1 (CDFW Watershed Restoration Grants and Wildlife Conservation Board): $12,087,889
  - Proposition 13 (DWR, Costa Machado Water Act): $6,047,500
  - Proposition 84 (DWR Flood Protection Corridor Program and California Natural Resources Agency River Parkways Program): $14,850,000
  - Proposition 1E (DWR FloodSAFE Ecosystem Stewardship and Statewide Resources Office): $3,900,000
  - U.S. Bureau of Reclamation and USFWS Central Valley Project Improvement Act Habitat Restoration Program and Conservation Project: $2,775,186

- USFWS Anadromous Fish Restoration Project and North American Wetland Conservation Act: $1,422,000
- U.S. Natural Resources Conservation Service: $10,100,000
- San Francisco Public Utilities Commission: $2,000,000

- **Sources:**
  - Akiona R, P.E. San Joaquin Valley Regional Director, River Partners. Turlock (CA). January 13, 2021—email to Boysen K, Environmental Incentives, Denver (CO).
  - U.S. Bureau of Reclamation. 2016a. *Dos Rios Ranch Riparian Brush Rabbit Recovery Project Environmental Assessment*. May 2016.
  - U.S. Bureau of Reclamation. 2016b. *Dos Rios Ranch Riparian Brush Rabbit Recovery Project Finding of No Significant Impact*. June 2016.

Fremont Weir Adult Fish Passage Modification Project

Fremont Weir Adult Fish Passage Modification Project led by the Bureau of Reclamation is not considered a multi-benefit project, and was not implemented under the CVFPP. However, it reduced a stressor (fish passage barrier) as identified in Appendix K of the Conservation Strategy. This project improved adult fish passage at Fremont Weir and along the Tule Canal in the Yolo Bypass. The project constructed a new fish passage structure at Fremont Weir to widen and deepen the fish ladder and remediated barriers in the Tule Canal.

- **Project Implementer:** DWR
- **Project Status:** Constructed
- **Type:** Fish passage project
- **Location:** Lower Sacramento River CPA, Yolo County
- **Funding:** Estimated total cost $6,782,325
- U.S. Bureau of Reclamation: $6,782,325

Documentation of contribution amount not available for DWR and nongovernmental organization contributions.

- **Sources:**
  - California Department of Water Resources. 2014. *Lower Sacramento River/Delta North Regional Flood Management Plan*. July 2014. Viewed online at: www.yolocounty.org. Accessed: January 2021.
  - California Natural Resources Agency. [Date unknown]. *Fremont Weir Adult Fish Passage Modification Project, Yolo Bypass, CA: Fish Passage Improvements*. Viewed online at: www.resources.ca.gov. Accessed: January 2021.

– California Natural Resources Agency. 2018. *Fremont Weir Adult Fish Passage Modification Project—Securing Fish Passage in the Yolo Bypass: Frequently Asked Questions (FAQ)*." May 2018. Viewed online at: Fremont-Weir. Accessed: January 2021.

– U.S. Bureau of Reclamation. 2017. "Project Details." Viewed online at: www.usbr.gov. Accessed: January 2021. Last updated: August 22, 2017.

– U.S. Bureau of Reclamation. 2020. "Fremont Weir Adult Fish Passage Modification Project." Viewed online at: Fremont-Weir. Accessed: January 2021. Last updated: November 4, 2020.

Projects Anticipated to be Initiated, in Process, or Completed Between 2022 and 2027

In addition to the projects described that were completed between 2016 and 2021, many more projects progressed in terms of their funding and planning. The following projects are categorized as anticipated to be initiated or completed, meaning they were completed in 2022, are under construction, or are likely to be proposed for consideration and may be implemented over the next five years. Input from these projects relevant to the measurable objectives will be placed into the Flood Performance Tracking System and information will be updated as the projects are developed.

Upper Sacramento River Conservation Planning Area

- **Knights Landing Flood Management Project:** This proposed project would improve the existing SPFC levees near the small community of Knights Landing while creating ecosystem restoration and enhancement.

- **Kopta Slough Flood Damage Reduction and Habitat Project:** This proposed project would restore floodplain and riparian habitat, re-establish the historical river channel, and establish erosion protection.

- **Lower Deer Creek Flood and Ecosystem Improvement Project, Phase I:** This proposed project would enhance fish passage and rearing conditions for salmonids and improve the reliability of flood protection along lower Deer Creek.

- **Tisdale Weir Rehabilitation and Fish Passage Project:** This proposed project would reconstruct Tisdale Weir to correct structural deficiencies extending its life for an additional 50 years while addressing fish stranding issues by improving fish passage through the weir to the Sacramento River.

- **Sutter Bypass Weir #1 Remediation Project:** CDFW has identified this weir as a major fish passage barrier for Butte Creek spring-run Chinook salmon (*Oncorhynchus tshawytscha*). This project has received non-CVFPP (via the Central Valley Project Improvement Act) funding for a feasibility study, planning, design, and implementation. This project will restore physical processes and provide other habitat and species benefits consistent with the Conservation Strategy.

Lower Sacramento River Conservation Planning Area

- **Agricultural Road Crossing 4 Fish Passage Project:** This proposed project will remediate a priority fish passage barrier while maintaining private land access.
- **Little Egbert Tract Multi-Benefit Project:** This proposed project aims to reduce flood risk, improve agricultural sustainability, and restore habitat in the Little Egbert Tract.
- **Lookout Slough Tidal Habitat Restoration & Flood Improvement Project:** This project is under construction; it will create tidal habitat for delta smelt (*Hypomesus transpacificus*) and other salmonids by building a setback levee that will provide flood protection and improve climate resiliency in the region (U.S. Fish and Wildlife Service 2019). Although this project is not being implemented under the CVFPP, it is located within the footprint of the Lower Sacramento River CPA and may contribute toward the measurable objectives if surplus value can be quantified.
- **Lower Elkhorn Basin Levee Setback Project:** This project is under construction; it will set back levees and modify SPFC facilities, widening the Yolo and Sacramento Bypasses, and will restore floodplain and riparian habitat.
- **Yolo Bypass Salmonid Habitat Restoration & Fish Passage Project:** This is a non-CVFPP project that would improve fish passage and increase floodplain rearing habitat in the Yolo Bypass and lower Sacramento River Basin. Funding for this project is provided by the Central Valley Project and SWP as a mitigation requirement stipulated by the 2019 Biological Opinion (National Marine Fisheries Service 2019) for impacts related to the operation of their facilities. Because this project will likely be counted as mitigation, it may not count toward meeting Conservation Strategy measurable objectives.

Upper San Joaquin River Conservation Planning Area

- **Arroyo Canal Screening and Sack Dam Passage Project:** This proposed project would construct a new dam and fish screen at the Arroyo Canal to improve fish passage.
- **Eastside Bypass Improvements Project:** This project is under construction and will address fish passage barriers in the Eastside Bypass in conjunction with reinforcing the levee, modifying the control structure, replacing existing culverts, and removing two weirs.
- **Reach 2B and Mendota Pool Bypass Improvement Project:** This proposed project would provide flood benefits by creating an expanded floodplain and creating an alternate channel around Mendota Pool.
- **Cottonwood, Dry, Berenda Creek Arundo Eradication and Sand Removal Project:** This ongoing project is in the process of restoring 17 miles of creeks by removing 25,000 tons of sediment and eradicating false bamboo (*Arundo donax*) to enhance flood flows, provide groundwater recharge, and restore native riparian habitat.

Lower San Joaquin River Conservation Planning Area

- **Three Amigos Non-structural Alternative Flood Management Project:** This project was completed in 2022 and restored and reconnected the historic floodplain, providing transient storage on more than 3,100 acres along 8 miles of the San Joaquin River upstream and downstream of its confluence with the Tuolumne River. USACE O&M manuals for the three local maintaining agencies involved are pending finalization.

- **Dos Rios Floodplain Expansion and Ecosystem Restoration Project and Hidden Valley Ranch Mitigation Project (Phase 2):** This proposed project would expand previous phases of floodplain restoration at Dos Rios Ranch to include the 497-acre Hidden Valley Ranch parcel and continue to reconnect and expand floodplain habitat. Modification to the federal levee is in planning stages and is anticipated to move to construction within the coming two years.

- **Paradise Cut Multi-Benefit Improvement Project:** This proposed project would modify Paradise Cut to enhance flood conveyance and ecosystem benefits, including expansion of the bypass, modifications to the weir, and habitat restoration along the channel and adjacent floodplains.

Feather River Conservation Planning Area

- **Sunset Pumps Facility Removal Project:** This project is currently in the design and planning phase and seeks to remove the Sunset Pumps Diversion Dam, pumps, and pump platform constructed in the 1920s. This project will restore the channel elevation consistent with the upstream and downstream slope, restore connectivity for fish species including spring-run Chinook salmon and green sturgeon (*Acipenser medirostris*), reduce flood risk, and by improving physical processes will provide other benefits to Conservation Strategy habitats and species.

- **Hallwood Side Channel and Floodplain Restoration Project:** This project is designed to restore and enhance ecosystem processes with a primary objective of enhancing productive juvenile salmonid rearing habitat to increase the natural production of fall-run and spring-run Chinook salmon and Central Valley steelhead (*Oncorhynchus mykiss*) in the lower Yuba River. Once completed, the project will result in up to 3 feet of water surface elevation reduction for the 100-year design flow. Phases 1 and 2 were implemented from 2019 to 2021, Phase 3 is underway in 2022, and Phase 4 is funded and planned to be completed in 2023.

References

National Marine Fisheries Service. 2019. *Biological Opinion on the Long-term Operation of the Central Valley Project and State Water Project*. October 21. National Marine Fisheries Service, West Coast Region.

U.S. Fish and Wildlife Service. 2019. *Biological Opinion for the Reinitiation of Consultation on the Long Term Coordinated Operations of the Central Valley Project and State Water Project*. October 21. Sacramento, CA: U.S. Fish and Wildlife Service.

Appendix G
Central Valley Flood Protection Board Advisory Committee Recommendations

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APPENDIX G

Central Valley Flood Protection Board Advisory Committee Recommendations

Acronym	Definition
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
DWR	California Department of Water Resources
NGO	nongovernmental organization
RFMP	regional flood management plan
State	State of California

G.1 Introduction

As part of the California Department of Water Resources' (DWR's) continuing outreach to stakeholders, DWR is committed to participating in the Central Valley Flood Protection Board (CVFPB) Advisory Committee, which was first formed during development of the 2016 Conservation Strategy. The Advisory Committee is composed of federal and State of California (State) agency staff, nongovernment organizations (NGOs), regional and local stakeholders, and other interested parties. The Advisory Committee provides a productive, collaborative forum for dialogue on a wide range of issues relevant to the successful implementation of the Central Valley Flood Protection Plan (CVFPP) and its Conservation Strategy (or Strategy). The CVFPB reconvened the Advisory Committee in the summer of 2020 to develop recommendations that would help inform the content of the Conservation Strategy Update. To do so, and to address key issues, it formed the following three subgroups:

- Implementation of Multi-benefit Projects
- Permitting
- Performance Tracking

Each Advisory Committee subgroup used specific guidance for the types of input requested to develop recommendations for the Conservation Strategy Update:

- Implementation of Multi-benefit Projects:
  - Additional recommendations or priorities for future actions to reduce impediments to multi-benefit project implementation.
  - Examples of successful multi-benefit project development and implementation and the lessons learned from those projects, particularly related to engagement and funding.
  - Potential legislative actions to aid the implementation of multi-benefit projects.
- Permitting:
  - Examples of successful project permitting and the lessons learned from those projects.
  - Information about recent and ongoing efforts to develop more efficient permitting mechanisms.
  - Key issue areas for each permit or approval.
- Performance Tracking:
  - Proposed monitoring and performance tracking needs, in addition to measurable objectives tracking.
  - Issues in documenting project outcomes and data handling.

Each subgroup developed their recommendations through a series of individual meetings, discussions, and presentations to the larger CVFPB Advisory Committee, which occurred during the summer, fall, and winter months of 2020. The final subgroup recommendations were provided to the CVFPB in January and February 2021 and provided valuable guidance and insight for the development of the Conservation Strategy Update as well as the CVFPP Update.

The Advisory Committee submitted 79 recommendations to DWR, several of which contain various actions and many overlap. Many of these recommendations were incorporated into the Conservation Strategy Update and the CVFPP Update. Some recommendations cover activities that are already ongoing or under consideration for future updates. Other recommendations fall outside the scope of the CVFPP or authority of DWR, but may contain content that could be used as guidance or aligns with the purpose of the CVFPP. The recommendations were placed in one or more of six categories. Category 1 recommendations, those that were incorporated into the Conservation Strategy Update, can primarily be found in Table 3-8. Category 2 recommendations, those that were incorporated into the CVFPP Update, can primarily be found in Table 3.3 and Appendix C, Section C4 of the CVFPP, although some are incorporated in content. Table G-1 provides the list of recommendations from the Advisory Committee, along with how their incorporation is accounted for in the CVFPP planning process. The six categories are defined as follows:

1. **Included in Conservation Strategy.**

   This recommendation aligns with the purpose, scope, and content of the Conservation Strategy and is included in the 2022 Strategy Update. This status also applies to recommendations whose overall intent aligns with the Strategy but contains some elements that may not be feasible to include at the full level of detail given.

2. **Included in CVFPP.**

   This recommendation aligns with the purpose, scope, and content of the CVFPP and is included in the 2022 Plan Update. This status also applies to recommendations whose overall intent aligns with the CVFPP but contains some elements that may not be feasible to include at the full level of detail given.

3. **Considered for use as guidance or best management practices to inform other program or planning activities.**

   This recommendation does not align with the content or scope (or both) of the Conservation Strategy and CVFPP, but provides valuable insight that can be incorporated into broader policies or other DWR efforts (such as development of an agricultural stewardship tool or vegetation roughness model).

4. **Already being implemented by other ongoing activities.**

   This recommendation is in the process of being implemented, either by DWR or other agencies. For recommendations that are in the process of being implemented and are also included in the Conservation Strategy or CVFPP Update, a status of 1 or 2 will also be assigned.

5. **Considered for future CVFPP planning cycles.**

   This recommendation aligns with purpose of the Conservation Strategy or CVFPP (or both) but may not be feasible to implement in the 2022 planning cycle because of cost or related resource practicality. This recommendation may be revisited in future planning cycles as additional resources become available.

6. **Not considered for inclusion in this CVFPP planning cycle.**

This recommendation is outside of the scope of the Conservation Strategy and CVFPP, because of either jurisdictional or resource limitations. The recommendation may be beyond the authority of DWR or the CVFPP (such as requiring actions from outside agencies); may be more appropriate for implementation by other plans, programs, or agencies (such as development of an agricultural mitigation program); or may involve a level of detail not appropriate for the CVFPP.

In addition to the Advisory Committee recommendations, many recommendations were incorporated into the 2022 CVFPP Update from the following sources:

- 2017 CVFPP Update recommendations.
- 2017 CVFPP Update Chapter 2 Areas of Agreement/Areas of Continuing Conversation.
- 2016 Conservation Strategy.
- Regional flood management plan (RFMP) regional priorities white papers.
- Advisory Committee Subgroup recommendations.
- Water Resilience Portfolio Actions.
- DWR and Division of Flood Management strategic plans.
- Stakeholder surveys and interviews related to the Conservation Strategy.

After consolidating these recommendations, DWR synthesized the recommendations into a manageable list for consideration and prioritization in the 2022 CVFPP Update. DWR considered these policies based on:

- The identification of relevant federal, State, and local partners that may be engaged for effective collaboration and implementation of policies.

- The appropriateness of recommendations for the level of detail and ability to implement.

- Priority near-term (< five years) and longer-term (>+ five years) recommendations and the appropriate location for their documentation.

- The inclusion of range for consideration, based on cost and practicality.

Table 3-8 displays priority actions of the Conservation Strategy Update, including most of the CVFPB Advisory Committee recommendations categorized as Category 1. Some of the recommendations are incorporated into the content of the Strategy Update and thus are not included in Table 3-8. It is important to note that the implementation of any recommendations depends on the availability of sufficient staffing and funding resources.

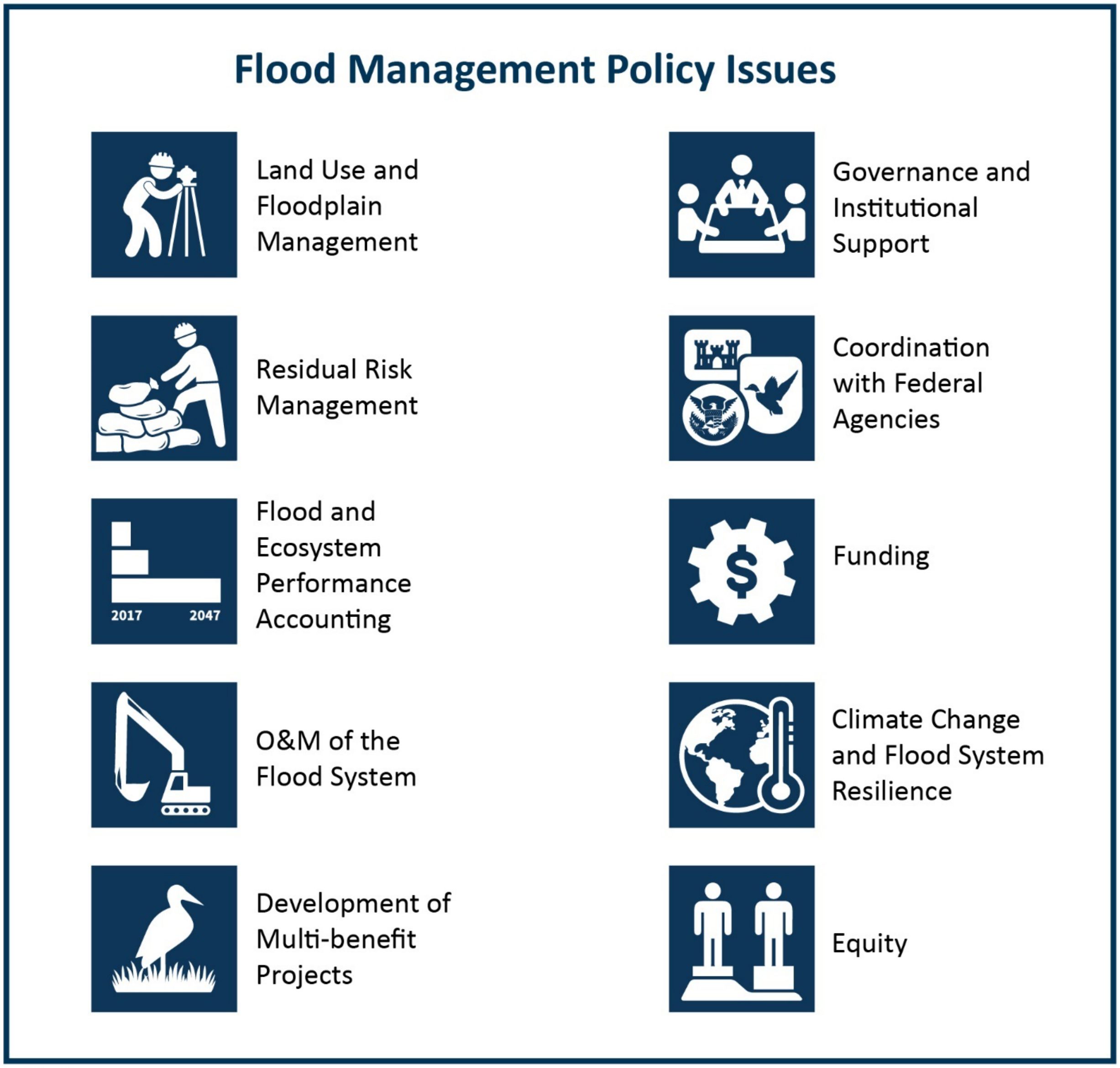
The priority actions are grouped by six key components of Strategy implementation: Coordination, Collaboration, and Alignment; Outreach and Engagement; Funding; Regulatory Compliance; Data and Information; and Climate Adaptation.

The 2022 CVFPP Update provides a short list of high-priority policy recommendations in Table 3.3 that includes most of the Category 2 recommendations. Recommendations are organized around 10 flood management policy issue categories (Figure G-1): Land Use and Floodplain Management; Residual Risk Management; Flood and Ecosystem Performance Accounting; O&M of the Flood System; Development of Multi-benefit Projects; Governance and

Institutional Support; Coordination with Federal Agencies; Funding; Climate Change and Flood System Resilience; and Equity. Two of these categories are new and were developed through the 2022 CVFPP Update process: Climate Change and Flood System Resilience; and Equity.

More specificity and supporting information for the high-priority recommendations provided in Table 3.3 are included in Appendix C of the Plan Update, “CVFPP Supplemental Recommendations.” Appendix C also contains supplemental recommendations that build on discussions within the CVFPB Advisory and Coordinating Committees, RFMPs, and other stakeholders.

Figure G-1. Policy Issue Categories



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Recommendations and categories were refined through feedback from stakeholders and the Advisory Committee as both the CVFPP and the Conservation Strategy developed into final drafts. It is important to note that although DWR will attempt to make progress on the recommendations identified as Status 1 or 2 (included in the Conservation Strategy or CVFPP Update), their inclusion does not guarantee implementation or adoption of the full suite of actions during the 2022 to 2027 planning cycle. The Advisory Committee members are encouraged to continue evaluating the advancement of these recommendations in the 2022 to 2027 planning period.

Within Table G-1, the first column provides the assigned recommendation number, with the applicable subgroup identified as follows:

- I = Implementation of Multi-benefit Projects
- P = Permitting
- T = Performance Tracking

Table G-1. CVFPB Advisory Committee Recommendations

Note: Recommendations were kept verbatim as received from the Advisory Committee.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I01	Include specific examples of each a Multi-Benefit flood system, a Single Purpose project, a Multi-Benefit project, a mitigation project, and a project that provides uplift in the updated Conservation Strategy. Consider using the performance tracking tool to show projects advancing the Conservation Strategy.	1 - Included in Conservation Strategy (Appendix F).	Conservation Strategy Appendix F provides examples of projects that meet various criteria relevant to the Conservation Strategy (refer to I11 and T01a).	Refer to content in Appendix F, Attachment F.1.	Not applicable.
I02	Include in the Conservation Strategy a protocol that can be provided by resource agencies and RFMPs to assist a project proponent in understanding and guiding them through project formulation and identify how a particular project warrants consideration as a multi-benefit project.	1 - Included in Conservation Strategy.	Refer to I07a and P25.	Table 3-8: Develop guidance to help project proponents identify project components meet multi-benefit and Conservation Strategy measurable objectives. They can use this beginning in the early design phase and through project permitting to optimize ecological features and potentially expedite the regulatory process.	Not applicable.
I03	State to issue funding and guidance to the RFMP areas on engagement and formulation in developing a landscape vision for the Region that includes an integrated portfolio of multi-benefit projects to advance the Conservation Strategy measurable objectives while meeting CVFPP goals.	2 - Included in CVFPP.	Continued development of the RFMP Program is a priority of the CVFPP.	Not applicable.	Table 3.3 #08: Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan Program, which will support the six planning regions and facilitate the following: • Establishment of regional technical advisory committees to improve coordination, landscape-scale connectivity, and development of a regional vision for multi-benefit projects.
I04	Each of the RFMPs to map regional opportunities for flood improvement, habitat, water supply, water quality, recreation, agriculture sustainability, etc.	2 - Included in CVFPP.	RFMPs are currently scoped to provide this type of content for CVFPP planning processes; however, additional details and mapping formats may be added in the future.	Not applicable.	Table C-6 #5: Ensure regular engagement of local communities throughout project development, design, and construction of projects. Issue funding and guidance to the RFMP areas on engagement and formulation in developing a landscape vision for the Region that includes an integrated portfolio of MBPs to advance the Conservation Strategy measurable objectives while achieving CVFPP goals. Assist each of the RFMPs to map regional opportunities for flood improvement, habitat, water supply, water quality, recreation and recreational access, agriculture sustainability, etc.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I05a	Encourage funding agencies to coordinate amongst themselves (interagency coordination) prior to issuing guidelines to sync schedules, strategize on how to best fund large projects, and align various funding programs to best advance multi-benefit projects.	2 - Included in CVFPP.	Agency coordination is a key component of the CVFPP and Conservation Strategy.	Not applicable.	Table 3.3 #01: Establish basin-specific task forces of high-level decision-makers and staff from State, federal, and local agencies, Tribes, and other partners to further advance implementation of projects and programmatic implementation of the CVFPP: • Facilitating interagency coordination and collaboration regarding multi-benefit project funding prior to issuing guidelines, collaborating on funding strategies and priorities, and aligning funding programs to best advance multi-benefit projects.
I05b	CNRA or state/fed should designate a high-level person (or team of people) to champion and manage agency coordination on multiple benefit project funding on or near SPFC facilities.	6 - Outside the scope of CVFPP and Conservation Strategy.	While directing actions of other agencies is outside of the scope of the CVFPP, promoting agency coordination is a priority and efforts are ongoing (refer to P02 and P03).	Not applicable.	Table 3.3 #01: Establish basin-specific task forces of high-level decision-makers and staff from State, federal, and local agencies, Tribes, and other partners to further advance implementation of projects and programmatic implementation of the CVFPP: • Facilitating interagency coordination and collaboration regarding multi-benefit project funding prior to issuing guidelines, collaborating on funding strategies and priorities, and aligning funding programs to best advance multi-benefit projects.
I05c	Expand membership on the CDFW Restoration Leaders Committee, which is working to simplify funding requirements, to include other agencies.	6 - Outside the scope of CVFPP and Conservation Strategy.	Directing the actions of other agencies is outside the scope of the CVFPP.	Not applicable.	Not applicable.
I06a	State and/or Federal agencies should designate a high-level person (or team of people) to better identify where permitting requirements align across agencies on multiple-benefit project implementation on or near SPFC facilities and disclose where alignment is not possible.	6 - Outside the scope of CVFPP and Conservation Strategy.	While directing the actions of other agencies is outside the scope of the CVFPP, promoting agency coordination is a priority and efforts are ongoing (refer to I05b, P02, and P03).	Not applicable.	Table 3.3 #01: Establish basin-specific task forces of high-level decision-makers and staff from State, federal, and local agencies, Tribes, and other partners to further advance implementation of projects and programmatic implementation of the CVFPP: • Facilitating interagency coordination and collaboration regarding multi-benefit project funding prior to issuing guidelines, collaborating on funding strategies and priorities, and aligning funding programs to best advance multi-benefit projects.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I06b	Intra-agency leadership vision is communicated down to staff level and across divisions within agencies to provide guidance on what project champions and agency staff can do to navigate implementation challenges, while ensuring project expectations are clearly articulated from the leadership and staff level.	6 - Outside the scope of CVFPP and Conservation Strategy.	Directing the actions of other agencies is outside the jurisdiction of the CVFPP (refer to I06a).	Not applicable.	Refer to I06a.
I06c	Commitment from agency staff and project proponents to follow a dispute resolution process when challenges arise (with an emphasis of working with agency at the staff level from the bottom up.) If the “Cutting the Green Tape Initiative” works well on restoration projects, expand this effort for Multi-Benefit Project’s.	6 - Outside the scope of CVFPP and Conservation Strategy.	The "Cutting the Green Tape Initiative" aligns with the goals of the CVFPP, but implementing this level of detail is outside the scope of the document (refer to P06a).	Not applicable.	Refer to P06a.
I07a	Promote early engagement and coordination with regulatory agencies to improve permitting and conservation outcomes: • RFMPs should provide the forum for early agency engagement coordination. RFMPs should convene quarterly or bi-annual meeting (virtual meeting sufficient) to share progress and obtain agency input on Multi-benefit projects. • Develop a protocol for minimum description of a multi-benefit project to create a productive, early engagement with state and federal regulators to get “not-regulatory, pre-permitting” guidance on projects. Marry protocol recommendation with list of funding sources. • Project proponents should work within the RFMP structure to host workshops with multiple agencies and stakeholders early in the planning process and concept design phase to identify expectations and goals, incorporate meaningful fish and wildlife enhancements, and identify ways to ways to avoid and minimize biological impacts and associated mitigation requirements.	1 - Included in Conservation Strategy. 2 - Included in CVFPP. 3 - Considered for use as guidance or best management practices to inform other program or planning activities.	Part of a broader strategy to coordinate with regulatory agencies. Early engagement and agency coordination is a key component of the CVFPP and Conservation Strategy (refer to I02, P02, and P25).	Table 3-8: Promote early engagement and coordination with regulatory agencies to improve the permitting process and conservation outcomes. DWR, project proponents, and RFMPs may benefit by convening workshops and meetings with the regulatory agencies when developing project priority lists and during project design.	Table 3.3 #08: Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan Program, which will support the six planning regions and facilitate the following: • Establishment of a collaborative forum for early agency engagement and coordination where project proponents (e.g., State or local partners) can share progress and obtain agency input.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I07b	Provide Information and tools to assist potential multi-benefit project champions in advancing multi-benefit projects. The DWR team drafting the Conservation Strategy update should work with regulatory agency staff to: • Develop an efficient format for summarizing the information (type of information and level of detail expected) necessary to determine if and how a project reduces flood risk and advance the conservation strategy, the minimum requirement of all multi-benefit flood management projects. • Describe a process for how project proponents should advance the project through the funding and permitting process. Consider a four phased process: 1) introduction and early conceptual design with multiple agencies and stakeholders, 2) project proponents' complete checklist to identify how the project meets minimum criteria for special consideration as multi-benefit projects, 3) agency assistance in identifying funding sources and achievable implementation strategies, 4) permitting. Provide clear milestones delineating the end of each phase to help project proponents avoid expensive delays. Consider how the performance tracking tool already under development could be used to provide information useful for completing the form and process described above.	1 - Included in Conservation Strategy. 2 - Included in CVFPP. 3 - Considered for use as guidance or best management practices to inform other program or planning activities.	Part of a broader strategy to coordinate with regulatory agencies. DWR is exploring additional means of assisting project proponents to advance multi-benefit projects. Decision support tools are under development, and this level of detail may be considered as additional resources become available (refer to I01 and I02).	Section 3.4.5.1: DWR has been developing internal data management and decision support tools to balance its compensatory mitigation needs and other habitat obligations, while working toward goals to increase the quantity and quality of habitats and contribute to species' recovery. These decision support tools complement the FPTS in that they are forward-looking, comparing project data from the FPTS to forecasted needs and objectives across DWR programs.	Table C-4 #2: Develop an ecological accounting system that allows determination of how ecological benefits attained from multi-benefit projects can be attributed to mitigation or uplift, along with specific examples of how a project or group of projects could be developed to demonstrate functionality. Develop guidance for regions on how to use the accounting system to leverage ecosystem credits to streamline permitting processes, align with grant funding opportunities, and remove impediments to multi-benefit project implementation. Table C-6 #2: DWR should work with regulatory agency staff to describe a process for how project proponents should advance projects through the funding and permitting process. Provide clear milestones delineating the end of each project development phase to help project proponents avoid expensive delays.
I07c	Project proponents and regulators should view each other as project partners in the development of multi-benefit projects that advance the conservation strategy. • Encourage and fund trust building efforts as part of planning and implementation grants including agency and public engagement events such as field trips, volunteer days, and ribbon cutting ceremonies. • For particularly complicated projects, encourage and fund structured decision-making processes to clarify underlying assumptions of different parties.	3 - Considered for use as guidance or best management practices to inform other program or planning activities.	Coordination between entities is a key component of the CVFPP, but the implementation of this recommendation may be done within program or planning activities (refer to P02).	Not applicable.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I07d	CVFPB should draft and send letter to CNRA secretary explaining how funding of the RFMPs both could advance the governor's water resilience portfolio and save the agency money and staff time.	6 - Outside the scope of CVFPP and Conservation Strategy.	The intent of this recommendation aligns with the purpose of the CVFPP, but its implementation is outside the scope of these documents.	Not applicable.	Not applicable.
I08a	Consider impacts and benefits to regional agricultural sustainability and county tax base in multi-benefit project planning.	4 - Already being implemented by other ongoing activities.	Systemwide and regional projects already consider economic impacts as a result of land use conversion during project planning and formulation.	Table 3-8: Seek revisions to federal funding guidelines to fully account for the benefits provided by restored ecosystems, wildlife-friendly agricultural lands, and recreation, and thereby increase federal funding for multi-benefit flood projects.	Refer to I08b.
I08b	Support efforts of YB/CS Partnership Agricultural Sustainability Working Group to identify an agricultural sustainability program that would be implemented with large-scale multi-benefit projects.	2 - Included in CVFPP.	Supporting the YB/Conservation Strategy Partnership aligns with the purpose of the CVFPP.	Not applicable.	Table 3.3 #12: Develop landscape-scale agricultural sustainability strategies alongside environmental conservation strategies to advance sustainable floodplain land uses that are compatible with periodic flooding and adaptive to climate change.
I08c	Support efforts to develop an agricultural stewardship/land planning tool to improve the agricultural outcome of multi-benefit flood management projects. Consider simplifying and adapting DWRs 2018 Agricultural and Land Workgroup Framework. Engage the Regions to shape the tool to meet regional needs.	5 - Considered for future CVFPP planning cycles.	The CVFPP considers agricultural land stewardship is a consideration, and this level of detail may be considered in future planning cycles. Refer to I09.	Not applicable.	Refer to I09.
I08d	Adopt and encourage use of standardized agricultural and land stewardship tool and guidance to make agricultural land stewardship planning a routine part of multi-benefits flood project planning in the Central Valley at both the programmatic regional and site-specific project levels.	5 - Considered for future CVFPP planning cycles.	Refer to I09.	Not applicable.	Refer to I09.
I09	Support efforts of YB/CS Partnership Agricultural Sustainability Working Group to develop and refine an agricultural sustainability tool.	2 - Included in CVFPP.	Supporting the YB/Conservation Strategy Partnership aligns with the purpose of the CVFPP.	Not applicable.	Table 3.3 #07: Promote agricultural land stewardship and sustainability in multi-benefit project planning by leveraging regional flood management planning groups and partnerships to support the development and standardized use of relevant data and tools to identify the potential positive and negative effects of a proposed project.
I10	Develop an ag mitigation program that reinvests in nearby agriculture to make marginal lands more productive.	6 - Outside the scope of CVFPP and Conservation Strategy.	Refer to I08a and I08b.	Not applicable.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I11	Support DWR's efforts to develop a tracking tool (i.e., Lori Clamurro-Chew's efforts) and encourage DWR to clarify how the tracking tool will be used to support the goals and objectives of the CVFPP 2022 Update and the Conservation Strategy.	1 - Included in Conservation Strategy (Appendix F). 4 - Already being implemented by other ongoing activities.	A tracking system is under development (refer to I01, I07b, and T09).	Table 3-8: Develop guidance to help project proponents identify components in their projects that meet multi-benefit and Conservation Strategy measurable objectives. This can be used by project proponents beginning in the early design phase and through project permitting to optimize ecological features and potentially expedite the regulatory process. Refer to Appendix F.	Not applicable.
I12a	DWR and the CVFPB should develop a vegetation roughness model and map for the Sutter Bypass, as is done for the Yolo Bypass, that allow landowners and wildlife managers to identify those bypass areas that are critically important for continued vegetation control.	4 - Already being implemented by other ongoing activities. 5 - Considered for future CVFPP planning cycles.	The Mid-Upper Sacramento River RFMP is refining existing modeling for the Sutter Bypass as part of the Tisdale-Sutter Bypass Multi-Benefit Management Plan. Further updates and modeling analyses may be considered for future planning cycles.	Not applicable.	Not applicable.
I12b	Develop metrics that facilitate a cross walk between hydrologic roughness and habitat quality to integrate flood and environmental objectives.	3 - Considered as guiding principles or best management practices to inform other program or planning activities.	The analysis for this concept applies to other programs.	Not applicable.	Not applicable.
I12c	Have the RFMP assist project proponents in characterizing the effects of land use changes on flood conveyance capacity.	2 - Included in CVFPP.	This level of detail will be considered as additional resources become available.	Not applicable.	Table C-2 #8: Design an approach to track land use changes and flood management system improvements to assess whether life loss and property damage risks are increasing or decreasing. FEMA's data on repetitive loss property could be used for a pilot assessment of this change in risk.
I12d	Proposals to restore ecosystem function within bypass lands should include consideration of the potentially increased costs of vegetation and sedimentation management that may be incurred if agriculture or duck club land uses were to cease.	3 - Considered as guiding principles or best management practices to inform other program or planning activities.	Refer to I13 and P17.	Not applicable.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I12e	In regions of the Yolo and Sutter Bypasses where flood conveyance could be potentially impacted if vegetation were to grow uncontrolled, the CVFPB and DWR should prioritize multi-benefit habitat projects that enhance fish and wildlife benefits while retaining within the project footprint active agricultural production, wetland or grassland management, or otherwise include long-term funding to ensure that tree growth does not impede CVFPB's hydrologic design criteria.	3 - Considered as guiding principles or best management practices to inform other program or planning activities.	Refer to I13 and P17.	Not applicable.	Not applicable.
I13	Require all proposed projects to provide a comprehensive OMRR&R plan that describes those actions and costs in the project planning documentation, such that during environmental analysis and permitting, the future O&M requirements will be included in the CEQA/Environmental document analysis, thereby be included in project permit. (O&M is part of implementing the project)	3 - Considered as guiding principles or best management practices to inform other program or planning activities. 4 - Already being implemented by other ongoing activities.	DWR supports this recommendation; however, it is not considered to be a requirement at this time. However, the CVFPB does require an O&M plan for projects as part of their permitting process (refer to P16).	Table 3-8: Encourage and assist implementers of multi-benefit projects to develop O&M plans and incorporate these into their overall project description and regulatory applications.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I14	Develop a policy memo on potential revenue streams and explore potential legislation to identify funding mechanism to allow for long term O&M of ecosystem restoration projects/components while also allowing entities like LMA's to take on long term obligations without using their funds and increase long-term liabilities. The memo should also look into liability waivers for LMA's that are used for other public items, like trails, and explore the option of having the agencies benefiting from multi benefit project (CDFW, CVFPB, and DWR) to jointly share in the long-term liability. Solicit input from the RFMPs on funding concepts. Reference recommendations from the 2017 Investment Strategy, included and not limited to: • Consider using revised bond language from proposition 13, modified to allow fund maintenance endowments on existing lands and newly acquired lands • endowment grants from DWR using General funds • endowment grants from CDFW or WCB • endowment funds from the Ecological non-profit organizations • New SSJDD assessment or another-type of systemwide assessment • Water fee • Sell sequestered carbon and water conserved water • User fees • Includes prioritization of funding for long term O&M in/near disadvantaged communities • Use AB 2087 to obtain credits that can be sold over time to finance long term O&M	3 - Considered as guiding principles or best management practices to inform other program or planning activities. 4 - Already being implemented by other ongoing activities.	The CVFPP considers overarching recommendations to address challenges associated with long-term O&M, including funding, but some specifics from this recommendation may not be included. The intent of this recommendation is captured in Chapter 4 of the CVFPP.	Not applicable.	Not applicable.
I15a	Encourage DWR to continue to develop a decision support tool to provide flexibility to meet multi-benefit objectives when using multiple multi-benefit sources, i.e. the DWR "One Landscape Vision"	2 - Included in CVFPP.	This recommendation is being implemented by ongoing activities that apply to other DWR programs as well (refer to I17).	Not applicable.	Table 3.3 #07: Continue to periodically update the best available science, tools, and data to improve understanding of the condition, performance, and response of the flood system for CVFPP updates, Conservation Strategy updates, and related performance tracking systems in collaboration with partners.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I15b	Simplify and unify administrative and application requirements for state and potentially federal grants. • State of California or CNRA together with CAL EPA develops uniform, administrative terms for all state grants used to fund Multi-benefit projects similar to the OMB Uniform guidance and Federal Form SF 424. Consider making state administrative requirements identical to federal requirements. • State of California or CNRA together with CAL EPA develops uniform policy on indirect cost definitions and recovery consistent with federal guidance. Consider using federal negotiated indirect cost recovery agreements.	2 - Included in CVFPP. 5 - Considered for future CVFPP planning cycles.	The intent of this recommendation aligns with the CVFPP, but the implementation of specific actions is outside of CVFPP jurisdiction.	Not applicable.	Table 3.3 #01: Establish basin-specific task forces of high-level decision-makers and staff from State, federal, and local agencies, Tribes, and other partners to further advance implementation of projects and programmatic implementation of the CVFPP: • Facilitating interagency coordination and collaboration regarding multi-benefit project funding prior to issuing guidelines, collaborating on funding strategies and priorities, and aligning funding programs to best advance multi-benefit projects.
I15c	Simplify the grant application process for bond funds. Encourage conceptual proposals and shorten the time required between grant application and executed grant agreement. See recommendations of CDFW Restoration Leaders Committee. • Create a special multi-benefit planning fund to assist landowners (private or public) with timely provision of planning and CEQA funds to avoid the long delays associated with getting planning grants. Need to develop special criteria to clarify what type of projects and applicants would qualify for this special program (i.e. a NGO that recently acquired a riverside land with state grant funds for restoration or conservation – don't make them get in line again for planning grant). • Encourage CNRA Departments to coordinate and pool funding to adequately fund Multi-benefit projects under a single, larger grant agreement rather than multiple, smaller grant agreements from different agencies or encourage individual departments/agencies to give larger grants.	2 - Included in CVFPP. 5 - Considered for future CVFPP planning cycles.	The intent of this recommendation aligns with the CVFPP, but the implementation of specific actions is outside of CVFPP jurisdiction.	Not applicable.	Table 3.3 #06: Obtain increased State and federal stable funding for flood management, including ongoing investments and multi-benefit capital projects in the Central Valley: • Advocate for new general obligation bond funding that promotes flexibility in funding flood management projects with single or multiple societal benefits.
I15d	CNRA or state/fed should designate a high-level person (or team of people) to champion and manage agency coordination on multiple-benefit project funding on or near SPFC facilities.	6 - Outside the scope of CVFPP and Conservation Strategy.	Refer to I05b and I06a.	Not applicable.	Refer to I05b.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I16	Make recommendations for future bond language to provide flexibility needed to fund planning, implementation, and long-term monitoring and maintenance of multi-benefit projects. DWR legal staff (or their consultants) to develop a technical memorandum on how past bond language resulted in unintended barriers or delays for planning, implementation, and long-term maintenance of Multi-benefit projects and make recommendations for future bond language to facilitate multi-benefit projects. Evaluate what limitations are controlled by bond language as opposed to overarching bond laws and regulations.	2 - Included in CVFPP. 5 - Considered for future CVFPP planning cycles.	While the CVFPP may not include some specifics, the intent of this recommendation is included to the extent currently feasible with available resources.	Not applicable.	Table 3.3 #06: Obtain increased State and federal stable funding for flood management, including ongoing investments and multi-benefit capital projects in the Central Valley: • Advocate for new general obligation bond funding that promotes flexibility in funding flood management projects with single or multiple societal benefits.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
I17	Direct more funding and incentives to local, regional, non-profit, and public/private partnerships to plan and implement Multi-benefit projects to achieve CVFPP goals rather than attempting to impose from the top down. • DWR to provide planning grants to RFMP agencies to engage regional stakeholders in the development of regional multi-benefit visions with a portfolio of specific multi-benefit projects. • Fund and empower Reclamation Districts to advance multi-benefit projects. • CNRA and or DWR provide leadership and technical assistance on developing advance mitigation credits. • Provide grants to regions and local flood management agencies to advance mitigation plans. • Provide incentives and/or legal mechanisms for urban flood control agencies to advance ecosystem restoration or multi-benefit project in nearby rural areas. • Give urban flood management agencies advance mitigation credits for ecosystem restoration and multi-benefit projects in nearby rural areas. (RCIS and MCAs that allow urban areas to get advance mitigation credit for projects in nearby rural areas.) • DWR should provide technical assistance and special planning grants to assist disadvantaged communities. • DWR should contract with local agencies or NGO's that specializes in working with disadvantaged communities to help multiple disadvantaged communities advance multi-benefit projects. • Prioritize public funding for projects that benefit disadvantaged communities. • Encourage DWR to continue to develop a decision support tool to provide flexibility to meet multi-benefit objectives when using multiple multi benefit sources, i.e. the DWR "One Landscape Vision".	2 - Included in CVFPP. 3 - Considered for use as guidance or best management practices to inform other program or planning activities. 4 - Already being implemented by other ongoing activities.	While some specifics of this recommendation may not be included, the overarching intent is reflected in the CVFPP and is being implemented through ongoing and proposed activities undertaken by DWR and other agencies.	Not applicable.	Table 3.3 #01: Review existing governance and authorities to identify overlapping authorities and propose recommendations for reconciliation between and among State, federal, and local agencies and Tribes to improve implementation of flood projects, particularly in rural and underserved communities. Table 3-3 #06: Obtain increased State and federal stable funding for flood management, including ongoing investments and multi-benefit capital projects in the Central Valley: • Increase funding to reduce residual flood risk in socially vulnerable communities and increase community resilience. Table 3-3 #08: Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan Program, which will support the six planning regions.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P01	Clarify required elements of a multi-benefit project and for specific regions determine whether a regional permitting approach, such as participation in HCPs or RCIS's for example, would facilitate subsequent permitting for future multi-benefit projects.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	The CVFPP and Conservation Strategy discuss a regional permitting approach.	Table 3-8: Consider developing a regional permitting approach to facilitate the implementation of multi-benefit projects. Using established permitting mechanisms such as HCPs, RCISs/MCAs, and others can facilitate the coordinated planning of multi-benefit projects throughout a region or corridor, potentially expediting permitting and providing a mechanism to secure advance mitigation.	Table 3-3 #02: Work with appropriate resource agencies to create and implement regional-scale and long-term permitting mechanisms, where appropriate, for implementation and operations and maintenance (O&M) of flood management activities, including multi-benefit projects. Table 3-3 #12: Explore, create, and implement regional-scale and long-term multi-benefit programs for planning, implementation, and long-term management that includes single-purpose projects as needed consistent with, and supportive of, broader, regional actions, to leverage funding sources and align program priorities.
P02	Encourage project proponents to engage in early coordination with regulatory agencies during conceptual design phase.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Early engagement and agency coordination is a key component of the CVFPP and Conservation Strategy (refer to I07a).	Table 3-8: Promote early engagement and coordination with regulatory agencies to improve the permitting process and conservation outcomes. DWR, project proponents, and RFMPs may benefit by convening workshops and meetings with the regulatory agencies when developing project priority lists and during project design.	Table 3-3 #01: Establish basin-specific task forces of high-level decision-makers and staff from State, federal, and local agencies, Tribes, and other partners to further advance implementation of projects and programmatic implementation of the CVFPP: • Facilitating interagency coordination and collaboration regarding multi-benefit project funding prior to issuing guidelines, collaborating on funding strategies and priorities, and aligning funding programs to best advance multi-benefit projects. Table 3.3 #08: Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan Program, which will support the six planning regions and facilitate the following: • Establishment of a collaborative forum for early agency engagement and coordination where project proponents (e.g., State or local partners) can share progress and obtain agency input.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P03	Develop agency workgroup with multiple agencies represented; encourage consistency among agencies where possible regarding permitting timelines and requirements.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Agency coordination is a key component of the CVFPP and Conservation Strategy.	Table 3-8: Consider reconvening the IAC workgroup to collaborate on effectively permitting multi-benefit projects and develop permitting protocols to find efficiencies among agencies, as appropriate.	Table 3.3 #02: Work with appropriate resource agencies to create and implement regional-scale and long-term permitting mechanisms, where appropriate, for implementation and O&M of flood management activities, including multi-benefit projects, considering the following: Initiating memorandums of agreement or memorandums of understanding between DWR and regulatory agencies to standardize and streamline some permitting elements for multi-benefit projects and provide greater transparency of the regulatory process.
P04	Work toward standardization of permitting/mitigation and avoidance and mitigation measure requirements that can be applied to multi-benefit projects in recognition that these projects provide important habitat components as part of their project description.	4 - Already being implemented by other ongoing activities.	DWR is participating in programs that are contributing to this effort; for example, the RCIS and MCA process in Yolo County and the Yolo Bypass Master Planning approach. However, given project-specific details and differences among permits, some standardization is not feasible (refer to P03 and P06).	Not applicable.	Not applicable.
P05	Regulatory agencies should provide greater transparency in permitting processes and mitigation requirements, to assist applicants in understanding the conditions and how mitigation measures are applied.	4 - Already being implemented by other ongoing activities. 6 - Outside the scope of CVFPP and Conservation Strategy.	Implementation of this recommendation is applicable to other agencies. However, pursuant to SB 473, CDFW is now posting new ITPs on their public website; refer to Appendix D for the URL (refer to P02 and P03).	Not applicable.	Not applicable.
P06a	Consider MOAs or MOUs between DWR and regulatory agencies (consistent with Cutting Green Tape initiative) to standardize permitting for multi-benefit projects.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Agency coordination is a key component of the CVFPP and Conservation Strategy.	Table 3-8: Seek a memorandum of agreement or memorandum of understanding between DWR, LMAs, and regulatory agencies that establishes standard avoidance and minimization measures for multi-benefit projects and O&M.	Table 3.3 #02: Initiating memorandums of agreement or memorandums of understanding between DWR and regulatory agencies to standardize and streamline some permitting elements for multi-benefit projects and provide greater transparency of the regulatory process.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P06b	Recognizing that each project is unique and regulatory agencies must specify acceptable mitigation to offset the specific impacts of the project, agencies should clarify policies applied to determine mitigation needs and requirements for individual unique projects, to reduce the unpredictability of case-by-case decision-making (policies are currently somewhat vague or not well understood by project proponents).	6 - Outside the scope of CVFPP and Conservation Strategy.	Standardizing and streamlining permitting processes aligns with the purpose of the CVFPP; however, directing the actions of other agencies is outside the CVFPP's scope (refer to P04).	Not applicable.	Not applicable.
P06c	Work with agencies to develop templates that can be applied to multi-benefit projects.	1 - Included in Conservation Strategy. 3 - Considered for use as guidance or best management practices to inform other program or planning activities.	This is part of a broader strategy to coordinate with regulatory agencies (refer to I02).	Table 3-8: Develop guidance to help project proponents identify components in their projects that meet multi-benefit and Conservation Strategy measurable objectives. This can be used by project proponents beginning in the early design phase and through project permitting to optimize ecological features and potentially expedite the regulatory process.	Not applicable.
P06d	Regional permitting could result in better consistency in permit requirements	1 - Included in Conservation Strategy. 4 - Already being implemented by other ongoing activities.	Refer to P01.	Table 3-8: Consider developing a regional permitting approach to facilitate the implementation of multi-benefit projects. Using established permitting mechanisms such as HCPs, RCISs/MCAs, and others can facilitate the coordinated planning of multi-benefit projects throughout a region or corridor, potentially expediting permitting and providing a mechanism to secure advance mitigation.	Not applicable.
P06e	Take advantage of CDFW and other agencies' processes for making incidental take permits available and seek access to incidental take permits early in project design/planning phase.	1 - Included in Conservation Strategy.	This recommendation will require coordination with other agencies. However, pursuant to SB 473, CDFW is now posting new ITPs on their public website; refer to Appendix D for the URL (refer to P02 and P05).	Refer to content related to this topic in Appendix D. Table 3-8: Promote early engagement and coordination with regulatory agencies to improve the permitting process and conservation outcomes. DWR, project proponents, and RFMPs may benefit by convening workshops and meetings with the regulatory agencies when developing project priority lists and during project design.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P07	Describe communication path opportunities and steps to include public agency coordination during project planning. Inform project proponents that early coordination can lead to improved understanding of permit requirements, and ways to optimize project benefits and avoid/minimize impacts. Where appropriate include project components that seek to meet the definition of multi-benefit and which measurable objectives are being met within the project description.	1 - Included in Conservation Strategy. 3 - Considered for use as guidance or best management practices to inform other program or planning activities.	This is part of a broader strategy to coordinate with regulatory agencies. Early engagement and agency coordination is a key component of the CVFPP and Conservation Strategy (refer to I07 and P02).	Table 3-8: Promote early engagement and coordination with regulatory agencies to improve the permitting process and conservation outcomes. DWR, project proponents, and RFMPs may benefit by convening workshops and meetings with the regulatory agencies when developing project priority lists and during project design. Develop guidance to help project proponents identify components in their projects that meet multi-benefit and Conservation Strategy measurable objectives. This can be used by project proponents beginning in the early design phase and through project permitting to optimize ecological features and potentially expedite the regulatory process.	Not applicable.
P08	Identify challenges and opportunities associated with species protected by both FESA and CESA where different mitigation paths are needed.	3 - Considered as guiding principles or best management practices to inform other program or planning activities.	While specifics of this recommendation may not be included, the overarching intent of aligning permitting requirements is consistent with the CVFPP's purpose.	Not applicable.	Not applicable.
P09	Certain multi-benefit projects may help some species but impact other species. In the past, DWR provided advanced mitigation funding, so this could be done for multi-benefit projects to offset adverse effects to species impacted by the project, particularly when it is not possible to incorporate mitigation for a particular species or habitat type into the project.	1 - Included in Conservation Strategy. 2 -Included in CVFPP.	Refer to P12.	Table 3-8: Secure funding for advance mitigation projects. Numerous multi-benefit flood, O&M, and single-purpose projects will require mitigation for impacts on multiple resources; funding advance mitigation increases the availability of compensatory mitigation and could provide conservation benefits over time.	Table C-4 #3: Identify existing permitting mechanisms, and/or recommend new policies, that allow mitigation or uplift "credits" attained through multi-benefit project implementation to assist in implementing future flood risk reduction projects, offset environmental impacts, or meet grant funding requirements. This may require using existing permitting mechanisms, such as the Regional Conservation Investment Strategies, developing new mitigation banks, or pioneering new policies that allow programmatic, regional approaches to mitigation crediting.
P10	Look at opportunities to elevate qualifying RFMP multi-benefit projects as a state prioritized regional beneficial project (i.e. as a Basin-Wide Feasibility Study project) to allow greater State participation for permitting, etc.	5 - Considered for future CVFPP planning cycles.	This level of coordination could be considered once additional resources are available.	Not applicable.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P11	Explore options for providing improved funding, technical support, and incentives; explore regional or statewide led solutions for assisting disadvantaged communities with permitting of multi-benefit projects.	2 - Included in CVFPP.	The overarching goal of assisting underserved communities is included in the CVFPP.	Not applicable.	Table 3.3 #01: Review existing governance and authorities to identify overlapping authorities and propose recommendations for reconciliation between and among State, federal, and local agencies and Tribes to improve implementation of flood projects, particularly in rural and underserved communities. Table 3.3 #11: Progress equity and environmental justice in flood management planning, design, decision-making, implementation, and monitoring.
P12	DWR could develop mitigation banks to alleviate mitigation needs for species and habitats not readily addressed by mitigation on-site.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Refer to P09.	Table 3-8: Secure funding for advance mitigation projects. Numerous multi-benefit flood, O&M, and single-purpose projects will require mitigation for impacts on multiple resources; funding advance mitigation increases the availability of compensatory mitigation and could provide conservation benefits over time.	Table 3.3 #02: Work with appropriate resource agencies to create and implement regional-scale and long-term permitting mechanisms, where appropriate, for implementation and O&M of flood management activities, including multi-benefit projects, considering the following: • Using mitigation banks or creating mitigation credits through a mitigation credit agreement as appropriate and to streamline costs, explore creating mitigation credits in bulk for use for flood risk reduction projects.
P13	Regulatory agencies should clarify rules and policies used to establish mitigation requirements for individual projects.	6 - Outside the scope of CVFPP and Conservation Strategy.	The implementation of this recommendation applies to the regulatory agencies (refer to P01).	Not applicable.	Not applicable.
P14	Where habitat creation onsite exceeds mitigation requirements, uplift should be acknowledged and described in the project description.	4 - Already being implemented by other ongoing activities.	Project proponents are incorporating this practice.	Not applicable.	Not applicable.
P15	Where channel vegetation must be removed periodically for conveyance, project proponents could enter into agreements with regulatory agencies for one-time mitigation up front that exceeds anticipated impacts from future periodic vegetation removal.	1 - Included in Conservation Strategy.	Refer to P16.	Table 3-8: Encourage and assist implementers of multi-benefit projects to develop O&M plans and incorporate these into their overall project descriptions and regulatory applications.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P16	In developing multi-benefit projects, include in agency consultation the need for long term operation and maintenance (from Sec. 7 standpoint) to develop a mutually acceptable long-term maintenance plan and to get listed species take coverage.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Implementation of specific actions will depend on agency partners.	Table 3-8: Encourage and assist implementers of multi-benefit projects to develop O&M plans and incorporate these into their overall project descriptions and regulatory applications.	Table 3.3 #02: Work with appropriate resource agencies to create and implement regional-scale and long-term permitting mechanisms, where appropriate, for implementation and O&M of flood management activities, including multi-benefit projects. Table 3.3 #09: Continue to prioritize actions that repair and rehabilitate existing flood system features by: • Incorporating long-term O&M considerations and best management practices into planning, design, permitting (including long-term O&M coverage in permits for system improvement projects), and construction phases of flood risk reduction projects, multi-benefit projects, and encourage other project proponents to do the same.
P17	Describe methods to secure maintenance plans and species take authorization approved by agencies and proponents to avoid repeated conflicts and repeated mitigation each time maintenance occurs. Describe environmentally sensitive methods and conditions for vegetation removal and replacement. Long-term maintenance plans should include structuring the actions that could affect the habitat in ways that maintain the habitat quality and also meet flood risk reduction needs.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Refer to P16.	Table 3-8: Develop guidance with standardized avoidance and minimization measures that can be incorporated into O&M plans for multi-benefit projects to maintain and optimize habitat quality while providing assurances and standardized methods for completing O&M.	Refer to P16.
P18	Develop templates for O&M that consider long-term maintenance of restoration projects. Long-term maintenance should be assumed and calculated during permitting process. Maintenance plans also need to consider long-term protection and enhancement of vegetation.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Refer to P16.	Table 3-8: Develop guidance with standardized avoidance and minimization measures that can be incorporated into O&M plans for multi-benefit projects to maintain and optimize habitat quality while providing assurances and standardized methods for completing O&M.	Refer to P16.
P19	Conflicting permit requirements related to protection of vegetation versus removal needs to be resolved through negotiations with standardized language developed that can be applied to individual situations.	5 - Considered for future CVFPP planning cycles.	This level of detail could be considered once additional resources became available (refer to P06d).	Not applicable.	Not applicable.
P20	Consider that providing State funding for long-term maintenance because multi-benefit project elements provide a statewide “general” benefit.	2 - Included in CVFPP.	This recommendation aligns with the purpose of the CVFPP.	Not applicable.	Table 3.3 #06: Obtain increased State and federal stable funding for flood management, including ongoing investments and multi-benefit capital projects in the Central Valley.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P21	Because there is a need for improved coordination among projects and landscape-scale connectivity, establish regional technical advisory committees. For the Upper Sacramento River region, the technical advisory committee met monthly to discuss status of projects, conflicts, and solutions which proved to be an effective process.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Regional coordination is a priority of the CVFPP.	Table 3-8: Develop landscape-scale permitting mechanisms that apply or complement existing means of expediting the permitting of multi-benefit projects. Consider reconvening the IAC workgroup to collaborate on effectively permitting multi-benefit projects and develop protocols to find efficiencies among agencies as appropriate.	Table 3.3 #08: Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan Program, which will support the six planning regions and facilitate the following: • Establishment of regional technical advisory committees to improve coordination, landscape-scale connectivity, and development of a regional vision for multi-benefit projects.
P22	Describe opportunities and methods for improved inter-project coordination and project integration with natural processes (climate change, hydrology, species migration, groundwater recharge and flow patterns, etc.) at a landscape scale. Look for and support opportunities to develop regional working groups.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	Some of this information is provided in the Conservation Strategy and the Climate Change Adaptation for the CVFPP Conservation Strategy Update Memorandum (Appendix H).	Refer to content in Section 3.4.1.	Table 3.3 #07: Continue to periodically update the best available science, tools, and data to improve understanding of the condition, performance, and response of the flood system for CVFPP updates, Conservation Strategy updates, and related performance tracking systems in collaboration with partners. Table 3.3 #08: Secure annual dedicated funding to continue and expand the successful Regional Flood Management Plan Program, which will support the six planning regions. • Establishment of regional technical advisory committees to improve coordination, landscape-scale connectivity, and development of a regional vision for multi-benefit projects.
P23	Ensure project proponents are aware of and have access to mapping and data that identifies connectivity gaps so their projects can be designed in a way to maximize habitat connectivity and species movement through corridors.	5 - Considered for future CVFPP planning cycles.	Making data available to project proponents is a goal of the CVFPP, and efforts are underway, but it is currently not feasible to provide this level of detail and certainty.	Table 3-8: Re-inventory vegetation, natural bank, and riparian-lined bank throughout all CPAs and continue to make this data publicly available. Refer to Table 3-6, "Data Gaps Related to Targeted Ecosystem Processes, Habitats, and Species."	Table 3.3 #07: Continue to periodically update the best available science, tools, and data to improve understanding of the condition, performance, and response of the flood system for CVFPP updates, Conservation Strategy updates, and related performance tracking systems in collaboration with partners.
P24	Continue to align other statewide plans – comprehensive approach not piecemeal or incremental approach to planning multiple benefit projects.	1 - Included in Conservation Strategy. 2 - Included in CVFPP.	This is part of a broader strategy to promote interagency coordination.	Refer to content in Section 3.4.1.	Refer to content in Chapters 2 and 3.
P25	Develop a protocol for determining whether a particular project meets the 2017 CVFPP definition of a multi-benefit project.	1 - Included in Conservation Strategy (Appendix F). 4 - Already being implemented by other ongoing activities.	This recommendation is being implemented by ongoing activities and is covered in the Conservation Strategy (refer to I02 and I07).	Refer to content in Appendix F.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
P26	Public, stakeholder, and agency engagement should be encouraged in development of a regional vision.	4 - Already being implemented by other ongoing activities.	Consistent with the past two CVFPP updates, stakeholder engagement is a core consideration as part of the public engagement and planning process (refer to I17 and P01).	Not applicable.	Not applicable.
P27	Ensure regular engagement of local communities throughout project development, design, and construction of projects.	2 - Included in CVFPP.	Refer to P26.	Not applicable.	Table C-6 #5: Ensure regular engagement of local communities throughout project development, design, and construction of projects. Issue funding and guidance to the RFMP areas on engagement and formulation in developing a landscape vision for the Region that includes an integrated portfolio of MBPs to advance the Conservation Strategy measurable objectives while achieving CVFPP goals.
T01a	Define the difference and create clear distinction between uplift and mitigation and track how a single site or parcel might change its status over time (for example, it might be uplift for five years and then convert to mitigation). [Cross-cutting with Permitting]	1 - Included in Conservation Strategy (Appendix F).	Refer to I01.	Refer to content in Appendix F.	Not applicable.
T01b	Track current and projected extent of available suitable habitat in different categories over time. (e.g. inundated floodplain, shaded riverine aquatic, Swainson's hawk foraging, etc.) Identify and track different kinds of mitigation (compensatory, out-of-kind, surplus, self-mitigation, and advanced).	1 - Included in Conservation Strategy (Appendices E and F). 4 - Already being implemented by other ongoing activities.	The CSMOs are being tracked and the compensatory mitigation element is addressed in Appendix E and continues to be developed.	Refer to Appendices E and F.	Not applicable.
T01c	Track amount of land/habitat needed to achieve CS objectives in relation to current and projected extent of available suitable habitat (previous bullet) to ensure that CS objectives can be met.	5 - Considered for future CVFPP planning cycles.	Tracking habitat related to the measurable objectives is a key component of the CVFPP, but providing this level of detail is not currently feasible (refer to T03).	Refer to T03a.	Not applicable.
T02a	Track uplift that 'free-rides' with a targeted mitigation project (e.g., Swainson's hawk mitigation for nesting includes a lot of SRA that improves habitat for other aquatic species as an unintended consequence). [Cross-cutting with Multi-Benefit Implementation] [Cross-cutting with Permitting].	6 - Outside the scope of CVFPP and Conservation Strategy.	Refer to T01b.	Not applicable.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
T02b	Need to address and track how these additional benefits are categorized/ credited (under what circumstances do they become mitigation and get credited as such or not).	6 - Outside the scope of CVFPP and Conservation Strategy.	Refer to T01b.	Not applicable.	Not applicable.
T03a	Track gains and losses in habitat for different species and for different functions so that we understand how much real (net) progress we are making towards CS measurable objectives, recovery plan objectives and others.	1 - Included in Conservation Strategy (Appendix F). 6 - Outside the scope of CVFPP and Conservation Strategy.	Tracking habitat and mitigation has been and continues to be a key component of the Conservation Strategy, but tracking recovery plan objectives is outside the CVFPP's scope.	Section 3.4.5.1: DWR has been developing internal data management and decision support tools to balance its compensatory mitigation needs and other habitat obligations, while working toward goals for increasing the quantity and quality of habitats and contributing to species' recovery. These decision support tools complement the FPTS in that they are forward-looking, comparing project data from the FPTS to forecasted needs and objectives across DWR programs.	Not applicable.
T03b	As a component of this, track lands not included in projects designated as mitigation where uplift is possible, relative to remaining need necessary to meet CS objectives (see bullet above).	1 - Included in Conservation Strategy (Appendix F). 4 - Already being implemented by other ongoing activities.	Refer to T03a.	Refer to content in Appendix F.	Not applicable.
T04	Track habitat types (marsh, riparian, SRA, natural bank, floodplain), outlined in the Conservation Strategy (Appendix L Sections 2 and 3 [Tables L3-x]) as well as species specific habitats. [Cross-cutting with Permitting]	1 - Included in Conservation Strategy (Appendix F). 4 - Already being implemented by other ongoing activities.	Refer to T03a.	Refer to content in Appendix F.	Not applicable.
T05	Track lost opportunities for restoring habitat that could occur with restoration or mitigation projects that block or otherwise preclude restoration of other habitat on those lands or the same or other habitat on adjacent lands. [Cross-cutting with Multi-Benefit Implementation]	5 - Considered for future CVFPP planning cycles.	Tracking habitat is a key component of the Conservation Strategy; however, this level of detail was determined to not contribute significantly to obtaining the measurable objectives. Existing FROA and future EcoFIP data could allow this type of analysis (refer to P09).	Not applicable.	Not applicable.
T06	Address question of baseline that arose a few times: to what baseline do we compare observed 'uplift'? Do we need to establish a baseline if we have objectives and are tracking current conditions?	1 - Included in Conservation Strategy (Appendix F). 4 - Already being implemented by other ongoing activities.	This element is addressed in Appendix F and continues to be developed.	Refer to content in Appendix F.	Not applicable.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
T07a	Assemble (/Develop) thresholds for suitable habitat quantity and quality and consistent metrics/ methods for tracking habitat relative to thresholds (e.g. CVHE). [Cross-cutting with Permitting]	6 - Outside the scope of CVFPP and Conservation Strategy.	This level of detail is beyond the scope of the CVFPP and Conservation Strategy; however, the measurable objectives were established with the goal of promoting ecosystem vitality throughout the system (refer to T06).	Not applicable.	Not applicable.
T07b	The above may involve assembly and relation of habitat types and thresholds from different sources (e.g., CS, species recovery plans, CVHE, etc.) and identification of gaps or inconsistencies.	6 - Outside the scope of CVFPP and Conservation Strategy.	Refer to T07a.	Refer to T03a.	Not applicable.
T08	Make the CVFPP Performance Tracking Tool and the DWR Habitat Portfolio Management System (HPMS) linkable/ connected. Since there will be considerable overlap in content and application, we recommend the linkage between the two be considered deliberately from the beginning to facilitate updating and maintaining the two as simply and effectively as possible.	2 - Included in CVFPP.	This alignment is under progress within the planning teams of the CVFPP 2022 process, and may have a publicly available interface when further developed.	Refer to T03a.	Table C-4 #2: Commit to continuing to fund, develop, and implement a flood and ecosystem performance accounting and adaptive management system for the CVFPP. This would include a common framework of indicators, metrics, tool sets, and databases that allow DWR and partners to determine progress towards the societal outcomes, CVFPP goals, and flood performance and ecological measurable objectives identified in the CVFPP; adaptively manage the flood system and inform future plan updates; and communicate progress to stakeholders.

No.	Recommendation [a]	Status of Incorporation of Advisory Committee Recommendations [b]	Comments	How the 2022 Conservation Strategy Addresses this Recommendation	How the 2022 CVFPP Update Addresses this Recommendation
T09	This tracking system should reveal the amount of current, planned, and potential habitat relative to CS measurable objectives as well as what is and is not working vis a vis 1) funding of project types (uplift, mitigation), 2) locations and landscape level coherence, and 3) increasing actual extent and quality of habitat over time. Ideally, the tracking process would include an inherent set of systematic incentives for actual net uplift so that we can meet our measurable objectives. Documenting quantitatively and in map form, these areas that are and are not working in the existing system should help motivate and direct improvements, so that we can move more quickly and effectively towards the Conservation Strategy goals and objectives. [Cross-cutting with Multi-Benefit Implementation]	4 - Already being implemented by other ongoing activities. 5 - Considered for future CVFPP planning cycles.	A tracking system is under development, and this level of detail may be considered as additional resources become available. Refer to T08.	Refer to T03a.	Not applicable.

[a] Recommendations are included verbatim as they were received from the Advisory Committee.

[b]

1. Included in Conservation Strategy.
2. Included in CVFPP.
3. Considered as guiding principles or best management practices to inform other program or planning activities.
4. Already being implemented by other ongoing activities.
5. Considered for future CVFPP planning cycles.
6. Outside the scope of CVFPP and Conservation Strategy.

Notes:

AB = Assembly Bill
CAL EPA = California Environmental Protection Agency
CDFW = California Department of Fish and Wildlife
CEQA = California Environmental Quality Act
CESA = California Endangered Species Act
CNRA = California Natural Resources Administration
CPA = conservation planning area
CS = Conservation Strategy
CSMO = Conservation Strategy Measurable Objectives
CVFPB = Central Valley Flood Protection Board
CVFPP = Central Valley Flood Protection Plan
CVHE = Central Valley Habitat Exchange
DWR = California Department of Water Resources
EcoFIP = ecological floodplain inundation potential
FEMA = Federal Emergency Management Agency
FESA = federal Endangered Species Act
FPTS = Flood Performance Tracking System
FROA = Floodplain Restoration Opportunity Analysis
HCP = habitat conservation plan
IAC = interagency advisory committee
ITP = incidental take permit
LMA = local maintaining agency
MBP = multi-benefit project
MCA = mitigation credit agreement
MOA = memorandum of agreement
MOU = memorandum of understanding
O&M = operations and maintenance
OMB = Office of Management and Budget
OMRR&R = operations and maintenance, repair, replacement, and rehabilitation
RCIS = regional conservation investment strategy
RFMP = regional flood management plan
SB = Senate Bill
Sec. = Section management
SPFC = State Plan for Flood Control
SRA = shaded riverine aquatic
SSJDD = Sacramento-San Joaquin Drainage District
WCB = Water Control Board
YB = Yolo Bypass

Appendix H
Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update

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Contents

Attachment

Tables

Figures

Figures (continued)

Acronyms and Abbreviations

Acronym	Definition
AEP	annual exceedance probability
AR	atmospheric river
CMIP5	Coupled Model Intercomparison Project Phase 5
Conservation Strategy (or Strategy)	Central Valley Flood Protection Plan Conservation Strategy
CPA	conservation planning area
CVFPP	Central Valley Flood Protection Plan
EcoFIP	Ecological Floodplain Inundation Potential
ET	evapotranspiration
FIP	floodplain inundation potential
FIRO	Forecast-informed Reservoir Operations
Flood-MAR	flood-managed aquifer recharge
FROA	Floodplain Restoration Opportunity Analysis
GCM	general circulation model
HEC-RAS	Hydrologic Engineering Center River Analysis System
HEC-ResSim	Hydrologic Engineering Center Reservoir System Simulator
IEA	International Energy Agency
km	kilometer(s)
memorandum	Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update
Portfolio	Water Resilience Portfolio
RCP	representative concentration pathway
SPA	systemwide planning area
SPFC	State Plan of Flood Control
SRA	shaded riverine aquatic

Acronym	Definition
SSIA	State Systemwide Investment Approach
State	State of California
Strategy (or Conservation Strategy)	Central Valley Flood Protection Plan Conservation Strategy
SWE	snow water equivalent
VIC	variable infiltration capacity

Glossary

Glossary Term	Definition
adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. (Definition from International Panel on Climate Change 2014.)
adaptation measure	An adaptation measure refers to an action that enhances resilience or reduce vulnerability to observed or expected changes in climate.
adaptation strategy	An adaptation strategy refers to a policy or planning approach designed to enhance resilience or reduce vulnerability to observed or expected changes in climate.
adaptive management	(1) a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives (California Water Code Section 8502). (2) management that improves the management of biological resources over time by using new information gathered through monitoring, evaluation, and other credible sources as they become available, and adjusts management strategies and practices to assist in meeting conservation and management goals. Under adaptive management, program actions are viewed as tools for learning to inform future actions (California Fish and Game Code Section 13.5).
conservation planning area (CPA)	One of five subdivisions of the systemwide planning area that differs from other CPAs in regard to natural resources and CVFPP activities. Each CPA consists of one or more regional flood management plan regions and the adjoining upstream portions of the SPA.
dynamic equilibrium	In the context of river systems, the natural balance between sediment size and volume with stream slope and discharge. It can be widely variable over short periods of time depending on activities occurring in the watershed, including snowmelt time, natural vegetation cover, etc.

Glossary Term	Definition
dynamic hydrologic and geomorphic processes	In the context of river systems, the processes of water flow subsurface, overland, and in rivers and the resulting entrainment, transport, and storage of sediment in river channels and on floodplains.
floodplain	*Active (or "connected") floodplain:* The geomorphic surface adjacent to the stream channel that is typically inundated on a regular basis (i.e., with a recurrence interval of about 2 to 10 years or less). It is the most extensive low-depositional surface, typically covered with fine overbank deposits, although gravel bar deposits may occur along some streams.
Inactive (or disconnected) floodplain	Historical floodplains that are no longer inundated because of channel incision, flow regime changes, or intervening levees. The floodplain surface often contains abandoned channels or secondary channels (i.e., chutes).
geomorphology	The study of the characteristics, origins, and development of landforms.
multi-benefit project	In the context of the CVFPP, projects designed to reduce flood risk and enhance fish and wildlife habitat. Multi-benefit projects may also create additional public benefits such as sustaining agricultural production, improving water quality and water supply reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and educational opportunities, or any combination thereof. (Definition from DWR 2017a.)
operations and maintenance (O&M)	The effort that must be expended to keep project facilities in good working condition so they continue to operate as designed—wear and tear on facilities that are not adequately maintained can reduce their capacity or make them more vulnerable to failure. O&M also refers to the management of adjustable features (e.g., flow rate, stage, reservoir storage) to achieve the desired conditions.
resilience	The capacity of a resource and natural or constructed system to adapt to and recover from changed conditions after a disturbance. (Definition from DWR 2018.)

Glossary Term	Definition
shaded riverine aquatic (SRA) cover	The unique, nearshore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. Key attributes of this aquatic area are as follows: (1) The adjacent bank is composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water contains variable amounts of woody debris, such as leaves, logs, branches, and roots; often has substantial detritus; and has variable velocities, depths, and flows. (Definition from U.S. Fish and Wildlife Service 1992.) SRA cover provides structural and functional integrity for several regionally important fish and wildlife species. It has drastically declined in area and has become increasingly fragmented in the Central Valley.
State Plan of Flood Control (SPFC)	The State and federal flood control works, lands, programs, plans, policies, conditions, and mode of O&M of the Sacramento River Flood Control Project, described in California Water Code Section 8350, and of flood control projects in the Sacramento River and San Joaquin River watersheds, authorized pursuant to Article 2 (commencing with Section 12648) of Division 6, Part 6, Chapter 2, for which the CVFPB or DWR has provided the assurances of nonfederal cooperation to the United States, and those facilities identified in California Water Code Section 8361 (California Water Code, Section 9110[f]).
systemwide planning area (SPA)	The geographic area that encompasses lands receiving flood damage reduction benefits from the existing SPFC facilities and operation of the Sacramento–San Joaquin River Flood Management System.
vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. (Definition from International Panel on Climate Change 2018.)
watershed	The land area from which water drains into a stream, river, or reservoir. The watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point. (Definition from DWR 2018.)

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CHAPTER H1

Introduction

The 2016 Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy, or Strategy) (DWR 2016) provided specific goals and objectives related to the conservation and restoration of ecological processes, habitats, and species, as well as the alleviation of ecological stressors within the Central Valley flood system. It is a critical supporting document of the CVFPP, and is being used as key guidance by State of California (State), regional, and local partners to implement multi-benefit projects that advance flood protection and ecosystem restoration. A key theme of the 2022 update to the CVFPP and Conservation Strategy is climate resilience; supported by a body of work to describe and better understand flood-related risks and vulnerabilities, and to provide a set of recommendations and adaptation strategies related to climate change. In addition, the 2020 Water Resilience Portfolio (Portfolio) identifies climate change as a key driver for California water resources and environmental management in the coming decades, and proposes management actions to mitigate impacts and improve system resiliency.

Climate change is a critically important issue, with major ecological consequences leading to changes in the abundance and distribution of many populations (Dunn and Møller 2019; Rosenzweig et al. 2008), including for the flood system in the Central Valley. The resilience thresholds of many ecosystems, including the riverine and floodplain habitats in the Central Valley flood system, are likely to be exceeded this century by an unprecedented combination of climate change and associated disturbances. This, combined with the cumulative effects of other anthropogenic activities, such as land use alterations and water use activities, will result in major impacts on ecosystem structures and functions (Trenberth and Hurrell 2019; Saether et al. 2019).

This Climate Change Adaptation Memorandum for the CVFPP Conservation Strategy Update (Memorandum or Appendix H) uses recent climate modeling analyses that have been developed to inform the 2022 CVFPP Update. Results are used to determine climate risks, vulnerabilities, and a fraction of the full range of uncertainties in the context of the Conservation Strategy, focusing on the measurable objectives and target species at the conservation planning area (CPA) scale. This evaluation involves three fundamental steps:

1. Estimate climate change drivers (e.g., changes in temperature, precipitation, and hydrology) at the scales and frequencies relevant to the Conservation Strategy’s measurable objectives.
2. Consider ecosystem responses to those changes, for the ecosystem process, habitats, species, and stressors identified in the Conservation Strategy.

3. Describe preliminary adaptation and management measures based on identified risks and vulnerabilities.

This Memorandum is consistent with, and supports the implementation of, the climate change adaptation measures described by Governor Gavin Newsom's Portfolio. The Portfolio was finalized on July 28, 2020, and provides the Administration's blueprint for equipping California to cope with more extreme droughts and floods and rising temperatures, while addressing long-standing challenges that include declining fish populations, over-reliance on groundwater, and a lack of safe drinking water in many communities. The Portfolio embraces a broad, diversified approach. Goals and actions are organized into four categories, one of which, "Protect and Enhance Natural Ecosystems," describes adaptation measures that are congruent with similar actions described by the Conservation Strategy.

This Memorandum informs the 2022 update to the Conservation Strategy, provides the basis to re-evaluate or refine measurable objectives in future updates, and more broadly, provides a template and process for how other State and regional programs can develop ecologically based climate change adaptation approaches.

Specifically, the objectives of this Memorandum are to:

1. Identify current climate modeling data and results that can be used to assess the spectrum of changes in hydrologic and geomorphic processes that could impact Conservation Strategy's measurable objectives and target species.
2. Estimate the ecological, habitat, and species-specific responses to these physical changes.
3. Describe preliminary adaptation measures and considerations for increasingly resilient multi-benefit projects.
4. Identify data gaps and additional tools or analyses that could be used to inform ecosystem responses and the development of adaptation measures.
5. Consider how Conservation Strategy-specific adaptation measures also provide benefits for larger CVFPP flood-related goals.

This Memorandum is organized into the following sections:

- **Chapter 2 – Background on Climate Modeling Research and Adaptation Approaches:** Summarizes existing climate change modeling and adaptation planning efforts, as well as key climate adaptation guidance relevant to the objectives of the Conservation Strategy.
- **Chapter 3 – Projected Hydroclimate Changes and Ecosystem Responses:** Analyzes projected changes in temperature, precipitation, and hydrology throughout the Central Valley, and describes the associated impacts of climate change on watersheds and ecosystems. Also characterizes the projected responses of the Conservation Strategy objectives to the effects of climate change.

- **Chapter 4 – Potential Adaptation Strategy and Measures:** Lists potential adaptation measures to improve the resilience and reduce the vulnerability of ecosystem processes, habitats, and species in the face of climate change.
- **Chapter 5 – Summary of Regional Climate Change Adaptation Strategies:** Identifies regional ecological risks and vulnerabilities, as well as opportunities to build ecological resiliency and mitigate the impacts of climate change.
- **Chapter 6 – Conclusions:** Summarizes key takeaways and recommendations from this memorandum.

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CHAPTER H2

Background on Climate Modeling Research and Adaptation Approaches

Research on climate change and its potential impacts has progressed rapidly in recent decades, although a great deal remains to be studied moving forward. Existing science has projected future changes in air temperature, precipitation, hydrologic responses, and sea level rise under numerous models and scenarios. However, ecological responses to these changes, particularly for habitats and species, have yet to be assessed in great detail. Uncertainties are also prevalent throughout much of this work, mainly due to the variability between climate models and lack of insight into all facets of hydroclimatic mechanisms and their changes. Nevertheless, climate change impacts on specific species and habitats represent an active field of scientific research, and these relationships are becoming increasingly well-understood.

The following tables summarize climate change modeling and adaptation planning efforts included for the 2022 CVFPP Update, as well as other climate adaptation guidance relevant to the Conservation Strategy's measurable objectives. Table H-1 includes brief descriptions and key findings of various reports focusing on climate change impacts. In general, these sources identify and estimate projected physical responses to climate change, assess impacts on ecosystems and human infrastructure, and provide strategies for adapting to future conditions. Table H-1 lists reports that provide a broad and inclusive overview of climate change impacts, and additional sources with a more focused approach can be found in Table H.1-1 of Attachment H.1.

Table H-2 provides a brief overview of a number of identified sources that provide climate adaptation guidance for the Conservation Strategy objectives, including physical processes, habitats, species, and stressors. Vulnerabilities and adaptation strategies related to climate change are also described for various listed species and habitats. The purpose of this table is to highlight key reports and studies that may be particularly insightful for the ecological processes, habitats, and species identified in the Conservation Strategy. Additional sources can be found in Table H.1-2 of Attachment H.1.

Table H-1. Summary of Climate Change Modeling and Adaptation Planning Efforts

Document Title and Author	Description	Reference
2022 CVFPP Update Climate Modeling Work and Key Results – California Department of Water Resources (2022)	The 2022 CVFPP Update is building on the climate analyses conducted for the 2017 update, and highlights three overarching themes: climate resilience; project implementation, accomplishments, and performance tracking; and alignment with other State efforts. Related climate modeling work and key results are referenced from the 2022 CVFPP Update Technical Analysis Appendix A: Climate Change Analysis.	Central_Valley_Flood_Protection_Plan
California Adaptation Planning Guide (APG) – California Governor's Office of Emergency Services (2020)	The California APG provides guidance to support local governments in addressing the impacts of climate change through local adaptation and resiliency planning. The APG is designed to be flexible for communities that wish to examine the consequences of climate change in a broader or more specific manner. The first APG was released in 2012 and was updated in 2020 to integrate and account for recent changes to information and practices. California Government Code Section 65302 requires local cities and counties to include climate adaptation and resiliency strategies in the safety section of their general plans. This planning guide aims to aid these local communities in their compliance with this code. The APG divides the adaptation planning process into four phases. Phase 1 (Explore, Define, and Initiate) includes identifying key assets of the local community, potential impacts of climate change, and important stakeholders in the area. Phase 2 (Assess Vulnerability) analyzes the climate change impacts identified in Phase 1 and determines the vulnerability of the community's assets. Phase 3 (Define Adaptation Framework and Strategies) takes the results from Phase 2 and develops an adaptation framework and strategies to address the local community's listed vulnerabilities. Finally, Phase 4 (Implement, Monitor, Evaluate, and Adjust) implements the adaptation framework from Phase 3 and continually monitors and evaluates its performance. Adjustments are made, if necessary.	2020-Adaptation-Planning-Guide-FINAL-June-2020-Accessible.pdf

Document Title and Author	Description	Reference
Delta Adapts: Creating a Climate Resilient Future – Delta Stewardship Council (2021)	Delta Adapts seeks to highlight future conditions and vulnerabilities to climate change in the Sacramento–San Joaquin Delta (Delta), and to describe mitigation and adaptation methods for communities, infrastructure, and ecosystems to address these impacts. Delta Adapts is divided into two phases: a vulnerability assessment (currently available), and an adaptation plan (in development). The vulnerability assessment characterizes existing and future vulnerabilities under climate change, and the adaptation plan aims to identify approaches that can be employed to enhance the region's resiliency. Primary climate stressors discussed in this report include precipitation and hydrologic patterns, air temperature, sea level rise, and extreme events. Secondary climate stressors include wind, fog, and wildfires. Key findings of the vulnerability assessment include worsening flood events, spatially varied climate change impacts on Delta residents, less reliable Delta exports, a lack of reservoir storage, water quality changes, threats to Delta ecosystems, and shifts in agricultural production trends.	Delta-Adapts-Vulnerability-Assessment

Document Title and Author	Description	Reference
CA Water Resilience Portfolio – California Natural Resources Agency, California Environmental Protection Agency, California Department of Food and Agriculture (2020)	The CA Water Resilience Portfolio contains recommended goals and actions for local and regional bodies to address water challenges in California. These are divided into four main categories: maintain and diversify water supplies, protect and enhance natural ecosystems, build connections, and be prepared. The Portfolio is a byproduct of Governor Newsom's Executive Order N-10-19 and was created with seven key principles in mind. These include: prioritize multi-benefit approaches that meet several needs at once; use natural infrastructure such as forests and floodplains; embrace innovation and new technologies; encourage regional approaches among water users sharing watersheds; incorporate successful approaches from other parts of the world; integrate investments, policies, and programs across State government; and strengthen partnerships with local, federal, and tribal governments, water agencies, irrigation districts, and other stakeholders. Vulnerability assessments are performed for various regions across California. Vulnerabilities are ranked in order of increasing vulnerability, from 1 to 4. Categories assessed include drinking water threats, water scarcity, unsafe beach conditions, impaired water quality, flood risks, limited drought readiness, threats to ecosystem vitality, challenges to sustainable groundwater management, sea level rise, affordability challenges, threats to agricultural sustainability, and aging infrastructure of statewide significance. Like adaptation planning, this Portfolio addresses various adaptation strategies to meet the State's water needs going forward. Specific adaptation strategies are listed under the four categories highlighted within the Portfolio, and additional adaptation strategies are included under the "Executing this Portfolio" section. In total, 32 adaptation actions are listed.	California-Water-Resilience-Portfolio-2020

Document Title and Author	Description	Reference
California's Fourth Climate Change Assessment – California Governor's Office of Planning and Research, State of California Energy Commission, California Natural Resources Agency (2018)	California's Fourth Climate Change Assessment identifies key vulnerabilities that the State faces as a result of climate change and provides guidance for actions that can improve resiliency. The assessment informs a number of State guidelines, programs, policies, and plans that aim to promote resiliency in California. The assessment outlines the vulnerabilities for individuals within California in the "Impacts of Climate Change on People" section. A map displaying the social vulnerability to heat using various health, social, and environmental factors is shown. The impacts of climate change on people, infrastructure, natural and working lands and waters, and the ocean and coast are assessed. Adaptation strategies are outlined throughout the assessment for the State to become more resilient in the face of climate change. Specific adaptation strategies include improvements to emergency management, disaster prevention, and increases to the institutional capacity of local and regional governments to protect all aspects of their regions.	www.climateassessment.ca.gov

Note:
APG = Adaptation Planning Guide

Table H-2. Summary of Climate Adaptation Guidance Relevant to Conservation Strategy Objectives

Document Title and Author	Description	Reference
Overview of Projected Future Changes in the California Central Valley – Central Valley Landscape Conservation Project (2017)	The Central Valley Landscape Conservation Project provides a general overview of the projected physical changes associated with climate change. These changes include the following: warming air temperatures, more arid landscapes, less snow with a higher percentage of precipitation as rain, more intense droughts and extreme heat, increased frequency and intensity of wildfire, changes to species phenology, declining groundwater levels, changes in stream flows, increased frequency and severity of flooding, increased stream temperatures, less agricultural acreage, more urban acreage, and shifts in vegetation types and composition. For floodplain inundation, stronger storms and higher peak flows earlier in the year as a result of more rapid snowmelt will likely lead to an increase in winter and spring flooding. Likewise, reduced snowpack and earlier snowmelt runoff have the potential to result in a decrease in mean annual flow. For impacts on streamflow regimes, runoff changes have the potential to impact sediment transport, channel migration, and the development of riparian zones.	http://climate.calcommons.org/article/central-valley-change
Projected Effects of Climate Change in California: Ecological Summaries Emphasizing Consequences for Wildlife – PRBO Conservation Science (2011)	The Projected Effects of Climate Change in California report gives a broad overview of the ecoregional-specific projected effects of climate change in California. The two main areas of interest for the Conservation Strategy are the Sacramento Valley Ecoregion and the San Joaquin Valley Ecoregion (pages 27 to 33). Each of these chapters covers the projected effects of climate change including changes to temperature, precipitation, streamflow and water availability, vernal pool hydrology, sea level rise, fire, vegetation change, and threats to wildlife. Projections to future time periods are included for each of the impacts of climate change.	Climate_Change-Consequences-for-Wildlife

CHAPTER H3

Projected Hydroclimate Changes and Ecosystem Responses

H3.1 Climate Change Modeling Approach and Results

This section uses climate change modeling the California Department of Water Resources (DWR) conducted to inform the 2022 CVFPP Update. As Chapter 1 described, some of this modeling output has been re-evaluated to advance the assessment of risks and vulnerabilities to the Conservation Strategy's measurable objectives. In particular, temperature, precipitation, and hydrology outputs were used to understand climate change impacts at the scale of the CPAs and to analyze changes in hydrology at ecologically important flow frequencies. Projected changes to sea levels, groundwater, and wildfires affecting the Central Valley are also discussed in a more qualitative manner using other supporting literature and studies. The following section summarizes the climate change modeling approach and provides the results; more detail can be found in Appendix A of the 2022 CVFPP Update Technical Analyses Summary Report: Climate Change Analysis (DWR 2022a).

Figures H-1 and H-2 provide a basin-scale overview of the five CPAs. The Sacramento River Basin contains the Upper Sacramento, Feather, and Lower Sacramento CPAs, and the San Joaquin River Basin contains the Lower San Joaquin and Upper San Joaquin River CPAs. Locations of index points are superimposed onto each map to highlight areas used in the subsequent analysis of regulated flow and stage in this chapter.

Figure H-1. Sacramento River Basin Conservation Planning Areas and Analysis Locations

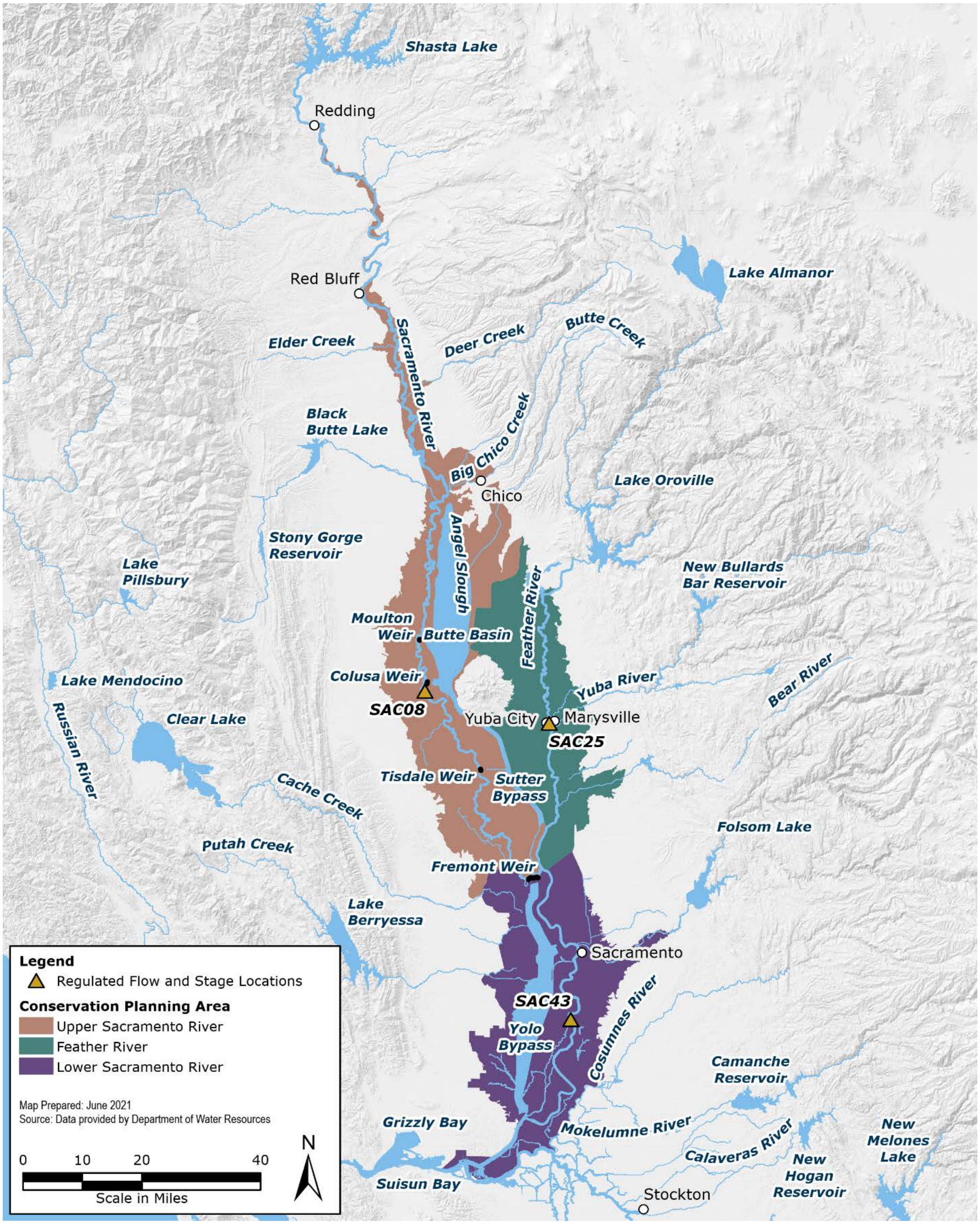
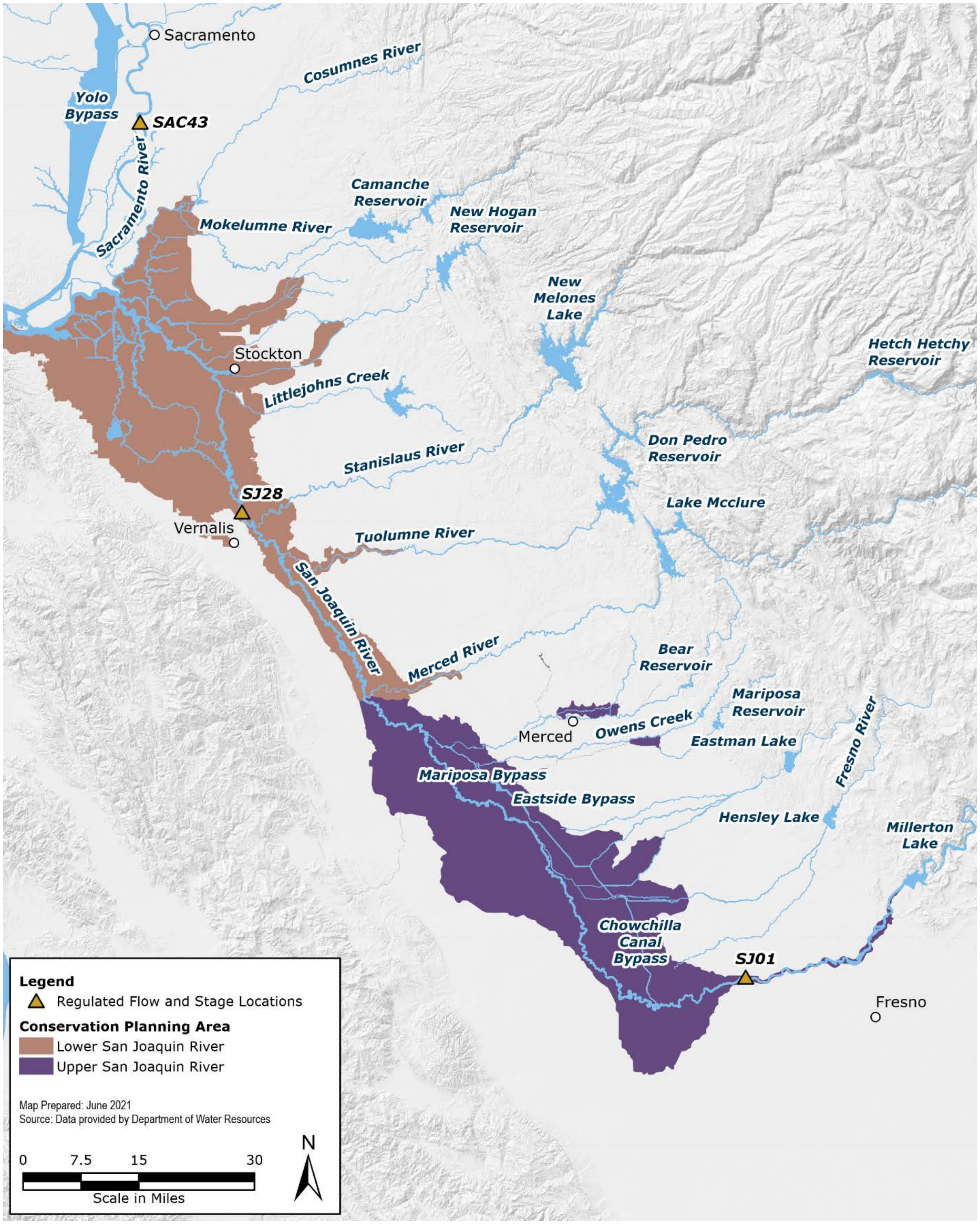


Figure H-2. San Joaquin River Basin Conservation Planning Areas and Analysis Locations

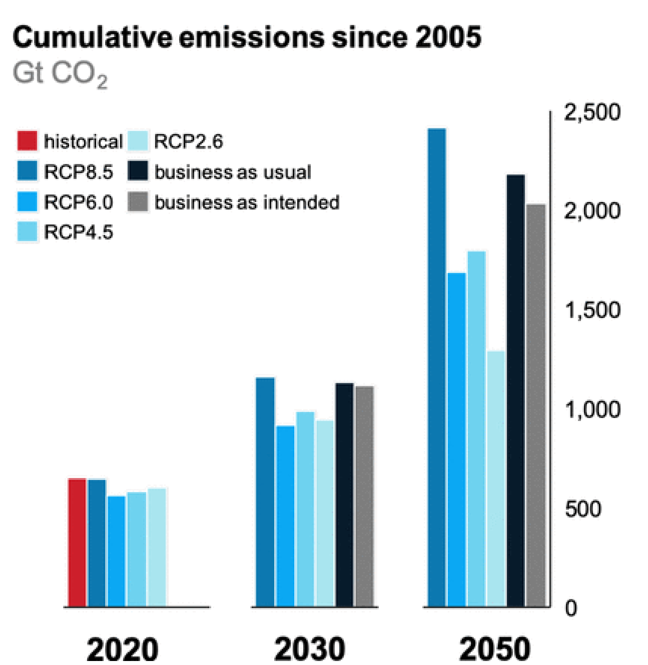


H3.1.1 Climate Scenarios

Future climate scenarios used in the 2022 CVFPP Update climate change analysis are based on climate model simulations from the Coupled Model Intercomparison Project Phase 5 (CMIP5) (van Vuuren et al. 2011). The climate models in the CMIP5 (Taylor et al. 2012; Rupp et al. 2013; DWR 2017b) were driven using a set of emission scenarios (called Representative Concentration Pathways [RCPs]) to reflect the potential trajectories of greenhouse gas emissions over the course of the century. The CMIP5 (van Vuuren et al. 2011) uses four scenario pathways (RCP2.6, RCP4.5, RCP6.0, and RCP8.5). Each RCP defines a specific emissions trajectory and subsequent radiative forcing (i.e., change in energy flux in the atmosphere).

Figure H-3 compares historical and projected trends and the four RCPs. Historically, emissions between 2005 and 2020 most closely resembled the RCP 8.5 scenario. For 2030 and 2050, "business-as-usual" (no efforts to reduce current emission trends) and "business-as-intended" (incorporation of announced policy changes and emissions targets) projections are included to highlight the Stated Policies and Current Policies forecasts from the International Energy Agency (IEA) (International Energy Agency 2019). For these two additional scenarios, emissions from energy use were combined with future land use and industrial emissions to estimate what cumulative emissions could be like under current trends. The IEA scenarios appear to fall between the RCP 8.5 and RCP 4.5 scenarios, with RCP 8.5 providing an overestimation of future emissions trends and RCP 4.5 displaying an underestimation (Schwalm et al. 2020).

Figure H-3. Total Cumulative Carbon Dioxide Emissions since 2005 through 2020, 2030, and 2050



Source: Schwalm et al. 2020

Climate change scenarios for the 2022 CVFPP Update were developed using 64 climate model projections downscaled from 32 CMIP5 general circulation models (GCMs) and 2 RCPs (RCP4.5 and RCP8.5) using the localized constructed analogs method (Pierce et al. 2014). Three statistically representative climate change scenarios for low, medium, and high climate change were constructed based on the ensemble-informed climate scenarios method, as well as a 30-year range of climate signals centered at 2072 (DWR 2022a). Ensemble members are plotted based on the projected change in precipitation and temperature. The medium scenario was developed from the 32 climate projections nearest to the medium change in temperature and precipitation. For the low and high climate change scenarios, a nearest-neighbor approach was used to sample the 10 nearest neighbors of the minimum (low) and maximum (high) change in both temperature and precipitation (DWR 2022a). These three scenarios improve on the median scenario used in the 2017 Update and should lead to an improved understanding of the uncertainty in hydroclimate outcomes.

Historical daily climate information (precipitation, minimum temperature, and maximum temperature) was available for the entire study area for the period of 1915 through 2011 at 1/16th degree (approximately 6 kilometers [km] or 3.75 miles) spatial resolution (Livneh et. al. 2013). The statistical changes calculated for the GCMs identified for the low, medium, and high scenarios were then mapped onto the historical information to develop climate-adjusted records that reflect future climate conditions. These climatologies are used to assess the projected changes described in the remainder of Section 3.1. In this methodology, the natural variability, which is best characterized through the observed records, is maintained and combined with the projected changes in climate patterns (DWR 2022a).

H3.1.2 Summary of Climate and Hydrology Scenario Results

Table H-3 summarizes the projected climate change trends discussed within Section 3.1. Temperature and precipitation were analyzed at both annual and monthly temporal scales. Changes to snowpack, streamflow seasonality and timing, regulated hydrology, sea level rise, groundwater, and wildfires were also examined.

Table H-3. Summary of Climate Projections Included in this Report [a]

Climate Change Component	Projected Change [b]
Mean Annual Temperature	Between a 2°C to 4°C increase by 2072, depending on climate projection model (Section H3.1.3).
Extreme Temperature	Extreme temperatures to increase under all three climate scenarios for all CPAs (Section H3.1.3).
Mean Monthly Temperature	Increased temperatures throughout the year, with greater divergence from historical temperatures in the summer (Section H3.1.3).
Mean Annual Precipitation	Variable, depending on climate change scenario used (decreases under low and medium; increases under high) (Section H3.1.4).

Climate Change Component	Projected Change [b]
Extreme Precipitation	Annual average three-day maximum precipitation to decrease under the low climate scenario and increase under the medium and high climate change scenarios. Annual 99th percentile three-day maximum precipitation is projected to increase under all climate scenarios. More severe atmospheric river events are anticipated (Section H3.1.4).
Mean Monthly Precipitation	Variable, depending on climate change scenario used for winter months (decreases under low; increases under medium and high). Decreased mean monthly precipitation during the remainder of the year (Section H3.1.4).
Snowpack	Reduced snowpack due to changing form of precipitation (rain rather than snow) and earlier spring snowmelt (Section H3.1.6).
Streamflow Seasonality and Timing	Shift in streamflow to the earlier months because of earlier spring snowmelt runoff and more precipitation as rain than snow (Section H3.1.7).
Regulated Hydrology	Varying projected changes to flow and stage, based on CPA and 2072 project implementation. In general, most CPAs show projected increase in both flow and stage. Three CPAs show minor increase in flow and stage for 10-year flood events, accompanied by a larger increase in flow and stage for 100-year flood events (Section H3.1.8).
Sea Level Rise	Increasing rate of sea level rise as warming conditions continue. Increased water levels and salinity in the Delta (Section H3.1.9).
Groundwater	Greater stress on groundwater supplies from decreased surface water quantities and evapotranspiration in summer months (Section H3.1.10).
Wildfires	More severe wildfires in upper watersheds under increased warming conditions. Increased peak flows, debris flows, and contaminant presence downstream of burned areas (Section H3.1.11).

[a] Each component of climate change is described by its estimated changes (trends) in the adjacent column.

[b] Numbers in parentheses correspond to the section each climate change component is described.

Notes:
°C = degree(s) Celsius
CPA = conservation planning area

H3.1.3 Changes in Temperature

Figure H-4 includes projected changes in mean annual temperature for each CPA. The Upper Sacramento and Feather River CPAs are projected to experience the greatest change in mean annual temperature. The Lower Sacramento and Lower San Joaquin River CPAs are projected to experience the lowest change in temperature of the CPAs, but only by a small margin. Overall, all CPAs will experience a relatively similar increase in mean annual temperature. In general, warmer temperatures are expected to decrease soil moisture and increase evapotranspiration (ET), particularly under periods of sustained drought (Ullrich et al. 2018; Mann and Gleick 2015). Drier soils and increased temperatures are also observed following years of below-average precipitation, suggesting drought conditions may be a key driver for these changes (Cayan et al. 2010).

Figure H-4. Projected Changes in Mean Annual Temperature (°C) by CPA

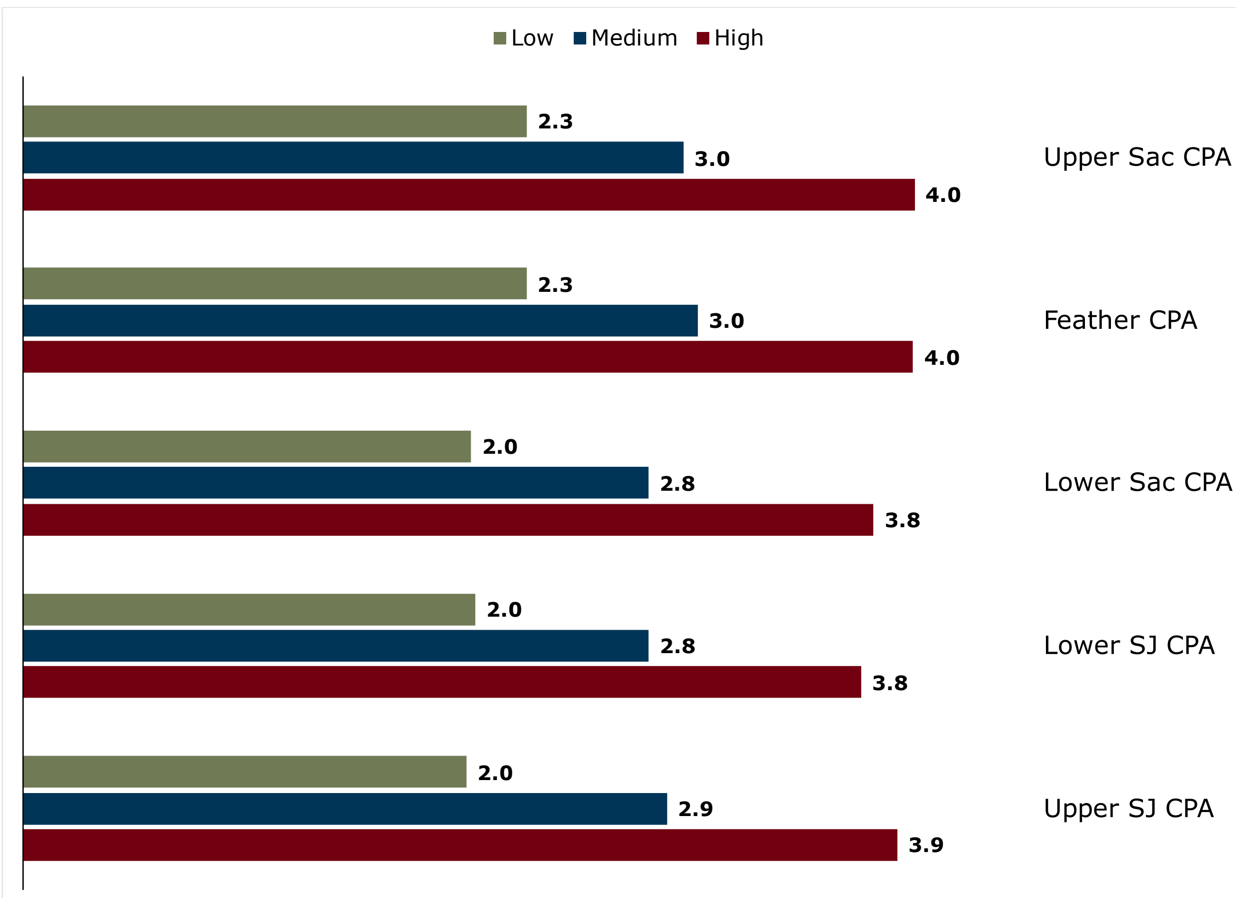
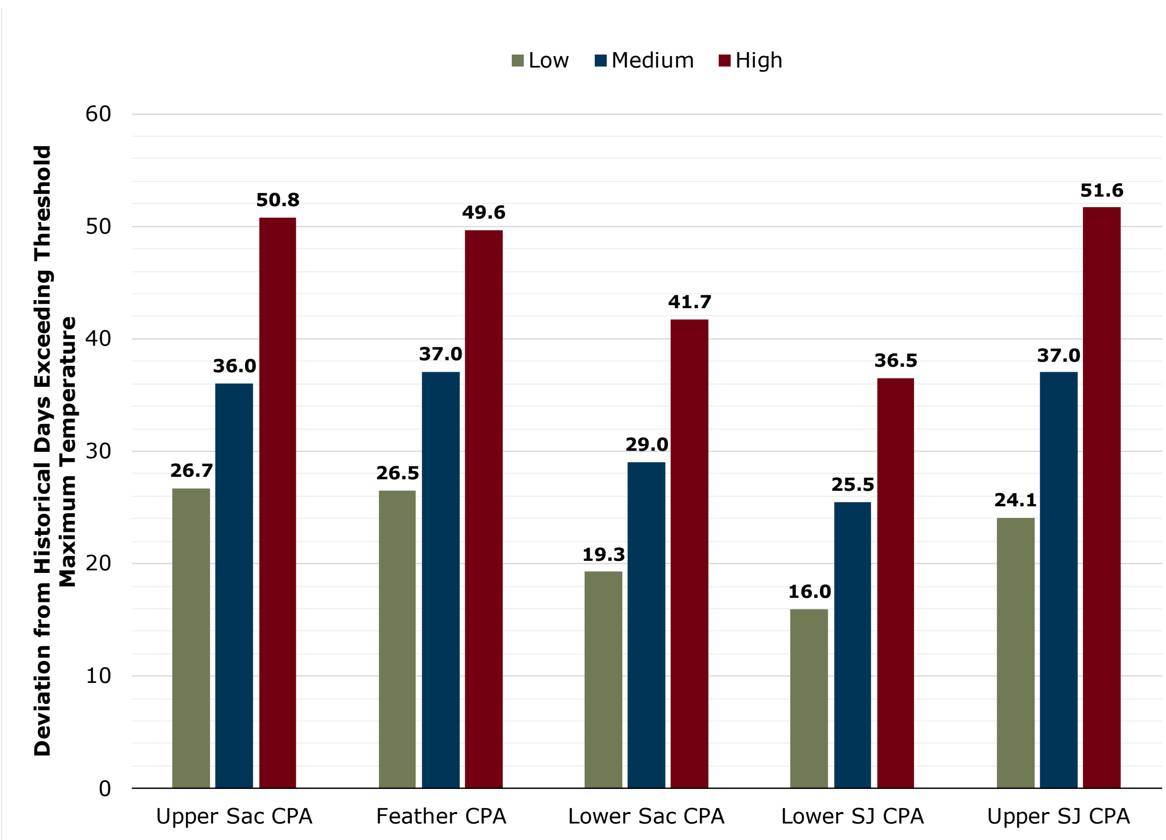


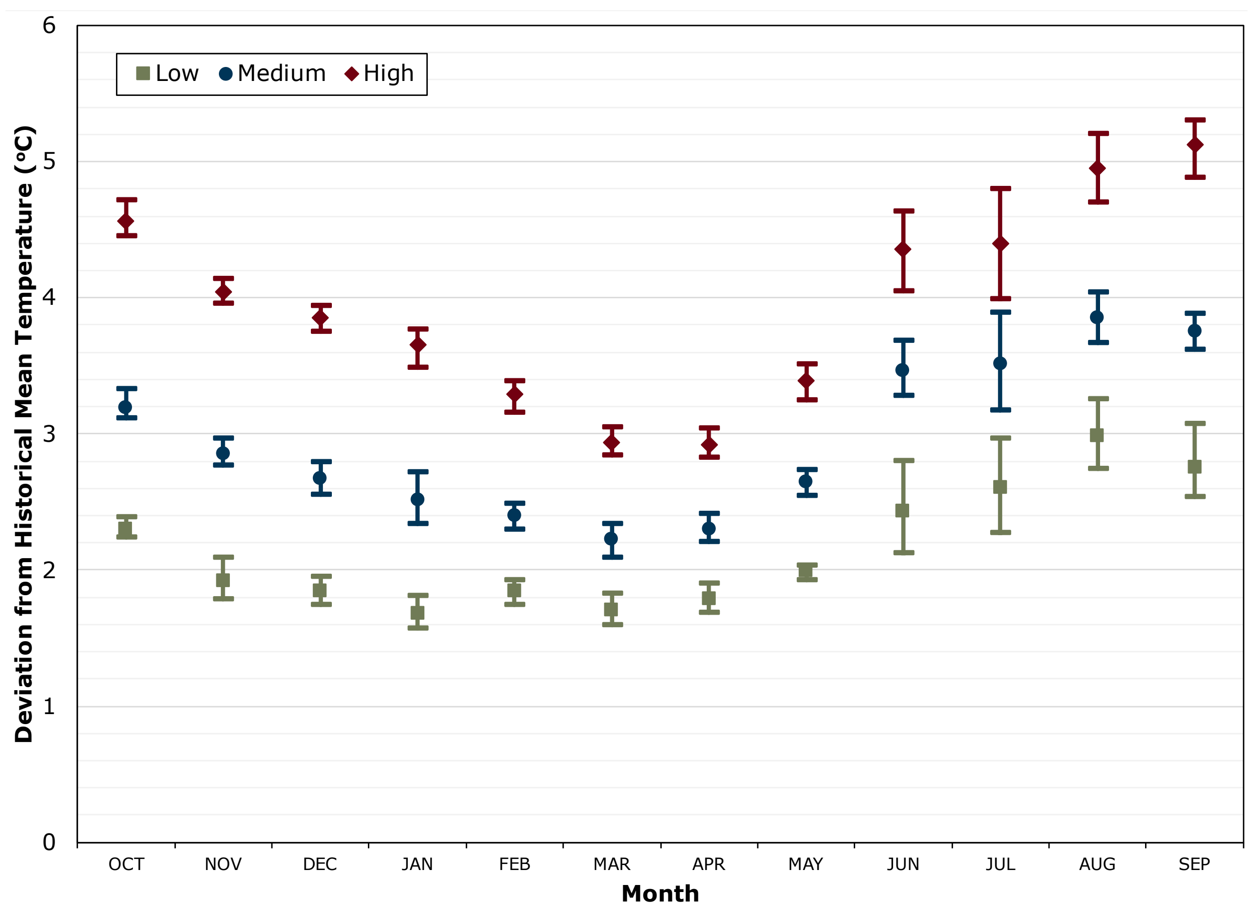
Figure H-5 examines maximum temperature changes for all CPAs. For this analysis, a threshold temperature was determined using the 98th percentile of daily maximum temperature between January 1, 1971 and December 31, 2000. This historical reference period was selected to be consistent with the approach used for climate change analyses in the 2022 CVFPP Update. The thresholds for the Upper Sacramento, Feather River, Lower Sacramento, Upper San Joaquin, and Lower San Joaquin CPAs ranged from 38.4°C to 39.4°C (101.1 degrees Fahrenheit [°F] to 102.9°F). This threshold temperature is then compared with the daily maximum temperature for each day between January 1, 1915 and December 31, 2011 for the baseline scenario as well as the low, medium, and high scenarios (climate scenarios are incorporated into historical temperatures to project changes in temperature). Days determined to be greater than or equal to the threshold temperature are summed for each water year (October 1 to September 30). The average number of annual days exceeding the threshold temperature were compared to the baseline scenario to produce Figure H-5. The deviation from historical days exceeding the threshold maximum temperature increases from low to high climate scenarios. Downstream CPAs (i.e., the Lower Sacramento and Lower San Joaquin CPAs) show a smaller magnitude of change than upstream CPAs (Upper Sacramento, Feather, and Upper San Joaquin), likely due to the proximity to coastal regions. Section H3.3 describes species-specific impacts of extreme temperature days.

Figure H-5. Deviation from Historical Days Exceeding Threshold Maximum Temperature (°C) by CPA



On a monthly scale, all CPAs show similar trends in projected changes to mean temperature. Figure H-6 shows the range of mean monthly predicted temperature deviations for all CPAs under the low, medium, and high climate change scenarios. The upper and lower whiskers for each month indicate the 90th and 10th percentile mean temperature deviations from all CPAs, and the point lying between them displays the average deviation from mean historical temperature. June through September show the largest range of mean monthly temperature deviations, while late-winter and spring months show the smallest. This indicates changes to mean monthly temperature have greater variation between CPAs during the transition to warmer months. CPA-specific plots showing the deviation from historical monthly mean temperature under each of the three climate scenarios can be found in Attachment H.1 (Figures H.11 through H.15).

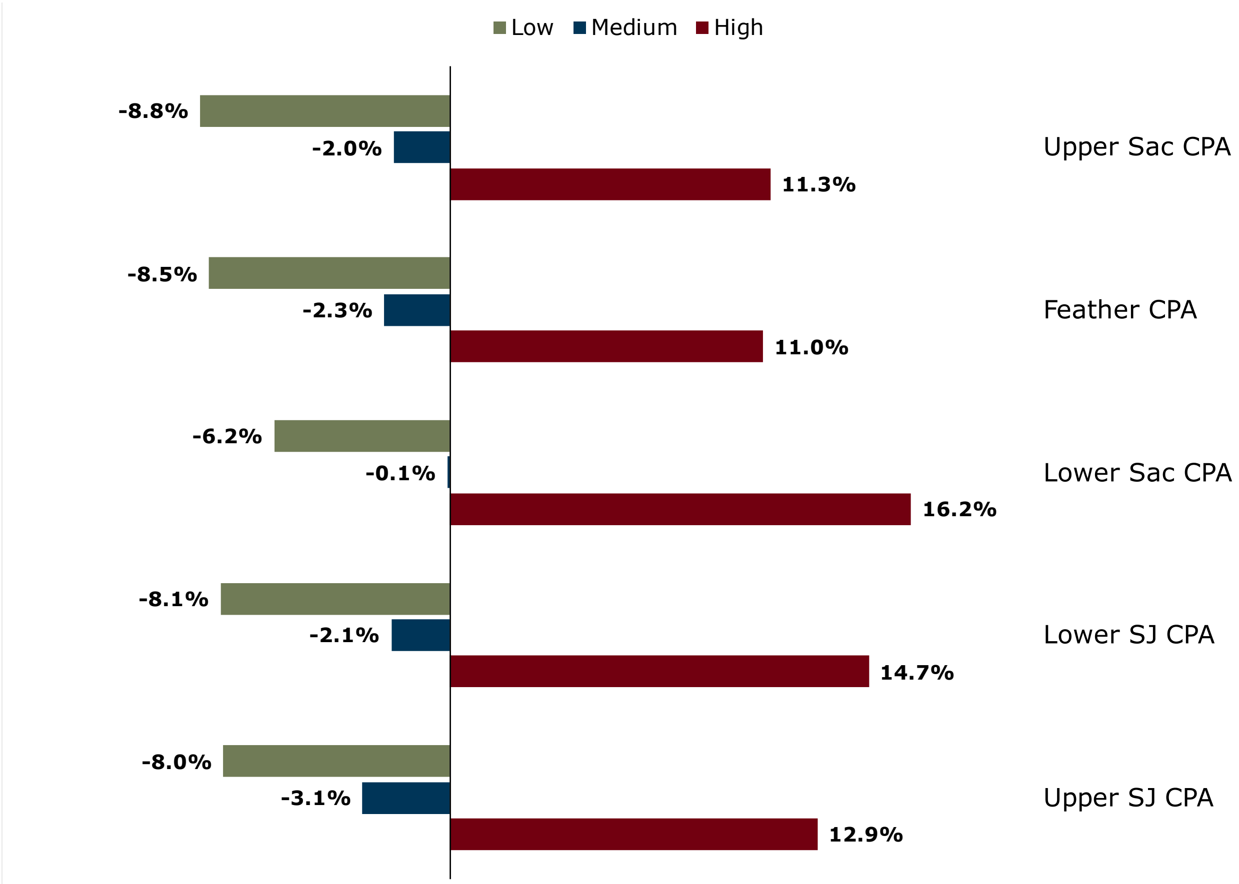
Figure H-6. Range of Projected Changes in Mean Monthly Temperature for all CPAs



H3.1.4 Changes in Precipitation

Projected changes in mean annual precipitation vary greatly, depending on the climate change scenario used. Figure H-7 highlights the percent change in average annual precipitation for all CPAs. Under the low and medium climate change scenarios, mean annual precipitation is projected to decrease; the high climate change scenario displays an increase across all CPAs.

Figure H-7. Projected Percent Change in Mean Annual Precipitation by CPA

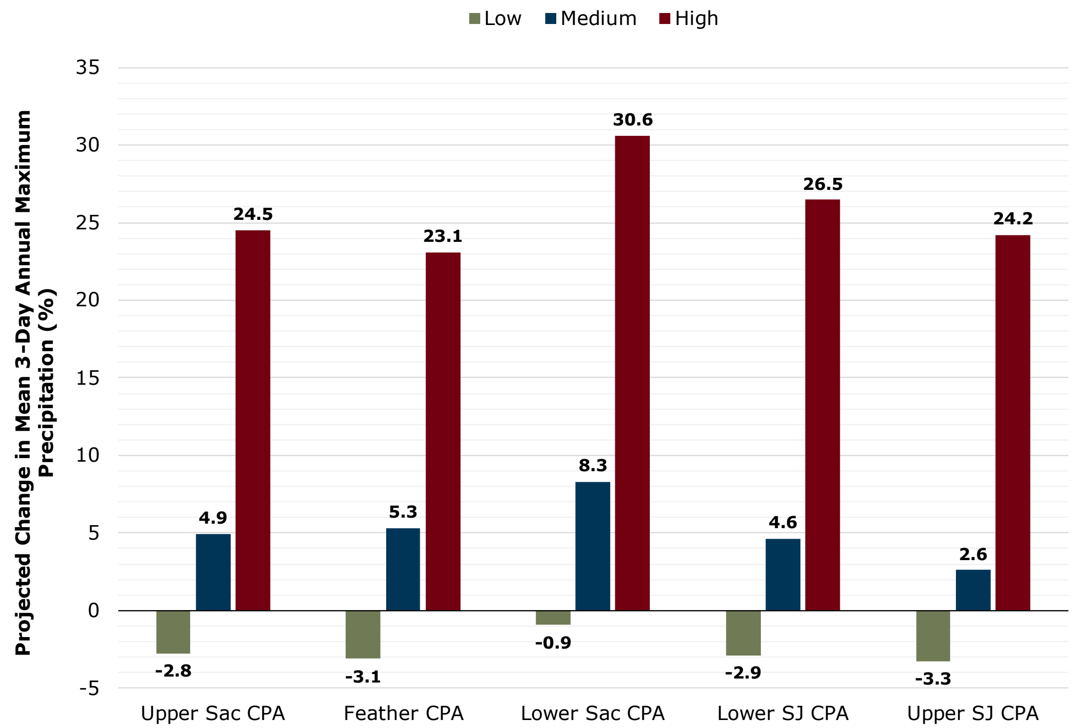


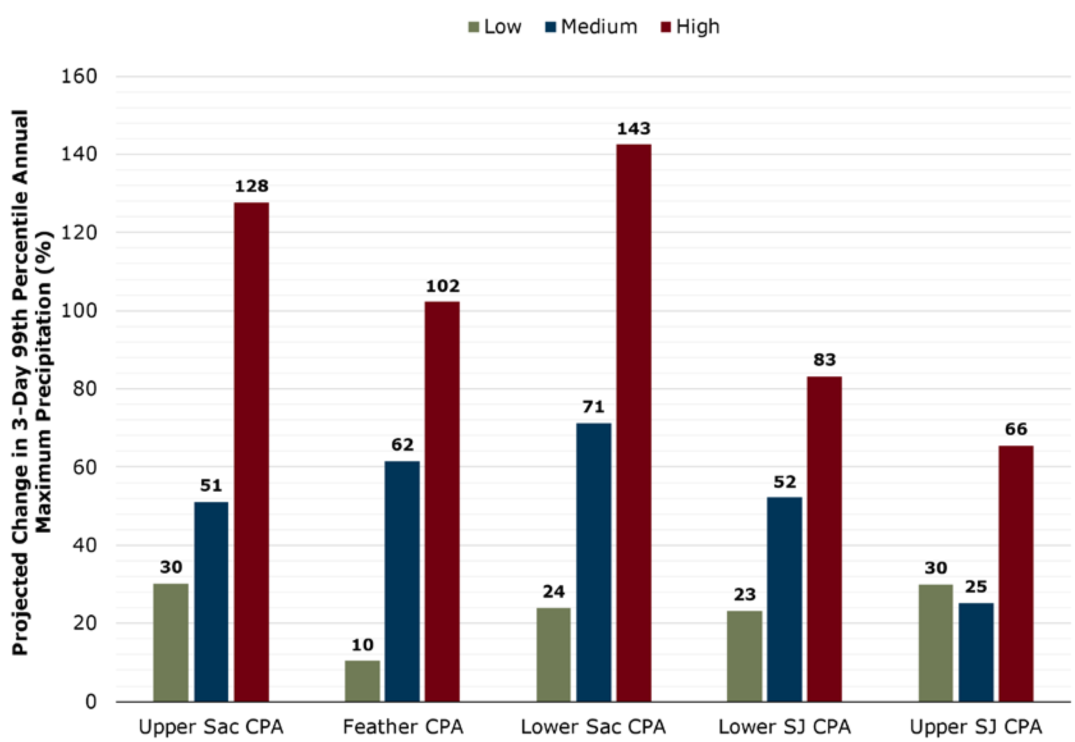
The annual maximum precipitation amounts for the historical period of water years between 1916 and 2011 were compared to the low, medium, and high climate change scenarios. The three-day average (shown on the first panel of Figure H-8) and 99th percentile (shown on the second panel of Figure H-8) annual maximum precipitation were calculated for each CPA under each scenario and compared to baseline conditions.

For projected changes to three-day 99th percentile annual maximum precipitation, each CPA displays a significant increase from baseline conditions under all future climate change scenarios. Under the low climate change scenario, upstream CPAs (Upper Sacramento and San Joaquin) display the greatest increase. For the medium and high climate change scenarios, the magnitude of change is greater in the Sacramento River Basin than the San Joaquin River Basin. In the Sacramento River Basin under the high climate change scenario, three-day 99th percentile annual maximum precipitation is projected to increase by over 100 percent for each of the three CPAs.

The increase in three-day 99th percentile annual maximum precipitation can be attributed to more intense atmospheric river (AR; a long narrow, band of condensed water vapor that transports moisture from in the atmosphere) precipitation events. AR events have historically contributed between roughly one-third and one-half of California's annual precipitation (Florsheim and Dettinger 2015); however, increased warming from climate change will likely result in less frequent, more severe AR events, leading to an increased prevalence of AR conditions (Espinoza et al. 2018; Huang et al. 2020). Furthermore, AR storms are projected to contribute to a greater amount of total annual precipitation under future conditions (Gershunov et al. 2019).

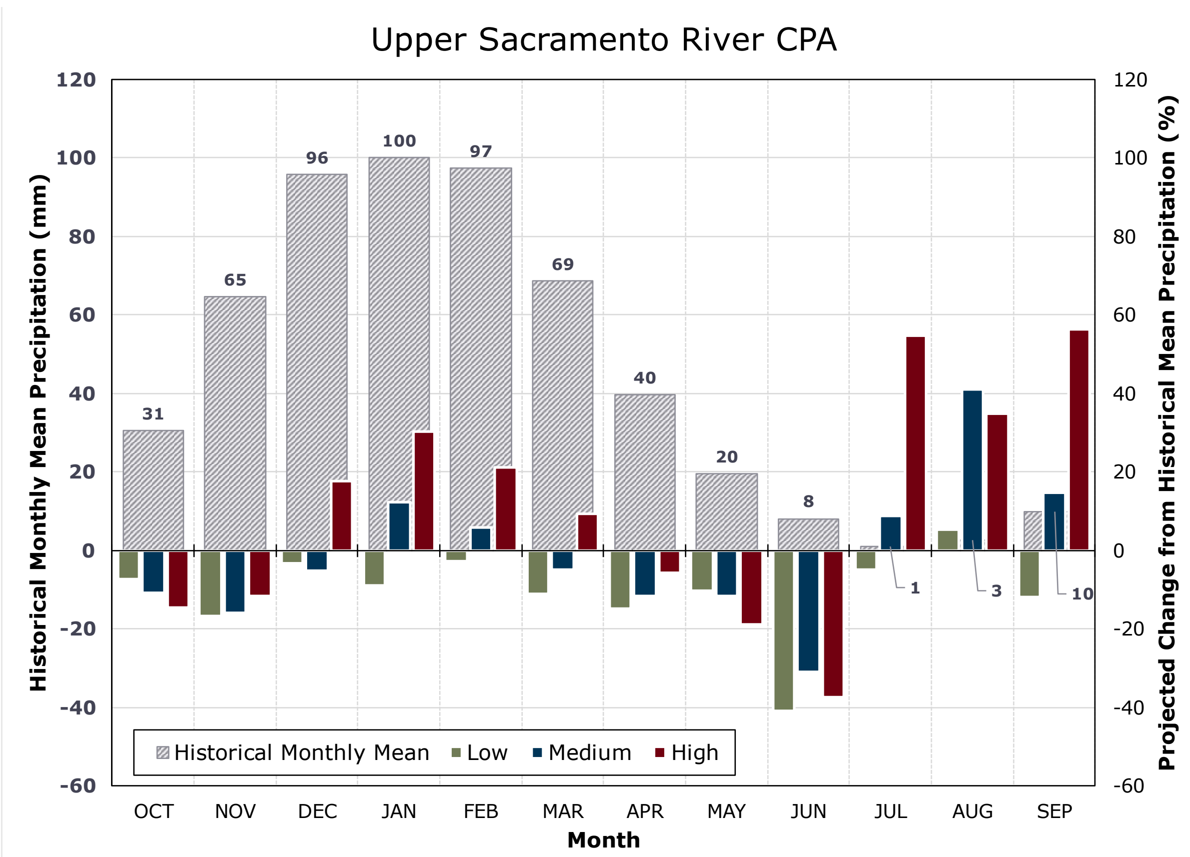
Figure H-8. Projected Change in Three-day Mean (first panel) and 99th Percentile (second panel) Annual Maximum Precipitation by CPA

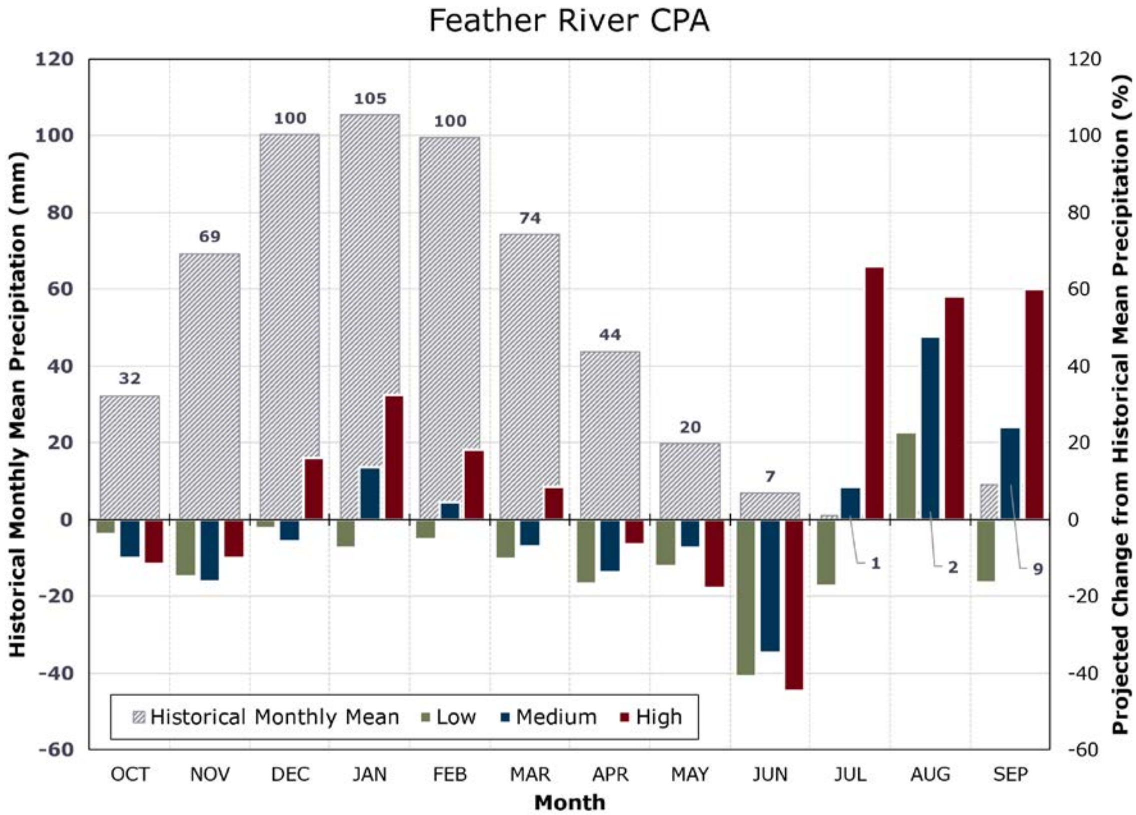




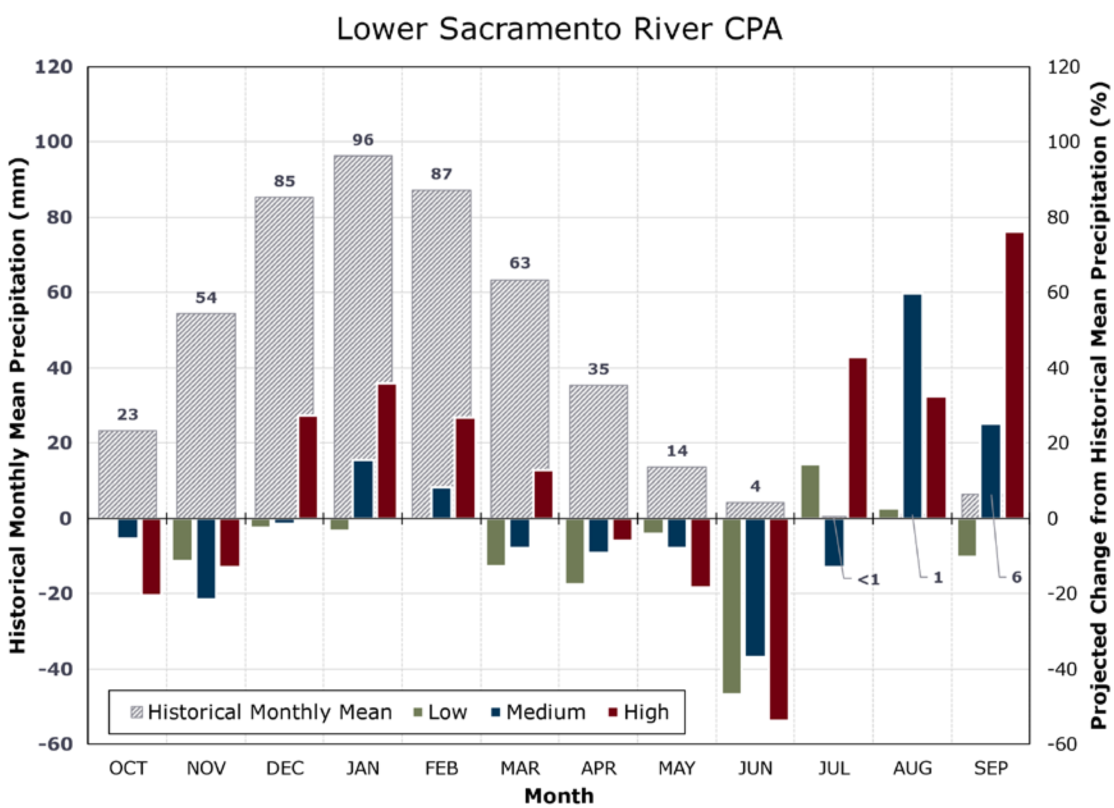
As depicted with the monthly projected changes in mean temperature, all CPAs show similar precipitation trends over the course of the year. Figure H-9 highlights the change in average monthly precipitation for all CPAs under each of the climate change scenarios, as well as baseline quantities (values labeled on the plots). During wetter months (December through March), the high and medium scenarios show the greatest increases in mean precipitation depths over baseline, while the low scenario shows reductions during this period. In addition, all the scenarios show a decrease in monthly mean precipitation compared to the baseline from April to July and October to November. For the medium scenario, this suggests both an overall decrease in mean annual precipitation (as Figure H-5 shows) and more condensed precipitation events in winter months. With the high climate change scenario, the precipitation extremes in the winter months make up for the loss of precipitation at other points throughout the year to result in a net increase to annual precipitation. For late summer and early fall months, the percentage change in monthly mean precipitation shows a much greater magnitude, although the absolute change in precipitation is relatively small in comparison to other months. For the Upper and Lower San Joaquin CPAs in particular, August shows an increase of over 100 percent, but the overall increase in mean precipitation is roughly 1 inch.

Figure H-9. Projected Changes in Mean Monthly Precipitation by CPA

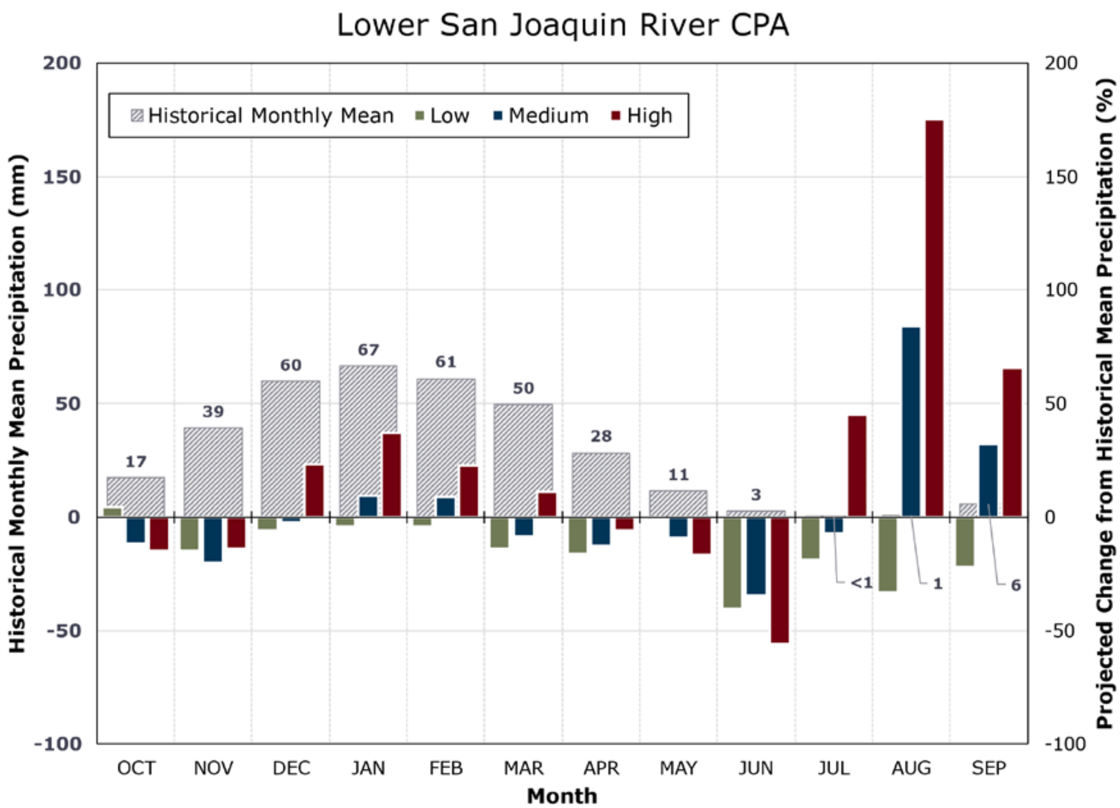


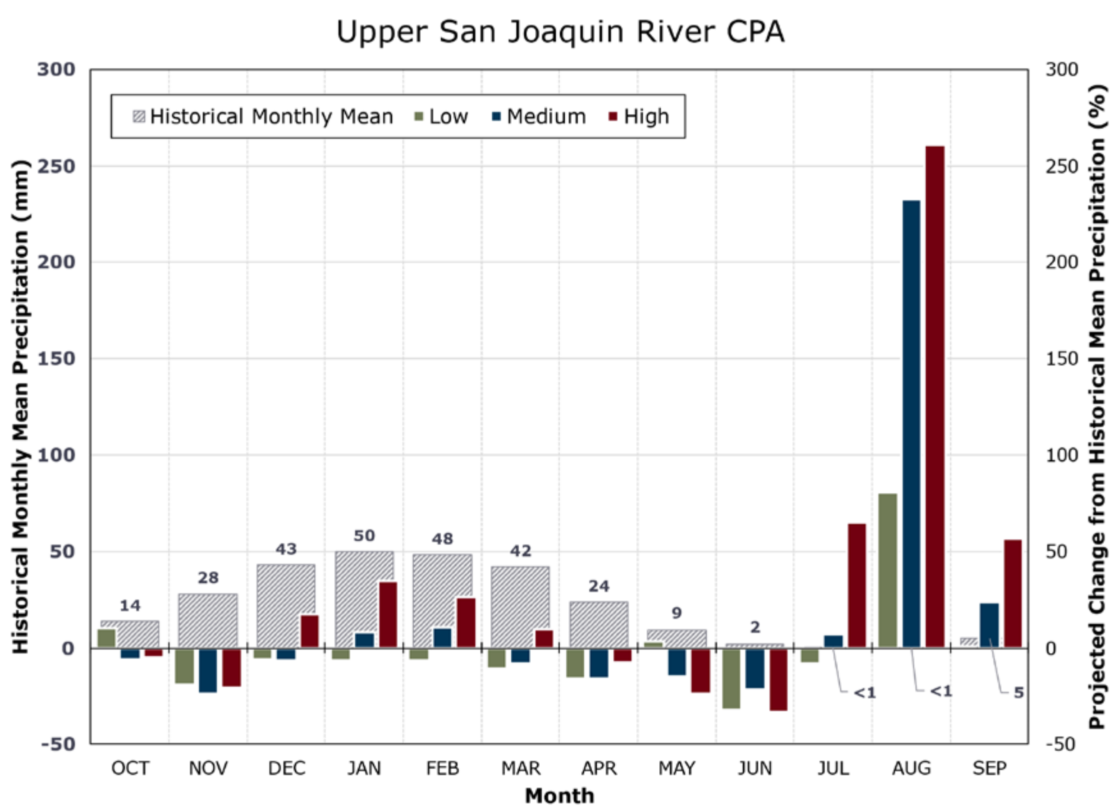


Feather River CPA
Historical Monthly Mean Precipitation (mm)
Projected Change from Historical Mean Precipitation (%)
120
100
80
60
40
20
0
-20
-40
-60
32
69
100
105
100
74
44
20
7
1
2
9
Historical Monthly Mean
Low
Medium
High
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Month



Lower Sacramento River CPA
Historical Monthly Mean Precipitation (mm)
Projected Change from Historical Mean Precipitation (%)
120
100
80
60
40
20
0
-20
-40
-60
23
54
85
96
87
63
35
14
4
<1
1
6
Historical Monthly Mean
Low
Medium
High
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Month


Lower San Joaquin River CPA
Historical Monthly Mean
Low
Medium
High
Historical Monthly Mean Precipitation (mm)
Projected Change from Historical Mean Precipitation (%)
200
150
100
50
0
-50
-100
17
39
60
67
61
50
28
11
3
<1
1
6
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Month


Upper San Joaquin River CPA
Historical Monthly Mean
Low
Medium
High
Historical Monthly Mean Precipitation (mm)
Projected Change from Historical Mean Precipitation (%)
300
250
200
150
100
50
0
-50
14
28
43
50
48
42
24
9
2
<1
<1
5
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Month

H3.1.5 Hydrology Scenarios

The historical and three future climate change scenarios were used as inputs to the Variable Infiltration Capacity (VIC) model to simulate future hydrologic conditions. The VIC model (Liang et al. 1994, 1996; Nijssen et al. 1997) is a spatially distributed hydrologic model that simulates land surface-atmosphere exchanges of moisture and energy at each model grid cell. The VIC model incorporates spatially distributed parameters describing topography, soils, land use, and vegetation classes. The outputs from this hydrologic model were used to assess changes in hydrologic variables described in Sections H3.1.6 and H3.1.8.

The future impacts of climate change on the flood management system were examined by considering the existing state of the system, future population and land use changes, and implementation of the State Systemwide Investment Approach (SSIA). Elements of the SSIA include physical improvements (e.g., levee setbacks) for systemwide, urban, rural, and small community areas, as well as residual risk management actions focusing on enhanced flood response and emergency management. Three project implementation scenarios were developed, including a baseline scenario for 2022 without-project implementation (existing condition), a 2072 scenario without-project implementation (without implementation of the SSIA), and a 2072 scenario with-project implementation (with implementation of the SSIA). Appendix C of the 2022 CVFPP Update Technical Analyses Summary Report: Flood Risk Analysis (DWR 2022c) provides more details. Scenarios reflect watershed-specific assumptions for climate change, and both of the 2072 projections are presented for the medium climate change scenario.

H3.1.6 Changes in Snowpack

Snowpack is an integral component of the hydrologic system in California. While only covering approximately a quarter of the total land area in the state, the Sierra Nevada region provides approximately 60 percent of California’s water, with much of this water originating in the form of snowpack (Reich et al. 2018). Historically, snowpack in the Sacramento and San Joaquin River Basins has typically developed at higher elevations from November through March (DWR 2022a). As temperatures begin to rise in the spring months, the snowpack gradually melts, supplying water to communities, ecosystems, and agriculture through the spring and summer.

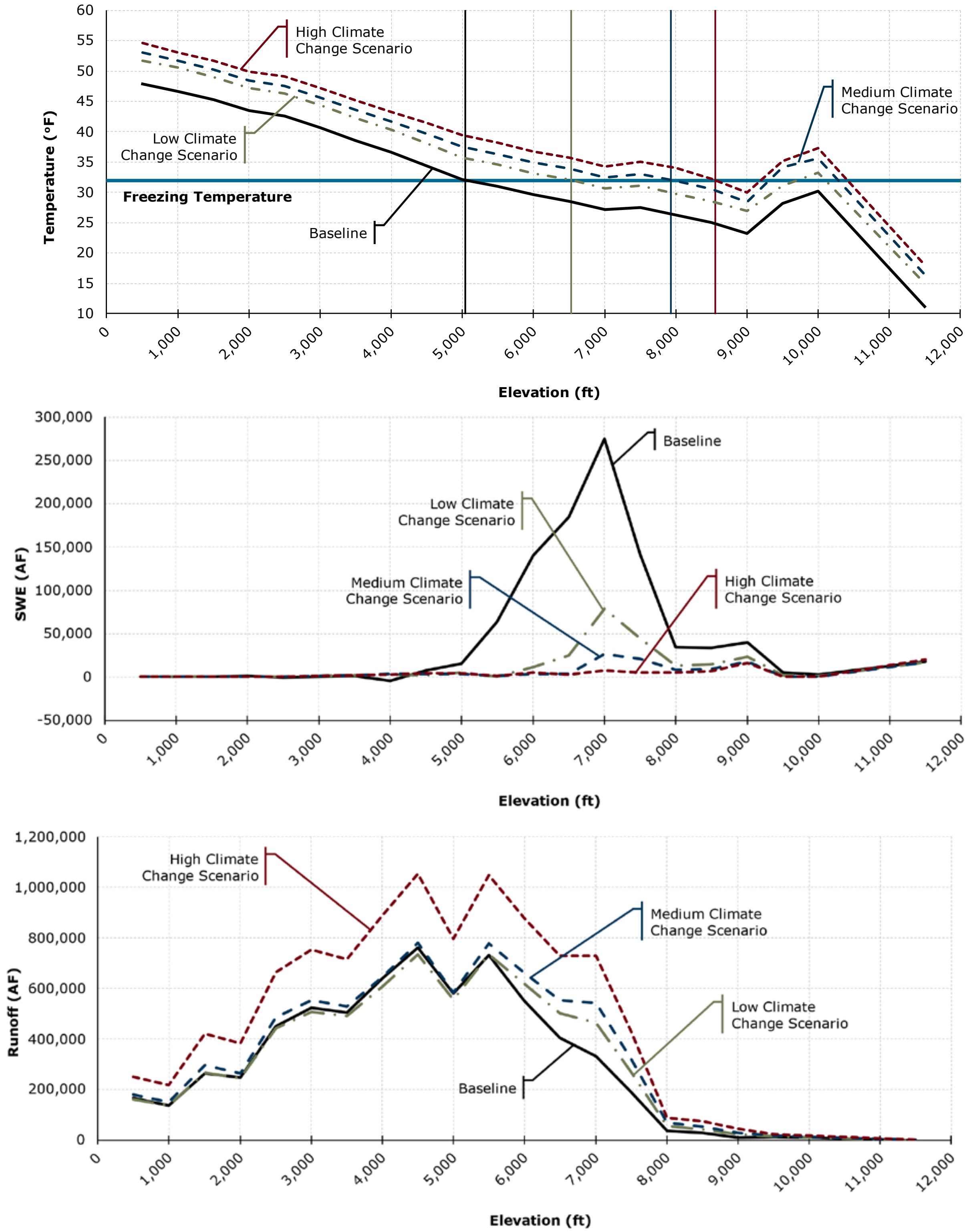
However, given the changes to both temperature and precipitation, the timing of snowmelt and composition of snowpack is projected to change, ultimately altering runoff characteristics (Pierce et al. 2018). Figures H-10 and H-11 display the change in the 1997 flood event average temperature (top panel), snow water equivalent (SWE; middle panel), and runoff (bottom panel) under the low, medium, and high climate change scenarios at different elevations in watersheds upstream of reference gauges (SAC-42 and SJR-75; locations roughly correspond to the SAC43 and SJ28 regulated flow and stage points as displayed on Figures H-1 and H-2) in the Sacramento and San Joaquin River Basins, respectively. The 1997 flood event, caused by a landfalling AR that resulted in an estimated $2 billion in damages (the largest in California’s history), is displayed to highlight the magnitude and pattern of these projected changes (DWR 2022a).

Under the conditions of the 1997 flood event, the Sacramento River Basin shows a freezing level elevation of about 5,000 feet under baseline conditions, and this elevation increases to roughly 6,500, 8,000, and 8,500 feet under the low, medium, and high climate change scenarios, respectively. For the San Joaquin River Basin, the baseline freezing elevation is slightly higher than 8,000 feet. Under the low, medium, and high climate change scenarios, this elevation is projected to increase to approximately 9,500, 10,200, and 11,500 feet, respectively. These findings indicate warmer temperatures are projected to occur at higher elevations (and potentially at a higher rate than lower elevations; Mountain Research Initiative EDW Working Group 2015), shifting the composition of precipitation from snow to rain (DWR 2022a). Precipitation that is no longer captured in snowpack will travel downstream as runoff, and higher temperatures will likely increase the rate and timing of snowmelt.

Furthermore, increasing temperatures and changes to snowpack composition will impact SWE (the volume of liquid water contained in snowpack) at different elevations. In the Sacramento River Basin, SWE is projected to decrease dramatically, with near-zero volumes across all elevations under the high climate change scenario. SWE volumes are still accumulated at higher elevations in the San Joaquin River Basin (DWR 2022a).

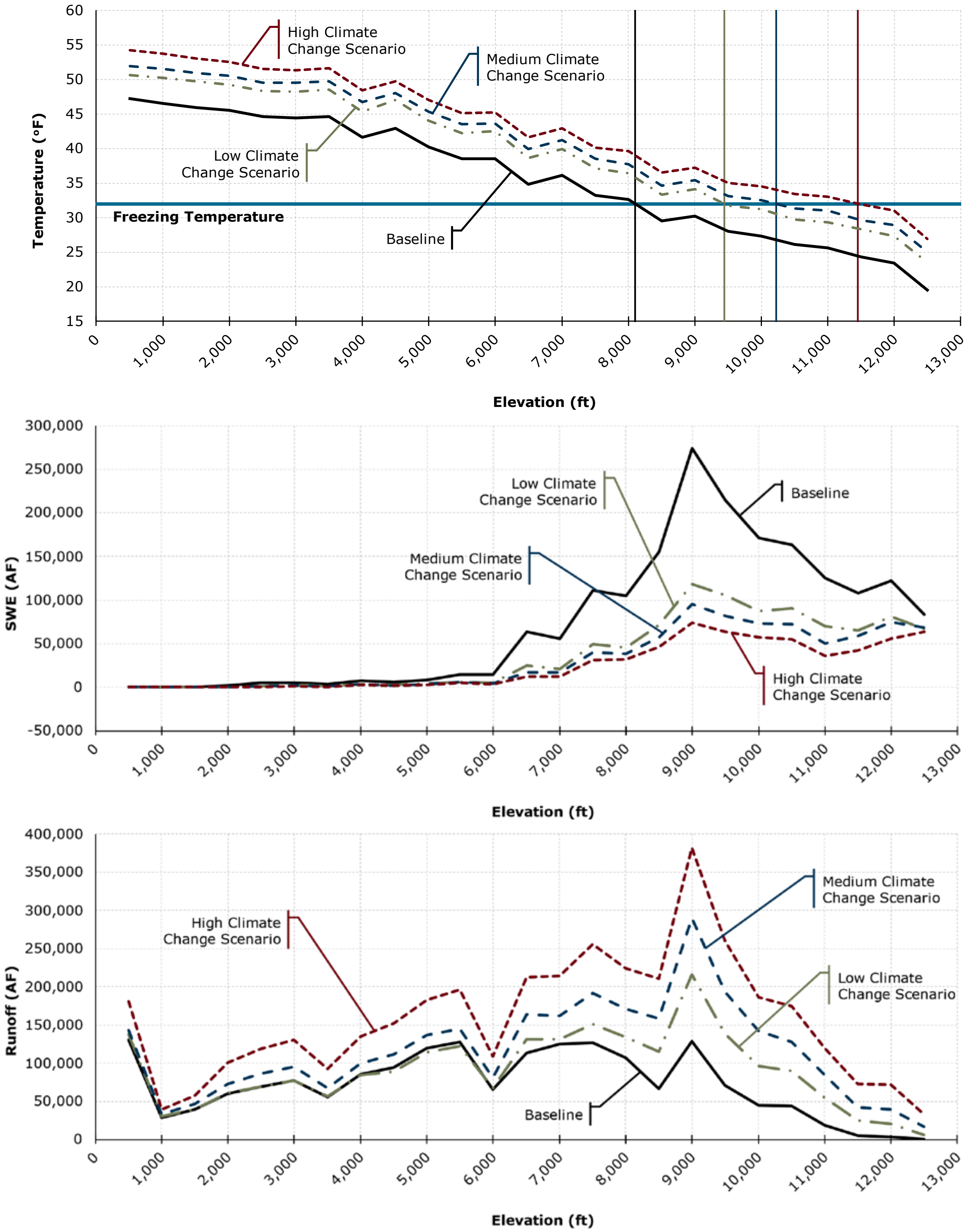
As a result of the overall decrease in snowpack, SWE, and timing of snowmelt, water networks will experience higher runoff flows earlier in the year, which are likely to induce increased flood risks and changes to water management operations. Under the high climate change scenario, runoff volumes are projected to increase across all elevations in both the Sacramento and San Joaquin River Basins. In the Sacramento River Basin, runoff volumes are also projected to increase under the low and medium climate change scenario between elevations of roughly 5,500 feet and 8,000 feet. In the San Joaquin River Basin, runoff volumes are projected to increase under all climate change scenarios at elevations greater than 6,000 feet.

Figure H-10. 1997 Flood Event Projected Change in Average Temperature (top), SWE (middle), and Runoff (bottom) at Different Elevations Upstream of the Sacramento River below Elk Slough (SAC-42)



Source: Modified from DWR (2022a)

Figure H-11. 1997 Flood Event Projected Change in Average Temperature (top), SWE (middle), and Runoff (bottom) at Different Elevations Upstream of the San Joaquin River below the Stanislaus River (SJR-75)



Source: Modified from DWR (2022a)

H3.1.7 Changes in Streamflow Seasonality and Timing

Historically, streamflow volumes have peaked in the winter and spring when precipitation and snowmelt quantities are largest (Lund 2016). As described in Section 3.1.6, changes in temperature and precipitation composition are projected to result in a decrease in snowpack and shift in snowmelt timing to earlier in the year. These changes will ultimately shift peak flows to earlier in the winter and spring (Reich et al. 2018). As such, late-spring and summer flows are expected to decrease.

Differences in watershed characteristics between the Sacramento and San Joaquin River Basins affect the historical patterns of streamflow as well as the magnitude of projected changes under climate change. In rain-dominated watersheds like the Sacramento River Basin, flows are projected to peak earlier and higher than historical flows (He et al. 2019). In snow-dominated watersheds like the San Joaquin River Basin, shifts in timing and changes in peak flows are projected to be minor by 2050, but substantial decreases in April through July peak flows are projected by late-century (Delta Stewardship Council 2021b). The magnitude of changes in both the Sacramento and San Joaquin River Basins are also expected to be more significant under the conditions described by the high climate change scenario as compared to the low climate change scenario.

H3.1.8 Changes in Peak Flood Events Using Regulated Hydrology

To examine changes in peak events, regulated (altered by human intervention) hydrology across all CPAs for current- stage (2022 without-project) and flow frequencies were compared to 2072 future conditions (without-project and with-project) using the medium climate change scenario. Regulated hydrology is generated through Hydrologic Engineering Center Reservoir System Simulator (HEC-ResSim) and Hydrologic Engineering Center River Analysis System (HEC-RAS) to simulate future flow regimes downstream of reservoirs (DWR 2022b). Data are compiled from specific index point locations identified on Figures H-1 and H-2. To develop regulated flow-frequency information under future climate change conditions at locations throughout the Sacramento and San Joaquin River Basins, climate change ratios and unregulated-to-regulated flow transforms were applied to unregulated volume-frequency curves. Note, unregulated flow volumes and regulated peak flows do not scale uniformly with one another due to operating regimes. Additional information is available in Appendix B of the *2022 CVFPP Update Technical Analyses Summary Report: Climate Change Volume Frequency Analysis* (DWR 2022b).

For each CPA, the regulated flow and stage-frequency curves are plotted for the 2022 without-project, 2072 without-project, and 2072 with-project scenarios (as described in Section H3.1.5). Figures H-12 through H-16 display these plots. Tables H-4 through H-8 also provide quantitative analyses of the 10-year (annual exceedance probability [AEP] = 0.1) and 100-year (AEP = 0.01) flood event characteristics, as well as comparisons for both the listed flow and stage values.

The Upper Sacramento CPA (Figure H-12 and Table H-4) shows a minor increase to flow and stage for 10-year events, accompanied by a much larger increase for 100-year events. Table H-4 provides insight into the quantitative changes in magnitude for both flow and stage at this location. Differences between the 2072 with-project and without-project scenarios are minor, as there are no upstream project improvements included in the 2072 with-project scenario at this index point. As such, both scenarios display roughly a 12-percent increase in flow and 1.7-foot increase in stage for 100-year events. Likewise, 10-year events are projected to increase by approximately 2.5 percent for flows and 0.5 feet for stage by 2072.

For the Feather River CPA (Figure H-13 and Table H-5), 10-year flood events increase in both flow and stage, while 100-year events remain roughly the same. For infrequent events beyond return periods of roughly 250 years, climate change conditions will likely result in more breach flows upstream, reducing 2072 flow and stage values from 2022 quantities. Similar to the Upper Sacramento CPA, differences between the 2072 without-project and with-project projections are minor due to a lack of upstream project improvements in the 2072 with-project scenario at this location. A 37.8-percent and 40.3-percent increase in flow can be seen for the 2072 without-project and with-project projections, respectively. Additionally, 3.5-foot and 3.2-foot increases (respectively) in stage are displayed.

For the Lower Sacramento CPA (Figure H-14 and Table H-6), the 2072 without-project projection results in an overall increase for both flow and stage for 10-year and 100-year events. A 27.3-percent increase in flow and 1.3-foot increase in stage are seen for the 10-year event, and a 9.0-percent increase in flow and 0.8-foot increase in stage are seen for the 100-year event. However, when compared to the 2072 with-project projection, an increase in flow and a decrease in stage can be seen for 10-year and 100-year events, likely due to levee setback and weir expansion projects in the region. Flows are projected to increase by 28.3 percent and 15.3 percent for 10-year and 100-year events, respectively. Stage, on the other hand, is projected to decrease by -0.3 foot and 0.5 foot for 10-year and 100-year flood events, respectively.

The Lower San Joaquin River CPA (Figure H-15 and Table H-7) shows an overall increase for both flow and stage with 10-year events. For regulated flow, a 7.3-percent increase and 42.1-percent increase are shown for the 2072 without-project and 2072 with-project projections, respectively. For regulated stage, a 0.6-foot- and 2.9-foot increase are shown for the 2072 without-project and 2072 with-project projections, respectively. However, for 100-year events, the 2072 without-project projection results in a higher stage and flow than the 2072 with-project projection. A 152.4-percent increase in flow is shown for the 2072 without-project scenario, whereas the 2072 with-project shows a 119.0-percent increase. Likewise, 3.0-foot and 2.8 foot increases in stage are shown for the 2072 without- and with-project scenarios, respectively. Higher flows for the Lower San Joaquin CPA are expected at this location due to the presence of downstream tributaries. Larger projects on the Tuolumne River have a pronounced impact on this location specifically.

The projected changes to regulated hydrology for Upper San Joaquin CPA are described on Figure H-16 and in Table H-8. Due to both the upstream location of this index point (SJ01) and the lack of adjacent planned project implementations, there are no differences between the 2072 without-project and with-project scenarios. For 10-year events, there are no projected differences in flow and stage between 2022 and 2072 scenarios. However, for 100-year events, a nearly 400-percent increase in flow and a 12-foot increase in stage are shown. These results are likely explained given SJ01's location downstream of Friant Dam. High-flow events that cannot be captured in Lake Millerton are released downstream, while lower-flow events (i.e., return periods lower than roughly 25-years [AEP = 0.04]) can be properly managed upstream.

Figure H-12. SAC08 (Upper Sacramento River CPA) Regulated Flow (Left) and Stage-frequency (Right) Curves

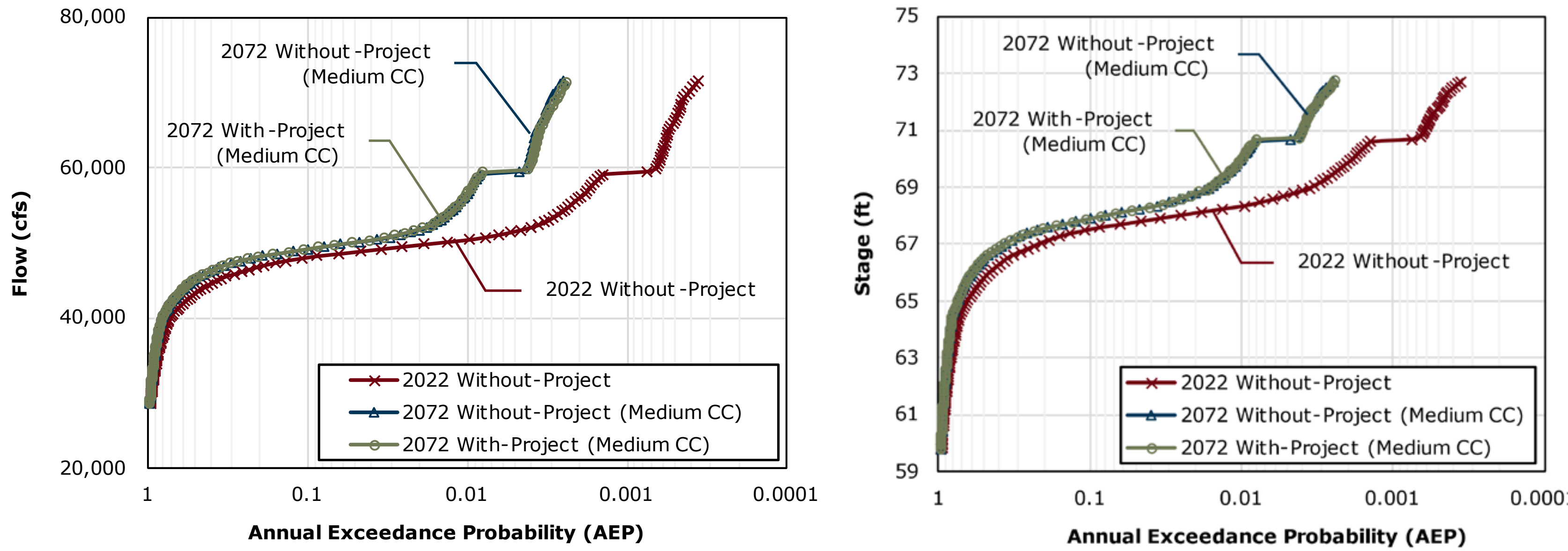


Table H-4. SAC08 (Upper Sacramento River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Medium CC) Flow (cfs)	2072 With-project (Medium CC) Flow (cfs)	2022 Without-project vs 2072 Without-project Percent Change	2022 Without-project vs 2072 With-project Percent Change	2072 Without-project vs 2072 With-project Percent Change
AEP = 0.1	48,000	49,100	49,200	2.3	2.5	0.2
AEP = 0.01	50,400	56,500	56,600	12.1	12.3	0.2
AEP	**2022 Without-project Stage (feet)**	**2072 Without-project (Medium CC) Stage (feet)**	**2072 With-project (Medium CC) Stage (feet)**	**2022 Without-project vs 2072 Without-project Difference (feet)**	**2022 Without-project vs 2072 With-project Difference (feet)**	**2072 Without-project vs 2072 With-project Difference (feet)**
AEP = 0.1	67.5	67.9	67.9	0.4	0.4	0.0
AEP = 0.01	68.3	70.0	70.0	1.7	1.7	0.0

Notes:
AEP = annual exceedance possibility
CC = climate change
cfs = cubic foot (feet) per second
vs = versus

Figure H-13. SAC25 (Feather River CPA) Regulated Flow (Left) and Stage (Right)- frequency Curves

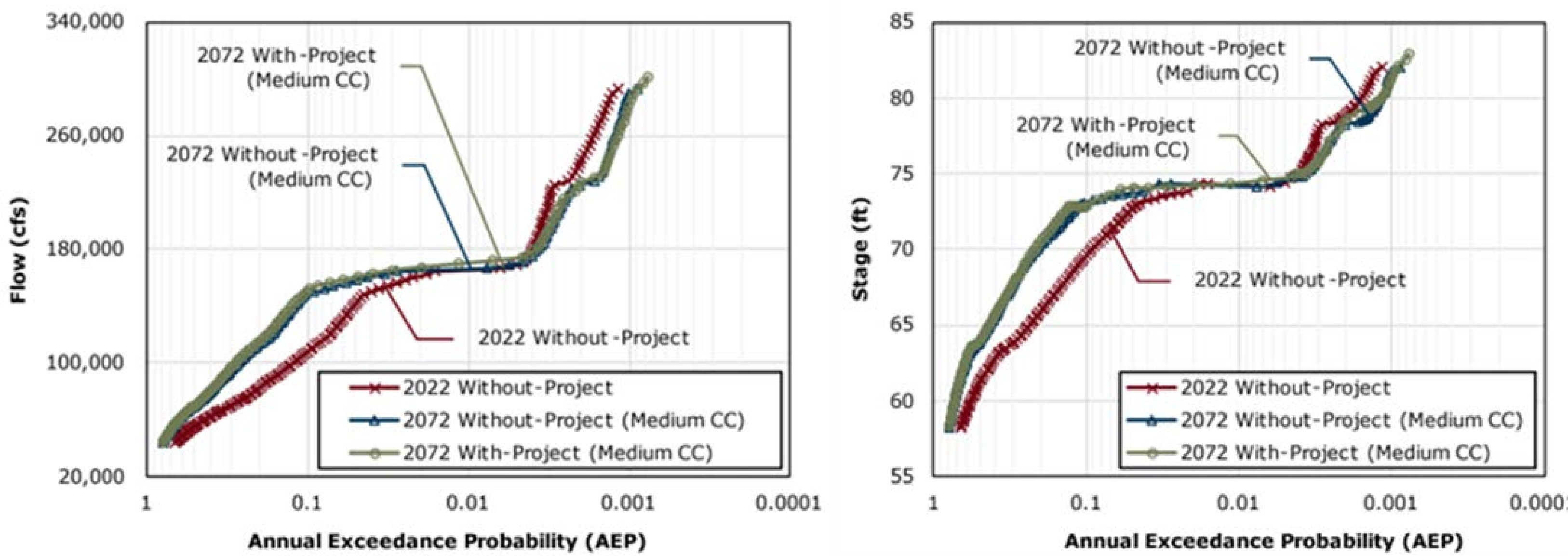


Table H-5. SAC25 (Feather River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Medium CC) Flow (cfs)	2072 With-project (Medium CC) Flow (cfs)	2022 Without-project vs 2072 Without-project Percent Change	2022 Without-project vs 2072 With-project Percent Change	2072 Without-project vs 2072 With-project Percent Change
AEP = 0.1	107,800	148,600	151,200	37.8	40.3	1.7
AEP = 0.01	165,800	166,400	170,400	0.4	2.8	2.4
AEP	**2022 Without-project Stage (feet)**	**2072 Without-project (Medium CC) Stage (feet)**	**2072 With-project (Medium CC) Stage (feet)**	**2022 Without-project vs 2072 Without-project Difference (feet)**	**2022 Without-project vs 2072 With-Project Difference (feet)**	**2072 Without-project vs 2072 With-project Difference (feet)**
AEP = 0.1	69.6	73.1	72.9	3.5	3.2	-0.3
AEP = 0.01	74.2	74.2	74.4	0.0	0.1	0.2

Notes:
AEP = annual exceedance possibility
CC = climate change
cfs = cubic foot (feet) per second
vs = versus

Figure H-14. SAC43 (Lower Sacramento River CPA) Regulated Flow (Left) and Stage (Right)-frequency Curves

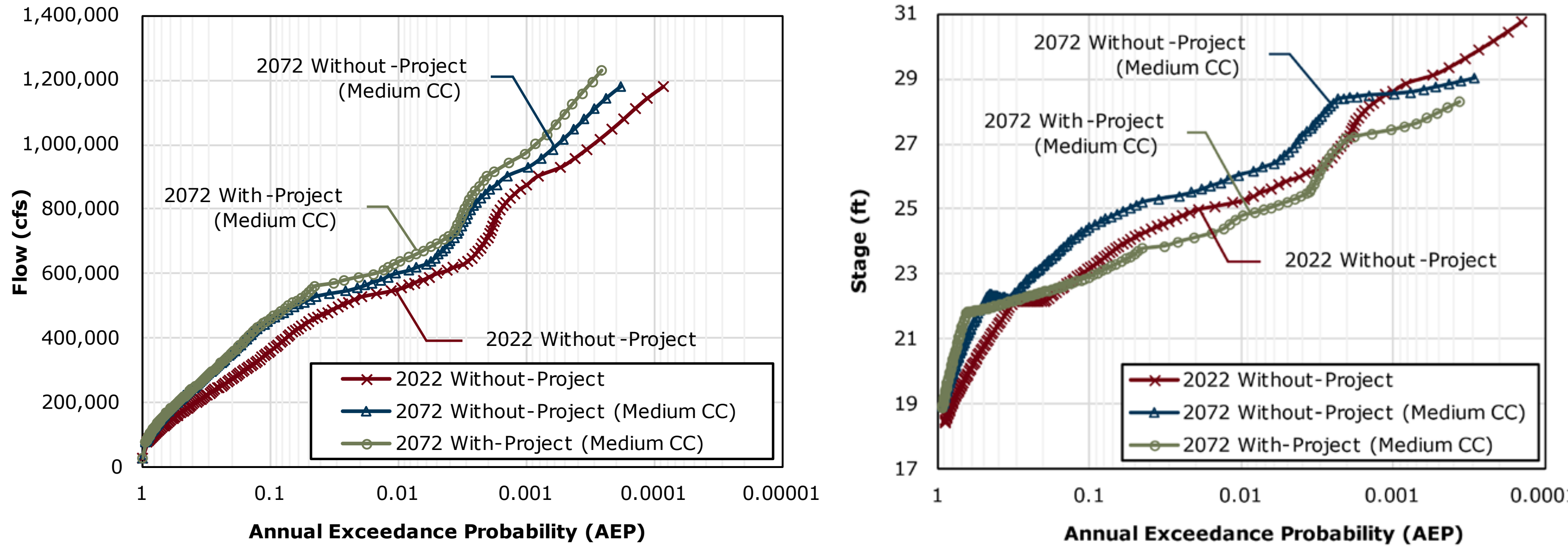


Table H-6. SAC43 (Lower Sacramento River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Medium CC) Flow (cfs)	2072 With-project (Medium CC) Flow (cfs)	2022 Without-project vs 2072 Without-project Percent Change	2022 Without-project vs 2072 With-project Percent Change	2072 Without-project vs 2072 With-project Percent Change
AEP = 0.1	360,000	458,200	461,700	27.3	28.3	0.8
AEP = 0.01	552,000	601,800	636,200	9.0	15.3	5.7
AEP	**2022 Without-project Stage (feet)**	**2072 Without-project (Medium CC) Stage (feet)**	**2072 With-project (Medium CC) Stage (feet)**	**2022 Without-project vs 2072 Without-project Difference (feet)**	**2022 Without-project vs 2072 With-project Difference (feet)**	**2072 Without-project vs 2072 With-project Difference (feet)**
AEP = 0.1	23.2	24.4	22.9	1.3	-0.3	-1.5
AEP = 0.01	25.3	26.1	24.8	0.8	-0.5	-1.3

Notes:
AEP = annual exceedance possibility
CC = climate change
cfs = cubic foot (feet) per second
vs = versus

Figure H-15. SJ28 (Lower San Joaquin River CPA) Regulated Flow (Left) and Stage (Right)-frequency Curves

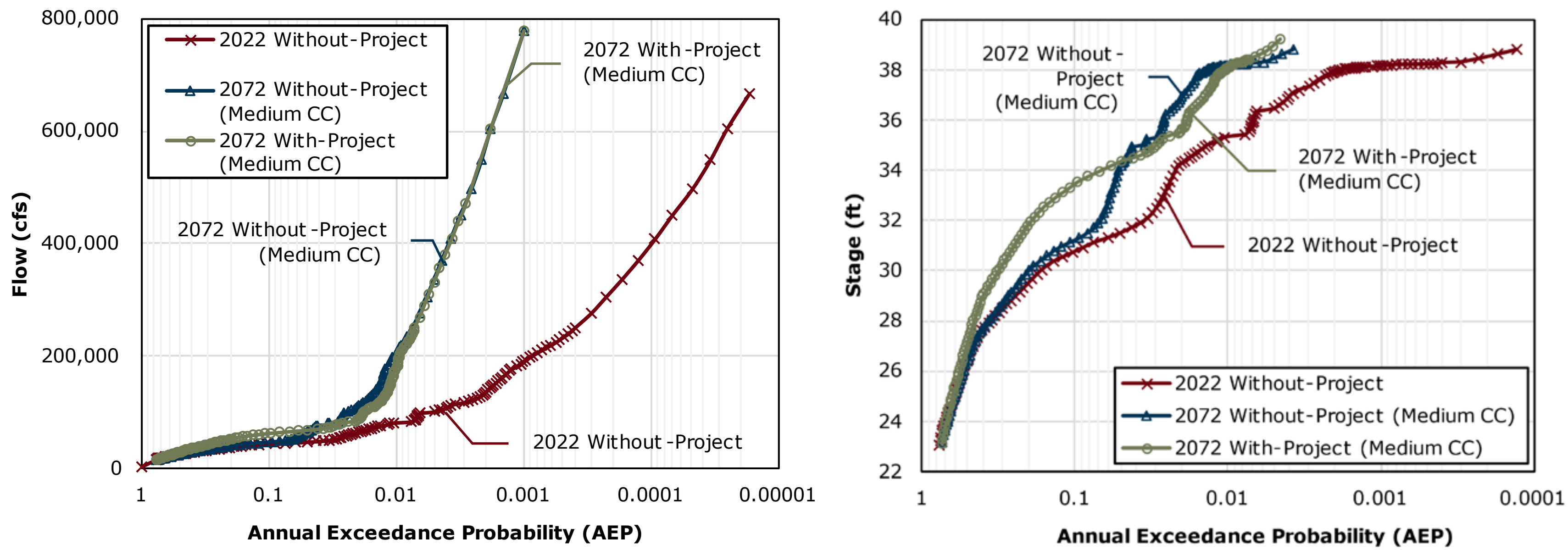


Table H-7. SJ28 (Lower San Joaquin River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Medium CC) Flow (cfs)	2072 With-project (Medium CC) Flow (cfs)	2022 Without-project vs 2072 Without-Project Percent Change	2022 Without-project vs 2072 With-project Percent Change	2072 Without-project vs 2072 With-project Percent Change
AEP = 0.1	43,900	47,100	62,400	7.3	42.1	32.5
AEP = 0.01	82,000	207,000	179,600	152.4	119.0	-13.2
AEP	**2022 Without-project Stage (feet)**	**2072 Without-project (Medium CC) Stage (feet)**	**2072 With-project (Medium CC) Stage (feet)**	**2022 Without-project vs 2072 Without-project Difference (feet)**	**2022 Without-project vs 2072 With-project Difference (feet)**	**2072 Without-project vs 2072 With-project Difference (feet)**
AEP = 0.1	30.6	31.2	33.5	0.6	2.9	2.2
AEP = 0.01	35.2	38.2	38.1	3.0	2.8	-0.1

Notes:
AEP = annual exceedance possibility
CC = climate change
cfs = cubic foot (feet) per second
vs = versus

Figure H-16. SJ01 (Upper San Joaquin River CPA) Regulated Flow (Left) and Stage (Right)-frequency Curves

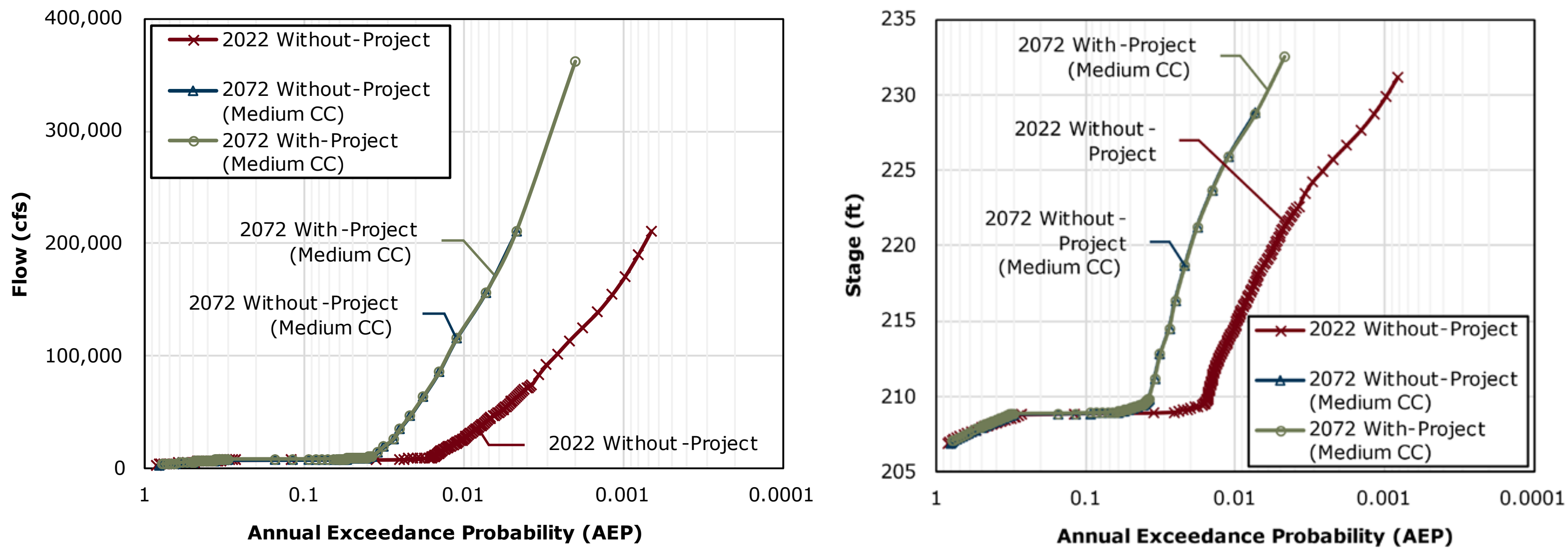


Table H-8. SJ01 (Upper San Joaquin River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Medium CC) Flow (cfs)	2072 With-project (Medium CC) Flow (cfs)	2022 Without-project vs 2072 Without-project Percent Change	2022 Without-project vs 2072 With-project Percent Change	2072 Without-project vs 2072 With-project Percent Change
AEP = 0.1	8,100	8,100	8,100	0.0	0.0	0.0
AEP = 0.01	26,500	126,800	126,800	378.5	378.5	0.0
AEP	**2022 Without-project Stage (feet)**	**2072 Without-project (Medium CC) Stage (feet)**	**2072 With-project (Medium CC) Stage (feet)**	**2022 Without-project vs 2072 Without-project Difference (feet)**	**2022 Without-project vs 2072 With-project Difference (feet)**	**2072 Without-project vs 2072 With-project Difference (feet)**
AEP = 0.1	208.8	208.9	208.9	0.0	0.0	0.0
AEP = 0.01	214.7	226.7	226.7	12.0	12.0	0.0

Notes:
AEP = annual exceedance possibility
CC = climate change
cfs = cubic foot (feet) per second
vs = versus

H3.1.9 Changes in Sea Level

Global and regional sea levels have been increasing over the past century and are expected to rise at an increasing rate throughout this century as the warming effects of climate change continue. Coastal sea levels impact Sacramento–San Joaquin Delta (Delta) communities, infrastructure, and ecosystems as water levels and water quality conditions (i.e., salinity) propagate upstream. Severe precipitation events (particularly from ARs) and increased regulated flows and stages will further exacerbate flood risk throughout the Delta (Figure H.1-6 in Attachment H.1; Delta Stewardship Council 2021a).

The 2022 CVFPP Update projection for sea level rise is developed with a planning horizon of 2072, using the medium-high risk, high emissions scenario from the State's *Sea Level Rise Guidance 2018 Update* (Figure H.1-7 in Attachment H.1; California Natural Resources Agency and California Ocean Protection Council 2018). The sea level projection for the San Francisco tide gauge was interpolated using a third order of polynomial regression line. The sea level rise projection for 2072 (i.e., the boundary condition at the Golden Gate Bridge) was determined to be roughly 3.68 feet. In addition, some sensitivity analyses were conducted with a range of sea level rise from 0 to 6 feet to capture a range of outcomes.

Projections for sea level rise are incorporated into hydrodynamic modeling (i.e., stage-frequency determinations) for the 2022 CVFPP Update to assess impacts on the Delta. Three conditions were used to develop stage-frequency relationships: existing hydrology conditions, existing hydrology conditions with sea level rise, and future climate change hydrology with sea level rise. Simulated water surface elevations along the Sacramento and San Joaquin Rivers under various historical flood event conditions were also compared to current top-of-levee elevations to assess life and flood risk in the Delta. Sea level rise will likely have a greater effect on water surface elevations for smaller flood events. This effect will decrease with more significant flood events induced by future climate change hydrology, further increasing water surface elevations (Maendly 2018).

H3.1.10 Changes in Groundwater

As described, temperatures are projected to increase under the low, medium, and high climate change scenarios. With reduced snowpack and earlier snowmelt, reservoirs are projected to fill earlier in the year. Existing reservoir operations may require this water to be released to mitigate flood risk, reducing the amount of reservoir storage available for spring and summer. As such, groundwater sources, which supply roughly 40 percent of the water in California, may undergo additional stress as pumping intensifies under a reduction in surface water and increased ET (DWR 2013a).

In the Central Valley, groundwater storage levels declined by 13 million acre-feet between 2005 and 2010 (DWR 2018a). Between 1996 and 2015, the Merced Subbasin declined at a rate of roughly 120,000 acre-feet per year, totaling an approximate 2.4 million acre-feet deficit (DWR 2020). If unchecked and exacerbated by the impacts of climate change, continuous declines in aquifer storage can lead to increased costs, subsidence, and strain on water supply and flood infrastructure (Water Environment Federation 2017).

H3.1.11 Changes in Wildfires

Wildfire risk is associated with a variety of climatological factors (temperature, soil moisture, drought, etc.) that are projected to shift under the effects of climate change. Over the last few decades, the number and severity of wildfires have steadily increased in the western United States, and further increases in magnitude and frequency are anticipated throughout the century. In the Sierra Nevada region of California, the annual average area burned is projected to increase between two and four times the 1961 to 1999 averages by the end of the century (2070 to 2099) under extreme warming conditions (Westerling 2018).

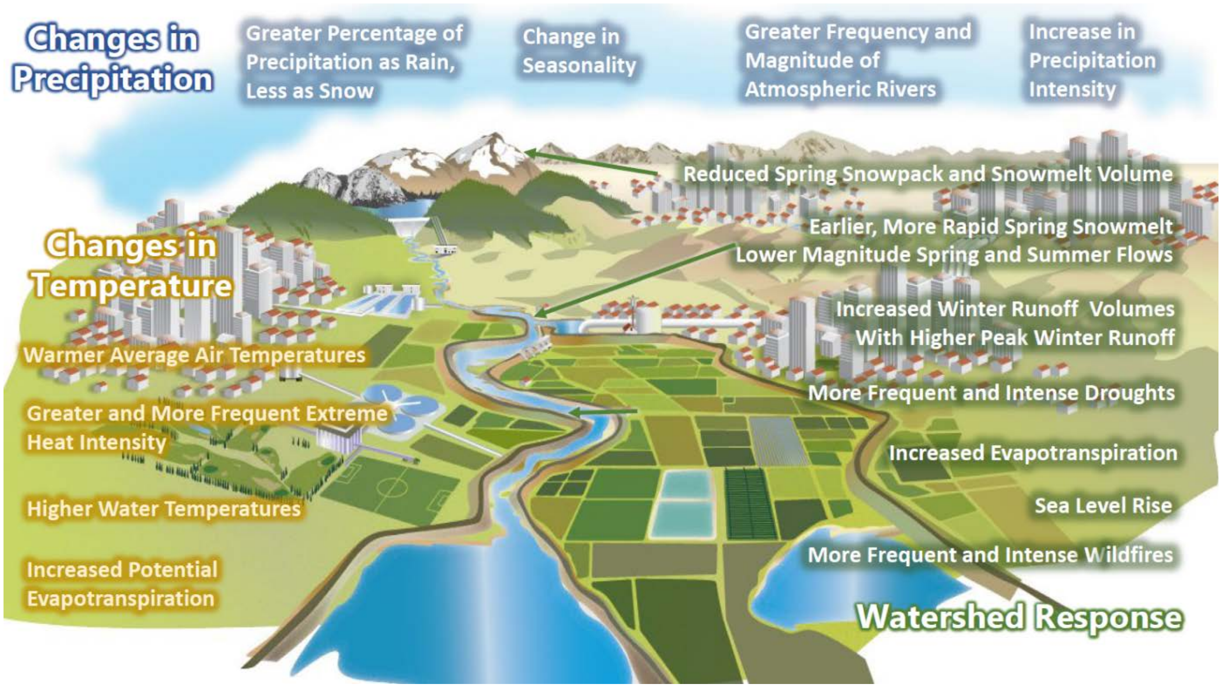
Wildfires are not only associated with substantial damages to property, infrastructure, lives, and ecosystems; they can also lead to downstream impacts. Because most fires in California occur in upper watersheds where there are the greatest number of forested areas, debris and other wildfire-related pollutants and compounds are carried downstream by runoff (Pennino et al. 2022). Wildfires can remove the tree canopy layers and biomass, resulting in decreased capacity to intercept and absorb rainfall. The soil surface is altered by high-severity fires, potentially collapsing soil structure and clogging soil pores with ash, or hydrophobic topsoil. These factors combine to dramatically increase peak runoff and sedimentation during post-fire rainfall events.

H3.2 Watershed Response

The changes in temperature, precipitation, and hydrology are likely to result in a watershed-scale changes that are specific to each CPA. The watershed response resulting from the climate drivers quantified in Section H3.1 are described generally here to provide an example of how large-scale climate impacts may result in ecosystem changes. Specifically, changes in precipitation include a greater percentage of precipitation occurring as rain and less as snow, shifts in precipitation seasonality, increased prevalence of AR conditions, and increases in extreme precipitation intensity. Changes in temperature include warmer average air temperatures, more frequent and intense extreme heat events, higher water temperatures in surficial water bodies (especially lakes and rivers), and an increase in potential evapotranspiration. The watershed-scale responses (Figure H-17) to these changes include the following:

- A reduction in spring snowpack and snowmelt volume.
- Earlier, more rapid snowmelt and lower-magnitude spring and summer flows.
- Increased winter runoff volumes and higher peak-winter runoff rates.
- More frequent and intense droughts.
- Increased ET.
- More frequent and intense wildfires.
- Sea level rise.

Figure H-17. Changes in Precipitation and Temperature, and Watershed Responses as a Result of Climate Change



The watershed responses to climate drivers listed on Figure H-17 will exert further stress on a system that already struggles to supply adequate water to meet agricultural and environmental demands. The increased winter runoff with higher peak flows will lead to increased flooding and stress on the levees. The shift in timing of snowmelt toward winter could cause reservoirs to fill up earlier in the season, and current flood rule curves would require this water to be released, leading to a deficit of water in spring and summer. The reduction in spring snowmelt and lower magnitude of spring and summer flows will reduce floodplain inundation and associated geomorphic processes.

The increased temperatures can stress riparian vegetation and create growing conditions potentially favoring many species of invasive plants. More frequent droughts and increased water demand by plants due to greater ET stress will increase the agricultural water deficit and will likely increase groundwater extraction, which could threaten groundwater-dependent ecosystems. Furthermore, drier conditions will reduce the accretion of creeks, driving the water system to be less elastic and recoverable during periods of stress. For October and November specifically, less precipitation will likely impact fall runs and the robustness of the water system to manage initial precipitation events. Sea level rise will exacerbate flooding in low -lying areas near the Sacramento-San Joaquin Delta and alter the boundaries of the salt water/freshwater interface. Riverine ecosystems in these areas will also become more tidally influenced with sea level rise, shifting the habitats for specific species. The increasing prevalence of high-intensity wildfires will affect rainfall runoff and flooding characteristics by potentially altering sediment loads and generating more rapid, higher-magnitude flood events.

H3.3 Ecosystem Response

The process of predicting the nature and magnitude of ecosystem response to climate change, and associated changes to watershed processes summarized earlier, is complicated because ecosystem responses may be directly (e.g., increases in stream temperatures that reduce habitat suitability for fish) or indirectly (e.g., changes in plant phenology, which affect the availability of invertebrate prey, which affect productivity and survivorship of birds) related to climate change. Furthermore, the nature and magnitude of ecosystem responses may vary both spatially and temporally.

The ability of native habitats and species to withstand the stressors associated with climate change depends on functioning natural physical processes that provide resiliency within the system. Rivers and riparian habitats are especially vulnerable to climate change given their dependence and critical connections to various flows for critical functions. Additionally, effects such as weather, drought, and fires occurring in upstream watersheds as well those occurring downstream, such as sea level rise, affect the entire span of river ecosystems. Ecological responses to climate change also vary among different scales of ecological organization from individual plants and animals to populations of species to communities consisting of multiple populations, and there is overwhelming evidence that recent, rapid global changes in climate are affecting ecosystems at all scales of organization (Teplitsky and Charmantier 2019). Examples include changes in distribution, migration patterns; timing of breeding and reproductive success; and changes in physiology and morphology (Ambrosini et al. 2019; Dunn 2019; McKechnie 2019; Radchuk et al. 2019).

To effectively manage natural resources and prioritize conservation efforts in response to climate change, it is important to identify key characteristics among individuals, populations, and communities that may be most affected by a changing climate (Van de Pol and Bailey 2019). The complex relationships among climate change; the watershed-scale response to climate change; and the response of ecological processes, habitat, and species is well-illustrated by the native fishes addressed in the Conservation Strategy (i.e., anadromous salmonids, green sturgeon, and delta smelt). These species' responses to climate change and changes in watershed processes are particularly difficult to estimate because the changes to physical conditions are likely to be location-dependent; and these species are potentially affected through multiple mechanisms that include changes to flow timing, duration, magnitude, and water temperature.

Changes in flows or water temperatures may, in turn, affect access to habitat, the timing of environmental cues that trigger critical behaviors (e.g., spawning), and the quality or quantity of suitable habitat, all of which may vary by life stage (e.g., egg, fry, juvenile, adult). These changes may also affect the food web of these species, as well the abundance and composition of predators on these species, both of which can affect the survival and growth of individual fish, which then are upscaled to effects on fish populations and aquatic communities.

For example, seasonal changes in hydrology are important cues for migration timing for upstream-migrating adult salmonids and downstream-migrating juvenile salmonids. Climate change-driven changes to these cues, coupled with increased water temperature, may result in adults spawning when temperatures may become unsuitable for egg survival (Jennings and Hendrix 2020) or juveniles out-migrating at a size or time when ocean conditions may not be favorable (Herbold et al. 2018). Climate change also is predicted to result in decreased snowmelt that will lead to lower spring peak flows and summer baseflows, which when coupled with the potential for increased drought frequency, can increase the vulnerability of juvenile salmonids to predation and improve habitat conditions for nonnative predators (Michel et al. 2020). In addition, end-of-May storage in reservoirs, which provides sources of cold water supporting salmonid habitat downstream of dams, is projected to fall to less than historical levels more frequently, further degrading salmonid habitat quality (Bureau of Reclamation 2016).

Furthermore, the effects of climate change on water temperature, a critical component of fish habitat suitability, are likely to depend greatly on location and to vary seasonally. As an example, greater warming is expected in winter and early spring in the upper San Francisco Estuary than in the western estuary, and greater warming overall is occurring in the northern part of the estuary than in the western region of the estuary (Bashevkin et al. 2021). Increases in San Francisco Estuary water temperatures are predicted to reach sublethal levels for delta smelt, ultimately compressing suitable habitat for the completion of their life cycle and resulting in timing shifts of their life cycle and a mismatch with important food resources or spawning windows (Brown et al. 2016). Elevated water temperature also significantly increases predation risks for juvenile salmonids (Michel et al. 2020). When combined with other factors, such as the use of large rock to protect levee slopes from erosion (which may become more frequently necessary to protect levees from higher-magnitude peak flows predicted to occur with climate change), the impacts on salmonids and other native fishes may be exacerbated by a loss of vegetative cover resulting in reduced shade, reduction in the food web, and improved habitat conditions (e.g., open water) for predatory species.

Despite these complexities and uncertainties, and to provide a basis for the identification of adaptation measures, the Conservation Strategy’s measurable objectives and target species were evaluated to generalize their potential ecological responses to climate change’s impacts (Table H-9). The evaluation was informed by key references (described in Table H-1), the technical appendices and documents associated with the Conservation Strategy, and the professional judgment of ecologists, biologists, hydrologists, and geomorphologists supporting DWR with the development of the Conservation Strategy Update and the publication of this report. Chapters 4 and 5 provide specific adaptation measures, drawing from those formulated for the Conservation Strategy, and additional guidance for increasing ecosystem resilience throughout the systemwide planning area (SPA).

Table H-9. Response of Conservation Strategy Measurable Objectives to Climate Change Drivers

Measurable Objectives	Climate Change Drivers and Ecological Responses
Ecosystem Processes: Floodplain Inundation	Increased magnitude of flooding and peak flows would lead to more extensive floodplain inundation where levees do not occur (or are already set back) and in existing floodways. However, much of this increased flooding would be expected in the winter over shorter durations, and ecologically beneficial spring flooding would be reduced in extent, duration, and magnitude throughout the SPA, particularly along the San Joaquin River.
Ecosystem Processes: Riverine Geomorphic Processes	Increased magnitude of flooding and increased peak flows potentially could increase riverine geomorphic processes (e.g., sediment transport, sediment deposition, erosion) throughout the SPA. However, the decreased duration of storms and reduced duration of spring snowmelt and runoff (particularly along the San Joaquin River) may reduce the spatial extent or magnitude of these processes throughout the SPA.
Stressors: Invasive Plants	Warmer air temperatures, more frequent and intense droughts, and increased severity and frequency of disturbances (in the form of wildfires) are likely to create conditions that favor the establishment of plants that are adapted to frequent and repeated disturbance, which include most species of invasive plants. These same climate changes also may reduce the influence of abiotic conditions (e.g., elevated soil moisture) that favor riparian and wetland plants (e.g., willow, cottonwood, tule, cattail) over upland plants (e.g., nonnative annual grasses and herbaceous broadleaf plants) within floodways.
Stressors: Fish Passage Barriers	As defined in the 2016 Conservation Strategy, fish passage barriers are water management structures such as dams, weirs, control structures, and water diversions that block, delay, strand, or otherwise adversely influence anadromous fish as they migrate upstream or downstream. Reductions in spring and summer flows, particularly during dry years and prolonged droughts, can further exacerbate existing fish passage barriers or result in new barriers.
Stressors: Revetment	The need for revetment is likely to increase, at least to some degree, for the reasons described in the "Ecosystem Processes: Riverine Geomorphic Processes" row of this table, primarily in portions of the SPA where levees occur directly adjacent to river channels.
Stressors: Levees	Increased flooding magnitude and peak flows may require larger levees (e.g., taller, wider), levee structural improvements (e.g., cutoff walls, stability, and underseepage berms), levee extension, relocation, or removal. Levees that are relocated (i.e., setback levees) or removed increase the size of the floodway allowing for more transient storage, greater system resiliency (particularly related to climate change factors), and improved ecosystem functions and values.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Habitats: Shaded Riverine Aquatic (SRA) Cover	Climate change drivers related to SRA cover are discussed in the "Ecosystem Processes: Riverine Geomorphic Processes," "Stressors: Revetment," and "Habitats: Riparian" sections throughout this table. Overall, some elements of SRA cover, such as natural, eroding banks may become more common with climate change and associated increases in peak flows; however, the potential for increased use of revetment and the expected decrease in riparian vegetation are likely to result in an overall decline in SRA cover throughout the SPA.
Habitats: Riparian	Several climate change factors are likely to affect riparian vegetation. More frequent flooding and increased peak flow magnitudes may increase the scouring of existing riparian vegetation stands, particularly where there is not adequate space in the floodplain to spread out floodwaters. Shifts in the amount, timing, and duration of spring runoff may also affect the regeneration of early-seral riparian species (e.g., cottonwoods and willows) that rely on spring flood events. Decreased summer flows, increased air temperatures, increased frequency and severity of droughts, and changes in soil moisture and atmospheric water deficit all may result in shifts to upland and nonnative species that are better adapted to increased aridity and more frequent and severe droughts. This shift in riparian vegetation community composition may be exacerbated by more frequent and intense wildfires.
Habitats: Marshes and Wetlands	Key climate change drivers include warmer air temperatures and increased frequency and severity of drought, coupled with more frequent and increased peak floods (generally earlier in the year) and altered spring and summer runoff. The San Joaquin River may be especially prone to the impacts of climate change, due to its greater reliance on spring snowmelt as a driver of wetland hydrology. Most climate change impacts are expected to negatively affect marsh and wetland habitats because the sources of wetland hydrology and extended wetland hydroperiods (e.g., spring flooding, shallow groundwater influenced by summer base flows, elevated soil moisture) would be reduced in magnitude, frequency, and/or extent (particularly in the San Joaquin River). However, increased scouring from increased winter flooding and higher peak flows may benefit marshes and wetlands by resetting succession and allowing early successional plants to establish following floods.
Target Species: Delta Button-celery Slough Thistle	In addition to the potential climate change impacts described in the "Habitats: Marshes and Wetlands" section of this table, changes in air temperatures, the amount and timing of precipitation (including more frequent droughts), decreased soil moisture, and increased evaporative demand could stress individual plants leading to reduced growth, seed output, and potential plant death. The magnitude of these impacts on Delta button-celery and slough thistle populations is difficult to predict and is likely to vary greatly from population to population based on localized edaphic conditions, location within the floodway, and other factors.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Steelhead (Central Valley Distinct Population Segment)	Steelhead migrate upstream to spawn high up in tributaries in fall and winter, usually on the descending limb of the hydrograph. Therefore, higher and earlier peak flows can decrease egg survival if there is increased gravel scour, and can affect juvenile survival by decreasing the ability of juveniles to survive over winter when rearing in natal streams. Elevated water temperatures, decreased summer flows, and more frequent and intense drought cycles may affect juvenile survival by affecting rearing habitat quantity and quality, physiology, and availability of prey. More frequent and intense wildfires may result in greater sediment loads to tributaries due to erosion and debris flows, which can decrease the quality and quantity of spawning and rearing habitat, and affect the survival of eggs and juveniles in unregulated streams used for spawning and rearing (e.g., Deer Creek, Mill Creek). Refer to the "Habitats: Riparian and Habitats: SRA Cover" section of this table for more information.
Target Species: Chinook (Fall-/Late-fall-run Evolutionarily Significant Unit) [a]	Fall/Late-fall Chinook salmon migrate upstream to spawn in tributaries in fall and winter. Therefore, higher and earlier peak flows can decrease egg survival if there is increased gravel scour, and can affect juvenile survival by decreasing rearing habitat conditions for juveniles. Elevated water temperatures, and more frequent and intense drought cycles may affect adult upstream migration and access to spawning habitat, as well as timing of egg hatching (higher temperatures will result in faster development). Refer to the "Habitats: Riparian and Habitats: SRA Cover" section of this table for more information.
Target Species: Chinook (Winter-run Evolutionarily Significant Unit) [a]	Winter-run Chinook salmon migrate upstream to spawn in the Upper Sacramento River in winter, but spawn timing is affected by water temperature, with cool spring temperatures triggering earlier spawn timing and warm spring temperatures resulting in later spawn timing. Egg survival depends on cool water temperatures in spawning habitat, which depend on releases from Shasta and Keswick dams. Therefore, higher water temperatures and more frequent and severe drought cycles can affect spawn timing and egg survival. Juveniles rear in the mainstem Sacramento River and in non-natal tributaries where elevated water temperatures, decreased summer flows, and more frequent and intense drought cycles may affect juvenile survival by affecting rearing habitat quantity and quality, physiology, and availability of prey. Refer to the "Habitats: Riparian and Habitats: SRA Cover" section of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Chinook (Spring-run ESU) [a]	Spring-run Chinook salmon time their adult upstream spawning migration with the snowmelt hydrograph and then hold in deep pools over the summer; therefore, changes to timing, magnitude, and duration of spring snowmelt may affect spawning behavior and timing. Higher and earlier peak flows may decrease egg survival if there is increased gravel scour, and may decrease juvenile survival by decreasing their ability to survive over winter. Elevated water temperatures, decreased summer flows, and more frequent and intense drought cycles may affect juvenile survival by affecting rearing habitat quantity and quality, physiology, and availability of prey; and may decrease the quality and quantity of adult over-summer holding habitat, which requires deep, cold water pools. More frequent and intense wildfires may result in greater sediment loads to tributaries due to erosion and landslides, which can decrease the quality and quantity of adult holding, spawning, and rearing habitat, and affect the survival of eggs and juveniles in unregulated streams used for spawning and rearing (e.g., Deer Creek, Mill Creek). Refer to the “Habitats: Riparian and Habitats: SRA Cover” section of this table for more information.
Target Species: Green Sturgeon (Southern Distinct Population Segment)	Green sturgeon adults migrate upstream to spawn in the Upper Sacramento and Feather rivers in late winter and spring in response to the snowmelt hydrograph, and hold/spawn in deep mainstem pools; therefore, changes to the timing, magnitude, and duration of spring snowmelt may affect spawning behavior and timing. Green sturgeon larval survival is negatively affected by higher water temperatures. Elevated water temperatures, decreased summer flows, and more frequent and intense drought cycles affecting summer water temperatures may affect juvenile survival by affecting rearing habitat quantity and quality, physiology, and availability of prey. Increased Delta salinity associated with sea level rise may affect the prey base for juvenile and subadult green sturgeon. Refer to the “Habitats: Riparian and Habitats: SRA Cover” section of this table for more information.
Target Species: Delta Smelt	Sea level rise, and the attendant increased salinity intrusion into the Delta, may further shrink, or shift upstream, areas of brackish water required by this species. Delta smelt require a mosaic of habitat types, including wetlands and floodplains. Delta smelt require low salinity habitat, and elevated temperatures may limit habitat for juvenile delta smelt. Refer to the “Habitats: Marshes and Wetlands” section of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Monarch Butterfly	The impacts of climate change on monarch butterfly include direct effects on individuals due to drought, temperature increases, catastrophic wildfire, and large storms; as well as changes to suitable roosting, breeding, and migration habitat (e.g., loss of nectar resources). Refer to the “Habitats: Riparian” section of this table for more information.
Target Species: Valley Elderberry Longhorn Beetle (VELB)	The impacts of climate change on the VELB depend largely on the impacts on the species’ sole host plant, blue elderberry. Relative to many other Central Valley riparian trees and shrubs, blue elderberry tends to occur more commonly in areas of infrequent flooding and lower groundwater and soil moisture. Changes in air temperatures; the amount and timing of rainfall (including more frequent droughts); and the timing, duration, and magnitude of peak runoff and spring runoff may have positive or negative effects on blue elderberry (and thereby the VELB), with some of these effects potentially benefiting the species by creating growing conditions more suitable for blue elderberry shrubs, relative to current conditions, and other effects creating growing conditions less suitable for elderberry relative to current conditions. The net effect of these changes on the VELB cannot be predicted and likely depends to a large extent on site-specific conditions. Refer to the “Habitats: Riparian and Habitats: SRA Cover” section of this table for more information.
Target Species: Giant Garter Snake (GGS)	Wetland-dependent reptiles, such as GGS, are sensitive to changes in the amount of precipitation and snowpack, drought, timing of snowmelt and runoff, and groundwater depth, which affect the availability and distribution of wetland habitat. An increase in flooding severity and changes in flood duration and timing could displace snakes, particularly those overwintering in the bypasses. Changes in precipitation and water availability may also affect irrigation and the extent of rice acreage, an important habitat for this species. With increasing droughts resulting water scarcity, farmers may convert from rice to dry crops. Additionally, irrigation channels may become drier and obsolete, disrupting connectivity of suitable habitat and movement corridors. More significant flood events may result in increased maintenance of channels and levees, leading to the disturbance or direct mortality to this species. GGS are sensitive to disturbance regimes, and more stressful environmental conditions could exasperate emerging diseases, such as snake fungal disease and parasitic infections. Refer to the “Habitats: Marshes and Wetlands” section of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Yellow-billed Cuckoo	Riparian birds, including the yellow-billed cuckoo, are primarily sensitive to drought because of the impact of reduced water availability on riparian vegetation and physical processes driven by flow regimes. Increased drought frequency and intensity and warmer air temperatures result in changes in soil moisture that have indirect effects on riparian birds by increasing evapotranspiration, and by further altering riparian vegetation species composition and habitat structure, key elements associated with habitat quality for riparian birds. Changes in phenology can cause mismatches in the timing of large insect emergence, which is critical to providing amino acids for reproduction and to feed their young. Warming temperatures may cause a mismatch between the timing of genetically driven circannual rhythms (such as the timing of migration and reproduction) and resource availability. More frequent flooding and increased peak flows can destroy nests and nesting, foraging, and resting habitats. Earlier annual snowmelt and earlier peak flows, lower streamflow, and changes in length of inundation may lead to an altered hydrograph, which affects riparian vegetation and the timing and availability of food for riparian birds. More frequent and intense wildfires may result in increased direct loss of nests, decreased food availability, and changes in vegetation species composition and structure important for riparian birds. Yellow-billed cuckoos require large blocks of riparian habitat for breeding, so factors that lead to habitat fragmentation and reduce patch size decrease habitat value and availability for cuckoos. Refer to the "Habitats: Riparian" section of this table for more information.
Target Species: Swainson's Hawk	Swainson's hawks typically nest in mature, dense-canopied cottonwoods, willows, and valley oaks associated with riparian forest habitat, and in isolated trees next to agricultural and grassland habitat. Riparian woodlands are a key nesting habitat for this species in the Central Valley. Increased drought frequency and intensity and warmer air temperatures result in changes to soil moisture that directly affect riparian habitats by increasing evapotranspiration and further altering riparian vegetation species composition and habitat structure, which could decrease both the frequency of large nesting trees and the amount of foliage on the trees. Reductions in water availability for crops may decrease the amount of row crop foraging habitat important for Swainson's hawks. Increased drought frequency and intensity and decreases in soil moisture may affect the prey base for this species by reducing the vegetation that supports small mammals and large invertebrates, both in grassland and agricultural habitats. More frequent wildfires may affect nesting trees, result in the direct take of nests, and reduce the prey base. In addition, increased droughts would decrease wetlands, which would reduce dragonfly productivity, another prey item of Swainson's hawks. Refer to the "Habitats: Riparian" section of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Least Bell's Vireo	Riparian birds, including the least Bell's vireo, are primarily sensitive to drought because of the impact of reduced water availability on riparian vegetation and physical processes driven by flow regimes. Increased drought frequency and intensity and warmer air temperatures result in changes in soil moisture that directly affect riparian birds by increasing evapotranspiration, and further altering riparian vegetation species composition and habitat structure, key elements associated with habitat quality for riparian birds. Changes in phenology can cause mismatches in the timing of insect emergence critical to providing amino acids for reproduction and feeding young and the primary food source for least Bell's vireos. Warming temperatures may cause a mismatch between the timing of genetically driven circannual rhythms (such as the timing of migration and reproduction) and resource availability. More frequent flooding and increased peak flow can destroy nests and nesting, foraging, and resting habitats. However, least Bell's vireos typically nest in dense, low, shrubby vegetation characteristic of early successional stages in riparian areas. If the timing is appropriate, more frequent flooding and increased peak flow could result in more early successional riparian habitats. Earlier annual snowmelt and earlier peak flows, lower streamflow, and changes in length of inundation may lead to an altered hydrograph, which affects riparian vegetation and the timing and availability of food for riparian birds. More frequent and intense wildfires, which have become more prevalent in riparian areas due to more invasive weeds and the lack of floodplain inundation, may result in increased direct loss of nests, decreased food availability, and changes in vegetation species composition and structure important for riparian birds. Refer to the "Habitats: Riparian" section of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Yellow-breasted Chat	Riparian birds, including the yellow-breasted chat, are primarily sensitive to drought because of the effect of reduced water availability on riparian vegetation and physical processes driven by flow regimes. Increased drought frequency and intensity and warmer air temperatures result in changes in soil moisture that directly affect riparian birds by increasing evapotranspiration, and further altering riparian vegetation species composition and habitat structure, key elements associated with habitat quality for riparian birds. Changes in phenology can cause mismatches in the timing of insect emergence, which is critical to providing amino acids for reproduction and feeding young, and can also cause mismatches in the timing of vegetation fruiting in late summer and fall, which is key for post-breeding migratory fat deposition and the timing of fall migration in chats. Warming temperatures may cause a mismatch between the timing of genetically driven circannual rhythms (such as the timing of migration and reproduction) and resource availability. More frequent flooding and increased peak flow can destroy nests and nesting, foraging, and resting habitats. However, chats typically nest in dense, low, shrubby vegetation characteristic of early successional stages in riparian areas. If the timing is appropriate, more frequent flooding and increased peak flow could result in more early successional riparian habitats. Earlier annual snowmelt and earlier peak flows, lower streamflow, and changes in length of inundation may lead to an altered hydrograph, which affects riparian vegetation and the timing and availability of food for riparian birds. More frequent and intense wildfires, which have become more prevalent in riparian areas due to more invasive weeds and the lack of floodplain inundation, may result in an increased direct loss of nests, decreased food availability, and changes in vegetation species composition and structure important for riparian birds. Refer to the “Habitats: Riparian” section of this table for more information.
Target Species: Tricolored Blackbird	Tricolored blackbirds breed in continuous areas of emergent marsh vegetation and riparian scrub, for which early successional stages in both habitats are preferred. Earlier, more rapid spring snowmelt and peak runoff flows with lower-magnitude spring flows under drastic snowpack reduction could reduce the amount of water needed to support emergent marsh vegetation and affect the timing and extent of inundation of the marsh habitat, which are important aspects in creating and maintaining preferred breeding habitat. Warmer air temperatures and increased frequency and severity of drought will result in reductions in soil moisture and increased evapotranspiration, decreasing overall breeding and foraging habitats for wetland-dependent birds including tricolored blackbirds. Refer to the “Habitats: Marshes” and “Wetlands and Habitats: Riparian” sections of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: California Black Rail	An increased magnitude of flooding and peak flows would lead to more extensive floodplain inundation and potentially longer inundation durations, where levees do not occur (or are already set back) and in existing floodways. More frequent flooding and increased flow can destroy black rail nests and nesting, foraging, and resting habitats. Black rails are also more susceptible to predation when their marsh habitats are flooded, forcing them out of the emergent vegetation. Because black rails occupy marsh islands in the Delta that are subject to flooding, changes in the timing and intensity of rain events or water storage releases could disrupt their annual life cycle if flood intensity increases during the breeding season, when higher volumes of water are released in spring due to heavy winter rains. Low flows resulting from a reduction in snowpack could create water levels that are insufficient to sustain emergent marshes and riparian vegetation during the dry season. Warmer air temperatures and higher water temperatures result in sea level rise exacerbate habitat and predation-related stresses for this species in the Delta where marshes are confined by levees that prevent the upward migration of marshes as water levels rise. As a result, the distribution of vegetation suitable for black rails will decrease in the Delta. In addition, the attendant increased salinity intrusion into the Delta may further shrink, or shift upstream, areas of brackish water marsh used by this species in the Delta. Increased drought intensity and frequency could reduce available habitat and shift areas of brackish marsh. Increased wildfires could burn both emergent marsh vegetation and associated scrub riparian habitat used by black rails in the Delta and result in the direct take of nests and displacement of individuals. Refer to the “Habitats: Marshes and Wetlands” section of this table for more information.
Target Species: Greater Sandhill Crane	Wintering habitat for greater sandhill cranes in the Central Valley generally consists of irrigated pastures and croplands, grain fields, small open ponds, wetlands, and floodplains that are open and without visual obstruction (e.g., dense vegetation). Wetlands are important for nocturnal roosts. The Central Valley wintering greater sandhill crane population does not appear to be particularly sensitive to the threat of climate change, but wintering habitat could be threatened by increased flood risk with sea level rise and increased magnitude of flooding and peak flows. Additionally, increased frequency and severity of droughts could decrease row crop planting (foraging habitat) and wetland habitat (roosting and foraging). Refer to the “Habitats: Marshes and Wetlands” section of this table for more information.

Measurable Objectives	Climate Change Drivers and Ecological Responses
Target Species: Bank Swallow	Climate change could be positive or negative for bank swallows. Higher-magnitude peak flows may create additional exposed banks that increase nesting habitat for this species; however, in other instances, the increased magnitude and frequency of flooding will likely lead to the increased use of revetment to protect levees in many locations, thereby eliminating habitat for this species. Refer to the “Ecosystem Processes: Riverine Geomorphic Processes” and “Stressors: Revetment” sections of this table for more information.
Target Species: Riparian Brush Rabbit Riparian Woodrat	These species require large patches of riparian scrub with dense understory providing sufficient cover. Flooding is a major threat to the remaining populations. Although riparian brush rabbits have been found in trees and tall shrubs during floods, it is doubtful they can survive in trees for long. Rabbits trapped in this manner are highly susceptible to predation, hypothermia, and starvation. Also, little refuge is available to brush rabbits fleeing rising waters, because agricultural fields abut the riparian corridors occupied by all three populations. Increased peak flows and more frequent flooding could affect the survival of this species, particularly within leveed reaches where higher refugia, above flood flows, do not occur or do not provide for connectivity to occupied habitat and suitable cover for the species. Additionally, more frequent and intense wildfires could eliminate habitat for these species. Riparian brush rabbits and riparian woodrats are vulnerable to environmental change of any kind because of their small population size, isolation, low genetic diversity, and inability to disperse to new habitats. Refer to the “Habitats: Riparian” section of this table for more information.

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CHAPTER H4

Potential Adaptation Strategies and Measures

This chapter is organized into two key parts:

- A background discussion that includes fundamental conservation biology and systems resiliency principles to guide the development of measures that can reduce ecosystem vulnerability and enhance resilience.
- An overarching climate change adaptation strategy, along with five corresponding adaptation measures. The first measure consists of direct modifications to the flood control system, grouped into landscape-scale measures, and habitat- and species-specific measures. The next four measures consist of implementation policy guidance and initiatives to improve knowledge and communication related to climate change risks, vulnerabilities, and opportunities.

These preliminary adaptation measures are intended to provide an initial set of recommendations for how DWR and its partners can most effectively conserve and restore the ecological processes, habitats, and species identified in the Conservation Strategy. These will likely be refined and improved in collaboration with project partners through the CVFPP development process.

H4.1 Overview of Ecological Vulnerability, Resilience, and Adaptation

Traditionally, an ecosystem's potential vulnerability to climate change impacts has been measured in relation to the ecosystem's historical condition. The logic behind this approach is that populations, communities, and ecosystems will be best prepared to cope with new or variable conditions if those conditions fall within the historical range of variability they have adapted to (Falk et al. 2019). However, the realized and potential rates of change in temperature, precipitation, and hydrology described in Section H3.1 are outside the range of the natural variability current ecosystems in the Central Valley have historically occurred under. In addition, the increased climatic extremes increase the frequency and magnitude of natural and anthropogenically intensified disturbances such as fire, flood, and drought. The stress these climatic changes and ecological disturbances will impart on natural communities may exceed the ecosystem's ability to recover. A species' vulnerability and its resilience are a product of many aspects of its ecology, population and conservation status, and current habitat conditions.

Vulnerability assessments help determine whether the species or systems are vulnerable to the effects of climate change and if so, to what extent. These assessments are important to link actions to impacts, and to create specific adaptation strategies and actions that reduce vulnerabilities (Stein et al. 2014). Species-specific vulnerability is based broadly on species-specific exposure, sensitivity, and adaptive capacity (Bateman et al. 2020). Species vulnerability assessments should not only address the effects of climate change; they should also include potential cumulative impacts of other, non-climate stressors and how those might interact with the effects of climate change (Gardali et al. 2012; Jongsomjit et al. 2013). Those stressors may include (among others) land conversion and development, changes in hydrology due to water management infrastructure, and channelization and disconnection of floodplain habitats due to levee construction.

Consequently, actions can be taken to reduce vulnerability or increase resilience. These actions (adaptations) are being guided by the following key principles of conservation biology and adaptive management (National Fish, Wildlife, and Plants Climate Adaptation Partnership 2012; California Natural Resources Agency 2014; Stein et al. 2014; Keeley et al. 2018):

- Where possible, reintroduce physical processes by removing impediments to natural processes and reconnecting rivers to their floodplains.
- Protect remaining habitats from loss and fragmentation and increase the size of protected areas.
- Provide for species movement and migration through habitat protection and restoration.
- Reduce other (non-climatic) stressors on species through management actions.
- Use adaptive management to take action under uncertain and changing climatic conditions and to increase understanding and inform actions.
- Increase institutional capacity for effective management.

Implementation of the CVFPP provides a critical opportunity to increase the climate change resiliency of species and habitats. This is primarily because rivers and floodplains are particularly important as corridors for the movement and migration of aquatic and terrestrial species (Seavy et al. 2009). The Central Valley's rivers and floodplains are highly managed systems; however, if enacted, many opportunities will reduce vulnerability to climate change impacts, rehabilitate the system for current conditions, and increase system resilience. As DWR, regional/local maintaining agencies, and other State and federal resource managers continue to advance multi-benefit projects within the SPA, floodplain managers will need to strive to build resilience into the system and develop countermeasures to mitigate the impacts of climate change by employing effective multi-objective adaptation approaches.

H4.2 Development of Adaptation Measures

Preliminary adaptation measures specific to the Conservation Strategy objectives and target species were developed using the following process:

1. Review current literature on climate adaptation and climate change impacts in the Central Valley (refer to Chapter H2).

2. Analyze the latest climate change modeling to determine probable climatic changes in each CPA (refer to Section H3.1).

3. Estimate climate change drivers of changes to watershed processes (refer to Section 3.2) and possible ecological responses for the Conservation Strategy's measurable objectives and target species (refer to Section H3.3).

4. Identify regional climate change risks and potential opportunities within each CPA (refer to Chapter H5).

5. Develop adaptation approaches that leverage existing DWR planning processes (including the CVFPP and Conservation Strategy), provide guidance for future Plan Updates, and could initiate the development of resources and tools that can be shared with agency partners and others developing multi-benefit projects.

H4.2.1 Adaptation Measure 1: Build Ecosystem Resilience

It is possible to reduce or mitigate the risks of climate change to the ecological processes, habitats, and species identified in the Conservation Strategy by implementing projects and management actions that restore ecosystem functions, increase the quantity and quality of essential habitats, and improve conditions for specific species. These adaptation measures and recommendations are organized into two groups: landscape-scale processes, and habitat and species-specific measures.

H4.2.1.1 Landscape-level Hydrologic, Ecological, and Geomorphic Process-specific Adaptation Measures

At the highest level, the most important and effective measures create more opportunities to restore and improve riverine geomorphic processes by increasing the river corridor width; allowing the formation of complex, dynamic, meandering channels; and reconnecting relict floodplains. This can be accomplished by removing or setting back levees along river corridors, removing revetment, or reconnecting and restoring floodplains. No matter where they occur geographically, these actions would generally help increase resilience. This is particularly true for climate change challenges, because they would allow more opportunities to restore natural physical and ecological processes and develop complex, diverse habitats along the channel margins, floodplains, and riparian zones. These actions would help achieve the following ecological goals: restoring ecosystem processes, increasing and improving habitats, reducing stressors, and contributing to the recovery of target species.

- **Levee Setbacks and Removal:** Relocating levees to expand floodways and bypasses or removing levees that are no longer needed for flood management, would increase climate change resilience. Section 3.1 describes the predicted increased peak flows, especially in the San Joaquin and its tributaries, which will greatly increase flood risk and will require major modifications to the existing levee infrastructure to minimize impacts on surrounding areas. Levees should be strategically set back to promote the formation of side channels, meander bend cutoffs, eroded banks, point bars, and similar features that create and sustain habitats for most native species. Levee setbacks also allow for the expansion of riparian and SRA habitat while promoting vegetative succession and riverine geomorphic processes that create and sustain habitats for target and other native species. Levee relocations could also be designed to meet multi-benefit project goals, such as groundwater recharge and the creation of suitable rearing habitat for target species. These also have the benefit of lowering the long-term operations and maintenance burden by decreasing erosional pressure on levees and reducing the overall length of levees along the river corridor.
- **Unnecessary Revetment Removal:** Levees or bank revetment within a river's natural meander zone can impede the physical processes needed to support complex aquatic and riparian ecosystems (Naiman et al. 1993; Lytle and Poff 2004). Revetment and levees prevent natural processes (such as meander zone migration and meander cutoffs) in portions of the SPA, which has prevented the formation of new habitat. The locations of unnecessary revetment should be systematically identified as opportunities for removal to promote natural riverine processes.
- **Floodplain Topographic Modification:** Floodplain modification can be used in the floodway to increase floodplain inundation for a wider range of flows by raising or lowering areas. This measure can increase the suitable inundated habitat needed to meet the Anadromous Fish Restoration Program's doubling goal for salmonid populations in the Central Valley. The current acreage of floodplain that is hydrologically connected to Central Valley rivers is extremely low relative to historical conditions, and climate change is expected to further reduce the flow-related habitat conditions needed for freshwater ecosystem health (Matella et al. 2014). Floodplain topographic modifications can be designed to promote a hydrologic connection to the river for specific target species and for a current or future flow regime. This is especially relevant along the San Joaquin River corridor, where natural flows have been modified to the extent that it is not feasible to establish the hydrologic reconnections of floodplain terraces at ecologically beneficial frequencies and durations because of to current reservoir operations and flow management paradigms.
- **Floodplain Heterogeneity Enhancement:** Where the levees cannot be set back further, this adaptation measure can optimize floodplains to achieve resilient ecological functionality under a changing climate. Creating microtopography on the floodplain also allows for greater habitat diversity and areas for sanctuary during extreme conditions (e.g., high ground refugia during floods and low shaded cooler areas during droughts).

- **Intentional Levee Breaks and Planned Weir Overflows:** Another strategy to mimic floodplain inundation processes is the use of intentional levee breaks (using operable levee gates, weirs, or other mechanisms) that allow the programmed inundation and dewatering of floodplains, or planned weir overflows. This concept is discussed in a journal article by Florsheim and Dettinger (2015) and provides an alternative to full levee setbacks or levee removal where those options are not feasible. Planned weir overflows could also be used in conjunction with flood risk reduction strategies, such as transitory storage for floodwaters.
- **Flood System Management to Promote Flood-Managed Aquifer Recharge (Flood-MAR):** Flood-MAR can be applied to use flood water to recharge water on agricultural lands, floodplains, and flood bypasses to provide the following benefits: water supply reliability, flood risk reduction, drought preparedness, aquifer replenishment, ecosystem enhancement, subsidence mitigation, water quality improvement, working landscape preservation and stewardship, and climate adaptation. Flood-MAR could be implemented at multiple scales to achieve multi-sector sustainability and climate resilience. Ongoing studies along the lower Tuolumne and Merced Rivers, and the mainstem San Joaquin River, are currently assessing the potential to evaluate the compatibility of floodplain recharge and restoration in a manner that can restore geomorphic processes, improve habitat conditions, and build ecological resilience while simultaneously improving groundwater storage.
- **Multiple-objective Operations and Maintenance:** Operations and maintenance approaches need to include criteria that consider natural river functions and processes (such as sediment transport and the development of complex, dynamic channel features), as well as habitat and species conditions, to alleviate the ecological stressors that have historically been caused by flood operations and maintenance actions. This is a complex issue that may involve revisions to federal policies and authorizations, but it is a critical strategy to adaptively manage the flood system and gradually improve ecological conditions over time in a manner that is compatible with flood conveyance objectives. This will likely require policy changes and cooperation with federal partners, but these types of multiple-objective operations and maintenance programs are currently being employed in other regions and could be further advanced in the Central Valley by DWR with federal, State, and local partners.
- **Reservoir Operations Updates:** Reservoir flood rule curves will need to be adapted to accommodate changing flow regimes and improved weather forecasting technology. As the snowmelt and peak flows shift to earlier in the season, reservoirs will fill sooner and be required to release flows. Reservoir management strategies (such as Forecast-informed Reservoir Operations [FIRO]) could allow for a more natural flow regime that mitigates some impacts of increasingly variable hydrology. When reservoirs are required to release flows sooner for flood control, reservoir operations need to consider the types and durations of flows needed to achieve multi-benefit ecological goals. For example, reservoirs can release flood flows in concert with downstream management to promote Flood-MAR. The term Eco-FIRO-MAR has been recently popularized to describe the importance of managing reservoirs in coordination with operations to promote groundwater recharge and ecological function.

- **Transitory Floodplain Water Storage Increases:** As flood system operations are modified, projects may also be implemented that improve and increase the transitory floodplain storage of floodwaters downstream. Not only do these projects provide ecological benefits, but they may also increase groundwater recharge, which provides regional ecosystem and water supply benefits consistent with other State and regional water management programs.

H4.2.1.2 Habitat and Species-specific Adaptation Measures

Even with the restoration of natural geomorphic processes, other factors or stressors may prevent or impede natural ecological recovery in ways that do not optimize conditions for native habitats or target species. These may include (among others) elevated or monotypic floodplains, and persistent invasive weeds. In addition, improved geomorphic processes may create or sustain target habitats too slowly to maintain or increase populations of target species, especially species whose population sizes already are low or whose distributions are limited. For these reasons, species-focused habitat creation, restoration, and enhancement actions may be needed to improve climate change resilience.

Multi-benefit projects can be designed adaptively to optimize habitat conditions and mitigate the impacts of climate change; general guidance related to the design of multi-benefit projects is provided here.

General Habitat and Species-specific Design Guidance for Increasing Resilience

- **Designs Allowing for Habitat Migration:** For restoration and conservation project planning and design, it is widely acknowledged that habitats will change and migrate in response to climate change; therefore, project planning and design should include buffers that allow this habitat evolution and migration. For example, sea level rise will change the location and distribution of tidal marsh habitat in the Delta. Therefore, estuarine restoration projects should account for this by designing projects to allow for the migration of tidal marsh habitats in the coming decades, according to current sea level rise projections.
- **Floodplain Topographic Modification:** Floodplains can be designed to accommodate an altered hydrologic flow regime. These modifications can be targeted to improve habitat for specific species (e.g., suitable spawning and rearing habitat for salmonids) or to create high-ground refugia for aquatic and terrestrial species, such as GGS, California black rail, riparian brush rabbit, and woodrat.
- **Invasive Plant Control:** Invasive plant management, particularly following disturbances such as wildfires that create conditions suited to invasive plant colonization and spread, will be required to sustain native plant communities. The restoration of disturbed areas, using native species adapted to future climate and hydrologic conditions, can be used to minimize the impacts of invasive plants on ecosystem processes, habitats, and species.

Climate change may further exacerbate negative contributors to target species (as described in the individual target species-focused conservation plans), in addition to the stressors identified in the Conservation Strategy. These plans also identified specific actions that could be implemented to optimize conditions for target species recovery. In addition to the overall recommendations related to improving processes and habitats, additional recommendations related to target species may further be warranted when combined with climate change projections. Some species are highly localized, or their distributions within the SPA are uncertain. To the extent that any actions take place to address the broader activities described here, they would need to be spatially explicit and likely prioritized, because their distributions are much more limited. Therefore, these species are much more likely to experience population declines or go extinct if they are not specifically targeted. As such, additional recommendations may be warranted to address target species-specific life history requirements. Table H-10 provides detailed adaptation strategies for Conservation Strategy habitats and target species.

Table H-10. Conservation Strategy Habitat and Species-Specific Adaptation Measures

Conservation Strategy Targets	Adaptation Measures
Habitat: SRA Cover	Increasing the ability of rivers to meander within a large floodplain supports the ecological and riverine geomorphic processes that create and sustain natural banks, encourage the succession and sustainability of riparian habitat, and thereby create and maintain SRA cover. Actively and passively restoring SRA habitat throughout the system provides key functions and values, including helping to decrease water temperatures, providing cover and refugia, providing direct and indirect sources of nutrients and food for aquatic species, and increasing habitat complexity, all of which benefit multiple aquatic and terrestrial species. **(SRA-1)**
Habitat: Riparian	Actions that expand floodways (i.e., created new bypasses and areas of transient storage), relocate levees to expand floodways, or remove levees and revetment that do not provide public safety benefits could contribute to the formation of side channels, meander bend cutoffs, eroded banks, point bars, and similar features that create and sustain riparian habitats. Increasing the amount of available floodway would and allow for riparian species assemblages to shift spatially within the floodway in response to future climatic conditions increasing overall resiliency of riparian habitats. Restoring riparian habitat throughout the system provides for improved connectivity and sufficiently buffered landscapes to sustain multiple species and provide key functions and values, particularly when part of a connected floodplain. Increasing the quality and quantity of native habitats in the system, including riparian, provides more overall opportunities for species persistence and habitat resiliency. **(RIP-1)**

Conservation Strategy Targets	Adaptation Measures
Habitat: Marshes and Wetlands	Actions that expand floodways (i.e., created new bypasses and areas of transient storage), relocate levees to expand floodways, or remove levees and revetment that are no longer needed for flood management, could contribute to the formation of side channels, and similar features that create and sustain marsh and wetland habitats. Increasing the amount of available floodway would allow for marsh and wetland species assemblages to shift spatially within the floodway in response to future climatic conditions. Actions that modified floodplain topography and restored marsh and wetland habitat within the floodway also could contribute toward the resiliency of riparian habitats. **(WET-1)**
Species: Delta Button-celery and Slough Thistle	Climate change resilience for these species would be improved through surveys to determine the locations of existing populations, thereby permitting seed collection and plant propagation, as well as facilitated colonization of other sites within the SPA using collected propagules. The better habitat conditions provided by restoring natural physical processes would provide more opportunities for native plant communities, including potentially these species, to propagate and persist. Additionally, targeted vegetation and invasive plant management actions would help sustain populations of these species in the face of climate change. **(PLANTS-1)**
Species: Delta Smelt	Modifications to bypasses, in particular the Yolo Bypass, to incorporate habitat mosaics that include wetlands and floodplains would benefit delta smelt. Levee setbacks in the lower system and the Delta would improve and expand floodplain and heterogeneous tidal wetland habitat complexes, which are likely to improve habitat conditions for delta smelt. **(SMELT-1)**
Species: Steelhead; Spring-run, Fall-/Late-fall-run, and Winter-run Chinook Salmon; Green Sturgeon	Riparian and SRA habitat restoration actions (described in this table) would contribute to cooling water temperatures and provide other fish-rearing habitat benefits, including cover, production of invertebrates to sustain aquatic food web productivity, and instream wood, all of which would improve these species' abilities to adapt to climate change. Additionally, creating floodplain habitat adjacent to rivers and tributaries may help to address changes in flood magnitude expected due to climate change, improve rearing habitat, and improve habitat conditions for juveniles that overwinter in tributaries. **(SALMONID/STURGEON-1)**
Species: Monarch Butterfly	Habitat restoration and enhancement that provides suitable breeding and migration habitat would increase the resilience of this species to climate change. Restored and enhanced habitat should have the following attributes: • An abundance of diverse nectar resources and milkweed species that bloom across the breeding and migration period (e.g., spring to fall). • Trees and shrubs for safe roost sites. • Water to drink. • Connectivity with other suitable habitat in the floodway. **(MONARCH-1)**

Conservation Strategy Targets	Adaptation Measures
Species: VELB	Actions that provide increased opportunities for blue elderberry shrubs to colonize new locations in response to hydrologic changes (i.e., to move to relatively wetter or drier locations as site-specific hydrologic conditions are altered due to climate change) would increase climate change resilience of the VELB. Examples of these actions are: expanding floodways by relocating river levees; removing levees and revetment that do not provide public safety benefits or protect infrastructure; and modifying floodplain topography to create areas within floodways that have hydrologic conditions capable of supporting blue elderberry shrubs. **(VELB-1)** In addition, habitat restoration that includes elderberry shrubs would increase the climate change resilience of the VELB. To have the greatest positive effect, habitat restoration actions should be prioritized to occur within, or near, the Sacramento River Wildlife Area, Sacramento River National Wildlife Refuge, Oroville Wildlife Area, and Feather River Wildlife Area. These areas currently support dense and diverse riparian habitats and VELB populations that could be enhanced or expanded by focused habitat restoration actions. In addition, the range of VELB throughout the SPA could potentially be expanded by restoring riparian scrub and woodland habitats and incorporating dense patches of elderberry shrubs as components of restored riparian habitats, ideally by starting with areas near the locations where the VELB is known to occur, and gradually progressing to more distant locations to support metapopulation processes. **(VELB-2)**
Species: Giant Garter Snake (GGS)	Actions that create or support marshes inundated during the active season for GGS (May 1 to October 1), and include all elements of suitable GGS snake habitat (in-water cover with suitable prey and lack of predators, upland refugia, and basking sites), and provide connectivity to known occupied habitat would increase the resilience of this species to climate change. Created marsh habitats should have the following attributes: • Consist of paired blocks of habitat composed of (ideally) two 539-acre blocks (minimum size) of buffered perennial wetlands per location. • Paired blocks should be separated by less than 5 miles and should be connected by a corridor of aquatic and upland habitat not less than 0.5 mile wide. • Paired blocks should be buffered by 0.32 mile of compatible habitat. **(GGS-1)**

Conservation Strategy Targets	Adaptation Measures
Species: Giant Garter Snake (GGS)	Aside from habitat restoration, in the Yolo and Sutter Bypasses and in areas near the confluence of the Sacramento and Feather Rivers, removing levees and expanding suitable aquatic habitat could create an opportunity to connect existing suitable habitats and provide safe upland refugia, which are important habitat components for giant garter snakes (particularly with the higher river flows expected to occur during the GGS's inactive period [brumation], when the species is more susceptible to the impacts of flooding). Removing or setting back levees in areas where the species occurs also would reduce the need for levee maintenance and minimize the potential for GGS to be disturbed by levee maintenance activities. When setting back levees on waterways that may support GGS, it would be valuable to consider leaving portions of levees in place to serve as high-water refugia. **(GGS-2)**

Conservation Strategy Targets	Adaptation Measures
Species: Bank Swallow	Removing revetment or setting back levees would create more breeding habitat and allow this species to better adapt to the impacts of climate change. The Bank Swallow Technical Advisory Committee (BANS-TAC) developed a Bank Swallow Conservation Strategy for California (2013). Specifically, the BANS-TAC recommends the following: • Remove 100,000 linear feet of existing revetment (19 miles) between Red Bluff and Chico Landing. • Remove 50,000 linear feet of existing revetment (10 miles) between Chico Landing and Colusa. • Remove 130,000 (25 miles) of existing revetment between Colusa and Verona, and possibly construct setback levees in this stretch. Removing revetment along the Sacramento River from Chico Landing to Colusa would be highly beneficial to this species, because this reach provides the largest amount of suitable vertical cut banks in the SPA. This is in part because some of the levees in these reaches are set back from the river, encouraging natural meanders and facilitating erosional processes that create suitable nesting habitat. From Colusa to Verona, the Sacramento River is the river is extremely constrained and revetment is present along the banks. Setting back the levees along these reaches would restore natural processes and benefit the species over time. Along the Feather River, the BANS-TAC recommendation for revetment removal is 10,000 linear feet (2 miles). In addition to these actions to restore breeding habitat, habitat restoration actions that increase grassland, riparian, marsh and wetland foraging habitat near breeding habitats would increase the climate change resilience of bank swallow. **(BANS-1)** The availability of breeding habitat also could be increased by managing reservoir releases on the Sacramento and Feather Rivers to promote breeding habitat formation during the nonbreeding season (September 1 to March 31). Specifically, the BANS-TAC recommends at least one bank-full flood event every three years, with the goal of promoting geomorphic processes that create bank swallow breeding habitat (e.g., bank erosion, meander migration, channel cutoff). Additionally, during the breeding season (April 1 to August 31), climate change resilience could be increased by managing reservoir releases to minimize higher flows that can destroy nesting colonies. Impacts on nesting colonies can occur when flow stages increase by as little as 1.6 to 3.3 feet during breeding. Higher flows, in the range of 14,000 to 30,000 cubic feet per second, have been associated with localized colony collapse and failure, and even higher flows (50,000 to 60,000 cubic feet per second) can cause extensive bank erosion and widespread destruction of nesting colonies. **(BANS-2)**

Conservation Strategy Targets	Adaptation Measures
Species: California Black Rail	Climate change resilience for the California black rail would be increased by creating and maintaining shallow, emergent wetland habitat in the Lower San Joaquin and Lower Sacramento River CPAs (generally 1 inch to 2 inches in depth with minimal fluctuation). Coupled with emergent wetlands, adjacent high-water refuge sites (e.g., riparian scrub/upland transition zones) are needed to provide cover for rails when flood events force them out of emergent wetlands. Restored and created marsh habitats should be as large as possible, generally not less than 20 acres; linear habitat designs with a high habitat edge to habitat area ratio should be avoided. Additionally, in addition to supporting riverine geomorphic processes that could create marsh habitats preferred by black rails, the removal of revetment, would benefit rails by removing cover and reducing habitat suitability for rats and other potential black rail predators. **(CABR-1)**
Species: Greater Sandhill Crane	Strategically lowering floodway elevations to form seasonally inundated habitats, particularly in the floodplains of the Cosumnes and Mokelumne Rivers, and allowing scour to create new floodplain areas and remove dense vegetation, could benefit greater sandhill cranes by creating potential roosting or foraging habitat. Cranes most likely would use wider floodplains, rather than narrow floodplains, because they select open habitats without visual impediments. Floodplain modification would positively affect cranes if the topography resulted in shallowly flooded open areas that cranes could use for roosting or foraging. Floodplain modifications that submerge shallowly flooded areas with deeper water would have a negative effect on cranes, because they are less likely than waterfowl to use deep water. The addition of new inundated floodplains near the edges of currently used roosting and foraging sites would most likely benefit cranes because of the potential to expand their current distribution. **(GSHC-1)** Dam releases that allow for wetlands and agricultural fields to be shallowly flooded between mid-September and early March could benefit greater sandhill cranes by providing potential roosting habitat. These sites would be most beneficial if potential roosting habitat is flooded to depths of 2 to 6 inches and occurs near of foraging locations (i.e., within 1.3 miles). Dam releases that flood potential roosting habitat to unsuitable depths for cranes (i.e., more than 6 inches) could negatively affect greater sandhill cranes by reducing the amount of roosting habitat available. **(GSHC-2)**

Conservation Strategy Targets	Adaptation Measures
Species: Least Bell's Vireo and Yellow-breasted Chat	These species depend on early successional to mid-seral riparian habitat with willow shrubs and other dense thickets of low bushes bordering streams or other bodies or water. Creating setback levees and facilitating natural hydrologic and geomorphic processes that lead to relatively continuous and dynamic riparian successional stages will provide opportunities to renew, expand, and sustain nesting habitat in response to climate change. Riparian restoration can be used to supplement natural succession and regeneration of riparian habitats. To be most suitable for these species, restored riparian habitats should have the following characteristics: • Minimum patch size of 2 acres, with parches greater than 10 acres providing better-quality habitat. • Location in or near core population areas to support metapopulation processes. • Mix of early and mid-succession species such as mugwort, willows, and cottonwoods. • Located in corridors wider than 800 feet. **(SONG-1).**
Species: Swainson's Hawk	The regeneration and sustainability of large, contiguous stands of riparian habitat, consisting of mature cottonwoods, sycamores, oaks, and willows, all of which provide high-quality nesting habitat, are important to increasing the climate change resilience of Swainson's hawk. Natural hydrologic and geomorphic processes that maintain a variety of age and size classes are particularly important for Swainson's hawks, so as current nest trees die off, younger trees mature into suitable replacements. Riparian restoration that incorporates species like oaks and cottonwoods can be used to supplement natural riparian regeneration. Breeding habitat, whether created and sustained through natural processes or restored through planting, must be situated next to suitable foraging habitat that provides important prey resources during the breeding season. Suitable foraging habitat includes grassland and agricultural crops such as alfalfa and irrigated pasture that are compatible with farming in new or expanded floodways and bypasses. **(SWHA-1)**

Conservation Strategy Targets	Adaptation Measures
Species: Western Yellow-billed Cuckoo	Riparian restoration in core cuckoo population areas could be important and effective in facilitating increases of this species' population, and in creating critical dispersal corridors to mitigate the effects of climate change. Corridors and large contiguous tracts of suitable breeding habitat throughout the SPA would maximize opportunities for this species to expand. To benefit this species, areas of restored riparian habitat should meet the following criteria: • Ideally greater than 200 acres in size and over 1,950 feet wide (smaller and/or narrower habitat patches may be suitable for the species but are not preferred). • Not smaller than 50 acres and 325 feet wide. • Total at least 20,450 acres of suitable habitat across the Sacramento River (five locations totaling at least 9,150 acres): – The Feather River (totaling 1,900 acres) – The Stanislaus River (totaling 1,900 acres) – The Cosumnes River (totaling 2,500 acres) – The Merced River (totaling 2,500 acres) – The Mendota Canal (totaling 2,500 acres) Aside from restoring riparian habitat, the restoration of riverine geomorphic processes would gradually increase the extent of riparian habitat and potentially increase habitat patch size (i.e., patches at least 200 acres in size). In addition, riverine geomorphic process, such as channel migration, result in disturbances that create, sustain, and renew the early successional to mid-seral habitat that is preferred by yellow-billed cuckoos. **(WYBC-1)**

Conservation Strategy Targets	Adaptation Measures
Species: Tricolored Blackbird	Creating setback levees or removing levees and revetment will allow natural hydrologic and geomorphic processes that create and sustain a range of emergent marsh and riparian successional stages, including early successional habitats generally preferred for breeding by tricolored blackbirds. Additionally, managed disturbances (e.g., fire, mastication, discing grazing), at intervals of five years for perennial marshes or every one to two years for seasonal wetlands, may be needed to maintain breeding habitat if suitable conditions do not result from climate change (i.e., current processes are modified by climate change in ways that no longer support this species). Additionally, for seasonal wetlands, it is important to sustain shallow inundation (6 to 18 inches) through April (San Joaquin Valley) or May (Sacramento Valley) to protect nest colonies from predators while not destroying nests. Invasive plant management is important to maintain and enhance tricolored blackbird breeding habitat. New weed infestations could negatively affect the emergent marsh and early successional riparian habitats that provide tricolored blackbirds with their historical and preferred nesting habitat. Native vegetation provides breeding habitat, and is an important food source for tricolored blackbirds because it supports native invertebrate populations. In general, invasive plants displace native plant species, often over substantial areas. Managing and controlling invasive plants would minimize these impacts. **(TCBB-1)** The expansion of bypasses would protect large areas of land from development, add agricultural land and natural vegetation to the floodway, and result in periodic, prolonged inundation of land that was previously isolated from the river system by levees. Due to the nature of the bypasses, this agriculture should be limited to row, hay, or silage crops, which provide favorable foraging habitat for tricolored blackbirds. **(TCBB-2)**

Conservation Strategy Targets	Adaptation Measures
Species: Riparian Wood Rats and Riparian Brush Rabbits	Actions that expand floodways, or create new floodways, would create additional opportunities for these species to escape increased peak flows that are expected to occur with climate change. The restoration of riparian habitat suitable for both species, and vegetation management focused on maintaining these habitats, would be necessary to ensure patches of suitable habitat were large and connected enough to support both species and facilitate dispersal to higher refugia while avoiding starvation and predation. Relocating levees farther from rivers (i.e., creating setback levees) is an important approach to increase space for river meanders, reconnect floodplains, allow the transport and deposition of sediment, support natural ecosystem disturbance processes, and increase the diversity of riverine and floodplain habitats. In particular, relocating levees in the areas around Caswell State Park and the San Joaquin River National Wildlife Refuge could reduce the depth, duration, velocity, or extent of flooding, thus reducing rabbit and woodrat mortality caused by floods while providing additional riparian habitat. Constructing setback levees could also decrease the need to add revetment on existing levees, further supporting the development of suitable vegetation adjacent to occupied habitat. Retaining and revegetating old, breached levees could also provide additional flood refugia for riparian brush rabbits and woodrats. (**MAMMAL-1)**

H4.2.2 Adaptation Measure 2: Further Incentivize and Prioritize the Implementation of Multi-benefit Projects

The identification, development, and implementation of multi-benefit projects in the Central Valley is the primary mechanism to improve and restore ecosystems, and gradually build ecological resilience. DWR should continue to identify and leverage opportunities to refine the CVFPP planning information in future updates to further develop climate change adaptation approaches, and promote management actions to address climate change risks to ecological conditions.

- **Minimize or Avoid Potential Ecological Impacts of Flood Risk Reduction Infrastructure Improvements:** The CVFPP includes a broad portfolio of actions to reduce flood risk, including some single-purpose flood management actions where multi-benefit options are not feasible. These may include raising, lengthening, and/or hardening levees or removing vegetation in channel corridors to increase the conveyance capacity of floodways. In these situations, single-purpose flood management actions can exacerbate ecological risks and vulnerabilities, especially as climate change impacts are realized. Wherever feasible, it is critical that DWR and its federal, State, and regional project partners develop and prioritize broader multi-benefit projects and flood management actions that reduce or alleviate ecological stressors and that provide needed flood protection throughout the flood system to establish much-needed resilience to climate change. These adaptation measures simultaneously reduce flood risk and restore fundamental hydrologic, geomorphic, and ecological processes that build resilience into the system.

- **Increase the Pace of Building Resilience:** There is a strong need to significantly increase the pace, scale, and geographic extent of multi-benefit project implementation, given the likely impending impacts of climate change. DWR and its project partners should work to streamline multi-benefit project implementation processes to the maximum extent feasible to increase the pace of project implementation. Adaptation Measures 3 and 4 could develop the knowledge base and evaluation criteria to increase multi-benefit project assessment, tracking, and implementation.
- **Prioritize Funding for Multi-Benefit Projects:** Prioritization for funding/implementation of multi-benefit projects should consider relative potential to improve hydrologic, ecological, and geomorphic processes.
- **Increase Prioritization of Climate Adaptation in the Planning Processes:** For future updates to the CVFPP and Conservation Strategy, consider ecologically based climate adaptation opportunities while developing recommendations and priority actions.

H4.2.3 Adaptation Measure 3: Perform More Detailed Analyses of Climate Change Impacts on Conservation Strategy Processes, Habitats, and Species

To date, the climate change modeling that has been performed to inform CVFPP planning has focused on potential risks to human health, flood management infrastructure, and economic conditions, and has been based on peak flood conditions. However, the ecological impacts on climate change are often due to changes in lower-magnitude, higher-frequency hydrologic events. Further analyses of climate change impacts on ecologically relevant flows are required to better understand risks and adaptation opportunities.

- **Address Ecosystem Vulnerability Data Gaps:** Perform additional climate change modeling to better understand ecosystem-specific responses to climate change, based on changes to the frequency, magnitude, timing, and duration of regulated flows. The existing modeling approach only yields event-based floods that are scaled, depending on the climate scenario. While reservoir operations will need to be modified in the future, it is important to understand the long-term effects of a future climate scenario under current management constraints, so operations can be evaluated and improved. Modeling data would be most useful if high, medium, and low climate change scenarios were evaluated for the entire period of modeled climate scenarios (present to 2099). This continuous dataset, which better captures interannual and intra-annual variability, would be invaluable for assessing how an altered flow regime is likely to affect specific ecosystems. An example would be for salmonids, where the acre-days of suitable habitat can currently be calculated only for historical conditions across the entire Central Valley. Continuous hydrology representing future climate scenarios would let resource managers design projects that are resilient to a future flow regime, or even assess whether a modified flow regime may be required to meet ecological goals. Additionally, utilization of detrended historical hydrological data to account for current climatic conditions can capture ongoing climate change in baseline conditions.

- **Expand Use of Decision-scaling Analyses:** Expand climate change decision-scaling analyses to better assess ecosystem sensitivities from potential stressors and evaluate the robustness of adaptation strategies. Decision-scaling considers a given system under existing conditions and applies a stress test analysis using climatic stressors to identify system sensitivities and potential vulnerabilities. This approach characterizes uncertainty in terms of future impacts for decision-making, and has been implemented by DWR to guide climate change vulnerability and adaptation planning (DWR 2018b). Furthermore, DWR, in collaboration with several entities, is developing a weather generator tool that will be able to reproduce realistic, long-term meteorological timeseries and create advanced climate change scenarios from processes simulated by GCMs. This weather generator will enhance the stress testing and evaluation of adaptation strategies in decision-scaling analyses.
- **Further Develop and Integrate Watershed Evaluations to Inform Adaptation Measure Development:** DWR is conducting climate vulnerability assessment and adaptation strategy evaluations at the watershed scale. These watershed studies employ a risk-based approach to assess impacts water infrastructure. The approach relies on a collaborative approach between local, State, federal, and tribal partners to better manage water resources. The watershed adaptation strategies are intended to reduce flood risk, replenish depleted aquifers, help ecosystems, and improve water quality. The watershed studies demonstrate how adaptation measures such as Flood-MAR, in conjunction with reservoir reoperations (e.g., FIRO), can reduce climate vulnerabilities and improve groundwater recharge. Two studies are in progress on the Merced and Tuolumne Watersheds, and more studies are planned within the San Joaquin Basin.

H4.2.4 Adaptation Measure 4: Develop Tools and Processes to Evaluate Climate Change Impacts at a Regional or Project-Specific Level

DWR funded the development of the Floodplain Restoration Opportunity Analysis (FROA), a geographic information system-based evaluation of floodplain inundation potential (FIP), which can help identify and prioritize the opportunity to reconnect frequently activated floodplains throughout the SPA, to a certain degree (DWR 2013b). While the original analysis provided valuable hydraulic assessment of potentially inundated areas systemwide, FROA is now more than 10 years old. The underlying datasets for FROA have improved vastly in the last decade (including high-quality hydraulic models, terrain, and updated hydrology). The focus on climate change and multi-benefit projects (which now includes Flood-MAR) has also created the need for improved technical analyses support implementation of floodplain restoration projects that build ecosystem resiliency while reducing flood risks.

- **Develop New Tools to Identify Floodplain Reconnection and Groundwater Recharge Opportunities:** Update the FROA analyses using Ecological Floodplain Inundation Potential (EcoFIP) modeling tools to evaluate habitat suitability at varied spatial and temporal scales.
  - Extend the EcoFIP tool to determine the potential for groundwater recharge on floodplains along the San Joaquin River corridor to address groundwater deficiencies; this should be coordinated with the DWR Flood-MAR program.

   - Use the EcoFIP tool to evaluate inundation extents, habitat suitability, and groundwater recharge under historical and future climate scenarios across the SPA.
   - Use the EcoFIP tool to assist with multi-benefit project identification, prioritization and evaluation. The systematic evaluation of restoration opportunities could lead to increased collaboration between agencies working on multiple objectives (e.g., flood control, ecosystem benefits, groundwater recharge), and increased funding to implement projects.
- **Identify Additional Tools or Analyses to Determine Potential Adaptation Opportunities:** Evaluate additional tools that provide a more refined understanding of floodplain restoration and flood infrastructure modification potential throughout each CPA.

H4.2.5 Adaptation Measure 5: Better Communicate Climate Changes Risks and Adaptation Opportunities to DWR Partners and Stakeholders

A high degree of cooperation and collaboration between DWR and its federal, State, regional, and local partners will need to occur to develop ecological resiliency and address the impacts of climate change. The first step in this process is the development of effective communication and outreach about the potential climate change risks and opportunities to build the governance structures and partnerships that will be required.

- **Improve Regional Coordination:** Coordinate with regional planning groups (such as the regional flood management plans, Central Valley Flood Protection Board Advisory Committee, and others) to ensure they have current information and data pertaining to climate change, for use in their own regional or statewide planning efforts. Provide resources and tools to regional flood management plans to better develop multi-benefit projects that provide climate resiliency.
- **Improve Climate Adaptation Communications:** Create, deliver, and publish (e.g., on the DWR website) fact sheets, workshop and conference notices, and reports of notable news regarding climate change locally and nationally.
- **Collaborate with Partners on Developing and Implementing Climate Adaptation Measures:** Engage with regional and local partners and nongovernmental groups within each CPA to identify and pursue adaptation measures related to climate change. Work with State and federal agencies to resolve policy or mandate discrepancies regarding climate change adaptation.

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CHAPTER H5

Summary of Regional Climate Change Adaptation Strategies

Building on the potential adaptation measures identified in Chapter H4, this section highlights regional climate change adaptation opportunities, using maps, for specific reaches in each CPA. The maps were compiled using data gathered, and analyses completed, while developing the 2016 Conservation Strategy, and the adaptation opportunities highlighted generally would be achieved through the Conservation Strategy's implementation. The maps visually depict the location and extent of specific climate change adaptation opportunities and constraints, including the following:

- Locations of existing natural habitats, including uplands, perennial and seasonal wetlands, and riparian areas.
- Locations of levees and revetment.
- Potential occurrences of target species through displayed habitats.
- Potential areas that could be reconnected to the river and the target species habitat that could occur in reconnected floodplains if these areas are restored (potential floodplain, wetland, riparian and SRA habitats). These potential floodplain areas are derived from the FROA (DWR 2013b). They represent minimal areas where topographic and hydrologic conditions are suitable to support ecologically beneficial floodplain inundation if projects that included levee setbacks, levee removal, or programmed inundation of floodplains were implemented (i.e., floodplains inundated by a two-year event or during a flow that occurs during the spring season for seven consecutive days with a 66-percent exceedance probability). These types of floodplain inundation events would also allow the restoration of more natural geomorphic processes that create habitat complexity, variability, and resilience, as well as the native habitats (including SRA, wetland, and riparian) that are critical for the survival of the Conservation Strategy's 20 target species.

By assembling and reviewing these data layers together, the maps identify general locations where relatively greater opportunities could exist to implement adaptation actions that would build climate change resilience for the Conservation Strategy's target habitats; particularly floodplain, wetland, riparian, and SRA habitats, and the 20 target species that depend on these habitats within the SPA. Table H-11 lists these 20 species and their preferred habitat within the SPA. Tables H-12 through H-21 indicate which of the 20 species could potentially benefit from climate change adaptation actions in the subsequent mapped reaches for each CPA

(Figures H-18 to H-34). Following each set of maps, a concise summary is provided of the opportunities or constraints to building climate change resilience, for each mapped reach in each CPA, and select opportunities are highlighted to help identify and initially prioritize possible adaptation actions. Many of these actions are consistent with, and build upon, the regional conditions, needs, and objectives identified in Section 5.2 of the 2016 Conservation Strategy.

Table H-11. Potential Habitats and Species Associations

Potential Habitat Type	Species Associations [a]
Potential floodplain/SRA (reconnected/restored)	Bank swallow California Central Valley steelhead Chinook – Central Valley spring run Chinook – Central Valley fall/late-fall run Chinook – Sacramento River winter run Delta smelt Green sturgeon Least Bell's vireo Monarch butterfly Slough thistle Tricolored blackbird Western yellow-billed cuckoo Yellow-breasted chat
Riparian (restored)	Delta button-celery Least Bell's vireo Monarch butterfly Riparian brush rabbit Riparian woodrat Swainson's hawk Western yellow-billed cuckoo Yellow-breasted chat VELB
Perennial wetland (restored)	Black rail GGS Greater sandhill crane Slough thistle Tricolored blackbird

[a] Species associations vary by CPA and reach, as shown in the tables within Sections H5.1 to H5.5.

Note:
SRA = shaded riverine aquatic

H5.1 Lower Sacramento River CPA

Table H-12. Species Distribution by Habitat and Reach in the Lower Sacramento River CPA

Habitat Type	Species Acronym [a]	Species Name	Reach 1	Reach 2
Potential Floodplain/SRA	SALMONID	California Central Valley Steelhead	Yes	Yes
	SALMONID	Chinook – Central Valley Spring Run	Yes	Yes
	SALMONID	Chinook – Central Valley Fall/Late-fall Run	Yes	Yes
	SALMONID	Chinook – Sacramento River Winter-run	Yes	Yes
	SMELT	Delta Smelt	Yes	Yes
	STURGEON	Green Sturgeon	Yes	Yes
	MONARCH	Monarch Butterfly	Yes	Yes
	BANS	Bank Swallow	Yes	Yes
Riparian	SWHA	Swainson's Hawk	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	Yes	Yes
	SONG	Yellow-breasted Chat	Yes	Yes
	SONG	Least Bell's Vireo	Yes	Yes
	MONARCH	Monarch Butterfly	Yes	Yes
	VELB	Valley Elderberry Longhorn Beetle	Yes	Yes
Perennial Wetland	GGS	Giant Gartersnake	Yes	Yes
	GSHC	Greater Sandhill Crane	Yes	Yes
	TCBB	Tricolored Blackbird	Yes	Yes
	CABR	California Black Rail	Yes	Yes

[a] Species acronyms are assigned in Table H-10 of Section H4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Notes:
SRA = shaded riverine aquatic

Figure H-18. Lower Sacramento River CPA Reach 1

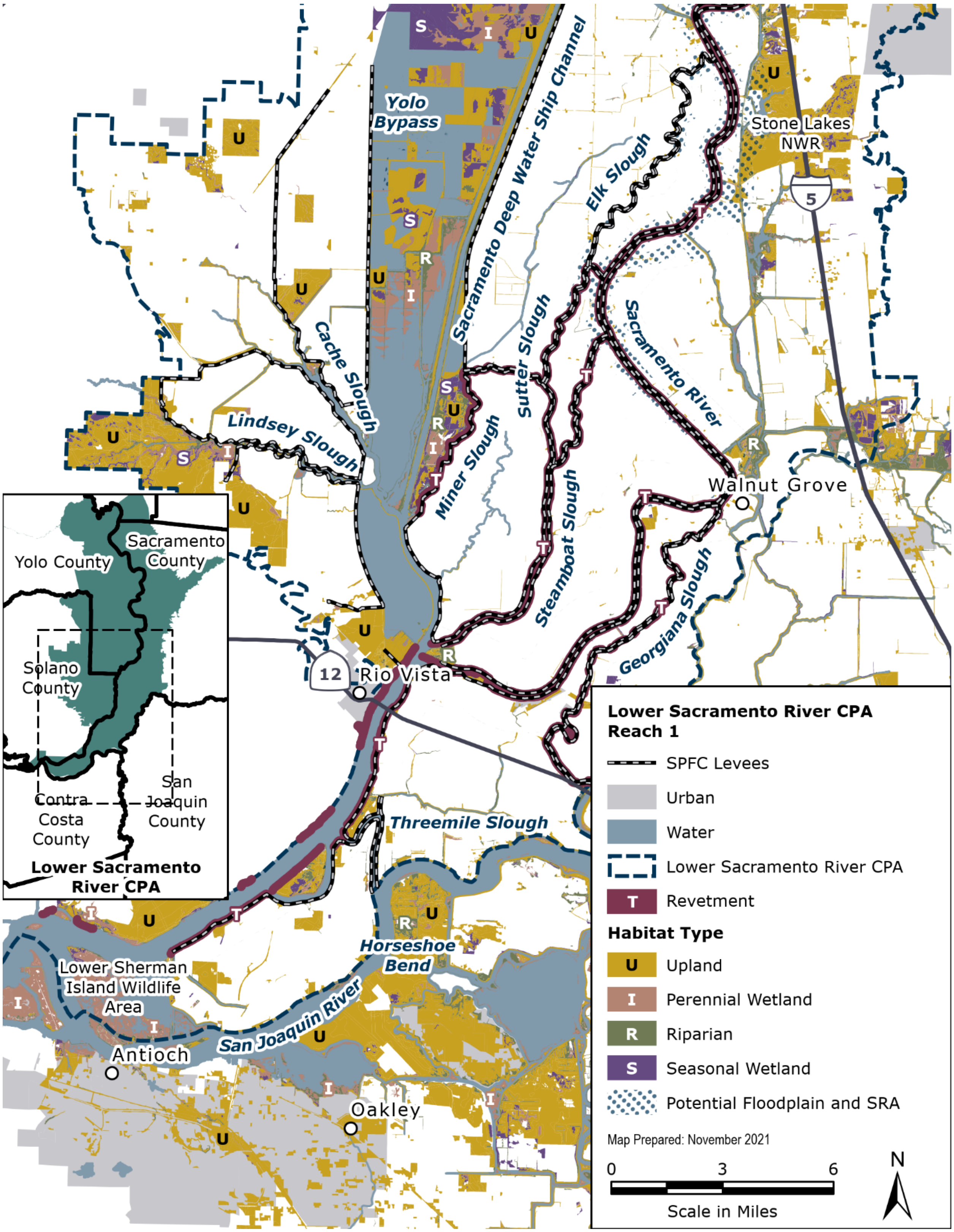
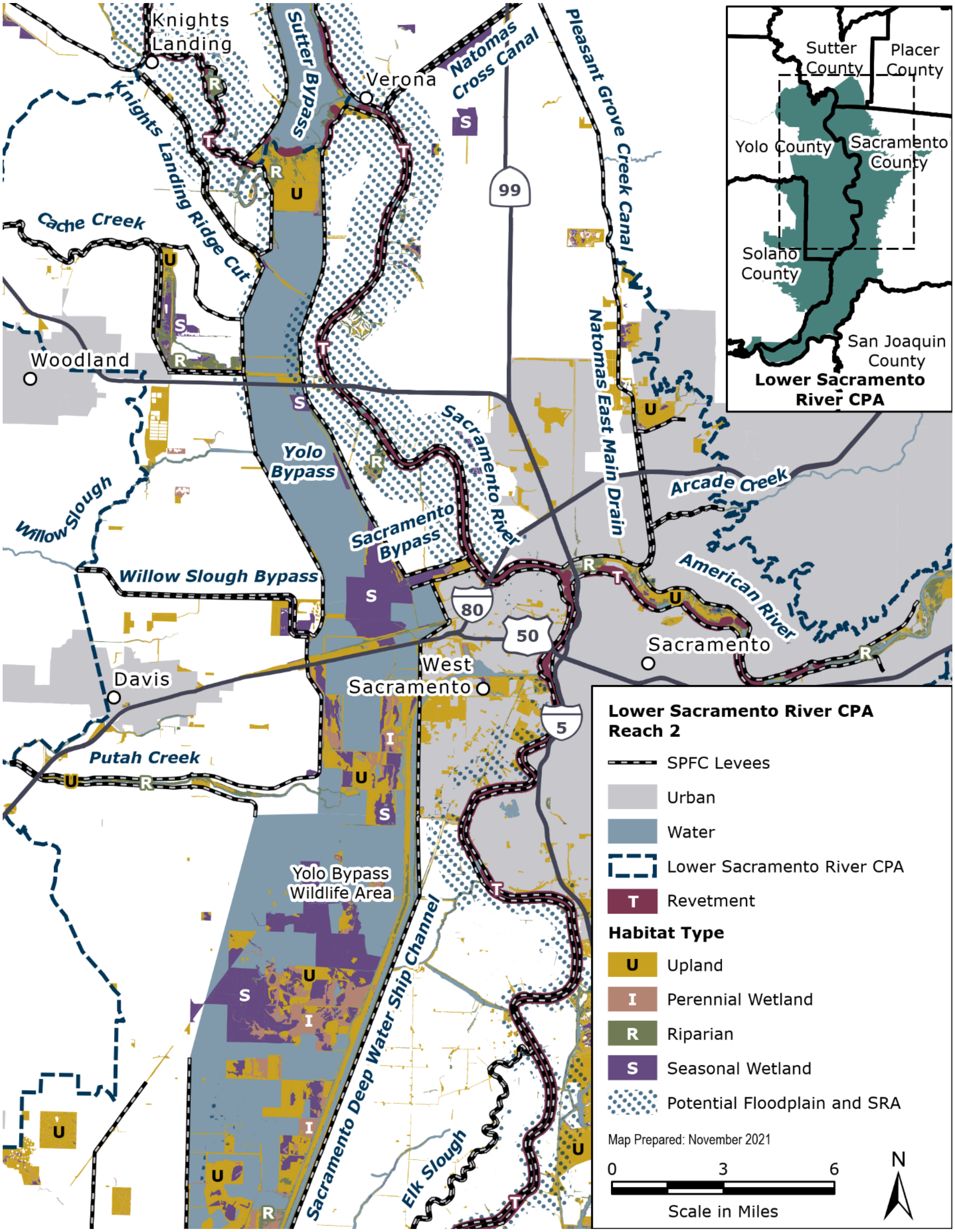


Figure H-19. Lower Sacramento River CPA Reach 2



H5.1.1 Climate Change Adaptation Risks and Opportunities – Lower Sacramento River CPA

Reach 1: Adaptation potential is constrained by expansive areas of levees and revetment protecting urban areas and the Delta, resulting in very limited areas that are suitable for creating potential floodplain, riparian, and SRA habitats. However, there are limited opportunities to create habitats along the Sacramento River outside of the urban areas, along the Sacramento River's tributaries, and along the Yolo Bypass. The Yolo Bypass also contains areas that would be suitable for creating and enhancing floodplain, wetland, and riparian habitats. Reach 1 also provides opportunities to collaborate with EcoRestore.

Reach 2: Adaptation potential is constrained by expansive areas of levees and revetment protecting urban areas, although Reach 2 is less constrained than Reach 1. There are areas suitable for creating potential floodplain, riparian, and SRA habitats along the Sacramento River outside of the urban areas and along the Yolo Bypass, and like Reach 1, the Yolo Bypass has areas suitable for creating and enhancing all habitat types. Reach 2 also provides areas suitable for enhancing riparian and SRA habitats adjacent to the American River.

Table H-13. Climate Change Adaptation Strategies Available in the Lower Sacramento River CPA

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
SRA-1	SMELT-1	High – Reach 1 provides nearly all of the habitat that exists for delta smelt. Opportunities to improve and restore habitats must consider effects of climate change on increasing water temperatures, which SRA should help to moderate, although there is considerable uncertainty about the quantity of SRA habitat needed to decrease water temperatures.	Moderate – Reach 2 provides some habitat for delta smelt and contributes to the main habitat in Reach 1, and provides the same types of opportunities as Reach 1.
	SALMONID/STURGEON-1	High – This reach provides important rearing and outmigration habitat for juveniles of all runs of Central Valley salmonids and green sturgeon. Opportunities to improve and restore these habitats must consider effects of climate change on increasing water temperatures similar to that described for delta smelt.	High – Same as Reach 1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
SRA-1	BANS-1	Limited – The extent of urban development and the extremely constrained river channels in Reach 1 limit the opportunity to remove revetment from banks and set back levees, which would allow erosional process the create suitable breeding habitat.	Moderate – Reach 2 is also constrained by expansive areas of levees and revetment protecting urban areas, but there are some opportunities for creating potential floodplain along the Sacramento River outside of the urban areas and in the Yolo Bypass.
	BANS-2	High – This CPA is occupied by breeding bank swallow. Reach 1 provides the opportunity to manage reservoir releases along the Sacramento River to promote processes to create bank swallow nesting habitat and minimize high flows during the breeding season, which can destroy nesting colonies.	High – Same as Reach 1.
RIP-1	MONARCH-1	High – Reach 1 currently provides generally suitable breeding and migration habitat, and is within the known early breeding zone for monarchs. Climate change adaptation potential for monarch butterfly could be improved by increasing breeding and migration habitat by planting an abundance of nectar resources and native milkweed species, ensuring the availability of trees and shrubs for roost sites, and increasing the connectivity of suitable habitat in the floodway.	High – Same as Reach 1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
RIP-1	SWHA-1	High – Reach 1 currently provides generally suitable breeding and abundant foraging habitat, and is occupied by Swainson's hawk. Climate change adaptation potential for Swainson's hawk could be improved by increasing breeding habitat by planting native tree species that will replace dead mature trees, trees lost through flooding, etc.	High – Same as Reach 1.
	WYBC-1	Limited – Suitable riparian habitat with the necessary characteristics does not currently occur in Reach 1, and existing urban areas constrain the opportunity for levee relocation or other actions that would allow suitable riparian habitat to be restored and self-sustaining.	Moderate – Suitable habitat with recent records for western yellow-billed cuckoo occurs in Reach 2. Although opportunities to expand suitable habitat are limited in this reach, there are some opportunities to restore additional suitable riparian habitat that would be connected to existing occupied habitats, primarily along the Sacramento River, outside of the urban areas and along the Yolo Bypass.
	SONG-1	Limited – Some suitable habitat exists in Reach 1, but yellow-breasted chat are currently relatively scarce and there is only one record for least Bell's vireo in the reach. Existing urban areas constrain the opportunity for levee relocation or other activities that would allow for suitable dynamic flow conditions that result in continuous early to mid-successional riparian used by these species.	Moderate – Suitable habitat with recent records for yellow-breasted chat occur in Reach 2. Although opportunities to expand suitable habitat are limited in this reach, there are some opportunities to restore additional suitable riparian habitat that would be connected to existing occupied habitats, primarily along the Sacramento River outside of the urban areas and along the Yolo Bypass.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
RIP-1	VELB-1	Moderate – Suitable elderberry habitat exists, and the valley elderberry longhorn beetle is known to occur throughout Reach 1, so while opportunities for levee relocation are limited due to existing urban areas, modifying floodplain topography will provide new areas for elderberry shrubs to colonize in the vicinity of existing habitat.	High – Suitable elderberry habitat exists and the VELB is known to occur throughout Reach 2. Although opportunities to expand suitable habitat are limited in this reach, there are some opportunities to relocate the levee and modify floodplain topography, which will provide new areas for elderberry shrubs to colonize adjacent to existing habitat.
	VELB-2	Moderate – Reach 1 provides moderate opportunities to plant elderberry shrubs in riparian restoration areas.	Moderate – Reach 2 provides moderate opportunities to plant elderberry shrubs in riparian restoration areas and, potentially, in newly expanded floodplain areas.
WET-1	SMELT-1	High – Reach 1 provides opportunities to improve and expand floodplain and heterogeneous tidal wetland habitat complexes, which are likely to improve habitat conditions for delta smelt. However, there are uncertainties about the effects of tidal wetland restoration on water temperatures, and the quantity of habitat needed to improve conditions that support survival of delta smelt.	Moderate – This reach provides habitat for delta smelt and contributes to the main habitat in Reach 1, and provides the same types of opportunities as Reach 1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
WET-1	SALMONID/STURGEON-1	High – Reach 1 provides opportunities to improve and expand floodplain and heterogeneous tidal wetland habitat complexes, which are likely to improve rearing habitat conditions for salmonids and green sturgeon. However, there are uncertainties similar to that described for delta smelt.	High – Same as Reach 1.
	GGS-1	Moderate – Giant gartersnakes are present in this CPA. Existing urban areas constrain the opportunity for creating levee setbacks to expand marsh habitat, but there are opportunities to enhance and manage existing wetlands to improve suitability for giant gartersnake, particularly within the Yolo Bypass.	High – Reach 2 contains a substantial number of areas in the Yolo Bypass that are suitable for creating and enhancing marsh habitat suitable for giant gartersnakes.
	GGS-2	Limited – In Reach 1, there are some limited opportunities for levee setbacks where new marsh habitat suitable for giant gartersnake could be created and connected to existing suitable habitat.	High – Similar to Reach 1, but in Reach 2 there are moderate opportunities for removing levees and expanding suitable aquatic habitat along the Sacramento River outside urban areas and in the Yolo Bypass.
	GSHC-1	Limited – Greater sandhill cranes are present in this CPA. Existing urban areas constrain the opportunity for creating levee setbacks to expand floodplain habitat, but there are opportunities to enhance and manage existing floodplains to improve suitability for greater sandhill cranes.	Limited – Same as Reach 1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
WET-1	GSHC-2	High – Reach 1 provides the opportunity to manage reservoir releases along the Sacramento River to promote shallow inundation of existing greater sandhill cranes roosting habitat, which could mediate climate change effects in drought years.	High – Same as Reach 1.
	TCBB-1	Moderate – Tricolored blackbirds are present in Reach 1, but existing urban areas constrain the opportunity for creating levee setbacks to expand suitable wetland habitat. However, there are opportunities to enhance and manage existing wetlands for breeding suitability.	Moderate – Same as Reach 1.
	CABR-1	Limited – California black rails are present in Reach 1 in low numbers, but existing urban areas constrain the opportunity for removing revetment to expand suitable habitat. However, there may be some opportunities to increase the area of shallow emergent wetlands and create adjacent high-tide refugia in the lower Yolo Bypass.	Limited – Same as Reach 1.

[a] Table H-10 provides adaptation strategy descriptions.

Notes:
CPA = conservation planning area
SRA = shaded riverine aquatic

H5.2 Upper Sacramento River CPA

Table H-14. Species Distribution by Habitat and Reach in the Upper Sacramento River CPA

Habitat Type	Species Acronym [a]	Species Name	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
Potential Floodplain/SRA	SALMONID	California Central Valley Steelhead	Yes	Yes	Yes	Yes	Yes	Yes
	SALMONID	Chinook – Central Valley Spring Run	Yes	Yes	Yes	Yes	Yes	Yes
	SALMONID	Chinook – Central Valley Fall/Late-fall Run	Yes	Yes	Yes	Yes	Yes	Yes
	SALMONID	Chinook – Sacramento River Winter-run	Yes	Yes	Yes	Yes	No	Yes
	STURGEON	Green Sturgeon	Yes	Yes	Yes	Yes	Yes	Yes
	BANS	Bank Swallow	Yes	Yes	Yes	Yes	Yes	Yes
	SONG	Least Bell's Vireo	Yes	Yes	Yes	Yes	Yes	Yes
	TCBB	Tricolored Blackbird	No	No	Yes	No	No	No
	WYBC	Western Yellow-billed Cuckoo	No	No	No	No	No	Yes
Riparian	MONARCH	Monarch butterfly	Yes	Yes	Yes	Yes	Yes	Yes
	SWHA	Swainson's Hawk	Yes	Yes	Yes	Yes	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	Yes	Yes	Yes	Yes	Yes	No
	SONG	Yellow-breasted Chat	Yes	Yes	Yes	Yes	Yes	Yes
	VELB	Valley Elderberry Longhorn Beetle	Yes	Yes	Yes	Yes	Yes	Yes
Perennial Wetland	GGS	Giant Gartersnake	Yes	Yes	Yes	Yes	No	No
	GSHC	Greater Sandhill Crane	Yes	Yes	Yes	Yes	Yes	Yes
	TCBB	Tricolored Blackbird	Yes	Yes	No	Yes	Yes	Yes

[a] Species acronyms are assigned in Table H-10 of Section H4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Figure H-20. Upper Sacramento River CPA Reach 1

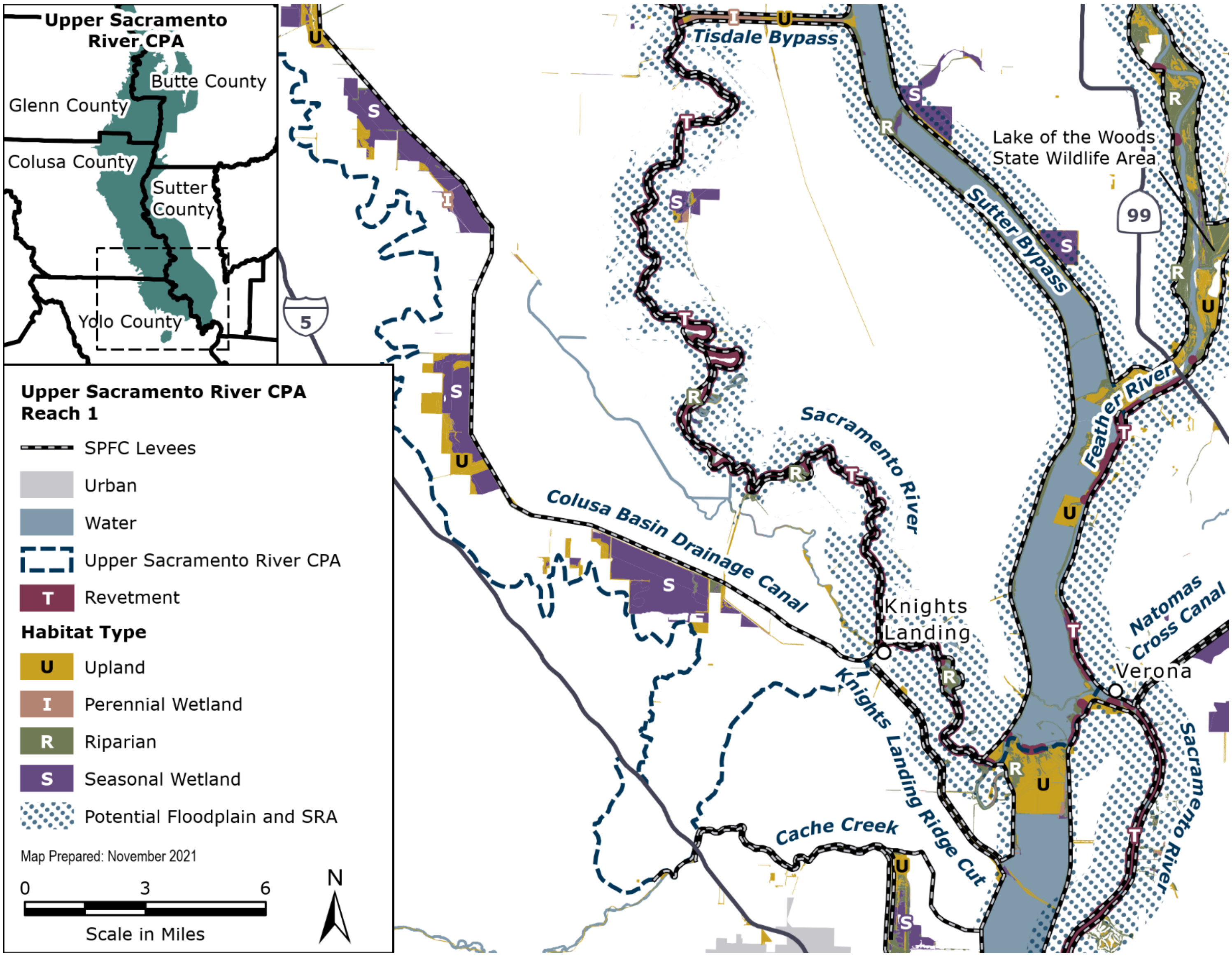


Figure H-21. Upper Sacramento River CPA Reach 2

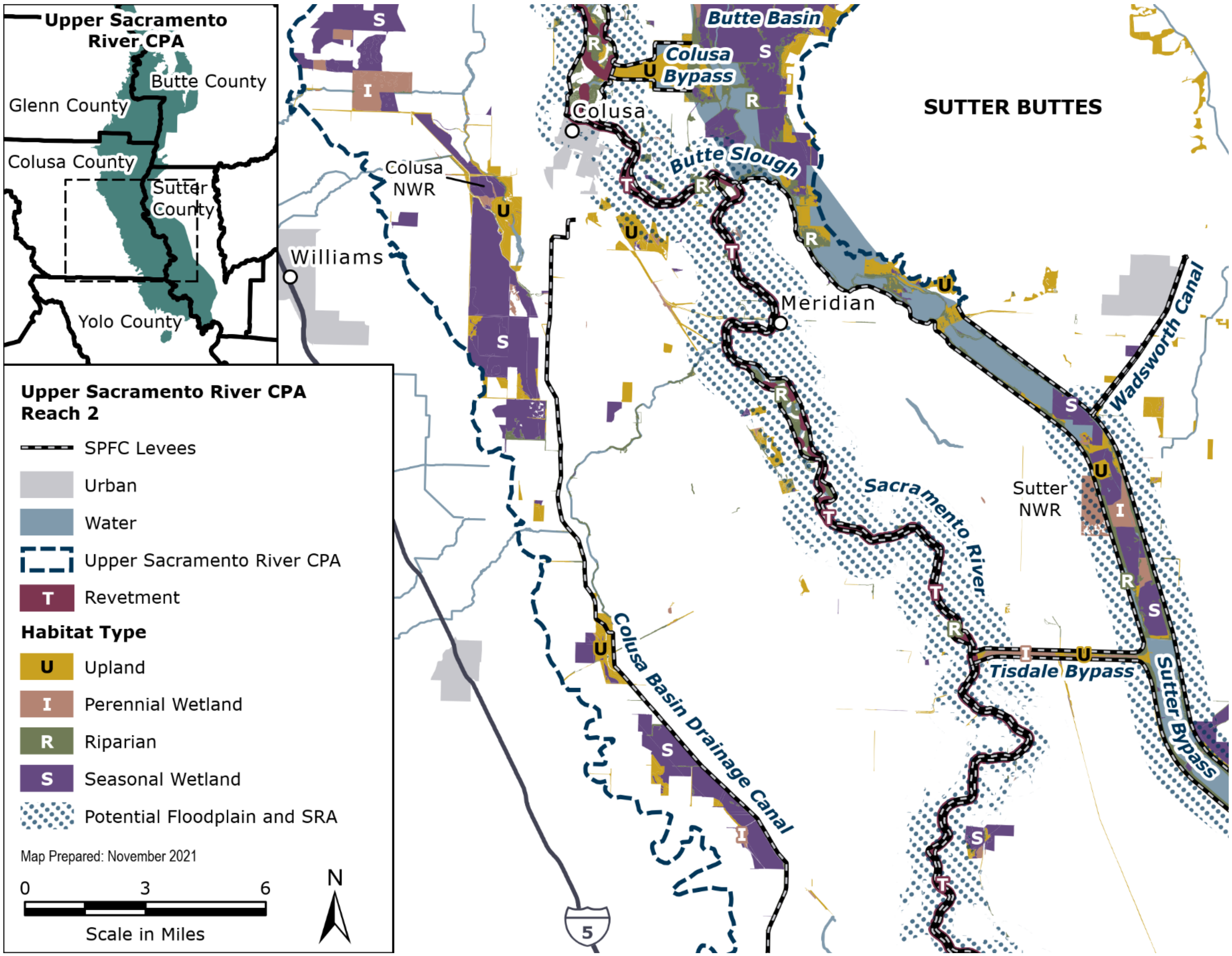


Figure H-22. Upper Sacramento River CPA Reach 3

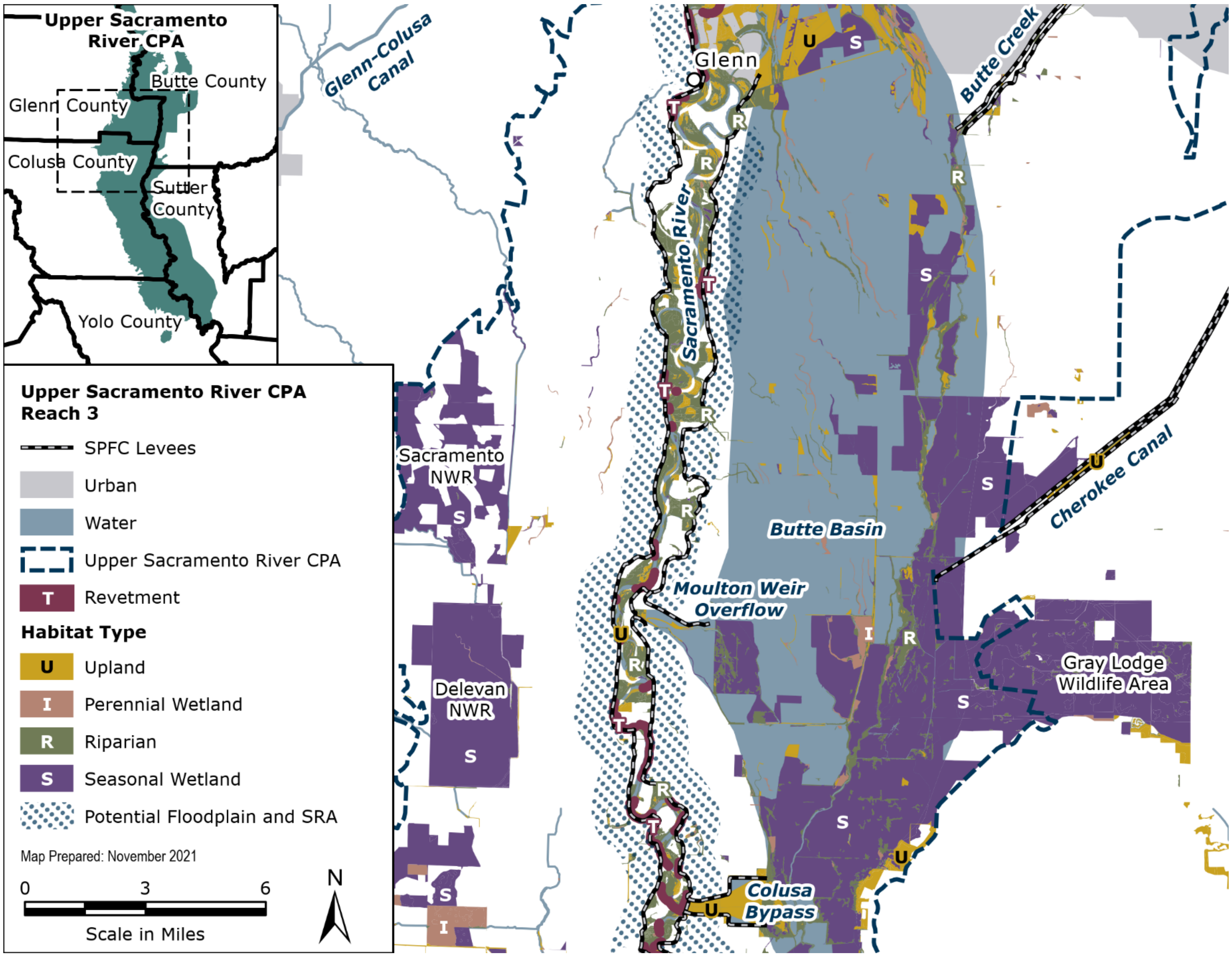


Figure H-23. Upper Sacramento River CPA Reach 4

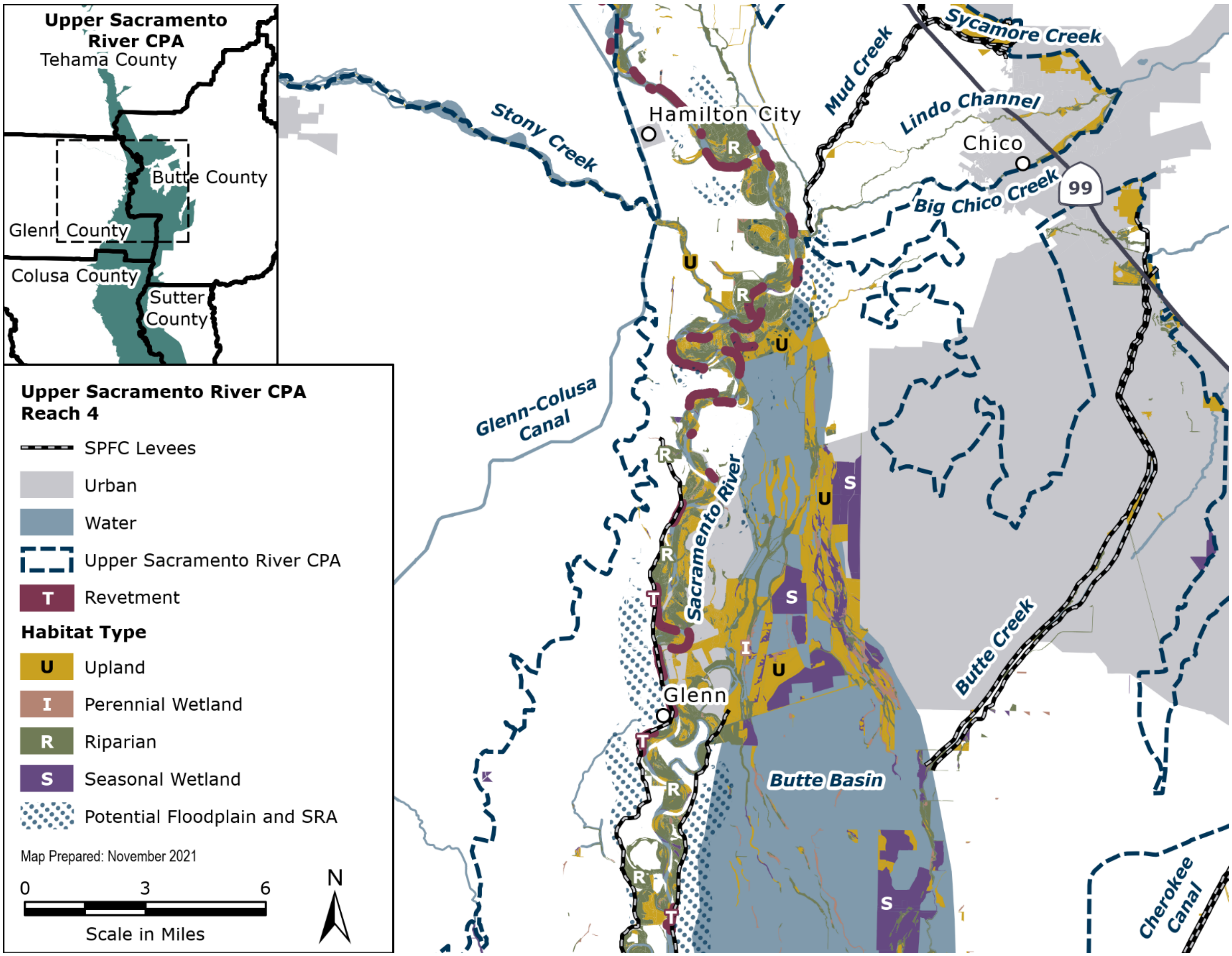


Figure H-24. Upper Sacramento River CPA Reach 5

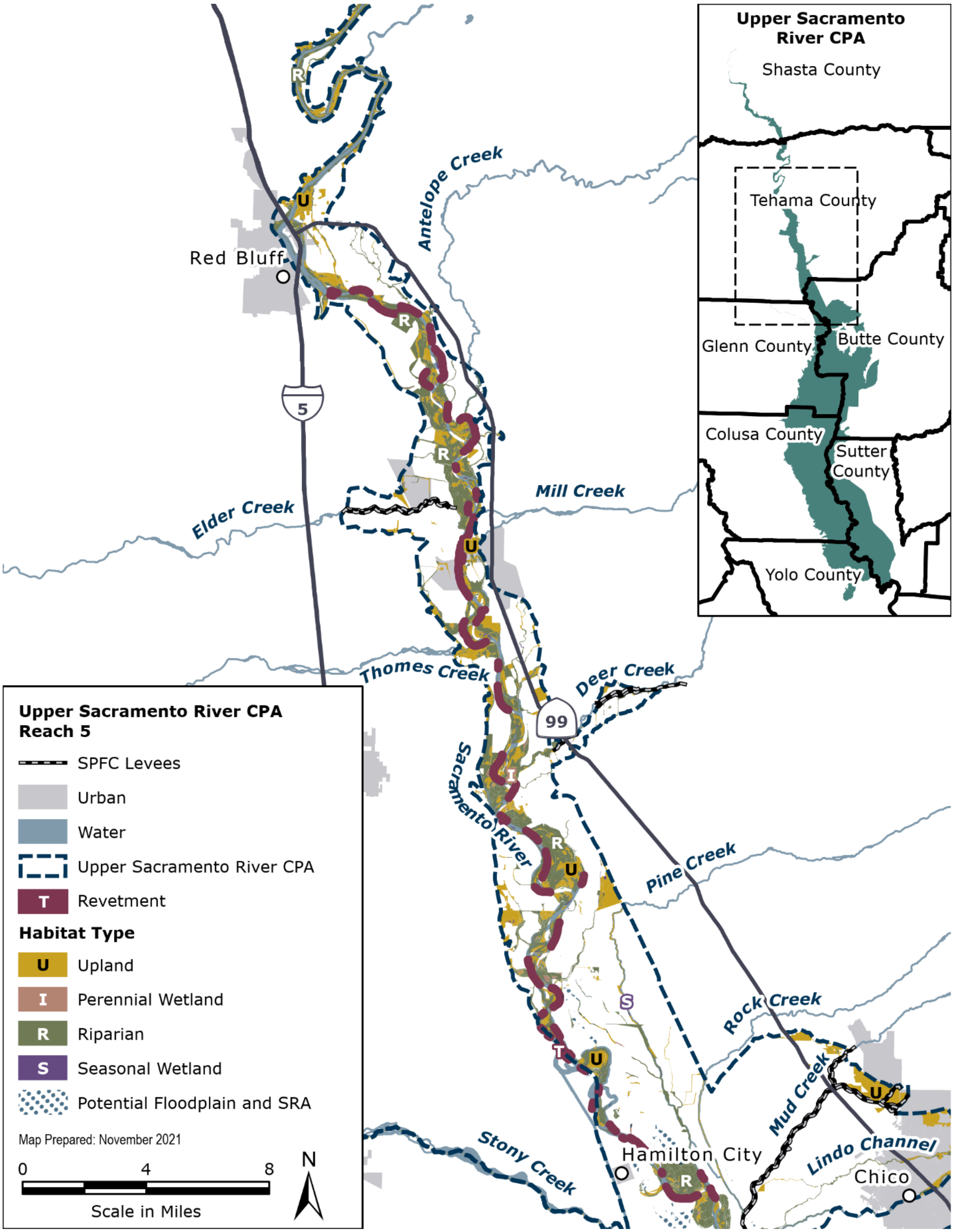
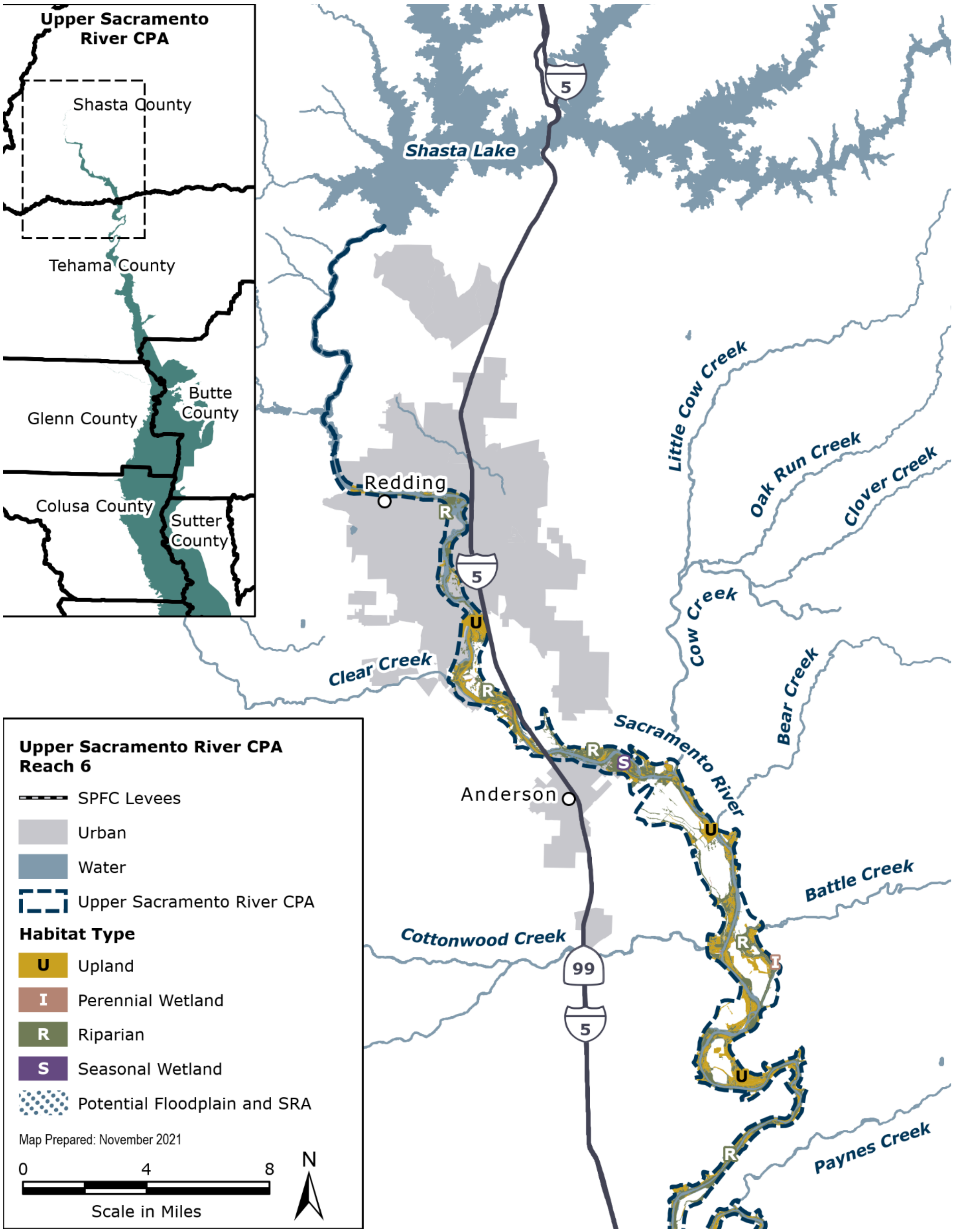


Figure H-25. Upper Sacramento River CPA Reach 6



H5.2.1 Climate Change Adaptation Risks and Opportunities – Upper Sacramento River CPA

Reach 1: There are expansive areas of disconnected floodplains that would be suitable for creating potential floodplain, wetland, riparian, and SRA habitats along the Sacramento River and adjacent to the Sutter Bypass. There also are areas suitable for enhancing riparian habitat along the river itself, although these opportunities are relatively limited by the presence of levees close to the river channel. The Sutter Bypass provides ample opportunities to create and enhance wetland, floodplain, riparian, and SRA habitats, and there are smaller areas suitable for enhancing wetlands and uplands along other State Plan of Flood Control (SPFC) facilities and waterways within this reach.

Reach 2: Similar to Reach 1, adaptation potential is high. There is an extensive amount of existing wetland habitat that could be expanded in this reach, and opportunities exist to reconnect floodplains along nearly the entirety of the Sacramento River through this reach, thereby increasing wetland, floodplain, riparian, and SRA habitat, and improving habitat connectivity to the adjacent Butte Basin and upper Sutter Bypass within the Feather River CPA (e.g., through the Tisdale Bypass and around Butte Slough).

Reach 3: This reach, as with Reach 2, supports a nearly continuous corridor of disconnected floodplain that could be restored along the Sacramento River. Existing riparian and wetland habitat in this reach could be expanded, habitat connectivity among all habitat types could be improved through floodplain restoration, and other opportunities exist to enhance riparian and SRA habitat adjacent to the Sacramento River.

Reach 4: Relative to downstream reaches in this CPA, Reach 4 supports much less disconnected floodplain, and levees are absent from most of this reach, particularly on the left bank of the Sacramento River, roughly north of the town of Glenn. Floodplain restoration could occur around the confluence of the Sacramento River with Big Chico Creek and Sycamore Creek, and in a few other locations. Additionally, because levees already are absent from much of this reach, abundant opportunities exist to restore and enhance wetland, riparian, and SRA habitat, particularly in areas where existing revetment could be removed to allow for improved riverine geomorphic processes.

Reach 5: Few areas of disconnected floodplains occur in this reach. However, because this reach lacks levees, abundant opportunities exist to restore, expand, or enhance riparian and SRA habitat along the Sacramento River, particularly in areas where existing revetment could be removed to allow for improved riverine geomorphic processes. Opportunities to restore wetlands and floodplains are relatively limited in this reach.

Reach 6: In Reach 6, the Sacramento River is confined within natural bluffs below Anderson, and above Anderson, by urban development that in many locations approaches the banks of the Sacramento River approximately up to the Anderson-Cottonwood Irrigation District Diversion Dam. Reach 6 is relatively unaffected by levees, revetment, and similar factors that can disconnect floodplains from rivers and reduce or eliminate riverine geomorphic processes that create and sustain wetland, riparian, and SRA habitats. However, despite a relative lack of levees and revetment, only limited opportunities (i.e., in selected locations along the river where these habitats currently are absent) exist to expand, enhance, or restore riparian and SRA habitat in this reach beyond current conditions.

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Table H-15. Climate Change Adaptation Strategies Available in the Upper Sacramento River CPA

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4	Adaptation Potential Reach 5	Adaptation Potential Reach 6
SRA-1	SMELT-1	Limited – Reach 1 is upstream of suitable habitat for delta smelt, but SRA contribution to nutrients and shading to decrease water temperatures could improve downstream habitat.	Limited – Same as Reach 1.	Limited – Same as Reach 1.	Limited – Same as Reach 1.	Limited – Same as Reach 1.	None.
	SALMONID/STURGEON-1	High – Reach 1 provides very important rearing and outmigration habitat for juveniles of all runs of Central Valley salmonids and green sturgeon. Increased SRA would improve rearing habitat by providing overhead cover that helps lower water temperatures, a substrate for food production that seasonally provides insects for fish to forage, and large wood that falls into the river which provides habitat complexity.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High– Reach 5 provides very important adult spawning habitat for green sturgeon and rearing and outmigration habitat for juveniles of all runs of Central Valley salmonids and green sturgeon. Increased SRA would improve habitat, as described for Reach 1, as well as storage of spawning gravels for green sturgeon.	Moderate – Reach 6 contains all of the spawning habitat for winter-run Chinook salmon that exists in the SPA, and also contains important rearing habitat. Although the opportunity for floodway expansion is constrained in this reach, any expansion of riparian and SRA habitat would provide a significant benefit to winter-run Chinook salmon.
	BANS-1	High – The majority of California bank swallows breed along the Sacramento River and its tributaries. This CPA lies within the area specifically recommended for revetment removal by the BANS-TAC, and the same types of opportunities exist in this reach for foraging habitat restoration as described for Reach 2 of the Lower Sacramento River CPA.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	None.
	BANS-2	High – Same as Lower Sacramento River CPA.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	None.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4	Adaptation Potential Reach 5	Adaptation Potential Reach 6
SRA-1	SONG-1	High – Yellow-breasted chat currently occur in Reach 1, and although there are no recent records for least Bell's vireo in this CPA, it is within the historic range. Reach 1 provides opportunities to facilitate dynamic riparian successional stages which could aid in recolonization of least Bell's vireo, and both species would benefit from increased riparian habitat, greater riparian patch size, and additional secondary growth used for nesting.	High – Same as Reach 1 related to nearly the entirety of the Sacramento River below Colusa.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Reach 5 lacks levees and there are few areas of disconnected floodplains available for enhancement of natural processes that support the yellow-breasted chat and least Bell's vireo.	Limited – Reach 6 provides limited opportunities to expand, enhance or restore dynamic riparian successional stages beyond current conditions.
	TCBB-1	None.	None.	High – Tricolored blackbirds occur in Reach 3, and abundant opportunities exist to facilitate natural river processes that create nesting habitats.	None.	None.	None.
	WYBC-1	None.	None.	None.	None.	None.	Limited – Reach 6 provides limited opportunities to expand, enhance or restore dynamic riparian successional stages beyond current conditions.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4	Adaptation Potential Reach 5	Adaptation Potential Reach 6
RIP-1	MONARCH-1	High – Same as the Lower Sacramento River CPA.	High – Same as the Lower Sacramento River CPA.	High – Same as the Lower Sacramento River CPA.	High – Same as the Lower Sacramento River CPA.	High – Reach 5 currently provides generally suitable breeding and migration habitat, and is within the known summer breeding zone for monarchs. Climate change adaptation potential for monarch butterfly could be improved by increasing breeding and migration habitat by planting an abundance of nectar resources and native milkweed species, ensuring the availability of trees and shrubs for roost sites, and increasing the connectivity of suitable habitat in the floodway.	High – Same as Reach 5.
	SWHA-1	High – Same as the Lower Sacramento River CPA.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Reach 6 provides limited opportunities to expand, enhance or restore existing riparian habitat beyond current conditions.
	WYBC-1	High – Suitable habitat occupied by western yellow-billed cuckoos exists in Reach 1. The expansion and enhancement of riparian habitat would increase the total amount of available riparian habitat and habitat patch size, enhancing the habitat for nesting and increase connectivity of occupied and suitable habitat.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	Moderate – Reach 5 lacks levees, and there are few areas of disconnected floodplains available for expansion and enhancement of riparian habitat.	Limited – Reach 6 provides limited opportunities to expand, enhance or restore riparian habitat beyond current conditions.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4	Adaptation Potential Reach 5	Adaptation Potential Reach 6
RIP-1	SONG-1	High – The high potential of Reach 1 for floodway expansion provides substantial opportunities to enhance and expand riparian habitat suitable for the yellow-breasted chat and least Bell's vireo.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Reach 6 provides limited opportunities to expand, enhance or restore riparian habitat beyond current conditions.
	VELB-1	High – Suitable elderberry habitat exists and the valley elderberry longhorn beetle is known to occur throughout Reach 1. The substantial opportunity in this reach to reconnect the floodplain to the river will provide new areas for elderberry recruitment adjacent to existing suitable habitat.	High – Same as Reach 1.	High – Same as Reach 1.	Moderate – Reach 4 is similar to Reaches 1 through 3, but with slightly less area available for floodplain reconnection and elderberry recruitment.	Moderate – Same as Reach 4.	Limited – Reach 6 provides limited opportunities for floodplain reconnection and elderberry recruitment.
	VELB-2	High – Reach 1 provides substantial opportunities to plant elderberry shrubs in existing and new riparian restoration areas, and potentially in newly expanded floodplain areas.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Reach 6 provides limited opportunities for additional riparian habitat beyond current conditions.
WET-1	SMELT-1	Limited – This CPA is located upstream of existing habitat for delta smelt, but floodplain contributions to nutrients and sediment from erosional processes could improve downstream habitat.	Limited – same as Reach 1.	Limited – same as Reach 1.	Limited – same as Reach 1.	Limited – same as Reach 1.	None.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4	Adaptation Potential Reach 5	Adaptation Potential Reach 6
WET-1	SALMONID/STURGEON-1	High – Reach 1 provides opportunities to restore and enhance floodplain and seasonally connected wetland habitats, which would improve and increase rearing habitats.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	Moderate – Although the opportunity for floodway expansion is constrained in Reach 6, any enhancement or restoration of floodplain, riparian, or SRA habitat would provide a significant benefit to winter-run Chinook salmon.
	GGS-1	High – Giant gartersnakes occur throughout this CPA. Reach 1 provides substantial opportunities to enhance, expand, and restore marsh habitat suitable for the giant gartersnakes.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	None.	None.
	GGS-2	High – Reach 1 provides substantial opportunities to expand the floodway, which would provide upland refugia and connect existing habitat for giant gartersnakes.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.	None.	None.
	GSHC-1	High – Greater sandhill cranes are present in this CPA. There are expansive areas suitable to create large areas of floodplain habitats suitable for greater sandhill cranes in Reach 1, increasing connectivity with existing habitat.	High – Same as Reach 1.	High – Same as Reach 1.	Moderate – Although Reach 4 provides limited opportunities for floodplain expansion, it contains much connected floodplain, providing substantial opportunities for enhancement of existing habitat.	Moderate – Same as Reach 4.	Limited – Reach 6 has very limited opportunities for floodplain expansion, and very little existing floodplain habitat that could be enhanced.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4	Adaptation Potential Reach 5	Adaptation Potential Reach 6
WET-1	GSHC-2	High – Same as Lower Sacramento River CPA.	High – Same as Lower Sacramento River CPA.	High – Same as Lower Sacramento River CPA.	High – Same as Lower Sacramento River CPA.	High – Same as Lower Sacramento River CPA.	Limited – Reach 6 provides very little floodplain habitat that could be enhanced by reservoir releases.
	TCBB-1	High – Reach 1 includes expansive areas to create potential riparian habitat, and opportunities to create and enhance wetlands that provide breeding habitat for tricolored blackbirds.	High – Same as Reach 1.	None.	None.	None.	None.

[a] Table H-10 provides adaptation strategy descriptions.

Notes:
CPA = conservation planning area
SPA = systemwide planning area
SRA = shaded riverine aquatic

H5.3 Feather River CPA

Table H-16. Species Distribution by Habitat and Reach in the Feather River CPA

Habitat Type	Species Acronym [a]	Species Name	Reach 1	Reach 2
Potential Floodplain/SRA	SALMONID	California Central Valley Steelhead	Yes	Yes
	SALMONID	Chinook – Central Valley Spring Run	Yes	Yes
	SALMONID	Chinook – Central Valley Fall/Late-fall Run	Yes	Yes
	STURGEON	Green Sturgeon	Yes	Yes
	BANS	Bank Swallow	Yes	Yes
	SONG	Least Bell's Vireo	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	No	Yes
Riparian	SWHA	Swainson's Hawk	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	Yes	No
	SONG	Yellow-breasted Chat	Yes	Yes
	MONARCH	Monarch Butterfly	Yes	Yes
	VELB	Valley Elderberry Longhorn Beetle	Yes	Yes
Perennial Wetland	GGS	Giant Gartersnake	Yes	Yes
	GSHC	Greater Sandhill Crane	Yes	Yes
	TCBB	Tricolored Blackbird	Yes	Yes

[a] Species acronyms are assigned in Table H-10 of Section H4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Figure H-26. Feather River CPA Reach 1

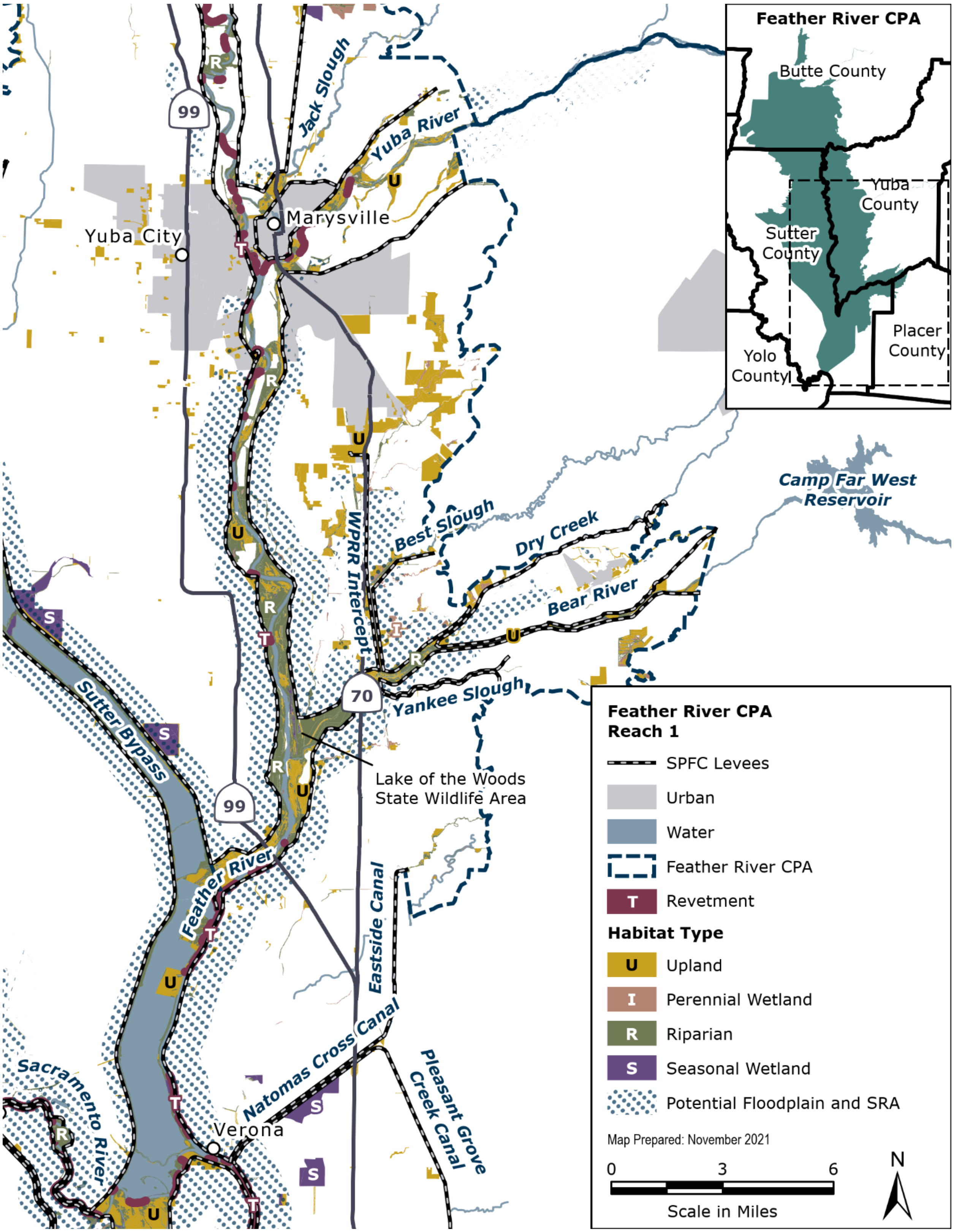
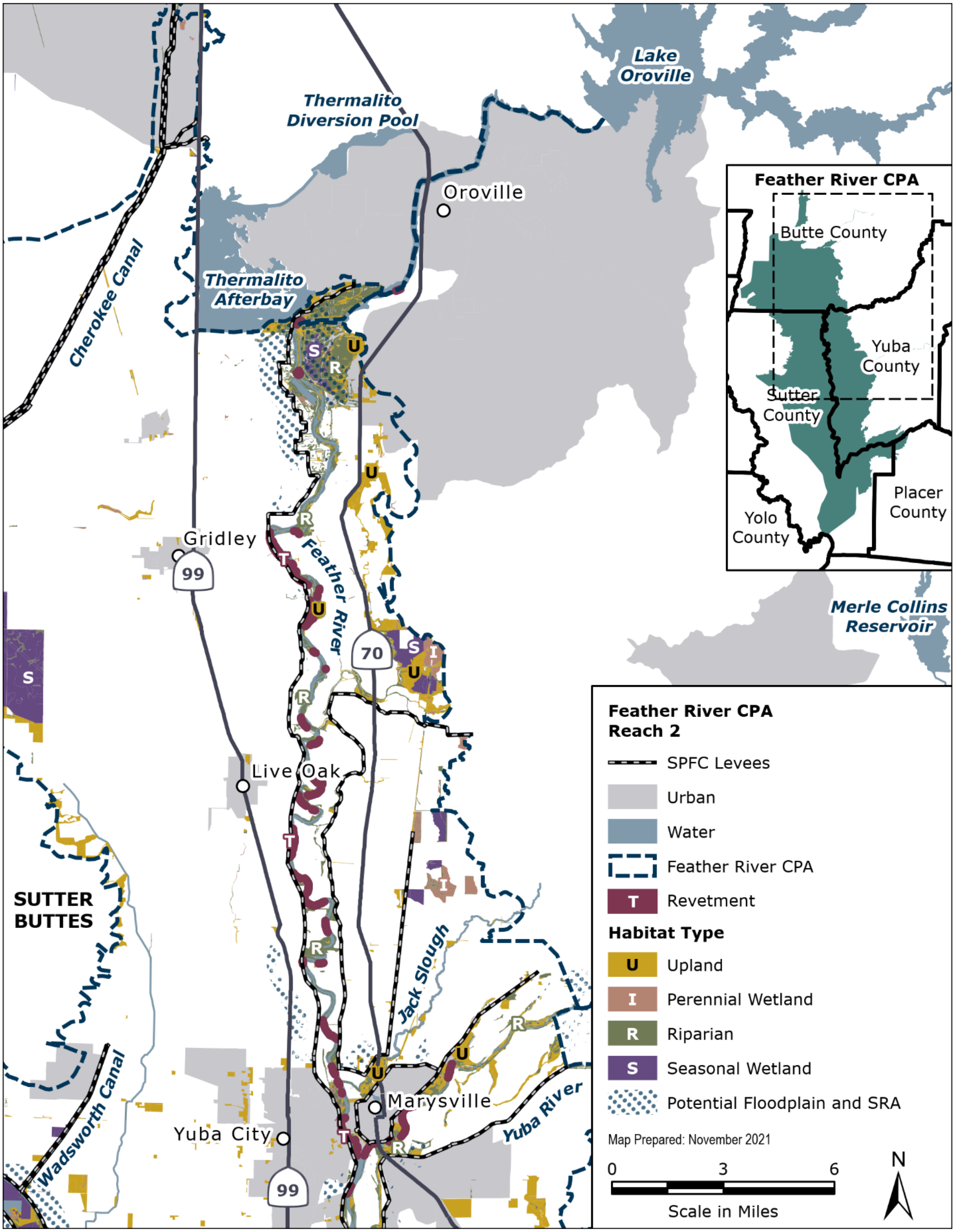


Figure H-27. Feather River CPA Reach 2



H5.3.1 Climate Change Adaptation Risks and Opportunities – Feather River CPA

Reach 1: Adaptation potential is provided by expansive areas suitable for reconnecting floodplains along the Feather River downstream of Yuba City and Marysville and along Best Slough/Dry Creek/Bear River near the Feather River confluence. Aside from floodplain habitat, wetland and riparian habitat could be restored if these floodplains were reconnected to the Feather River and its tributaries. Within the Feather River channel and Sutter Bypass, extensive opportunities exist to restore and connect SRA habitat, along with additional floodplain, riparian, and wetland habitat. There are also areas suitable for enhancing wetlands and uplands along other SPFC facilities and waterways in this reach.

Reach 2: Adaptation potential is limited to targeted areas suitable for creating potential floodplain, riparian, and SRA habitats along the Feather and Yuba Rivers, particularly near and within the Oroville Wildlife Area and downstream from the Thermalito Afterbay outfall channel along the right bank of the Feather River. There also are areas suitable for enhancing and expanding existing riparian and SRA habitats adjacent to the Feather and Yuba Rivers, and Cherokee Canal provides numerous opportunities to enhance and restore all habitat types. Other opportunities also exist for enhancing wetlands and uplands along other, smaller SPFC facilities and waterways in this reach.

Table H-17. Climate Change Adaptation Strategies Available in the Feather River CPA

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
SRA-1	SMELT-1	Limited – This CPA is located upstream of suitable habitat for delta smelt, but SRA contribution to nutrients and shading to decrease water temperatures could improve downstream habitat.	Limited – Same as Reach 1.
	SALMONID/STURGEON-1	High – Reach 1 provides very important adult spawning, and juvenile rearing and outmigration habitat for spring and fall/late-fall runs of Central Valley salmon, steelhead, and green sturgeon. Increased SRA would improve rearing habitat in the same manner described for the Upper Sacramento River CPA.	High – Same as Reach 1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
SRA-1	BANS-1	High – The majority of California bank swallows breed along the Sacramento River and its tributaries. This CPA lies within the Feather River region specifically recommended for revetment removal by the BANS-TAC, and the same types of opportunities exist in this reach for foraging habitat restoration as described for the Lower and Upper Sacramento River CPAs.	High – Same as Reach 1.
	BANS-2	High – Same as the Lower and Upper Sacramento River CPAs.	High – Same as the Lower and Upper Sacramento River CPAs.
	SONG-1	High – Yellow-breasted chat currently occur in Reach 1, and although there are no recent records for least Bell's vireo in this CPA, it is within the historic range. There is a substantial amount of area suitable for expanding the floodway in Reach 1, which would facilitate dynamic riparian successional stages that could aid in recolonization of least Bell's vireo, and both species would benefit as described for the Upper Sacramento River CPA.	Moderate – There are a moderate number of areas suitable for facilitating dynamic riparian successional changes adjacent to the Feather and Yuba Rivers, Cherokee Canal, and the Sutter Bypass.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
SRA-1	WYBC-1	High – Suitable habitat occupied by the western yellow-billed cuckoo occurs in Reach 1. The high potential of this reach for floodway reconnection provides substantial opportunities to facilitate dynamic riparian successional stages, which would improve climate change adaptation potential for the western yellow-billed cuckoo through increased riparian habitat overall and greater riparian patch size.	Limited – The area available for floodplain reconnection is relatively limited in Reach 2, constraining the potential to facilitate dynamic riparian successional stages and increase climate adaptation potential for the western yellow-billed cuckoo.
RIP-1	SWHA-1	High – Reach 1 currently provides suitable breeding and foraging habitat and is occupied by the Swainson's hawk. Climate change adaptation potential for the Swainson's hawk could be improved in this reach in the same manner described for the Lower and Upper Sacramento River CPAs.	Moderate – There are moderate opportunities to create and enhance riparian habitat in this reach as referenced in Reach 1.
	WYBC-1	High – The high potential of Reach 1 for floodway expansion provides substantial opportunity to enhance and expand riparian habitat suitable for the western yellow-billed cuckoo.	Limited – The area available for expanding floodplain habitats is relatively limited in Reach 2, constraining the potential to expand riparian habitat suitable for he western yellow-billed cuckoo.
	SONG-1	High – The high potential of Reach 1 for floodway expansion provides substantial opportunities to enhance and expand riparian habitat suitable for the yellow-breasted chat and least Bell's vireo.	Moderate – The moderate number of areas suitable for floodway expansion provides some opportunities to enhance and expand riparian habitat suitable for the yellow-breasted chat and least Bell's vireo.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
RIP-1	MONARCH-1	High – Same as the Upper and Lower Sacramento River CPAs.	High – Same as the Upper and Lower Sacramento River CPAs.
	VELB-1	High – Suitable elderberry habitat exists and the valley elderberry longhorn beetle is known to occur throughout Reach 1, and there are substantial opportunities for floodplain expansion, which will provide new areas for elderberry shrubs to colonize.	Limited – While suitable elderberry habitat exists and the VELB is known to occur in Reach 2, there are limited opportunities for floodplain reconnection that would provide new areas for elderberry shrub colonization.
	VELB-2	High – Substantial opportunities to expand suitable habitat similar to that described for the Upper Sacramento River CPA.	Moderate – There are moderate opportunities to expand suitable habitat similar to that described for the Upper Sacramento River CPA.
WET-1	SMELT-1	Limited – This CPA is located upstream of existing habitat for delta smelt, but floodplain contributions to nutrients and sediment from erosional processes could improve downstream habitat.	Limited – Same as Reach 1.
	SALMONID/ STURGEON-1	High – Same the Upper Sacramento River CPA.	High – Same as Reach 1.
	GGS-1	High – Giant gartersnakes occur throughout this CPA. Reach 1 provides substantial opportunities to enhance, expand, and restore marsh habitat suitable for the giant gartersnake.	Moderate – Similar to Reach 1, but opportunities are available only in select areas (e.g., within Cherokee Canal).
	GGS-2	High – Reach 1 provides substantial opportunities to expand the floodway, providing upland refugia and connecting existing habitat for the giant gartersnake.	Moderate – Similar to Reach 1, but opportunities are available in select areas.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
WET-1	GSHC-1	High – Greater sandhill cranes are present in this CPA. Reach 1 provides expansive areas suitable to create large areas of floodplain habitats suitable for the greater sandhill crane, increasing connectivity with existing habitat.	Moderate – Although Reach 2 provides limited opportunities for floodplain expansion, there are some opportunities for floodplain enhancement and creation in select areas, such as adjacent to the Feather and Yuba Rivers, Cherokee Canal, and the Sutter Bypass.
	GSHC-2	High – Reach 1 provides the opportunity to manage reservoir releases along the Feather River to promote shallow inundation of existing greater sandhill crane roosting habitat, which could mediate climate change effects in drought years.	High – Same as Reach 1.
	TCBB-1	High – Tricolored blackbirds are present in Reach 1, and the potential for floodway expansion provides extensive opportunities to create and enhance riparian and wetland habitats suitable for the tricolored blackbird within the existing floodway, thereby increase the breeding habitat available.	High – Tricolored blackbirds are present in Reach 2, and although the potential to expand the floodway is limited compared to Reach 1, there are some opportunities to expand and create suitable riparian and wetland habitats suitable for the tricolored blackbird within the existing floodway and thereby increase the breeding habitat available.

[a] Table H-10 provides adaptation strategy descriptions.

H5.4 Lower San Joaquin River CPA

Table H-18. Species Distribution by Habitat and Reach in the Lower San Joaquin River CPA

Habitat Type	Species Acronym [a]	Species Name	Reach 1	Reach 2	Reach 3
Potential Floodplain/SPA	SALMONID	California Central Valley Steelhead	Yes	Yes	Yes
	SALMONID	Chinook – Central Valley Spring Run	Yes	Yes	Yes
	SALMONID	Chinook – Central Valley Fall-/ Late-fall Run	Yes	Yes	Yes
	SMELT	Delta Smelt	Yes	No	No
	STURGEON	Green Sturgeon	Yes	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	Yes	No	Yes
Riparian	SWHA	Swainson's Hawk	Yes	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	No	Yes	No
	SONG	Yellow-breasted Chat	Yes	Yes	Yes
	SONG	Least Bell's Vireo	Yes	Yes	Yes
	MONARCH	Monarch Butterfly	Yes	Yes	Yes
	VELB	Valley Elderberry Longhorn Beetle	Yes	Yes	Yes
	PLANTS	Delta Button-celery	Yes	Yes	Yes
	MAMMAL	Riparian Bush Rabbit	No	Yes	Yes
	MAMMAL	Riparian Woodrat	No	Yes	Yes
Perennial Wetland	GGS	Giant Gartersnake	Yes	Yes	Yes
	GSHC	Greater Sandhill Crane	Yes	Yes	Yes
	TCBB	Tricolored Blackbird	Yes	Yes	Yes
	CABR	California Black Rail	Yes	No	No
	PLANTS	Slough Thistle	Yes	Yes	Yes

[a] Species acronyms are assigned in Table H-10 of Section 4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Notes:
CPA = conservation planning area
SPA = systemwide planning area

Figure H-28. Lower San Joaquin River CPA Reach 1

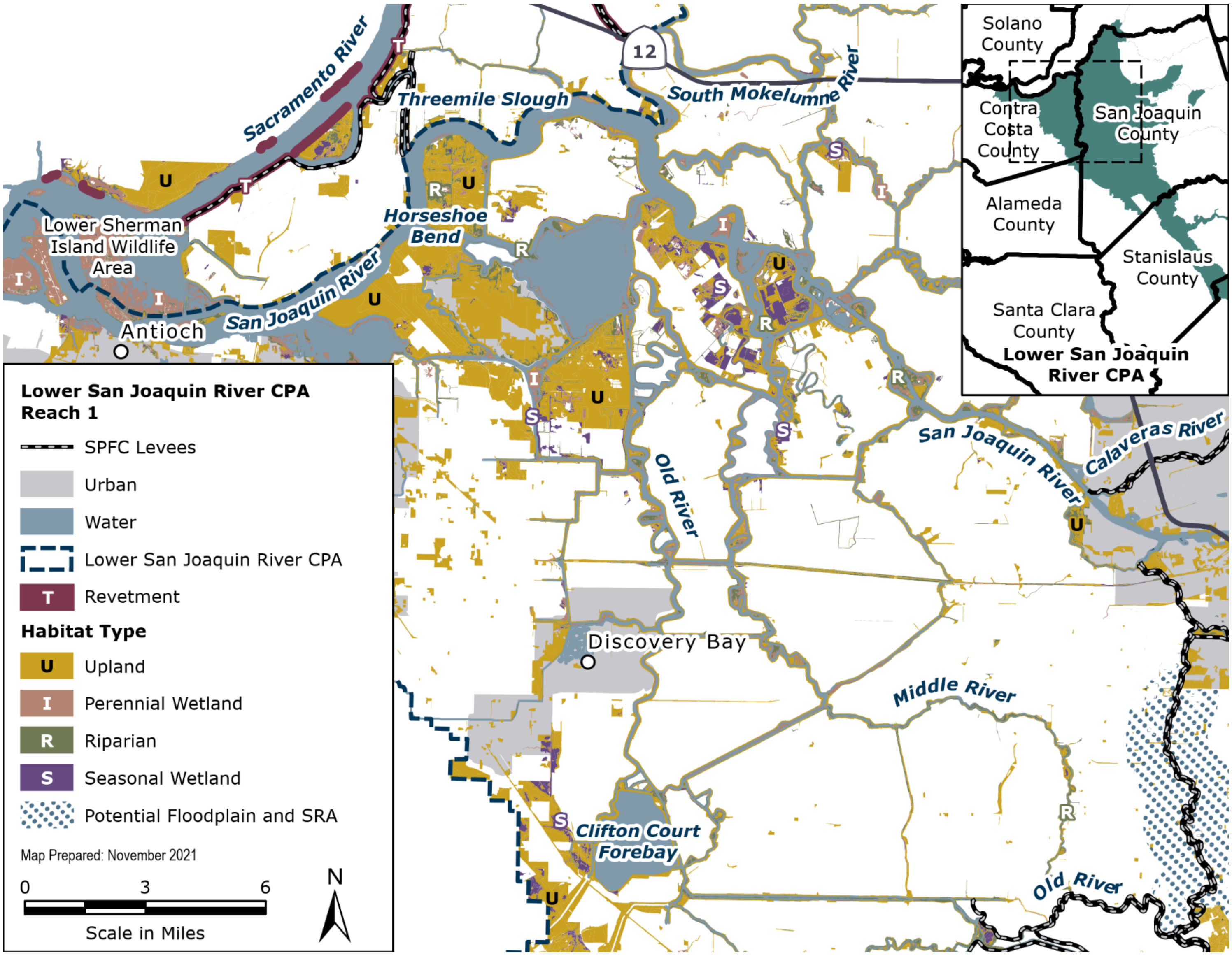


Figure H-29. Lower San Joaquin River CPA Reach 2

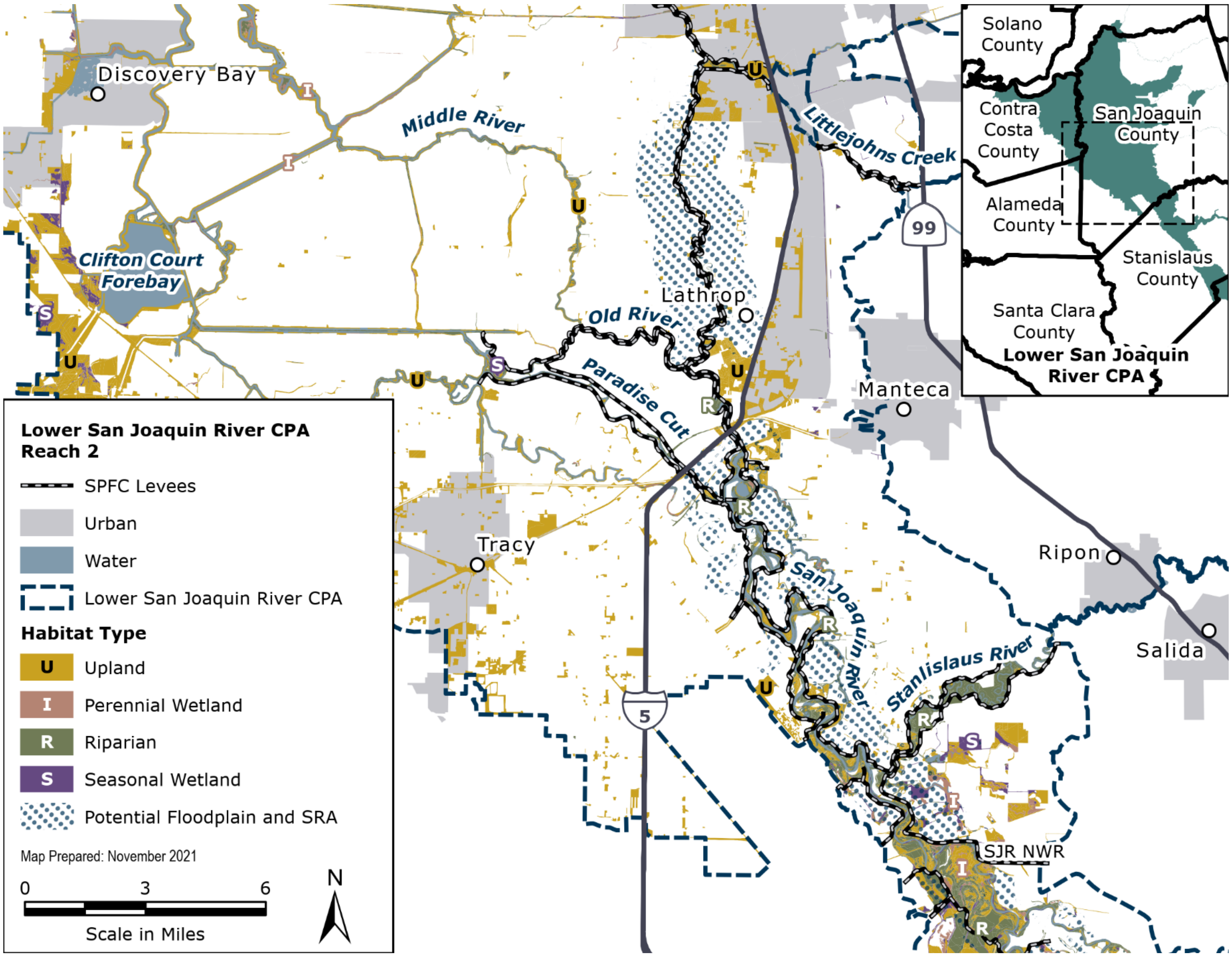
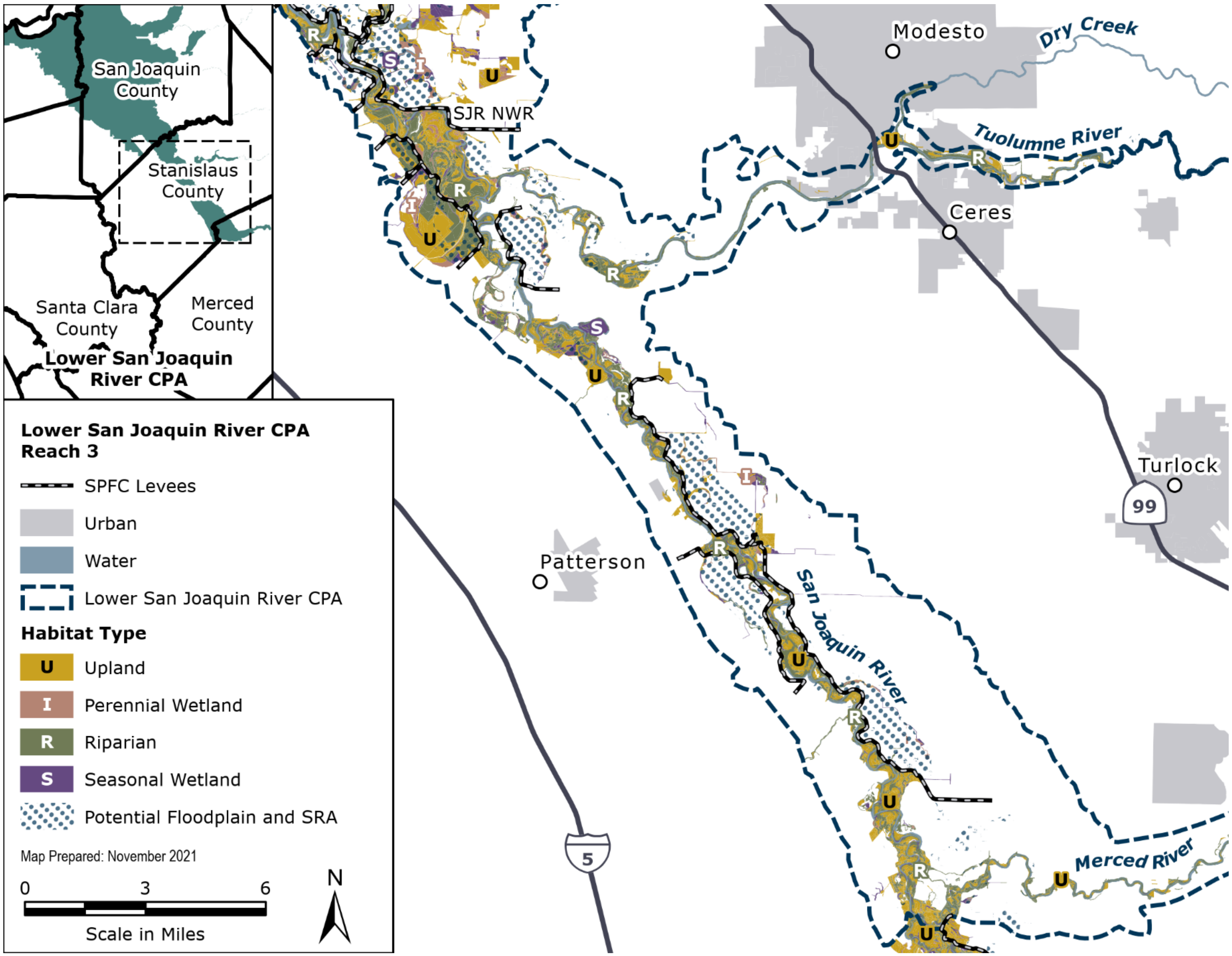


Figure H-30. Lower San Joaquin River CPA Reach 3



H5.4.1 Climate Change Adaptation Risks and Opportunities – Lower San Joaquin CPA

Reach 1: Adaptation potential is constrained by expansive areas of levees and revetment protecting urbanizing areas and the Delta, providing very few areas that are suitable for creating potential floodplain, riparian, and SRA habitats. However, there are some limited areas that may be suitable for enhancing riparian and wetland habitats along the San Joaquin River and its tributaries.

Reach 2: Extensive areas of disconnected floodplain exist from south of Stockton to Lathrop, and all habitat types could be restored or enhanced in this area. Additional adaptation opportunities to reconnect floodplains and restore riparian, wetland, and SRA habitat exist in Paradise Cut and along the San Joaquin River from Paradise Cut downstream to the Stanislaus River confluence and San Joaquin River National Wildlife Area. Targeted restoration of riparian and SRA habitat could occur along the lower Stanislaus River, although the proximity of levees to the river limits the area where restoration could occur unless levees are set back.

Reach 3: Adaptation potential is provided in expansive areas suitable for creating potential floodplain, riparian, and SRA habitats along the San Joaquin River, particularly near the San Joaquin River National Wildlife Area, where existing habitats could be expanded and connected to other habitats downstream in this reach. There are also some limited areas suitable for reconnecting floodplains along the Tuolumne River, and areas suitable for enhancing riparian and wetland habitats occur adjacent to both the San Joaquin and Tuolumne Rivers.

Table H-19. Climate Change Adaptation Strategies Available in the Lower San Joaquin River CPA

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
SRA-1	SMELT-1	High – Reach 1 provides a large portion of the existing habitat for delta smelt. Opportunities to improve climate change adaptation are the same as those described for the Lower Sacramento River CPA.	Limited – Reach 2 contributes to the main habitat for delta smelt in Reach 1. SRA contribution to nutrients and shading to decrease water temperatures could improve downstream habitat as described for the Lower Sacramento River CPA.	Limited – Reach 3 also contributes to the main habitat for delta smelt in Reach 1, and provides the same opportunities as described for Reach 2.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
SRA-1	SALMONID/STURGEON-1	High – This reach provides important rearing and outmigration habitat for juveniles of all runs of Central Valley salmonids and green sturgeon. Opportunities to improve and restore these habitats must consider effects of climate change on increasing water temperatures, similar to that described for the Lower Sacramento River CPA.	High – Same as Reach 1, except this reach does not provide habitat for winter-run Chinook salmon.	High – Same as Reach 2.
	BANS-1	Limited – Recent records of bank swallows in Reach 1 appear to be migrants rather than breeders, and the reach is outside the historic and current breeding distribution of this species. Expansive areas of levees and revetment provide very limited areas that might be suitable for creating potential breeding habitat.	Limited – Reach 2 appears to have had a very small breeding population of bank swallows that is now extirpated. Although this reach provides substantial opportunities for floodplain reconnection, which could facilitate erosional processes that create nesting habitat, it is unclear the degree to which bank swallows would respond given their limited historic presence.	Limited – Same as Reach 2.
	BANS-2	Limited – Same as BANS-1.	Limited – Same as BANS-1.	Limited – Same as BANS-1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
SRA-1	WYBC-1	Limited – Adaptation potential for the western yellow-billed cuckoo is constrained by expansive areas of levees and revetment in Reach 1, which provides few opportunities for floodplain reconnection.	None	High – Reach 3 provides substantial opportunities for floodplain reconnection and contains existing suitable habitat occupied by the western yellow-billed cuckoo. Facilitation of dynamic riparian successional stages should increase the total amount of riparian habitat and increase riparian habitat patch size, enhancing the reach for the nesting western yellow-billed cuckoo.
RIP-1	SWHA-1	Moderate – Reach 1 provides limited areas suitable for creating additional riparian habitat, but climate change adaptation potential for the Swainson's hawk could be improved in the same manner described for the Lower and Upper Sacramento River and Feather River CPAs.	High – Reach 2 currently provides suitable breeding and foraging habitat and is occupied by the Swainson's hawk. There are substantial areas suitable for expanding and enhancing riparian breeding habitat as described for the Lower and Upper Sacramento River and Feather River CPAs.	High – Same as Reach 2.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
RIP-1	WYBC-1	Limited – Adaptation potential for the western yellow-billed cuckoo is constrained by expansive areas of levees and revetment in Reach 1, which provides few opportunities to expand riparian habitat.	None.	High – Reach 3 provides substantial opportunities for floodplain expansion and contains existing suitable habitat occupied by the western yellow-billed cuckoo Increasing the total amount of riparian habitat and riparian habitat patch size would enhance this reach for nesting western yellow-billed cuckoos.
	SONG-1	Limited – The yellow-breasted chat occurs throughout Reach 1, and there is a recent record of least Bell's vireo; however, opportunities for climate change adaptations are constrained by expansive areas of levees and revetment. There are some limited areas that may be suitable for enhancing riparian and wetland habitats along the San Joaquin River and tributaries.	High – YBC currently occur in Reach 2, there are recent least Bell's vireo records from the San Joaquin National Wildlife Refuge, and this reach is within the historic range of least Bell's vireo. The high potential of Reach 2 for floodway expansion provides substantial opportunities to enhance and expand riparian habitat suitable for the yellow-breasted chat and least Bell's vireo.	High – Same as Reach 2.
	MONARCH-1	High – Same as the Upper and Lower Sacramento River and Feather River CPAs.	High – Same as the Upper and Lower Sacramento River and Feather River CPAs.	High – Same as the Upper and Lower Sacramento River and Feather River CPAs.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
RIP-1	VELB-1	Limited – While suitable elderberry habitat exists and the valley elderberry longhorn beetle is known to occur in Reach 1, there are limited opportunities for floodplain reconnection that would provide new areas for elderberry colonization.	High – Suitable elderberry habitat exists and the VELB is known to occur throughout Reach 2. There are substantial opportunities for expansion of suitable habitat similar to that described for the Upper Sacramento River CPA.	High – Same as Reach 2.
	VELB-2	Limited – There are limited opportunities to expand suitable riparian habitat in Reach 1.	High – Reach 2 provides substantial opportunities to expand suitable habitat similar to that described for the Upper Sacramento River CPA.	High – Same as Reach 2.
	PLANTS-1	Limited – Delta button-celery is likely extirpated from Reach 1, but its historical range includes this reach. Limited opportunities exist for riparian and wetland restoration where facilitated colonization could be implemented.	Moderate – Similar to Reach 1, but Reach 2 provides more areas with opportunities for riparian and wetland restoration where facilitated colonization could be implemented.	High – Similar to Reach 1, but there are substantial opportunities for riparian and wetland restoration also exist where facilitated colonization could be implemented.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
RIP-1	MAMMAL-1	None.	High – Reaches 2 and 3 provide most of the remaining habitat for these species within the SPA; there are several extant occurrences of both species, and there are substantial opportunities to create or restore riparian and upland refugia habitat required by these species throughout this reach.	High – Same as Reach 2.
WET-1	SMELT-1	High – Reach 1 provides opportunities to improve and expand floodplain and heterogeneous tidal wetland habitat complexes, which are likely to improve habitat conditions for delta smelt. However, there are uncertainties, as described for the Lower Sacramento River CPA.	Limited – Reach 2 is located upstream of habitat for delta smelt, but floodplain contributions to nutrients and sediment from erosional processes could improve downstream habitat, as described for the Lower Sacramento River CPA.	Limited – Same as Reach 2.
	SALMONID/STURGEON-1	High – Reach 1 provides opportunities for restoration and enhancement, as described for the Upper Sacramento River CPA.	High – Same as Reach 1, except this reach does not provide habitat for Sacramento River winter-run Chinook salmon.	High – Same as Reach 2.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
WET-1	GGS-1	Limited – Giant gartersnakes occur in this CPA, and although Reach 1 has very limited opportunities for marsh expansion or restoration, there are some select areas where marsh habitat could be enhanced for the giant gartersnake along the San Joaquin River and its tributaries.	High – Reach 2 provides substantial opportunities to enhance, expand, and restore marsh habitat suitable for giant gartersnake.	High – Same as Reach 2.
	GGS-2	Limited – Reach 1 has very limited opportunities for floodplain expansion that could expand and connect suitable habitat for the giant gartersnake.	High – Reach 2 provides substantial opportunities to expand the floodway, providing upland refugia and connecting existing habitat for the giant gartersnake.	High – Same as Reach 2.
	GSHC-1	Moderate – Greater sandhill cranes are present in this CPA. Although Reach 1 provides limited opportunities for floodplain expansion, there are some opportunities for floodplain enhancement and creation in select areas along the San Joaquin River and its tributaries.	High – Reach 2 provides expansive areas suitable for creating large areas of floodplain habitats suitable for the greater sandhill crane, increasing connectivity with existing habitat.	High – Same as Reach 2.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
WET-1	GSHC-2	High – Reach 1 provides the opportunity to manage reservoir releases along the San Joaquin River to promote shallow inundation of existing greater sandhill crane roosting habitat, which could mediate climate change effects in drought years.	High – Same as Reach 1.	High – Same as Reach 1.
	TCBB-1	Limited – Reach 1 is within the historical breeding range of the tricolored blackbird; however, adaptation potential for this species is constrained by expansive areas of levees and revetment. There are some limited areas that may be suitable for enhancing riparian and wetland habitats along the San Joaquin River and tributaries.	High – Reach 2 is within the historical breeding range of the tricolored blackbird, and there are substantial opportunities to create and enhance wetlands for breeding habitat throughout the reach.	High – Same as Reach 2.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3
WET-1	CABR-1	Limited – California black rails are present in Reach 1 in low numbers, but existing urban areas constrain the opportunity for removing revetment. However, there may be some opportunities to increase the area of shallow emergent wetlands adjacent to the San Joaquin River and high-tide refugia in the Delta.	None.	None.
	PLANTS-1	Limited – Slough thistle is likely extirpated from the SPA, but its historical range includes Reach 1. Limited opportunities exist for riparian and wetland restoration where facilitated colonization could be implemented.	Moderate – Similar to Reach 1, but there are more areas with opportunities for riparian and wetland restoration where facilitated colonization could be implemented.	High – Similar to Reach 1, but there are substantial opportunities for riparian and wetland restoration where facilitated colonization could be implemented.

[a] Table H-10 provides adaptation strategy descriptions.

Notes:
CPA = conservation planning area
SPA = systemwide planning area
SRA = shaded riverine aquatic

H5.5 Upper San Joaquin River CPA

Table H-20. Species Distribution by Habitat and Reach in the Upper San Joaquin River CPA

Habitat Type	Species Acronym [a]	Species Name	Reach 1	Reach 2	Reach 3	Reach 4
Potential Floodplain/SRA	SALMONID	California Central Valley Steelhead	Yes	Yes	Yes	Yes
	SALMONID	Chinook – Central Valley Spring Run	Yes	Yes	Yes	Yes
	SALMONID	Chinook – Central Valley Fall/Late-fall Run	Yes	Yes	Yes	Yes
	WYBC	Western Yellow-billed Cuckoo	Yes	Yes	Yes	Yes
	PLANTS	Slough Thistle	Yes	Yes	Yes	No
	SONG	Least Bell's Vireo	No	Yes	Yes	Yes
	SONG	Yellow-breasted Chat	No	No	Yes	No
Riparian	SWHA	Swainson's Hawk	Yes	Yes	Yes	Yes
	SONG	Yellow-breasted Chat	Yes	Yes	No	Yes
	SONG	Least Bell's Vireo	Yes	No	No	No
	MONARCH	Monarch Butterfly	Yes	Yes	Yes	Yes
	VELB	Valley Elderberry Longhorn Beetle	Yes	Yes	Yes	Yes
	PLANTS	Delta Button-celery	Yes	Yes	Yes	No
Perennial Wetland	GGS	Giant Gartersnake	Yes	Yes	Yes	Yes
	GSHC	Greater Sandhill Crane	Yes	Yes	Yes	Yes
	TCBB	Tricolored Blackbird	Yes	Yes	Yes	Yes

[a] Species acronyms are assigned in Table H-10 of Section 4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Figure H-31. Upper San Joaquin River CPA Reach 1

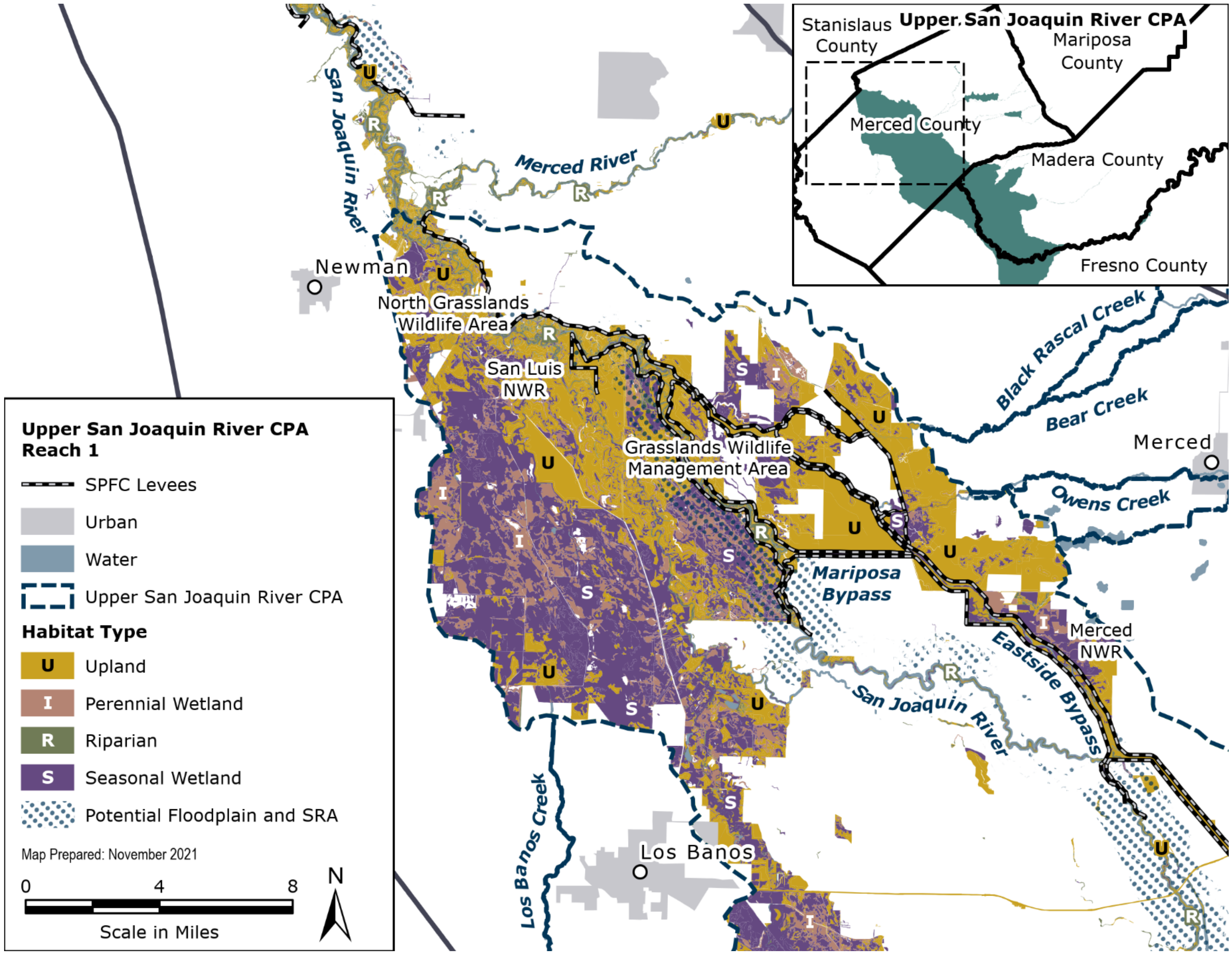


Figure H-32. Upper San Joaquin River CPA Reach 2

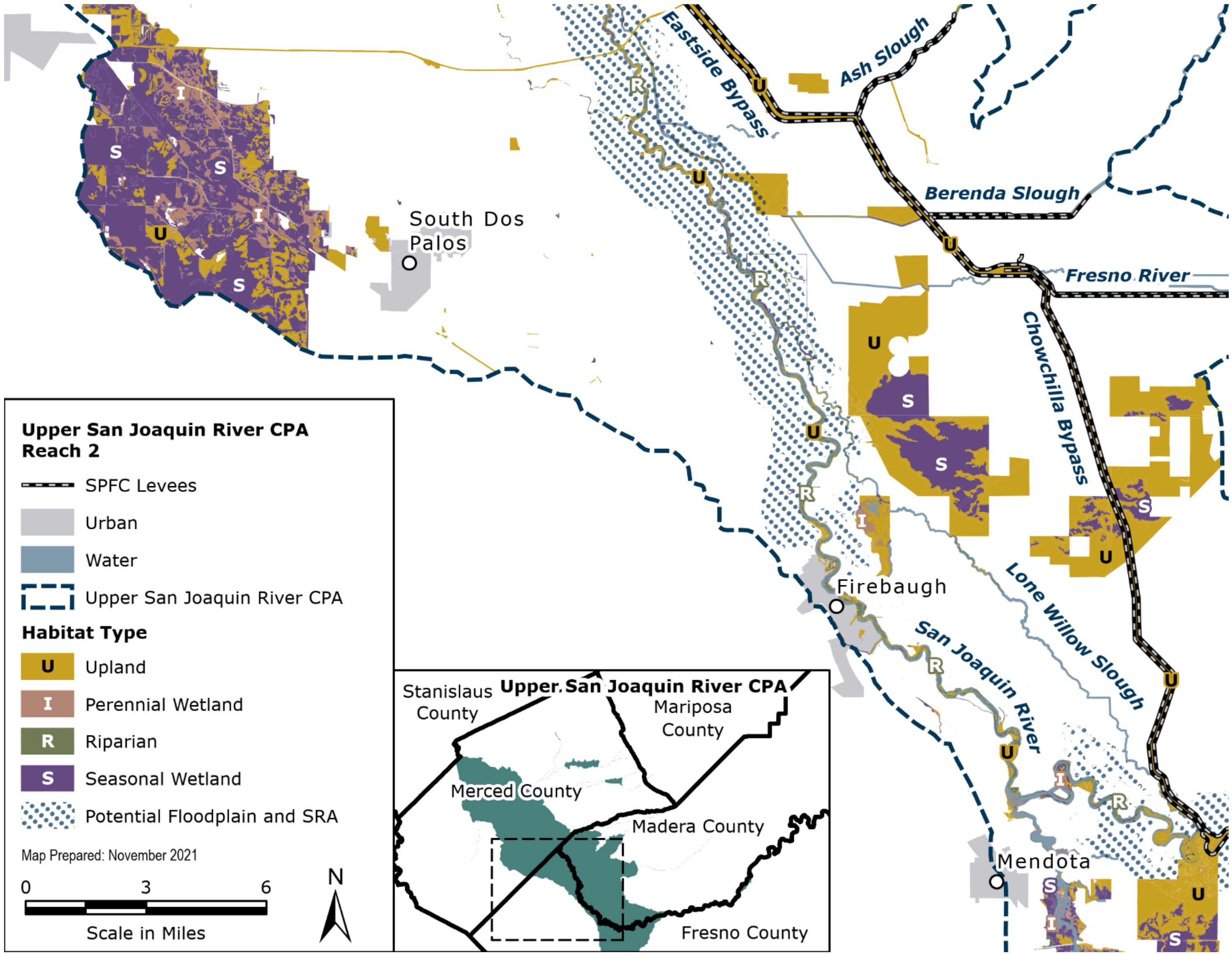


Figure H-33. Upper San Joaquin River CPA Reach 3

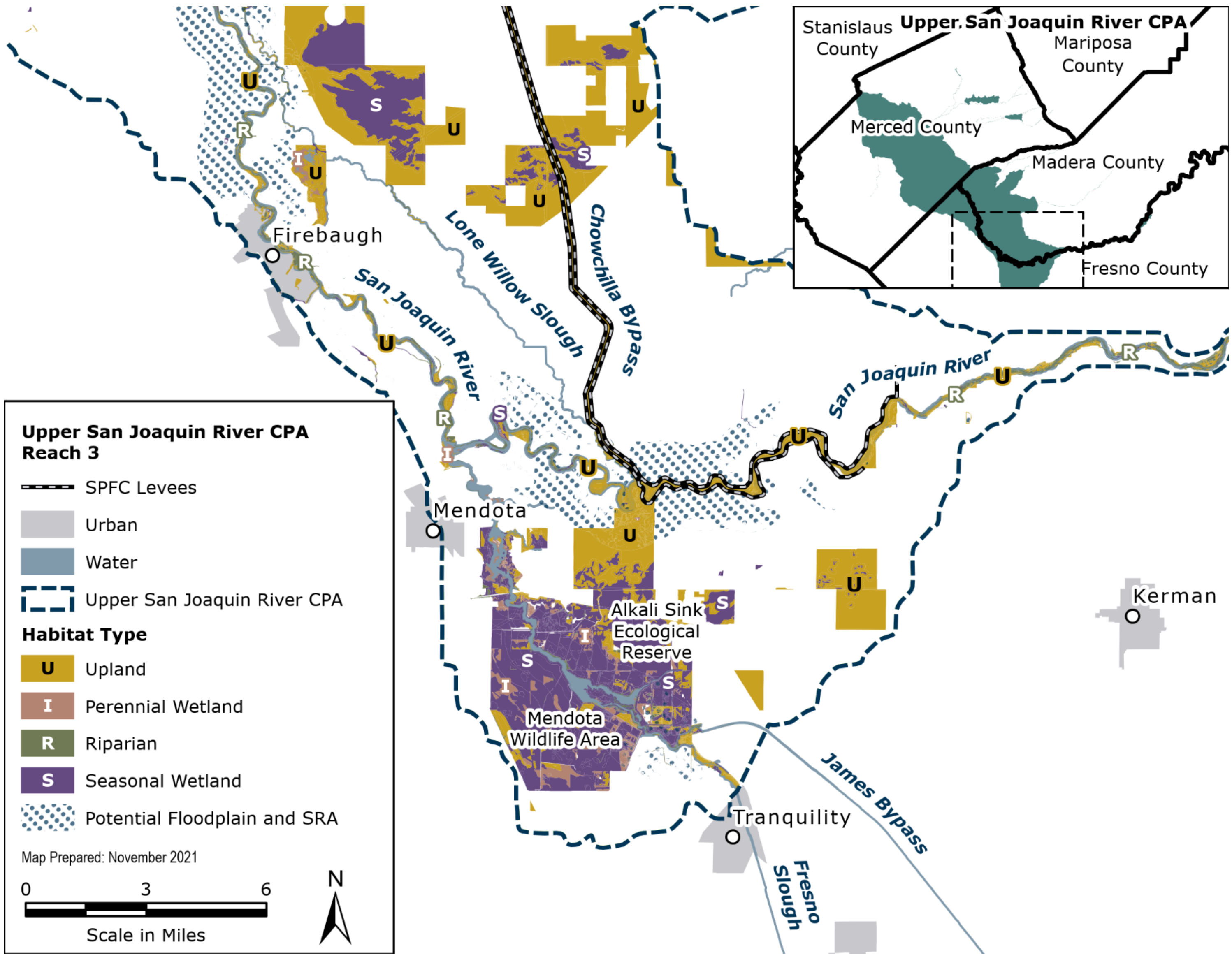
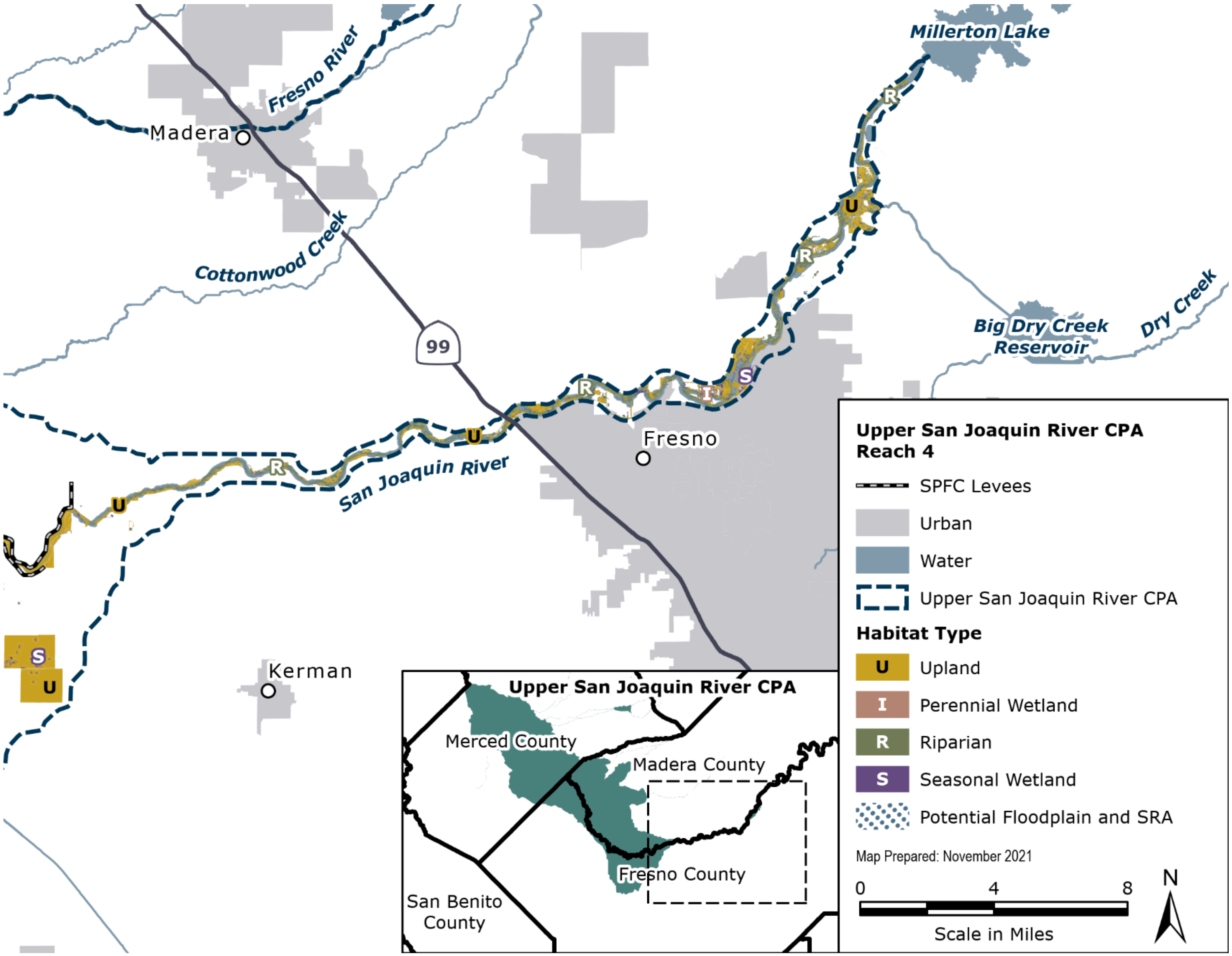


Figure H-34. Upper San Joaquin River CPA Reach 4



H5.5.1 Climate Change Adaptation Risks and Opportunities – Upper San Joaquin CPA

Reach 1: This reach supports the largest remaining wetland-upland complex in the Central Valley within the Grasslands National Wildlife Area, San Luis National Wildlife Refuge, and adjacent areas. Most of the opportunities to reconnect floodplains in this reach occur in these areas, providing abundant opportunities to increase climate change resilience by reconnecting floodplains to the river and by restoring habitats to create larger, interconnected blocks of habitat. Additional opportunities to reconnect floodplains and enhance riparian, SRA, and wetland habitats occur further south along the San Joaquin River and its tributaries.

Reach 2: There are extensive areas of floodplain with topographic conditions suitable for creation of floodplain habitats. This reach of the San Joaquin River is downstream of the flood bypasses and canal diversions, and is dry during most months of the year. Enhancing this reach would require both modifications to the channels and floodplains, as well as changes in flow releases through the reach. There is no floodplain rearing currently, and agricultural diversions and return flows could pose water quality issues. The San Joaquin River Flood Control Project Levees confines the channel in many locations, and there are consequently many opportunities for floodplain reconnection. The Chowchilla Bypass and Eastside Bypasses were not designed for fish passage, and projects are underway to improve fish passage within this reach.

Reach 3: Expansive areas suitable for creating potential floodplain, wetland, riparian, and SRA habitats occur along the San Joaquin River, particularly around the Chowchilla Bypass and near the Alkali Sink Ecological Reserve and Mendota Wildlife Area, where existing habitats could be expanded and habitat connectivity could be improved. Additional areas suitable for enhancing riparian and wetland habitats occur adjacent to the San Joaquin River.

Reach 4: Adaptation potential is limited to areas suitable for enhancing existing riparian habitat adjacent to the San Joaquin River.

Table H-21. Climate Change Adaptation Strategies Available in the Upper San Joaquin River CPA

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
SRA-1	SALMONID-1	High – Reach 1 provides important rearing and outmigration habitat for juvenile spring and fall/late-fall runs of Central Valley salmon and steelhead. Increased SRA would improve rearing habitat in the same manner described for the Upper Sacramento River CPA.	High – Same as Reach 1.	High – Same as Reach 1	High – Reach 4 provides important spawning habitat for spring-run Chinook salmon and steelhead, and rearing and outmigration habitat for juvenile spring and fall/late-fall runs of Central Valley salmon and steelhead. Increased SRA would improve rearing habitat in the same manner described for Reach 1 of the Upper Sacramento River CPA.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
SRA-1	WYBC-1	High – Breeding western yellow-billed cuckoos formerly occurred in the San Joaquin Valley and could become re-established with significant increases in riparian habitat. There are substantial areas suitable for floodplain expansion in Reach 1 which would allow for facilitation of dynamic riparian successional stages that could support habitat for the western yellow-billed cuckoo.	High – Same as Reach 1.	Moderate – Similar to Reach 1, but Reach 2 has less area available for floodplain expansion.	Limited – Within Reach 4, adaptation potential is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River.
	PLANTS-1	High – Slough thistle is likely extirpated from the SPA, but its historical range includes Reach 1. Substantial opportunities exist for riparian and wetland restoration where facilitated colonization could be implemented.	High – Same as Reach 1.	Moderate – Similar to Reach 1, but Reach 2 has slightly less are for expansion of riparian and wetland restoration where facilitated colonization could be implemented.	None.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
RIP-1	SWHA-1	High – Reach 1 currently provides suitable breeding and foraging habitat and is occupied by the Swainson's hawk. There are substantial areas suitable for expanding and enhancing riparian breeding habitat, as described for the Lower and Upper Sacramento River, Feather River, and Lower San Joaquin CPAs.	High – Same as Reach 1.	High – Same as Reach 1.	Moderate – Within Reach 4, adaptation potential is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River, but breeding habitat can be increased by planting native tree species used for breeding that will replace dead mature trees, trees lost through flooding, etc., and increase nesting substrate adjacent to the San Joaquin River.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
RIP-1	SONG-1	High – The yellow-breasted chat currently occurs in Reach 1. There are recent least Bell's vireo records from the San Luis National Wildlife Refuge and the Grasslands Wildlife Management Area, and this reach is within the historical range of the least Bell's vireo. The high potential of Reach 1 for floodway expansion provides substantial opportunities to enhance and expand riparian habitat suitable for the yellow-breasted chat and least Bell's vireo.	High – Same as Reach 1.	Moderate – Similar to Reach 1, but Reach 2 has less area available for riparian habitat creation due to expansive areas of levees.	Limited – Within Reach 4, adaptation potential is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River.
	MONARCH-1	High – Same as the Upper and Lower Sacramento River, Feather River, and Lower San Joaquin CPAs.	High – Same as the Upper and Lower Sacramento River, Feather River, and Lower San Joaquin CPAs.	High – Same as the Upper and Lower Sacramento River, Feather River, and Lower San Joaquin CPAs.	High – Same as the Upper and Lower Sacramento River, Feather River, and Lower San Joaquin CPAs.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
RIP-1	VELB-1	High – Suitable elderberry habitat exists and the valley elderberry longhorn beetle occurs throughout Reach 1. There are substantial opportunities for levee relocation and modifying floodplain topography similar to that described for the Lower and Upper Sacramento River, Feather River, and Lower San Joaquin CPAs.	High – Same as Reach 1.	Moderate – Similar to Reach 1, but Reach 2 has slightly less area for floodplain reconnection.	Limited – While suitable elderberry habitat exists and the VELB is known to occur in Reach 4, there are limited opportunities for floodplain reconnection that would provide new areas for elderberry shrubs to colonize.
	VELB-2	High – Reach 1 has substantial opportunities for expansion of suitable habitat similar to that described for the Lower and Upper Sacramento River, Feather River, and Lower San Joaquin CPAs.	High – Same as Reach 1.	Moderate – Similar to Reach 1, but Reach 3 has slightly less area for expansion of suitable riparian habitat.	Limited – Adaptation potential in Reach 4 is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
RIP-1	PLANTS-1	High - Several extant populations of Delta button-celery exist in Reach 1, so targeted vegetation management could enhance existing populations. Also, this reach provides substantial opportunities for riparian and wetland restoration where facilitated colonization could be implemented.	High – Delta button-celery is likely extirpated from Reach 2, but there are substantial opportunities for riparian and wetland restoration where facilitated colonization could be implemented.	Moderate – Similar to Reach 2, but Reach 3 has slightly less area for expansion of riparian and wetland restoration where facilitated colonization could be implemented.	None.
WET-1	SALMONID-1	High – Reach 1 provides opportunities for restoration and enhancement, as described for the Upper Sacramento River CPA.	High – Same as Reach 1.	High – Same as Reach 1.	High – Same as Reach 1.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
WET-1	GGS-1	High – Giant gartersnakes are present in this CPA, and records are especially concentrated in Reaches 1 and 2. Reach 1 provides expansive areas suitable for creating potential large areas of marsh habitat suitable for the giant gartersnake, increasing connectivity with existing habitat, especially within and adjacent to the conserved areas.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Within Reach 4, adaptation potential is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River, lacking opportunities to expand or create marsh habitat for the giant gartersnake.
	GGS-2	High – Reach 1 provides substantial opportunities to expand the floodway, providing upland refugia and connecting existing habitat for the giant gartersnake.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Reach 4 has very limited opportunities for floodplain expansion that could expand and connect suitable habitat for the giant gartersnake.

Adaptation Strategy [a] Habitat-related	Adaptation Strategy [a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2	Adaptation Potential Reach 3	Adaptation Potential Reach 4
WET-1	GSHC-1	High – Greater sandhill cranes are present in this CPA. Reach 1 provides expansive areas suitable for creating large areas of floodplain habitats suitable for the greater sandhill crane, increasing connectivity with existing habitat.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Within Reach 4, adaptation potential is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River, lacking opportunities to expand or create floodplain wetland habitats for the greater sandhill crane.
	GSHC-2	High – Same as the Lower San Joaquin CPA.	High – Same as Lower San Joaquin CPA.	High – Same as Lower San Joaquin CPA.	High – Same as Lower San Joaquin CPA.
	TCBB-1	High – Reach 1 is within the breeding range of the tricolored blackbird, and there are expansive areas available to create and enhance suitable wetland habitat.	High – Same as Reach 1.	High – Same as Reach 1.	Limited – Within Reach 4, adaptation potential is limited to areas suitable for enhancing riparian habitat adjacent to the San Joaquin River.

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CHAPTER H6

Conclusions

In the Central Valley of California, and within the CVFPP SPA in particular, ongoing and expected continued changes to temperatures, precipitation, and hydrology will affect the ecological process, habitats, and species that inhabit and use riverine corridors along the Sacramento and San Joaquin Rivers and their tributaries. These changes are already manifesting, and that rate of change has the potential to accelerate in the coming decades. The specific impacts on, and responses of, a particular natural community or species to these changes will vary depending on specific habitat needs and life history requirements. Many of the habitats and species identified in the Conservation Strategy have already been severely impacted as a result of the stressors from flood and water management infrastructure, land use changes, and other anthropogenic impacts. As climate change alters the fundamental ecological, hydrologic, and geomorphic processes that influence the distribution and quality of riverine habitats, these natural communities will undergo further stress and decline.

To mitigate the impacts of climate change, it will be necessary to build resilience by restoring these ecological, hydrologic, and geomorphic processes at a rate that can counteract the stressors of climate change. This will require the adaptation measures and actions recommended in this document to be enacted, and the pace and extent of multi-benefit project implementation to increase throughout the SPA in the coming years.

The Conservation Strategy provides guidance to make progress on developing projects that increase system resiliency; the main challenge DWR and its partners face related to climate change is primarily one of timing – for the pace of multi-benefit project implementation to increase, some of the fundamental policy issues already identified in the CVFPP and Conservation Strategy will need to be resolved, including funding, permitting, performance accounting, and addressing impediments to multi-benefit project development.

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CHAPTER H7

References

Ambrosini, R., A. Romano, and N. Saino. 2019. Changes in migration, carry-over effects, and migratory connectivity. In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Bank Swallow Technical Advisory Committee (BANS-TAC). 2013. Bank Swallow (Riparia riparia) Conservation Strategy for the Sacramento River Watershed, California. Version 1.0. Available at www.sacramentoriver.org.

Bashevkin, S.M., B. Mahardja, and L.R. Brown. 2021. Warming in the Upper San Francisco Estuary: Patterns of Water Temperature Change from 5 Decades of Data. EcoEvoRxiv. April 29. doi:10.32942/osf.io/6u47y.

Bateman, B.L., C. Wilsey, L. Taylor, J. Wu, G.S. LeBaron and G. Langham. 2020. North American bird require mitigation and adaptation to reduce vulnerability to climate change. Conservation Science and Practice. DOI: 10.111/csp2.242.

Brown L.R., L.M. Komoroske, R.W. Wagner, T. Morgan-King, J.T. May, R.E. Connon, and N.A. Fangue. 2016. Coupled Downscaled Climate Models and Ecophysiological Metrics Forecast Habitat Compression for an Endangered Estuarine Fish. PLoS ONE 11(1): e0146724. DOI:10.1371/journal.pone.0146724.

California Department of Water Resources (DWR). 2013a. California's Groundwater Update 2013.

California Department of Water Resources (DWR). 2013b. CVFPP Conservation Strategy Restoration Opportunity Analysis Floodplain Lowering and Setback Levee Actions.

California Department of Water Resources (DWR). 2016. *Central Valley Flood Protection Plan Conservation Strategy.* Sacramento (CA).

California Department of Water Resources (DWR). 2017a. Central Valley Flood Protection Plan 2017 Update. Sacramento (CA).

California Department of Water Resources (DWR). 2017b. Draft 2017 CVFPP Update – Climate Change Analysis Technical Memorandum. Viewed online at: www.cvfpb.ca.

California Department of Water Resources (DWR). 2018a. California Water Plan Update 2018.

California Department of Water Resources (DWR). 2018b. Climate Action Plan Phase 3: Climate Change Vulnerability Assessment.

California Department of Water Resources (DWR). 2020. Merced River Flood-MAR Reconnaissance Study: Technical Memorandum.

California Department of Water Resources (DWR). 2022a. 2022 CVFPP Update Technical Analyses Summary Report Appendix A: Climate Change Analysis.

California Department of Water Resources (DWR). 2022b. 2022 CVFPP Update Technical Analyses Summary Report Appendix B: Climate Change Volume Frequency Analysis.

California Department of Water Resources (DWR). 2022c. 2022 CVFPP Update Technical Analyses Summary Report Appendix C: Flood Risk Analysis.

California Natural Resources Agency. 2014. Safeguarding California: Reducing Climate Risk. An update to the 2009 California Climate Adaptation Strategy. Sacramento, California.

California Natural Resources Agency (CNRA) and California Ocean Protection Council (OPC). 2018. State of California Sea-Level Rise Guidance.

Cayan D.R., T. Das, D.W. Pierce, T.P. Barnett, M. Tyree, A. Gershunov. 2010. Future dryness in the southwest US and the hydrology of the early 21st century drought. Proceedings of the National Academy of Sciences. Volume 107(Issue 50): Pages 21,271 to 21,276.

Delta Stewardship Council (DSC). 2021a. Delta Adapts: Creating a Climate Resilient Future: Sacramento-San Joaquin Delta Climate Change Vulnerability Assessment.

Delta Stewardship Council (DSC). 2021b. Delta Adapts: Creating a Climate Resilient Future: Water Supply Technical Memorandum.

Dunn, P.O. 2019. Changes in timing of breeding and reproductive success in birds. In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Dunn P.O. and A.P. Møller. 2019. *Introduction*. In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Espinoza, V., D.E. Waliser, B. Guan, D.A. Lavers, and F.M. Ralph. 2018. Global analysis of climate change projection effects on atmospheric rivers. Geophysical Research Letters, 45: pp. 4299-4308. DOI: 10.1029/2017GL076968.

Falk, D.A., A.C. Watts, and A.E. Thode. 2019. Scaling Ecological Resilience. Frontiers in Ecology and Evolution. Volume 7. DOI: 10.3389/fevo.2019.00275.

Florsheim, J.L. and Dettinger, M.D. 2015. "Promoting Atmospheric-River and Snowmelt-Fueled Biogeomorphic Processes by Restoring River-Floodplain Connectivity in California's Central Valley." P.F. Hudson, H. Middelkoop (eds.), Geomorphic Approaches to Integrated Floodplain Management of Lowland Fluvial Systems in North America and Europe, DOI: 10.1007/978-1-4939-2380-9_6. © Springer New York 2015.

Gardali, T., N.E. Seavy, R.T. DiGaudio, and L.A. Comrack. 2012. A climate change vulnerability assessment of California's at-risk birds. PLoS ONE 7(3): e29507. DOI: 10.1371/journal.pone.0029507.

Gershunov, A., T. Shulgina, R.E.S. Clemesha, K. Guirguis, D.W. Pierce, M.D. Dettinger, D.A. Lavers, D.R. Cayan, S.D. Polade, J. Kalansky, and F.M. Ralph. 2019. Precipitation regime change in Western North America: The role of Atmospheric Rivers. Science Reports, 9, 9944. DOI: 10.1038/s41598-019-46169-w.

He, M., M. Anderson, A. Schwarz, T. Das, E. Lynn, J. Anderson, A. Munévar, J. Vasquez, and W. Arnold. 2019. Potential Changes in Runoff of California's Major Water Supply Watersheds in the 21st Century. Water, 11(8), 1651. DOI: 10.3390/w11081651.

Herbold, H., S.M. Carlson, R. Henery, R.C. Johnson, N. Mantua, M. McClure, P. Moyle, and T. Sommer. 2018. Managing for Salmon Resilience in California's Variable and Changing Climate. San Francisco Estuary and Watershed Science Volume 16, Issue 2 | Article 3. DOI: 10.15447/sfews.2018v16iss2art3.

Huang, X., D.L. Swain, and A.D. Hall. 2020. Future precipitation increase from very high resolution ensemble downscaling of extreme atmospheric river storms in California." Science Advances 6 (29). DOI: 10.1126/sciadv.aba1323.

International Energy Agency (IEA). 2019. World Energy Outlook 2019.

Intergovernmental Panel on Climate Change (IPCC). 2014. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea and L.L. White (eds.). Annex II: Glossary. Agard, J., E.L.F. Schipper, J. Birkmann, M. Campos, C. Dubeux, Y. Nojiri, L. Olsson, B. Osman-Elasha, M. Pelling, M.J. Prather, M.G. Rivera-Ferre, O.C. Ruppel, A. Sallenger, K.R. Smith, A.L. St. Clair, K.J. Mach, M.D. Mastrandrea and T.E. Bilir (eds.). In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: Pages 1,757 to 1,776.

Intergovernmental Panel on Climate Change (IPCC). 2018. Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

Jennings, E.D., and A.N. Hendrix. 2020. Spawn Timing of Winter-Run Chinook in the Upper Sacramento River. SFEWS Volume 18 | Issue 2 | Article 5. Viewed online at: Winter-run_Chinook_Salmon.

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: Pates 187 to 200.

Keeley A., D. Ackerly, D. Cameron, N. Heller, P. Huber, C. Schloss, J. Thorne, and A. Merelender. 2018. New concepts, models, and assessments of climate-wise connectivity. Environmental Research Letters 13(7).

Liang, X., D.P. Lettenmaier, E.F. Wood, and S.J. Burges. 1994. A Simple Hydrologically Based Model of Land Surface Water and Energy Fluxes for General Circulation Models. Journal of Geophysical Research. Volume 99: Pages 14,415 to 14,428.

Liang, X., D.P. Lettenmaier, and E.F. Wood. 1996. Surface Soil Moisture Parameterization of the VIC-2L Model: Evaluation and Modification.

Livneh, B., E.A. Rosenberg, C. Lin, V. Mishra, K. Andreadis, E.P. Maurer, and D.P. Lettenmaier. 2013. "A long-term hydrologically based data set of land surface fluxes and states for the conterminous U.S.: Update and extensions." Journal of Climate.

Lund, J. 2016. Climate Change and the Delta. San Francisco Estuary and Watershed Science, 14(3). DOI: 10.15447/sfews.2016v14iss3art6.

Lytle, D.A., and N.L. Poff. 2004. Adaptation to Natural Flow Regimes. Trends in Ecology & Evolution 19: Pages 94 to 100.

Maendly, Romain. (California Department of Water Resources). 2018. Development of Stage-Frequency Curves in the Sacramento – San Joaquin Delta for Climate Change and Sea Level Rise. California's Fourth Climate Change Assessment. Publication number: CCCA4-EXT-2018-011.

Mahardja, B., J.A. Hobbs, N. Ikemiyagi, A. Benjamin, and A.J. Finger. 2019. Role of freshwater floodplain-tidal slough complex in the persistence of the endangered delta smelt. PLoS ONE 14(1): e0208084. Viewed online at: Freshwater_Tidal_Slough-Delta_Smelt.

Mann, Michael E. and Gleick, Peter H. 2015. Climate change and California drought in the 21st century. Proceedings of the National Academy of Sciences. Volume 112(Issue 13): Pages 3,858 to 3,859.

McKechnie, A.E. 2019. Physiological and morphological effects of climate change. In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Matella, M. and Merenlender, Adina. 2014. Scenarios for Restoring Floodplain Ecology Given Changes to River Flows Under Climate Change: Case from the San Joaquin River, California. River Research and Applications. 31. 10.1002/rra.2750.

Michel, C.J., M.J. Henderson, C.M. Loomis, J.M. Smith, N.J. Demetras, I.S. Iglesias, B.M. Lehman, and D.D. Huff. 2020. Fish predation on a landscape scale. Ecosphere 11(6):e03168. 10.1002/ecs2.3168. National Fish, Wildlife, and Plants Climate Adaptation Partnership. 2012. National Fish, Wildlife and Plants Climate Adaptation Strategy. Association of Fish and Wildlife Agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric Administration, and U.S. Fish and Wildlife Service. Washington, D.C.

Mountain Research Initiative EDW Working Group (MRI). 2015. Elevation-dependent warming in mountain regions of the world. Nature Climate Change, 5: 424-430. DOI: 10.1038/nclimate2563.

Naiman, R.J., H. Decamps, and M. Pollock. 1993. The Role of Riparian Corridors in Maintaining Regional Biodiversity. Ecological Applications 3: Pages 209 to 212.

Nijssen, B., D.P. Lettenmaier, X. Liang, S.W. Wetzel, and E.F. Wood. 1997. "Streamflow simulation for continental-scale river basins." Water Resources. 33, pp. 711-724.

Pennino M.J., S.G. Leibowitz, J.E. Compton, M.T. Beyene, S.D. LeDuc. 2022. Wildfires can increase regulated nitrate, arsenic, and disinfection byproduct violations and concentrations in public drinking water supplies. Science of the Total Environment, 804: 149890. DOI: 10.1016/j.scitotenv.2021.149890

Pierce, David W., Daniel R. Cayan, and Bridget L. Thrasher. 2014. "Statistical Downscaling Using Localized Constructed Analogs (LOCA)." J. Hydrometeor. Number 15; Pages 2,558 to 2,585.

Pierce D.W., J.F. Kalansky, D.R. Cayan. 2018. Climate, Drought, and Sea Level Rise Scenarios for California's Fourth Climate Change Assessment. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CNRA-CEC-2018-006.CEC. Viewed online at: www.energy.ca.gov.

Reich K.D., N. Berg, D.B. Walton, M. Schwartz, F. Sun, X. Huang, A. Hall. 2018. Climate Change in the Sierra Nevada: California's Water Future. UCLA Center for Climate Science. Viewed online at: Climate_Change_In_The_Sierra_Nevada.

Rosenzweig, C., D.D. Karoly, M. Vicarelli, P. Neofotis, Q. Wu, G. Casassa, A. Menzel, T.L. Root, N. Estrella, B. Seguin, P. Tryjanowski, C. Liu, S. Rawlins, and A. Imerson. 2008. *Attributing physical and biological impacts to anthropogenic climate change*. Nature: Pages 353 to 358.

Rupp D.E., J.T. Abatzoglou, K.C. Hegewisch, and P.W. Mote. 2013. "Evaluation of CMIP5 20th century climate simulations for the Pacific Northwest USA." Journal of Geophysical Research: Atmospheres. Volume 118 (Issue 19): Pages 10,884 to 10,906.

Saether, B.E., S. Engen, M. Gamelon, and V. Grøtan. 2019. *Predicting the effects of climate change on bird population dynamics.* In *Effects of Climate Change on Birds.* Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Schwalm, Christopher R., Spencer Glendon, and Philip B. Duffy. 2020. "RCP 8.5 Tracks Cumulative CO2 Emissions." Proceedings of the National Academy of Sciences. Volume 117 (Issue 33): Pages 19,656 to 19,657.

Seavy, N., T. Gardali, G. Golet, T. Griggs, C. Howell, R. Kelsey, S. Small, J. Viers and J. Weigand. 2009. Why climate change makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration Volume 27(Issue 3): Pages 330 to 338.

Stein, B., P. Glick, N. Edelson, and A. Staudt, editors. 2014. Climate-smart conservation: putting adaptation principles into practice. National Wildlife Federation, Washington, D.C.

Taylor, Karl E., Ronald J. Stouffer, and Gerald A. Meehl. 2012. "An Overview of CMIP5 and the Experiment Design." Bulletin of the American Meteorological Society. Volume 93: Pages 485 to 498.

Teplistsky, C. and A. Charmantier. 2019. Projected population consequences of climate change. *Quantifying the climatic sensitivity of individuals, populations, and species.* In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Trenberth K.E. and J.W. Hurrell. 2019. *Climate Change*. In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Ullrich, P.A., Z. Xu, A.M. Rhoades, M.D. Dettinger, J.F. Mount, A.D. Jones, and P. Vahmani. 2018. California's drought of the future: A midcentury recreation of the exceptional conditions of 2012–2017. Earth's Future, Volume 6: Pages 1,568 to 1,587.

U.S. Department of the Interior, Bureau of Reclamation. 2016. *Reclamation, Managing Water in the West, Sacramento and San Joaquin Rivers Basin Study.* Report to Congress 2015. Prepared by CH2M HILL, Inc. under Contract No. R12PD80946. March.

Van de Pol, M., and L.D. Bailey. 2019. *Quantifying the climatic sensitivity of individuals, populations, and species.* In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Water Education Foundation (WEF). 2017. Layperson's Guide to Groundwater.

Westerling, Anthony Leroy. (University of California, Merced). 2018. Wildfire Simulations for California's Fourth Climate Change Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CCCA4-CEC-2018-014.

U.S. Department of the Interior, Bureau of Reclamation. 2016. *Reclamation, Managing Water in the West, Sacramento and San Joaquin Rivers Basin Study.* Report to Congress 2015. Prepared by CH2M HILL, Inc. under Contract No. R12PD80946. March.

Van de Pol, M., and L.D. Bailey. 2019. *Quantifying the climatic sensitivity of individuals, populations, and species.* In *Effects of Climate Change on Birds*. Second Edition. Edited by P.O. Dunn and A.P. Møller. Oxford University Press.

Water Education Foundation (WEF). 2017. Layperson's Guide to Groundwater.

Westerling, Anthony Leroy. (University of California, Merced). 2018. Wildfire Simulations for California's Fourth Climate Change Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CCCA4-CEC-2018-014.

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Attachment H.1
Climate Change Literature Review and References

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Climate Change Literature Review and References

Table H.1-1. Summary of Climate Change Modeling and Adaptation Planning Efforts

Document Title and Author	Description	Reference
CVFPP 2017 Update Climate Modeling Work and Key Results – California Department of Water Resources (2017)	The CVFPP is an outline for improving the management of flood risk in California's Central Valley. The plan was first released in 2012 and is updated every five years. The 2017 CVFPP Update included commentary on future climate change impacts for the Sacramento River Basin and the San Joaquin River Basin. Key findings include flood volume increases of 10% to 20% over 50 years in the Sacramento River Basin and increases of 60% to 80% in the San Joaquin River Basin. The Phase IIB Climate Change Analysis provided an in-depth assessment of historical climate conditions related to flood risks and how these conditions could change under future climate scenarios. Overall, the analysis found temperatures are expected to increase, precipitation varies between scenarios, extreme precipitation is expected to intensity, and flood magnitudes and frequencies vary based on watershed but are expected to increase.	Central-Valley-Flood-Protection-Plan
Effects of Climate Change on Birds, Second Edition – Dunn and Møller eds. (2019)	This book is a collection of papers on the biological effects of climate change with an emphasis on birds, but it also discusses impacts on other taxonomic groups. It consists of four sections: a general introduction to climate and climate change; an overview of methods and data sources for studying climate change and its effects; a focus on the individual and population-level consequences of climate change, ranging from changes in physiology and behavior to shifts in distribution and abundance and long-term evolutionary changes; and a focus on interspecific effects on climate change, as well as conservation challenges faced due to climate change, and a review of how the effects on birds are linked to other taxa.	Oxford University Press

Document Title and Author	Description	Reference
Merced River Basin Flood-MAR Reconnaissance Study – California Department of Water Resources (2020)	The Merced River Basin Flood-MAR Reconnaissance Study was conducted as a 'proof-of-concept' study to apply the concepts of Flood-MAR at the scale of a watershed. This study integrated surface and groundwater models and analyses, and aimed to serve as a template for future studies. This study analyzed climate vulnerability for the Merced River Basin. Peak flow response to temperature and precipitation changes were analyzed to assess opportunities to address groundwater-depletion vulnerabilities. Adaptation strategies are provided through the Flood-MAR Scenario Planning. Three scenarios are evaluated as a means to address vulnerabilities: existing infrastructure and existing operations; existing infrastructure and reservoir reoperation; and new and/or expanded infrastructure and reservoir reoperation.	Merced-River-Flood-MAR-Reconnaissance-Study
Climate-Smart Conservation – Stein et al. 2014	Climate-Smart Conservation provides guidance to natural resource managers and conservation professionals for incorporating climate change and adapting to that change into conservation science and resource management. This document provides an overview of how climate change may affect species and ecosystems, and outlines overall principles for the successful adaptation to climate change. It presents the key aspects of climate-smart resource management and conservation, which emphasize the need to identify possible adaptation strategies and actions and implement the strategies and actions that reduce biological impacts and meet future planning conservation and management goals for particular areas of concern.	ClimateSmartGuide

Document Title and Author	Description	Reference
Tuolumne River Watershed Vulnerability Assessment and Adaptive Planning Study – California Department of Water Resources (2020)	The Tuolumne River Watershed Vulnerability Assessment was conducted to improve stakeholders' understanding of how climate change impacts water systems in this region. This study used a bottom-up approach to provide an enhanced vulnerability assessment for the Tuolumne River Watershed. The study itself is a vulnerability assessment, and some key findings include an increase in large flood events and a decrease in October storage. Impacts on flood risk, water supply/irrigation, and the environment are assessed. Following the vulnerability assessment, this study provides an adaptation assessment, which discusses adaptation strategies for the specific vulnerabilities in this watershed. Adaptation strategies include Flood-MAR, rule curve modification, FIRO, increased channel capacity, and nonstructural improvements.	Not applicable
State of California Sea Level Rise Guidance 2018 Update – California Ocean Protection Council and California Natural Resources Agency (2018)	This document provides guidance to State governing bodies in their development of risk assessments, planning, financing, and permitting associated with addressing the impacts of sea level rise as a result of climate change. The report includes a collection of the best available science on sea level rise and projections, a guide for State governing bodies to respond to these projections, and preferred adaptation approaches. The guidance does not explicitly provide vulnerability or risk assessments, but it does provide guidance on how State governing bodies should conduct them. For example, the report states risks should be assessed at community and regional levels when possible. This report does not explicitly provide adaptation strategies, but does include commentary and recommendations on how these strategies should be developed. It recommends that adaptation planning and strategies should prioritize the following considerations: social equity, environmental justice, and the needs of vulnerable communities; as well as the protection of coastal habitats and public access; and should consider the unique characteristics, constraints, and values of existing water-dependent infrastructure, ports, and Public Trust uses.	Sea-Level-Rise-Guidance

Document Title and Author	Description	Reference
Safeguarding California Plan: 2018 Update – California Natural Resources Agency (2018)	The Safeguarding California Plan: 2018 Update describes the steps the State is taking to prepare for and adapt to the effects of climate change. Over 1,000 current actions from 38 State agencies are explained. While vulnerability assessments are not explicitly performed in this plan, Principle 7: increase investment in climate change vulnerability assessments of critical built systems, outlines the importance of assessing the vulnerabilities of current infrastructure. These are also included in the list of the State's ongoing actions across sectors. Within the “water” section, some overarching actions include vigorously prepare California for flooding, support regional groundwater management for drought resiliency, diversify local supplies and increase water conservation and use efficiency, reduce Sacramento-San Joaquin Delta climate change vulnerability, and prepare California for hotter and drier conditions and improve water storage capacity.	Safeguarding-California
DWR Climate Action Plan – California Department of Water Resources (2020)	The Climate Action Plan serves as a guide to combating the effects of climate change within all aspects of the DWR. The plan is separated into three phases: a greenhouse gas emissions reduction plan, climate change analysis guidance, and a climate change vulnerability assessment. Phase III outlined an approach for the climate change vulnerability assessment and developed and implemented an adaptation plan to protect staff, business operations, and assets. An adaptation framework and approach for formulating adaptation strategies was also outlined. Furthermore, Phase III introduced concepts, framing, and the principles of adaptation, and discussed how to use these to support adaptation monitoring, evaluation, and reflection as it progresses throughout the DWR (Initial adaptation plans are outlined for DWR’s four key assets vulnerable to climate change impacts, all of which are critical to DWR’s core function: staff safety; State Water Project; Upper Feather River Watershed; and ecosystems and habitats).	Climate-Action-Plan

Document Title and Author	Description	Reference
Sacramento and San Joaquin Rivers Basin Study – U.S. Bureau of Reclamation (2016)	The Sacramento and San Joaquin Rivers Basin Study explores the potential future impacts climate and socioeconomic change can have on Central California's water supply. This study also examines how these impacts could be addressed. In particular, it assesses changes in temperature, precipitation, snowpack, runoff, and sea levels. For socioeconomic changes, increasing populations and urban growth are examined. These climate and socioeconomic changes are used to assess potential impacts on water delivery, water quality, hydropower, flood control, recreation, and ecological resources. Under ecological impacts, specifically, it considers habitats, endangered species, and flow-dependent resiliency. Here, the majority of changes result from sea level rise and temperature increases, leading to higher salinity levels and reduced cold water availability.	Sacramento-And-San-Joaquin-Rivers-Basin-Study
Sacramento-San Joaquin River Basin Case Study – RAND Corporation (2021)	The Sacramento-San Joaquin River Basin Case Study takes the findings provided by the Sacramento and San Joaquin Rivers Basin Study and creates a robust decision-making (RDM) analysis to examine the use of the "Decision-making Under Deep Uncertainty" approach to assess water resources management in the long term. The purpose of this study is to show how RDM can be applied to existing studies to strengthen results and provide a more informed manner of decision-making. The RDM steps included in this case study are framing decisions, evaluating strategies across various futures, analyzing vulnerability, analyzing trade-offs, and developing new futures and strategies. The RDM re-evaluates many of the impacts described by the Sacramento and San Joaquin Rivers Basin Study.	Sacramento-San-Joaquin-River-Basin-Case-Study

Document Title and Author	Description	Reference
Increases in Flood Magnitudes in California under Warming Climates – Das et al. (2013)	This study uses an ensemble of 16 GCMs to assess flood risk in the Sacramento and San Joaquin Valleys from changes in temperature and precipitation. These GCMs were downscaled and applied to the Northern and Southern Sierra Nevada ranges, specifically. Under these projections, the future climate appears to be either wetter or drier as a result of changing storm magnitudes and decreased snowpack. Key findings for this study include: for the Northern Sierra Nevada, half of the projections show a wetter future climate and half show a drier future climate; three-day flood magnitudes are projected to increase in both the Northern and Southern Sierra, with larger magnitudes for a 50-year return period in the Southern Sierra; the median 50-year flood magnitude increases with time, location (i.e., higher in the Southern Sierra), and climate scenario (i.e., higher with a higher emissions scenario).	Increases-In-California-Flood-Magnitudes
Potential Changes in Runoff of California's Major Water Supply Watersheds in the 21st Century – He et al. (2019)	This study examines the potential changes to runoff in eight of the major watersheds in California's Central Valley as a result of climate change. Ten GCMs under two emissions scenarios were used to feed a VIC hydrologic model, to generate general runoff projections up to the year 2099. More specifically, changes to peak, seasonal, and annual runoff at different periods are examined, in addition to changes in timing. This study finds that watersheds' geographical characteristics impact the runoff response as a result of climate change. In watersheds dominated by rainfall, runoff is expected to peak earlier in the year, with higher volumes of flow. For watersheds dominated by snow, runoff peak timing is expected to remain the same, with decreases to peak volumes as the century progresses. Overall, this study finds climate change will bring higher flood risk and increased water scarcity for supply.	www.mdpi.com

Document Title and Author	Description	Reference
Projected Changes in Water Year Types and Hydrological Drought in California's Central Valley in the 21st Century – He et al. (2021)	This study examines the potential changes to water years, hydrological droughts, and runoff in the California Central Valley as a result of climate change. To assess these changes, four climate models under two emission scenarios were used. The study finds the timing and total volume of runoff is expected to shift more toward the wetter months (October to March) from the typical snowmelt months (April to July). Under the high-emission scenario, runoff volumes show a more pronounced increase in the wet season. Under the low-emission scenario, snowmelt season runoff decreases are more apparent. Finally, the study finds that on average, the Sacramento River region will experience more wet years than the San Joaquin region in the future. The San Joaquin region is expected to experience more hydrological droughts in the snowmelt season and fewer in the wet season under climate change.	www.mdpi.com
CASCaDE Project – U.S. Geological Survey (2020)	The Computational Assessments of Scenarios of Change for Delta Ecosystems (CASCaDE) Project was developed to address and model the variety of vulnerabilities the Delta faces presently and in the future. The U.S. Geological Survey hopes to inform better decision-making by analyzing projected conditions in the Delta under various scenarios. The current CASCaDE2 model builds on the DELFT3D-FM modeling framework (which includes hydrodynamics, salinity and temperature, sediment, fish, phytoplankton, bivalves, and contaminant modeling) by applying overlying climate modeling, as well as hydrology and operations and sediment supply modeling at the watershed level. Additionally, the CASCaDE2 model includes additional output on contaminants, as well as marsh habitat.	www.cascade.gov

Table H.1-2. Summary of Climate Adaptation Guidance Relevant to Conservation Strategy Objectives

Document Title and Author	Description	Reference
A Climate Change Vulnerability Assessment of California's At-Risk Birds – Gardali et al. (2012)	This study seeks to examine, classify, and rank several bird species in California, depending on their vulnerability to climate change. Overall, 128 species, subspecies, and distinct populations were classified as vulnerable. The study includes the targeted bird species included in the 2016 Conservation Strategy (bank swallow, California black rail, greater sandhill crane, least Bell's vireo, Swainson's hawk, and western yellow-billed cuckoo). It also assesses the vulnerability of specific habitats these bird species inhabit. Wetland and riparian habitat groups were considered some of most vulnerable to climate change, while grassland and oak woodland taxa were the least vulnerable. This study comments on the mechanisms behind the increased vulnerability of specific habitats, such as a decline in water availability leading to a reduction in freshwater wetland habitat. This study also finds that roughly 72% of the threatened and endangered species in California are at risk from the effects of climate change.	At-Risk-Birds
Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research – Seavy et al. (2009)	This study identifies and explains the importance of riparian habitats and why restoration efforts are needed to preserve the benefits they provide. Topics include the natural resilience of riparian systems, enhancing connectivity, promoting linkages between aquatic and terrestrial systems, expanding thermal refugia, and hydrological benefits. It also identifies restoration strategies that accommodate climate change, such as horticultural restoration practices, emphasizing the restoration of private lands, and promoting water and watershed management policies. This study identifies the natural resiliency of riparian ecosystems, as well as their potential to link aquatic and terrestrial ecosystems through habitat connectivity.	Riparian-Restoration-Importance

Document Title and Author	Description	Reference
Promoting Atmospheric-River and Snowmelt-Fueled Biogeomorphic Processes by Restoring River-Floodplain Connectivity in California's Central Valley – Florsheim and Dettinger (2015)	This study examines potential benefits from intentional levee breaks and weir overflow as a tool for flood management under the projected impacts of climate change. Climate change effects, such as winter flood increases, progressive spring snowmelt diminishes, and more exacerbated winter inundations are listed. To account for these changes, this study identifies that intentional levee breaks and weir overflow may serve as a method to better manage increased projected flood events while providing benefits to habitat conservation and restoration by restoring natural floodplain processes.	Atmospheric-River and Snowmelt-Fueled-Biogeomorphic-Processes
Climate Change Vulnerability of Native and Alien Freshwater Fishes of California: A System Assessment Approaches – Moyle et al. (2013)	This study performs a climate change vulnerability assessment for several native and alien freshwater fish species in the face of climate change. In total, it assessed 121 native and 43 alien fish species' current baseline vulnerability to extinction and future impacts due to climate change. A total of 82% of native species were classified as highly vulnerable, with only 19% of alien species being highly vulnerable. This study determines species requiring cold water are particularly likely to go extinct. Alien species are identified as having the potential to thrive under the changing conditions.	www.ncbi.gov

Supplementary Projected Hydroclimate Changes Figures

Figure H.1-1. Projected Changes in Mean Monthly Temperature – Upper Sacramento River CPA

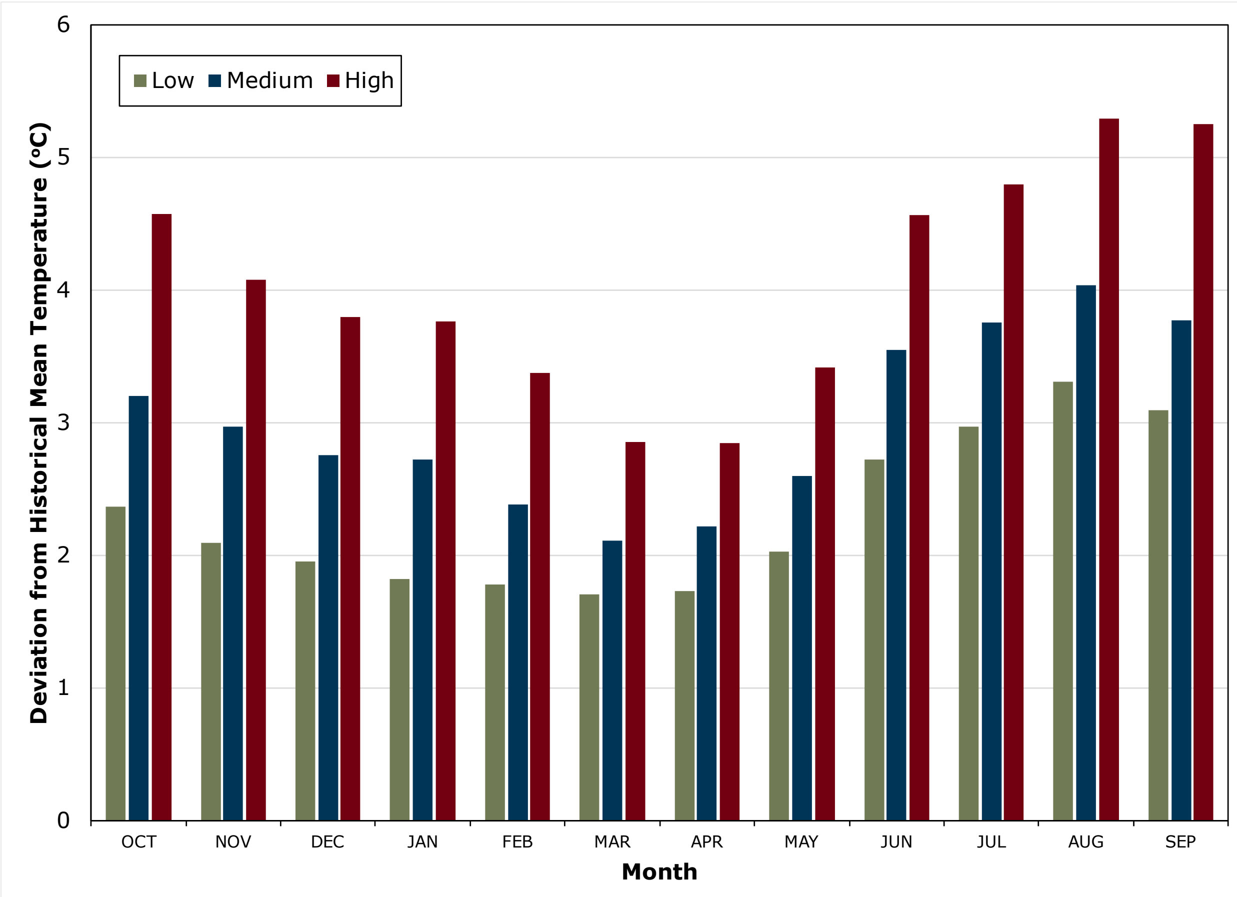


Figure H.1-2. Projected Changes in Mean Monthly Temperature – Feather River CPA

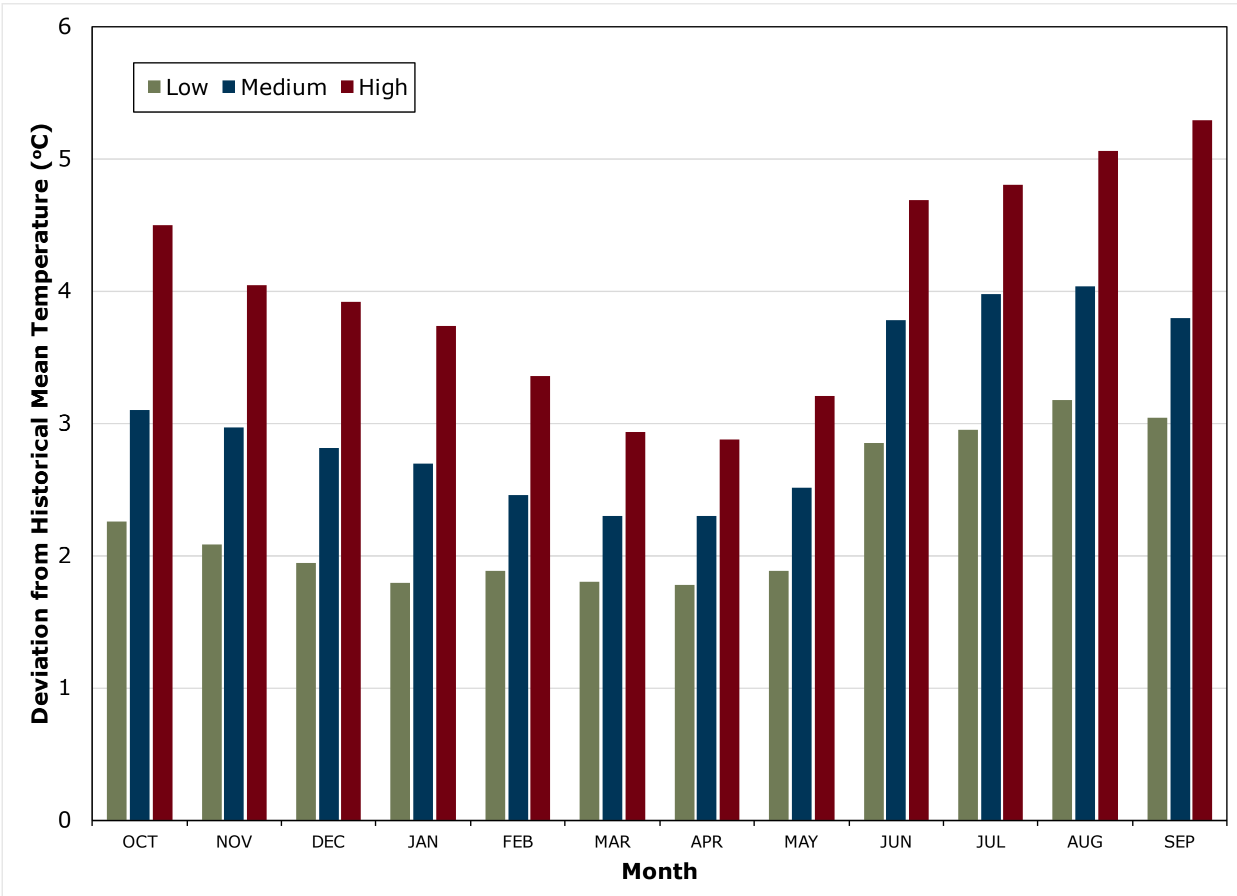


Figure H.1-3. Projected Changes in Mean Monthly Temperature – Lower Sacramento River CPA

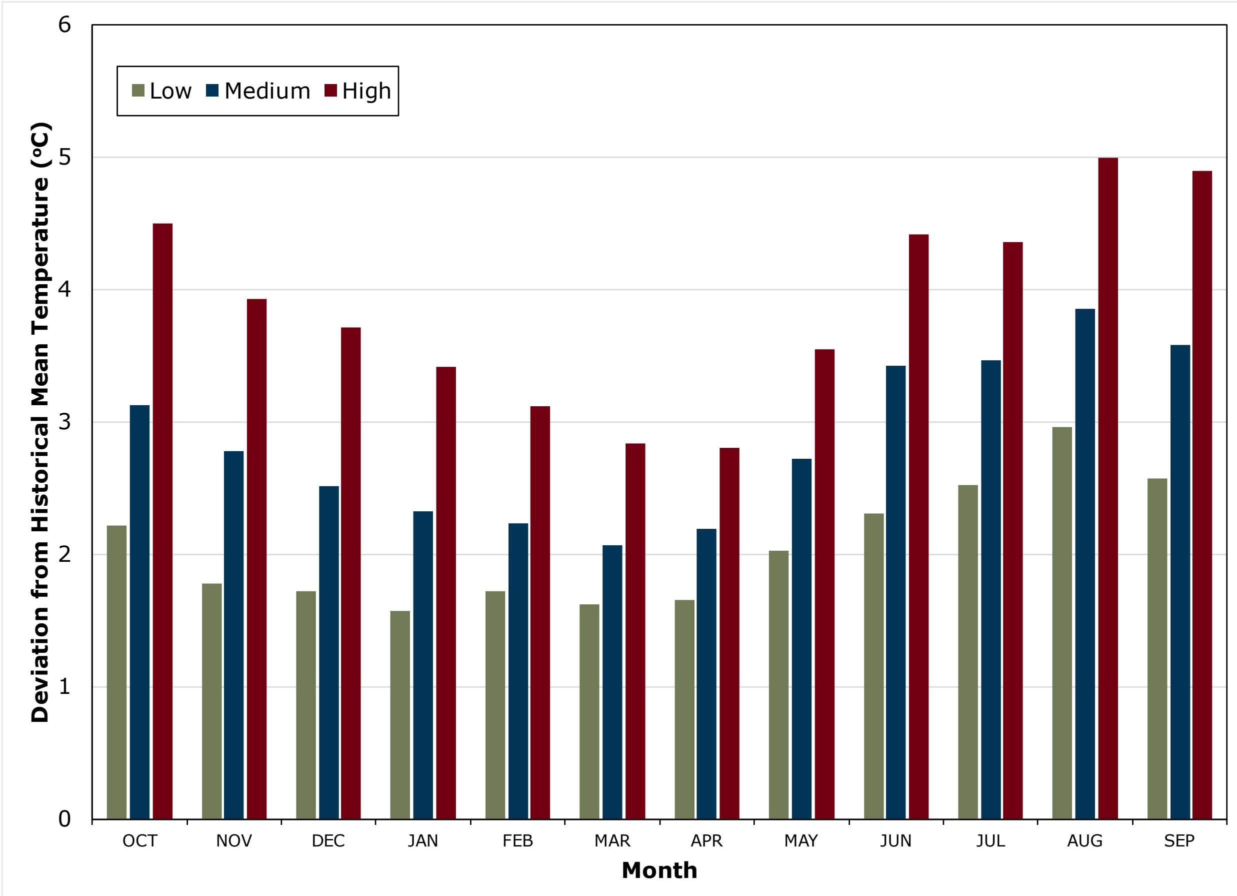


Figure H.1-4. Projected Changes in Mean Monthly Temperature – Lower San Joaquin River CPA

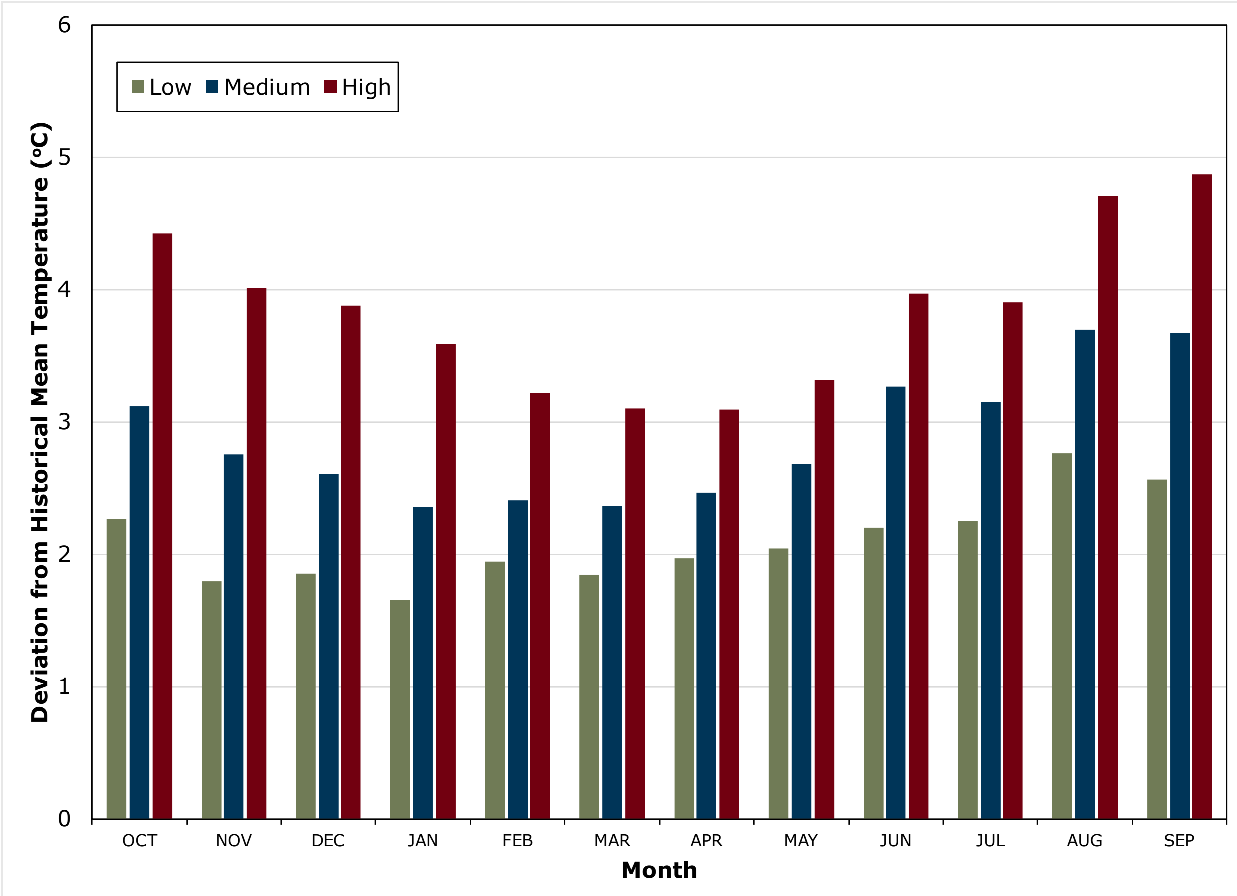


Figure H.1-5. Projected Changes in Mean Monthly Temperature – Upper San Joaquin River CPA

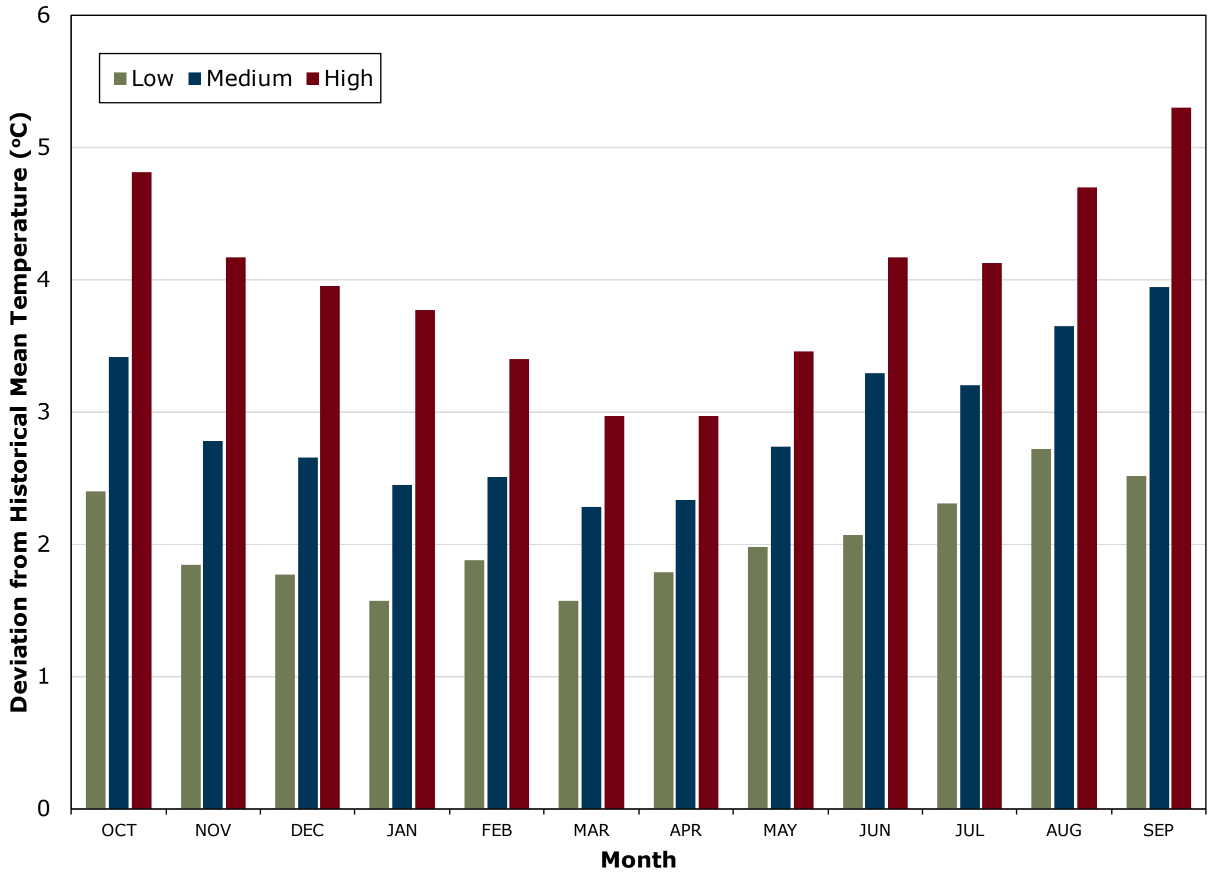
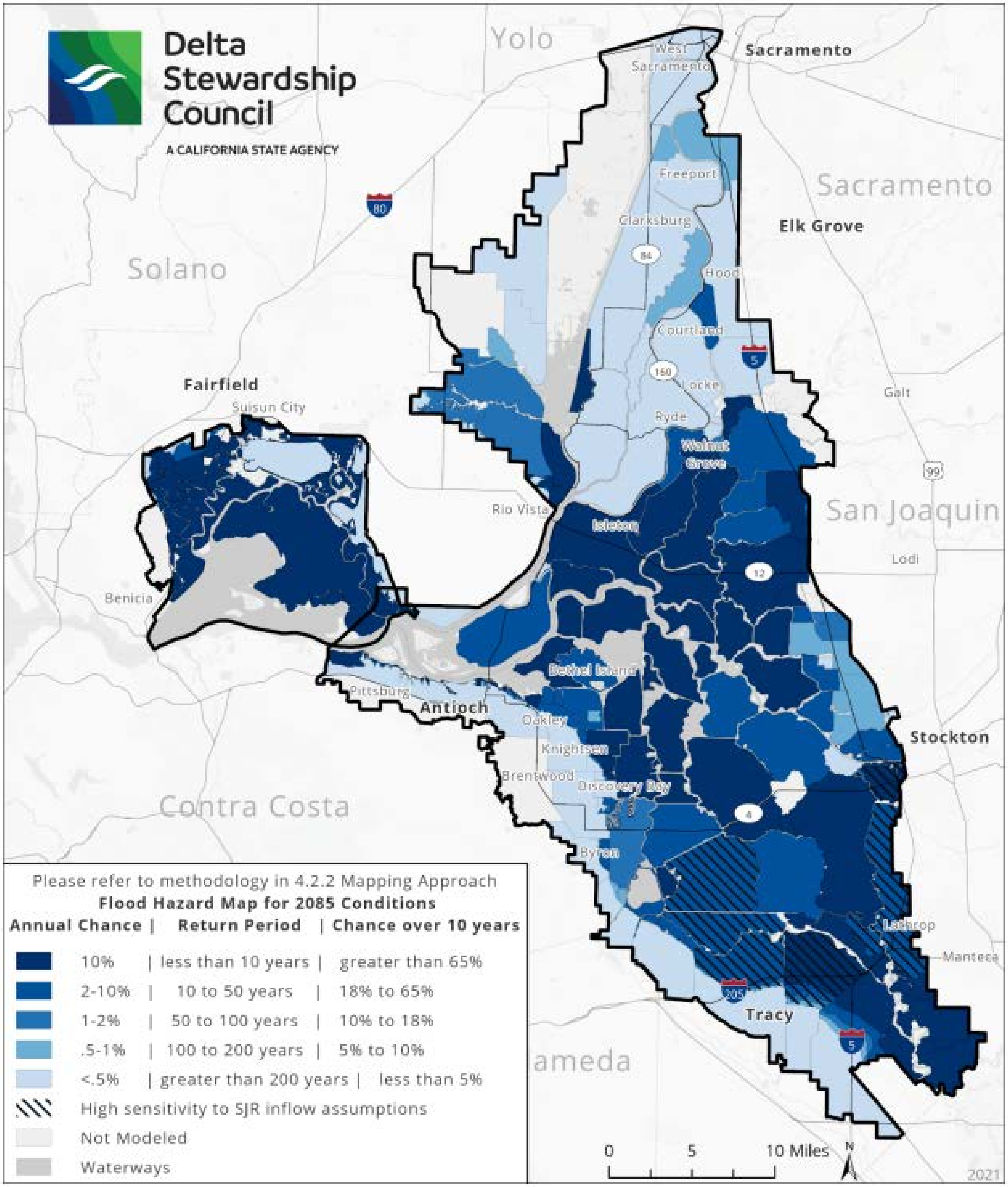
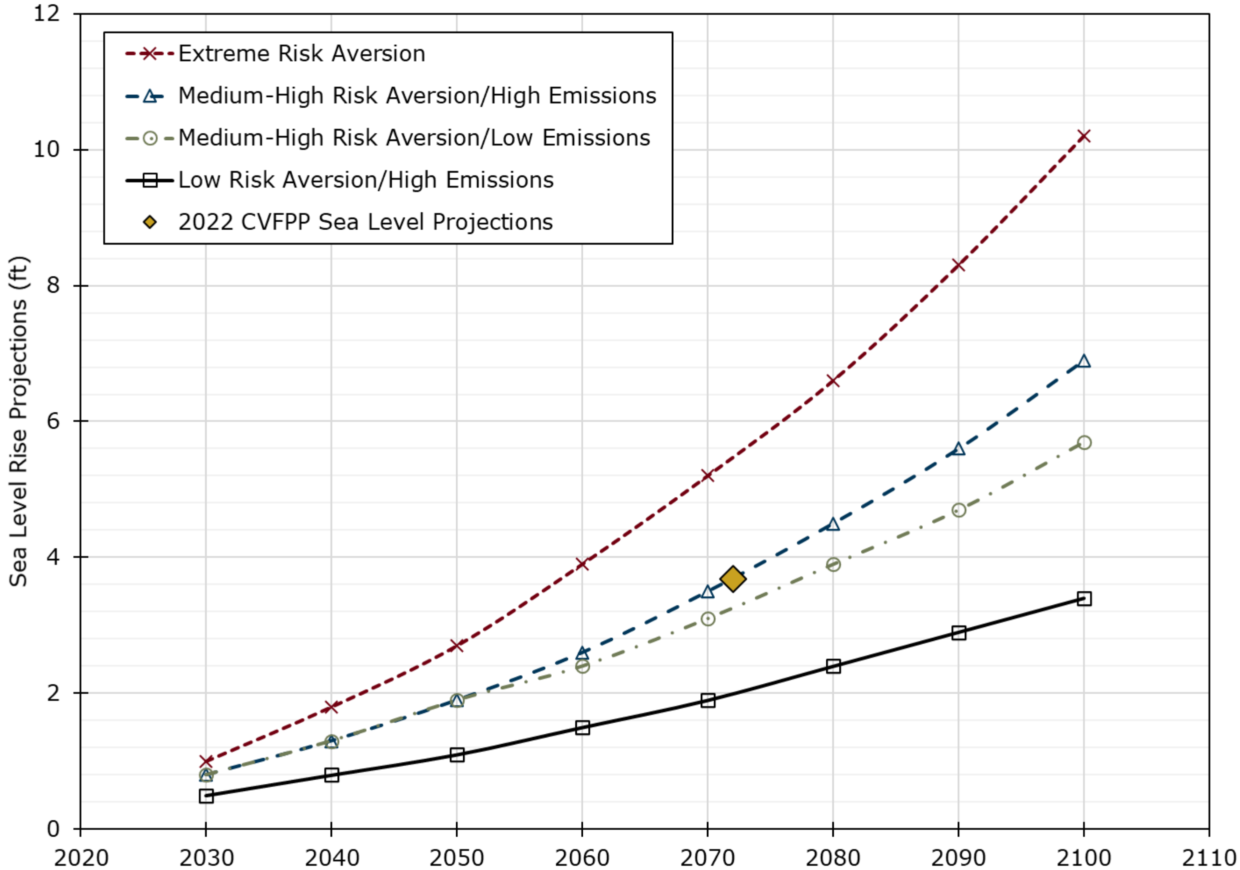


Figure H.1-6. Flood Hazard Map for 2085 Conditions



Source: Delta Adapts (Delta Stewardship Council 2021a)

Figure H.1-7. Projected Sea Level Rise (in feet) for San Francisco



Source: Adapted from CNRA and OPC (2018)

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Governor
State of California

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