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
SB	State Bill
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

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 three 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.

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.

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:

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, 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.

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).

3. **Potential CVFPP effect.** Implementing the CVFPP, including flood projects and operations and maintenance, could 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:

1. **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).

2. **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 ripariu*), bank swallow (*Riparia riparia*), Swainson's hawk (*Buteo swainsoni*), and giant gartersnake (*Thamnophis gigas*).

3. **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 re-evaluation, and are provided in Appendix B.

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 three proposed additions to the target species list for the 2022 Update consist of a fish 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). No changes were made to the master plant table (Table G-2 in Appendix G of the 2016 Conservation Strategy).

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.

Introduction to the Species

Delta smelt are endemic to the San Francisco Bay-Delta estuary. The Bay-Delta consists of San Francisco Bay and the Sacramento–San Joaquin Delta (Delta), defined as the legal 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).

Rationale

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

1. **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.

2. **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.

3. **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.

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” 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.

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.

Introduction to theSpecies

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).

Rationale

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

1. **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.

2. **Associated with target habitats.** The species' basic breeding habitat requirements are access to water and suitable nesting substrate (e.g., marsh vegetation or thornyvegetation) 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."

3. **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).

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.

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.

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.

Rationale

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

1. **Sensitive or special-status.** As a CSC, the yellow-breasted chat meets this criterion.

2. **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.

3. **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.

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.

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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	Nearly any 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	No
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

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Fish	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
	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

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]
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

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]
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

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]
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	Yes	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

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]
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

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]
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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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, three additional species are being added to the list of 17 target species:

1. Delta smelt (*Hypomesus transpacificus*).
2. Tricolored blackbird (*Agelaius tricolor*).
3. Yellow-breasted chat (*Icteria virens*).

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 authorizations or permits.[1] 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. No other types of conservation plans applicable to the Conservation Strategy have been updated since 2016.

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.

[1] The 2016 Strategy defines "conservation" as the maintenance, enhancement, and restoration of populations, communities, and ecosystem functions to sustain the services, benefits, and values of public trust resources.

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:
    1. Establish and protect self-sustaining populations.
    2. Restore and conserve healthy Central Valley wetland ecosystems.
    3. 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 (*O. 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. 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: Pages 12,905 to 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.

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).

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: Pages 4,692 to 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: Pages 11,458 to 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.

Regional Conservation Planning References

The following conservation planning references for the Sacramento–San Joaquin Valley and Delta have been published since 2016.[2]

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.
  - 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

[2] 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.

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 Reiniation 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.
  - California Central Valley 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 Habitat, Mitigation, and Monitoring Plan 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 California Central Valley 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.

U.S. 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 the Bureau of 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.

U.S. 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, California Central Valley 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.

U.S. 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 to 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): Pages 132 to 150. Accessed: April 2020.Viewed online: Rearing-Salmonids.

- 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: Pages 561 to 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: Pages 358 to 362.

- Uses otolith strontium isotope ratios to reconstruct juvenile habitat use bywinter-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 benefitsand 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)

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): Pages 959 to 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): Pages 349 to 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.

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): Pages 309 to 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 to 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): Pages 624 to 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): Pages 234 to 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): Pages 391 to 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: Pages 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): Pages 274 to 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): Pages 40 to 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.

Bank Swallow

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: Pages 111 to 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.

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: Pages 54 to 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.

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): Pages 5, 1 to 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.

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: Pages 50 to 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.

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 semi-natural 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 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 National Wildlife Refuge (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 and tricolored blackbird 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.

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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: Pages 42 to 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.

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: Pages 148 to 171.www.doi.org.

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: Pages 674 to 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: Pages 41,694 to 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

No additional references are available for this species beyond those provided in Appendix B.3, "Focused Conservation Plan: Yellow-Breasted Chat," and within this attachment, "Regional Conservation Planning References."

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, three 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: Pages 42 to 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*).

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Appendix B.1
Focused Conservation Plan:
Delta Smelt

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APPENDIX B.1

Focused Conservation Plan: Delta Smelt

Acronym	Description
°F	degree(s) Fahrenheit
CESA	California Endangered Species Act
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

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 uplisted 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, Nov. 16, 2020).

Critical habitat for delta smelt was designated in 1994 (59 FR 65256, Dec. 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, Nov. 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*."

Status and Trends

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).

Current Distribution

Figure B.1-1 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).

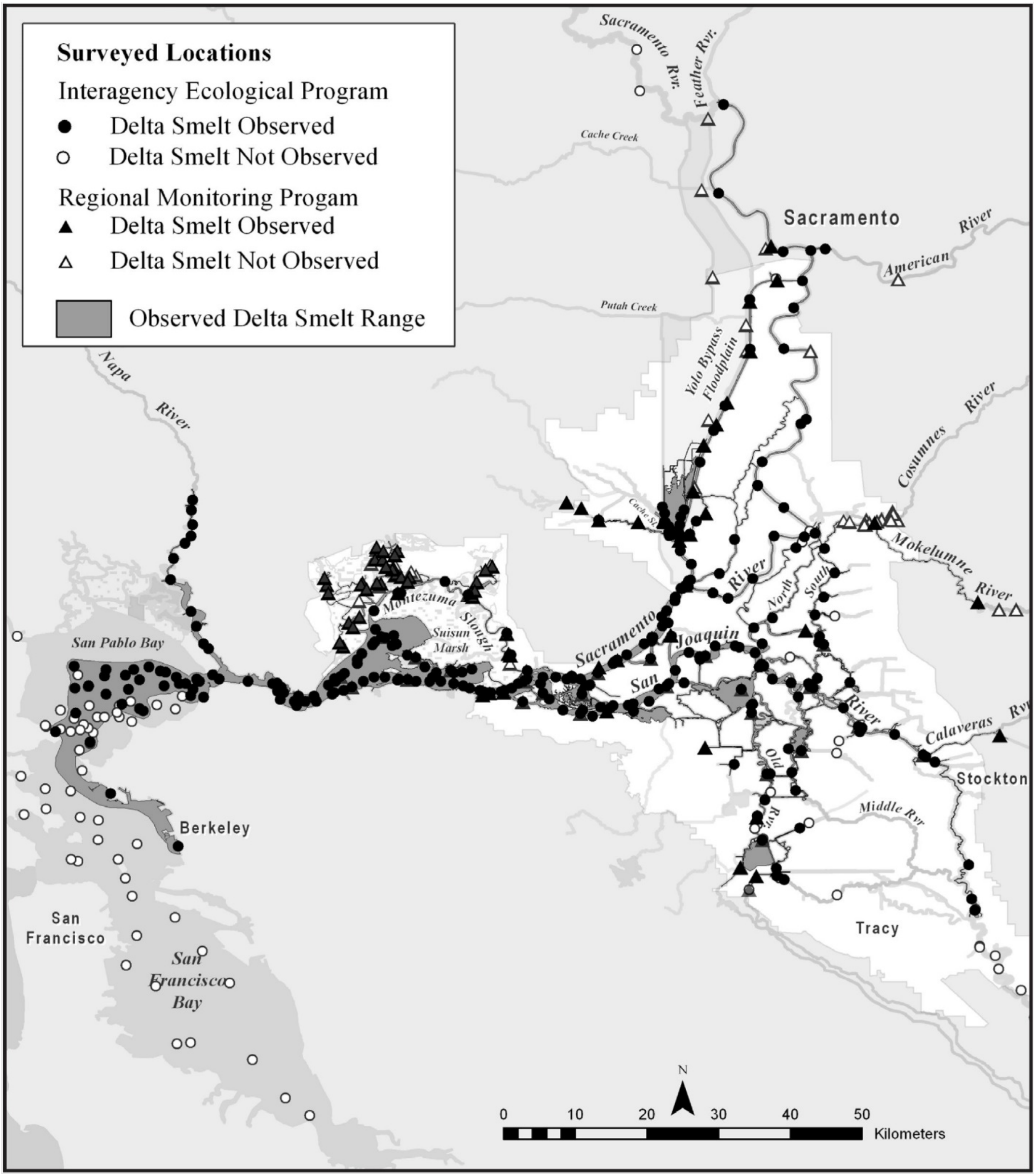
Additional spawning locations occur downstream of these CPAs and include Suisun Bay and Suisun Marsh, and in wet years the Napa River (U.S. Bureau of Reclamation 2007; U.S. Fish and Wildlife Service 2017). The most significant downstream habitat for delta smelt is the lower Napa River (a tributary of San Pablo Bay), although it is typically used only in wet years (Hobbs et al. 2007; Merz et al. 2011; Sommer and Mejia 2013).

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, Nov. 16, 2020).

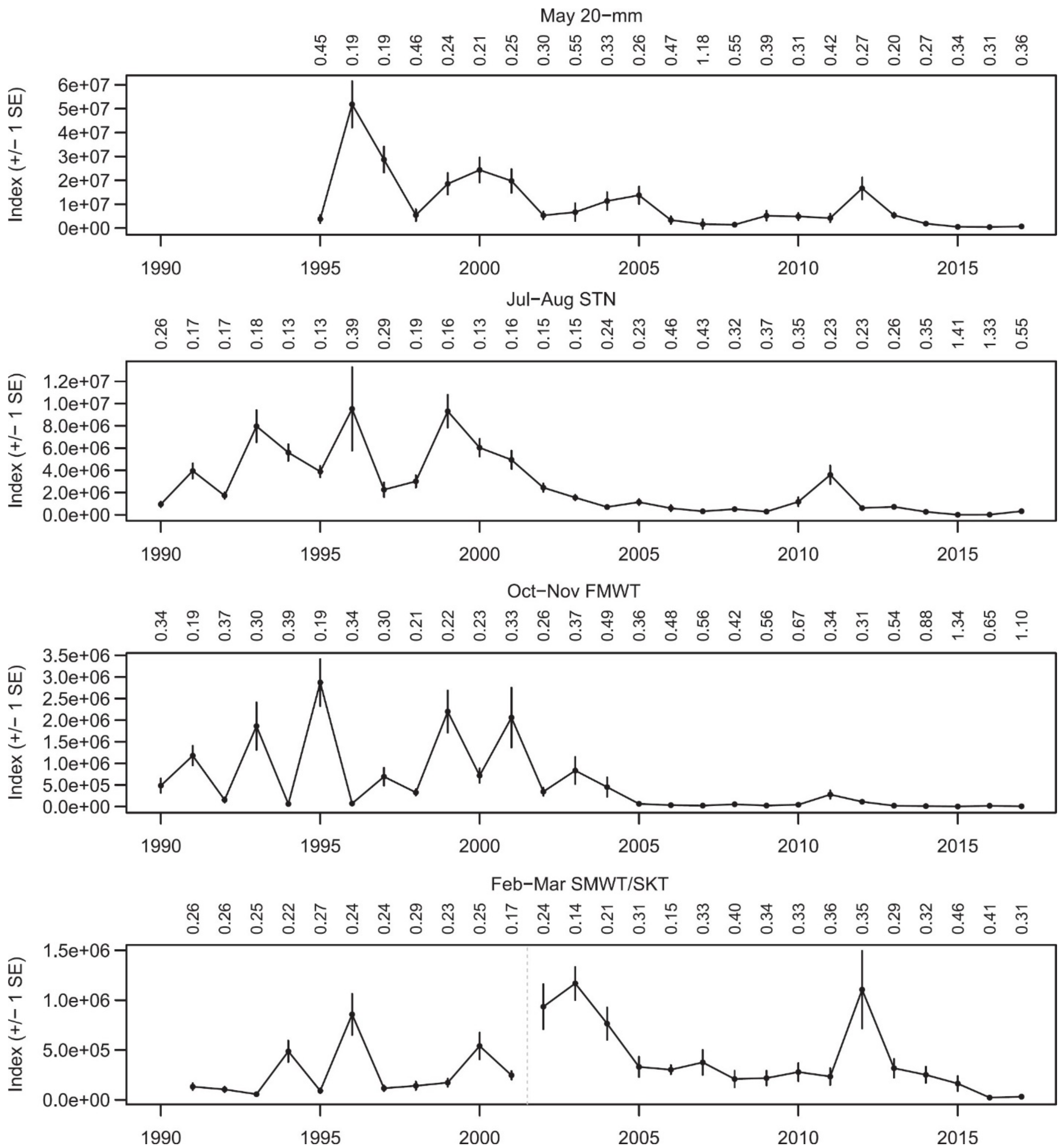
USFWS developed a procedure for estimating delta smelt abundance that is based on Spring Kodiak Trawl data. USFWS's resulting estimates of historical delta smelt abundance in January and February indicate the 2016 population is the lowest between 2002 and 2017, with only 16,000 individuals (95-percent confidence intervals 7,000 to 31,000 individuals) (U.S. Fish and Wildlife Service 2017).

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 (U.S. 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; U.S. 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; U.S. 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) (U.S. 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).

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], and 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 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). Thus, the location of the largest fish concentrations in the non-spawning 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).

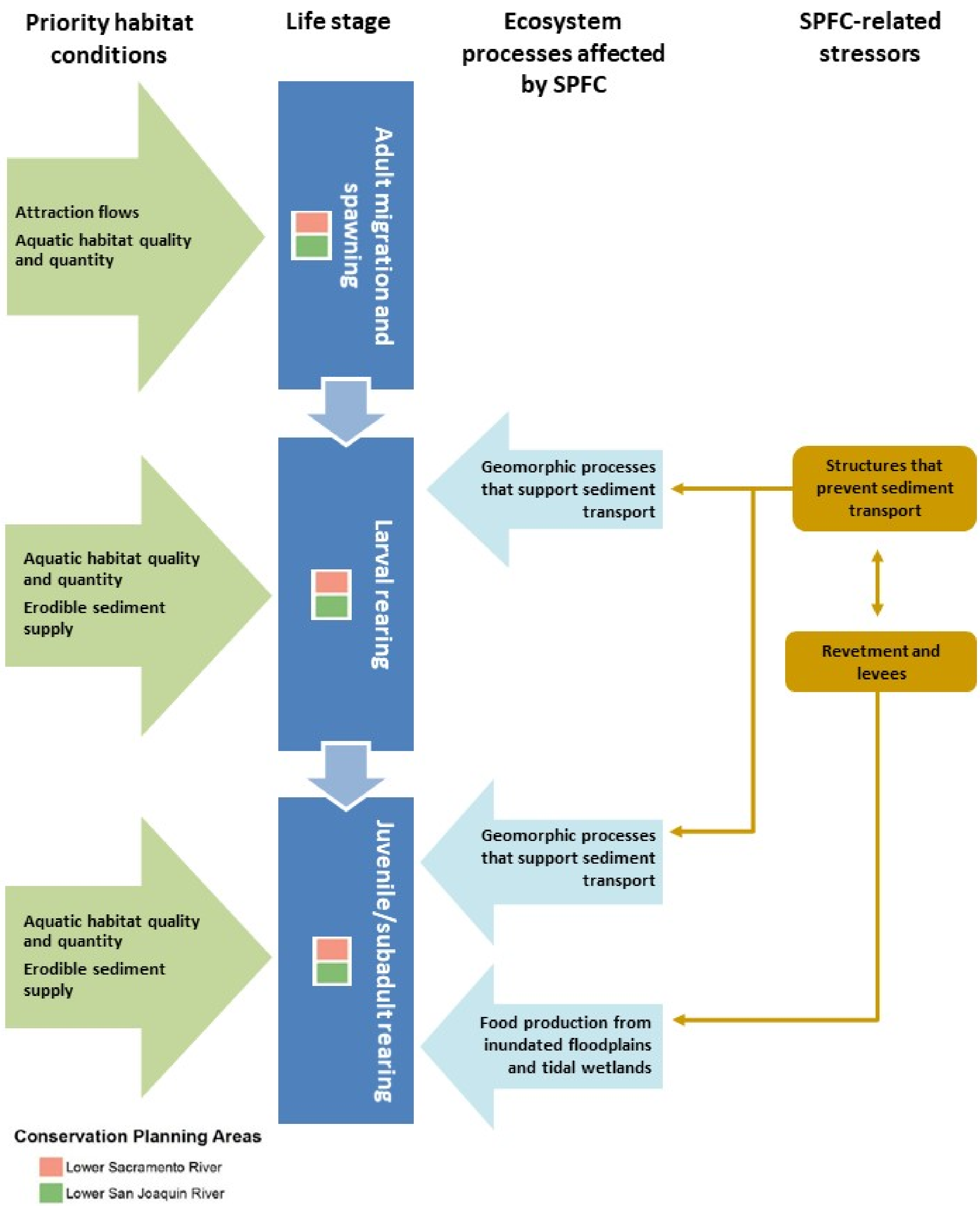
Freshwater-tidal wetlands in the Yolo Bypass may provide a refuge for the delta smelt population during drought conditions, functioning as a critical nursery habitat; particularly when delta smelt are facing serious decline (Mahardja et al. 2019). Delta smelt collected from the Yolo Bypass during the 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).

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]), 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).

Management Issues

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 latest findings on delta smelt (85 FR 73164, Nov. 16, 2020) identify 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, Dec. 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).

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.

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.

Conservation Strategy

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.

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). 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).

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.

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.

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.

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

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—modified 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).

Notes:
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.

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Appendix B.2
Focused Conservation Plan: Tricolored Blackbird

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APPENDIX B.2

Focused Conservation Plan: Tricolored Blackbird

Acronym	Definition
CESA	California Endangered Species Act
Conservation Strategy	Central Valley Flood Protection Plan Conservation Strategy
CPA	Conservation Planning Area
CVFPP	Central Valley Flood Protection Plan
ESA	Endangered Species Act
SPA	Systemwide Planning Area
SPFC	State Plan of Flood Control
USFWS	U.S. Fish and Wildlife Service

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).

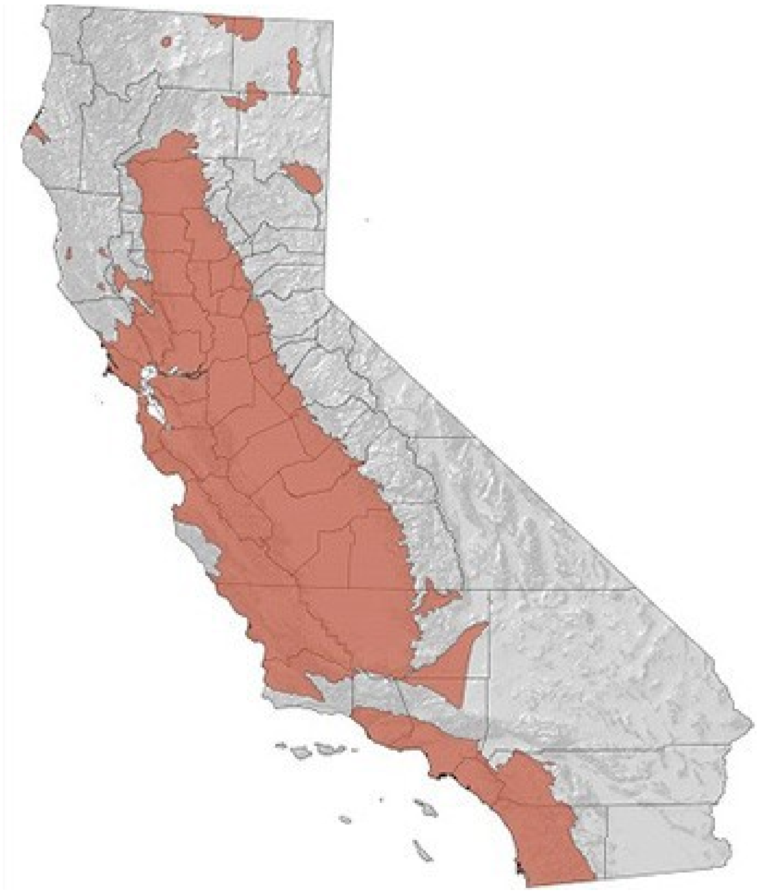
Status and Trends

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).

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). In 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).

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.

Habitat and Ecological Process Associations

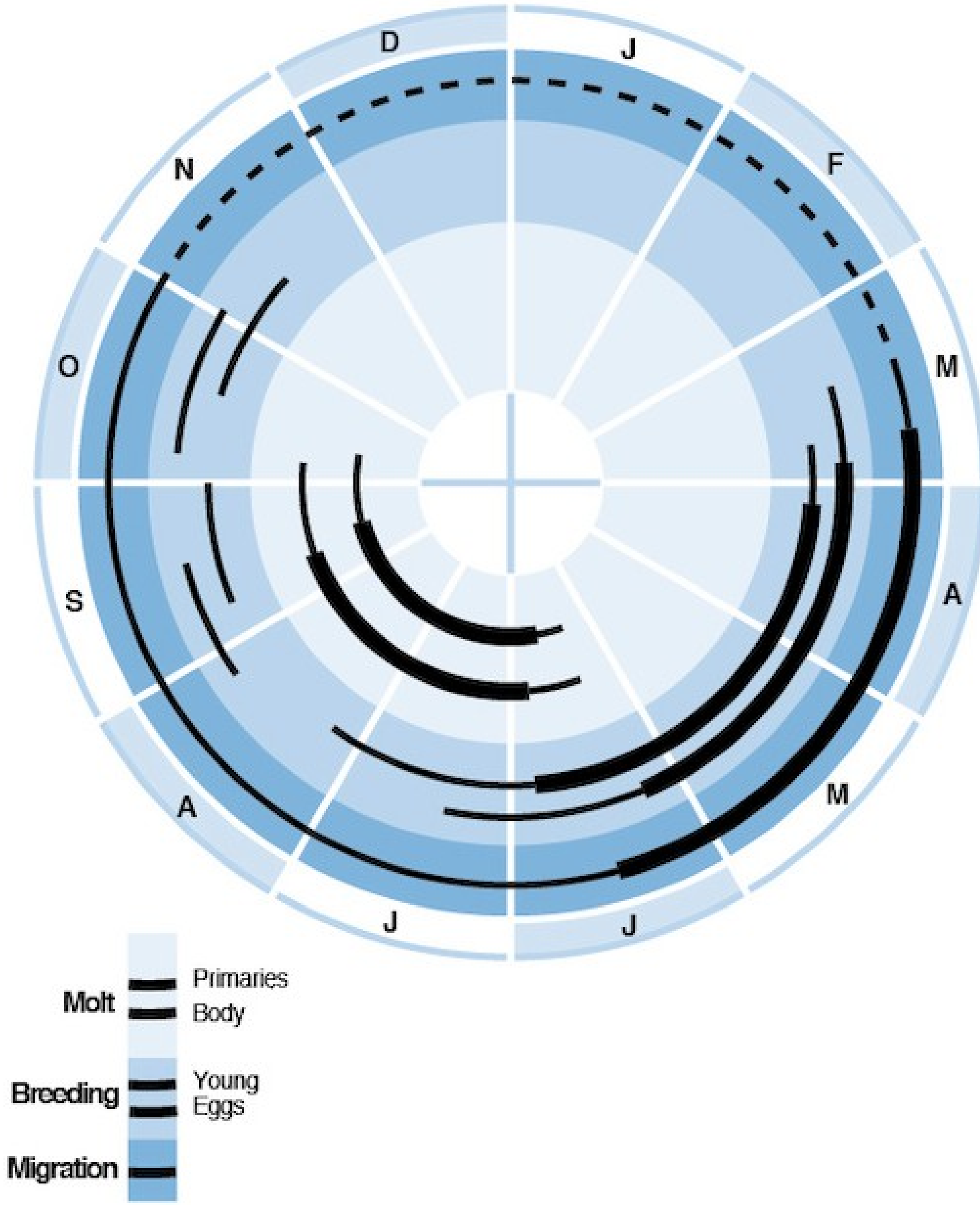
Conceptual Models

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.

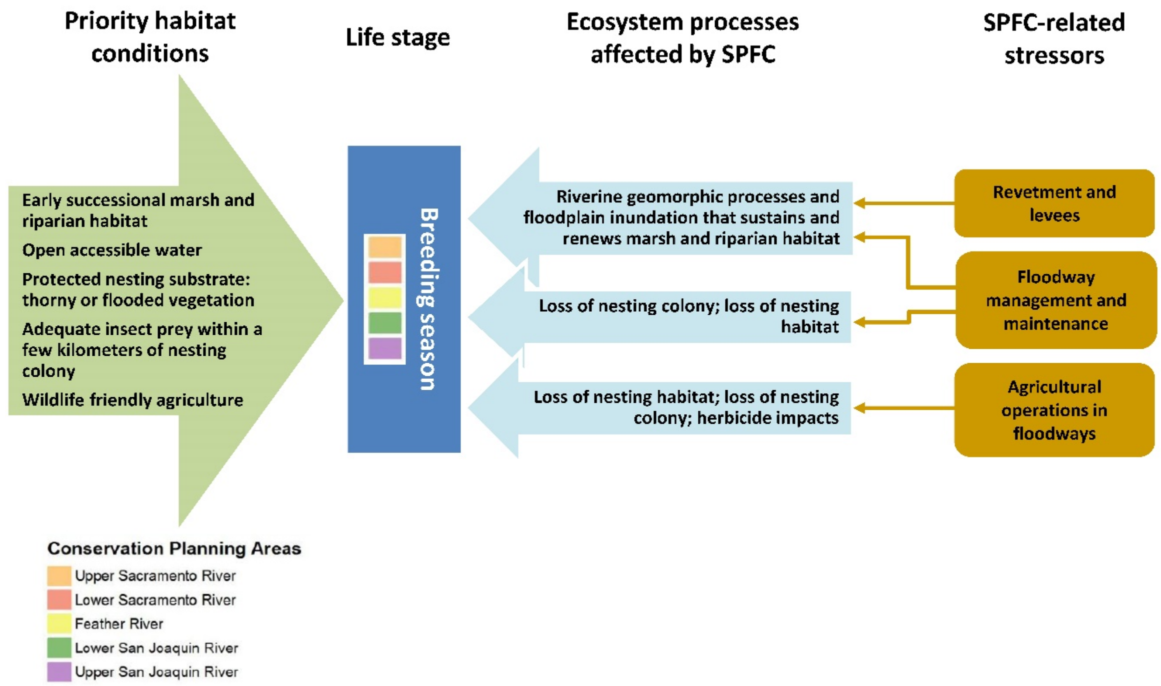
Figure B.2-2. Annual Cycle of the Tricolored Blackbird in California's Central Valley

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



Management Issues

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 to 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).

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.

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.

- **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.

Conservation Strategy

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.

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.

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

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.

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.

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.

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.
SRA Cover	SRA Cover and Bank and Vegetation Attributes of SRA Cover—total length (miles)	No	Not applicable.

Target	Indicator	Selected as Measure of Contribution	Additional Specificity
SRA Cover	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 ofemergent 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—modified 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.

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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

Acronym	Definition
CPA	Conservation Planning Area
CVFPP	Central Valley Flood Protection Plan
SPA	Systemwide Planning Area

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.

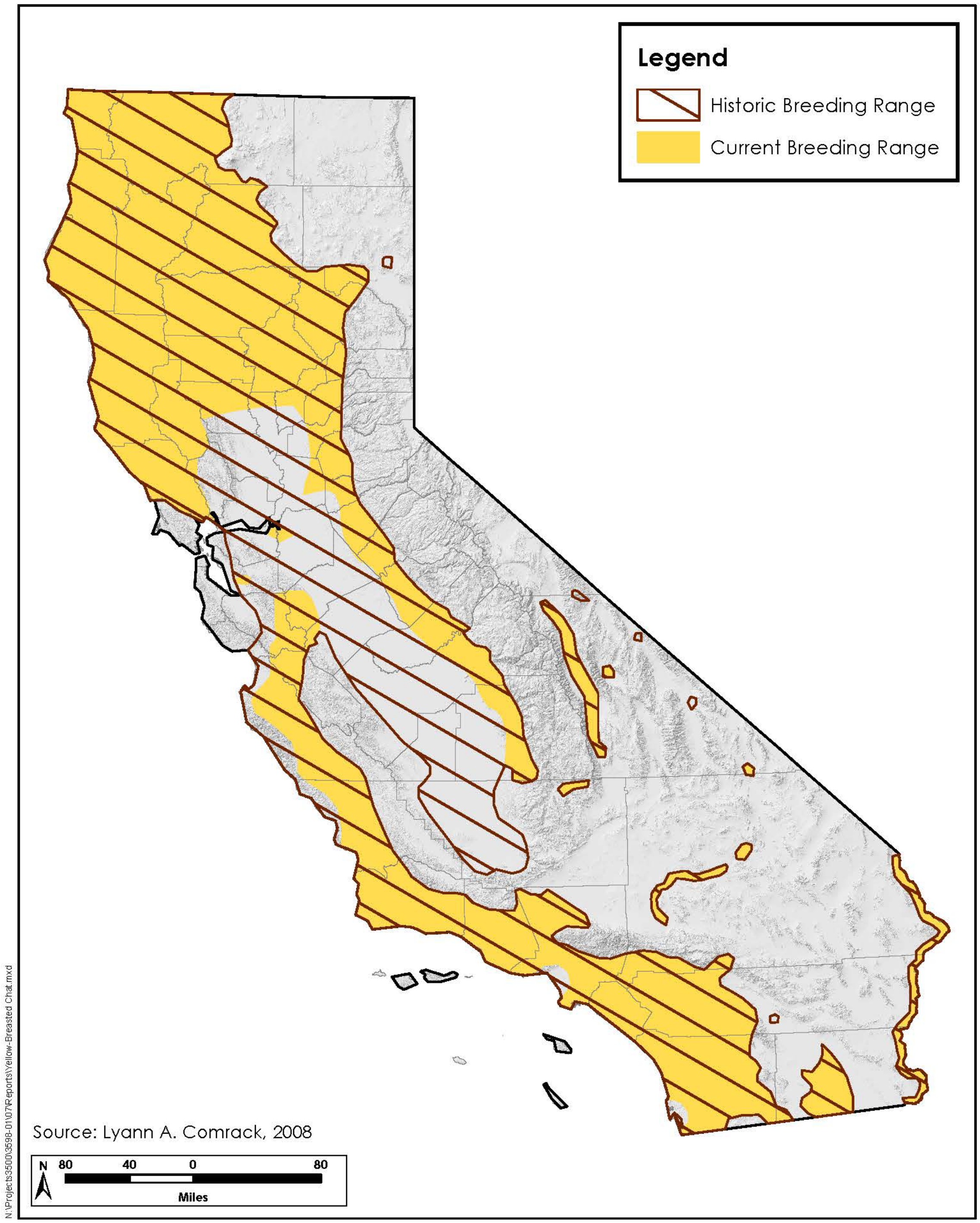
Status and Trends

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.

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).

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).

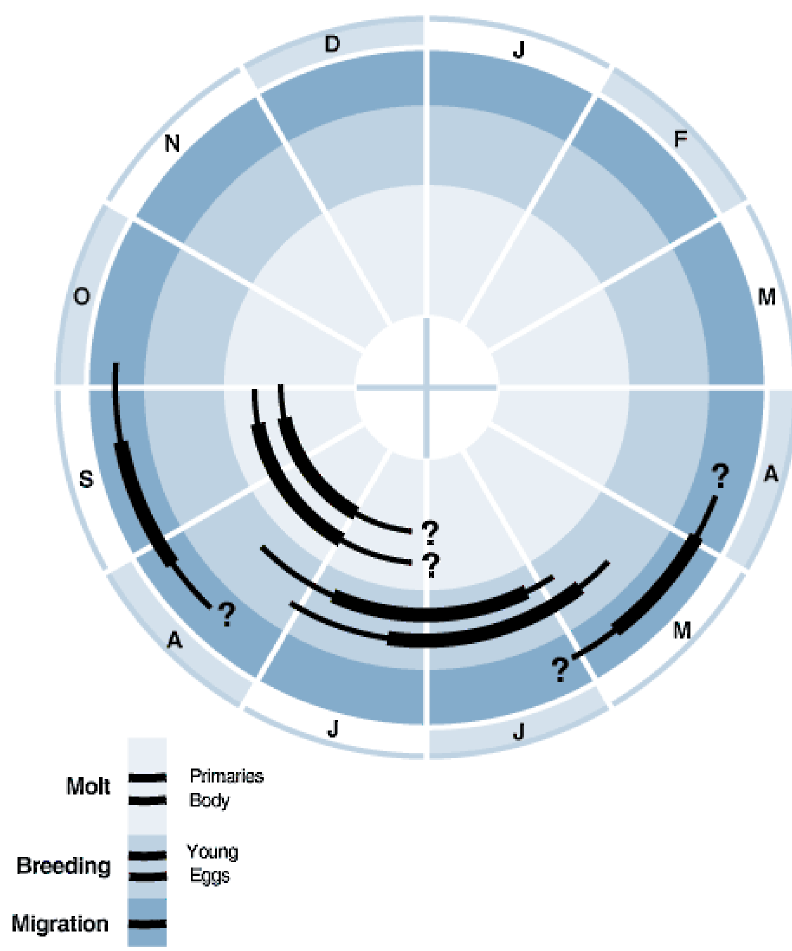
Life History

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.

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).

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:

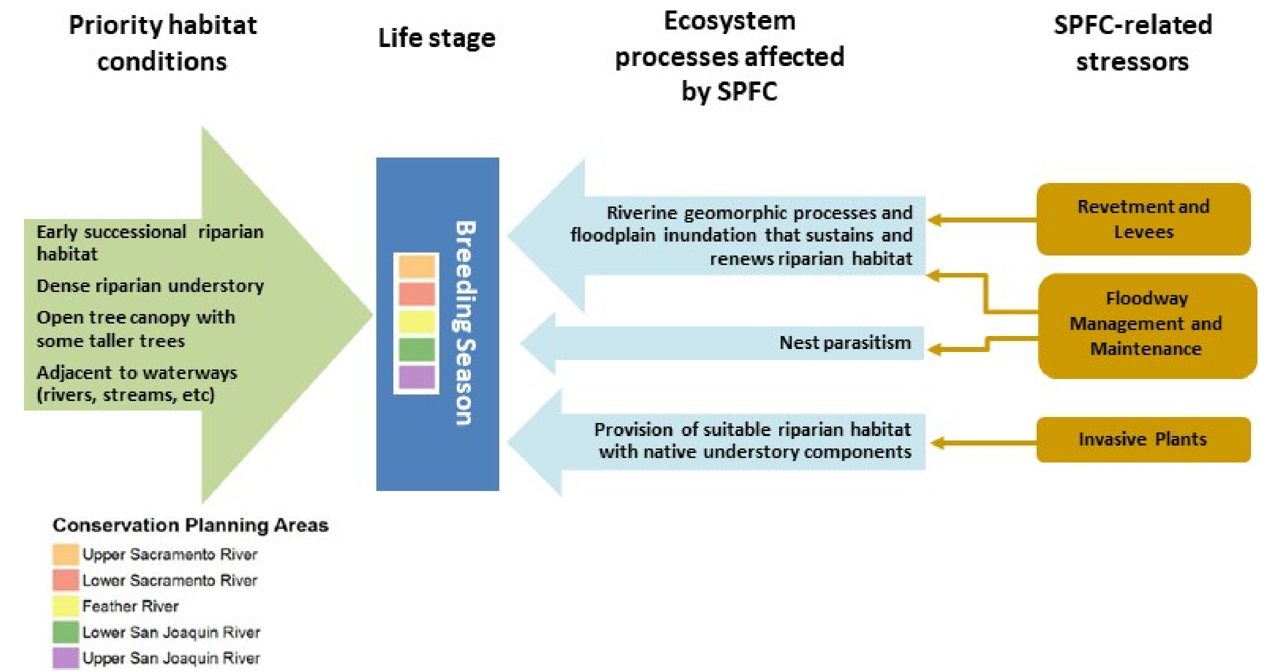
- Habitat conditions required by yellow-breasted chat within the SPA: Early successional riparian habitat, a dense riparian understory, an open tree canopy with some taller trees, and a location adjacent to a waterway. (Nesting habitat is usually restricted to the borders of streams, creeks, and rivers.) “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



Management Issues

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).

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.

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.

Conservation Strategy

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.

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.

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

SPFC Activity	Management Actions	Conservation Need 1. Increase and Sustain Nesting Habitat	Conservation Need 2. Reduce Nest Parasitism
Operations, Maintenance, and Floodway Management	Invasive-plant management	Positive	Positive
	Restoration of riparian, SRA, and marsh habitats	Positive	Positive
	Wildlife-friendly agriculture	Neutral	Negative
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

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.

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.

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.
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.
SRA Cover	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—modified 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.

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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	conservation investment strategy and
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

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.

Modifications to Relevant Conservation Plans

California EcoRestore

The EcoRestore Program is tracking 30 projects that are at various stages of development, from conceptual to completed. The California Department of Water Resources (DWR) is the lead agency for 28 of the 30 EcoRestore projects, including five that launched in 2018 (California Natural Resources Agency 2020a). The following progress has been made to date:

- *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 (California Natural Resources Agency 2020b). 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, 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.

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. The following goals of the updated plan are relevant to the Conservation Strategy:

- Improve integrated watershed management.
- Restore critical ecosystem functions.
- Improve interagency alignment and address persistent regulatory challenges.
- Support real-time decision-making, adaptive management, and long-term planning.

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.

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).

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 on several waterways and facilities in the Strategy's Plan Area (Anadromous Fish Restoration Program 2018a, 2018b, 2019).

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 (Central Valley Joint Venture 1990, 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*).

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.

Butte Regional Conservation Plan

The final Butte Regional Conservation Plan (BRCP) was submitted to USFWS, NMFS, and California Department of Fish and Wildlife 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*).

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 2020a). 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 2020b). 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.

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*).

Yolo Habitat Conservation Plan and Natural Community Conservation Plan

The Yolo HCP and NCCP (ICF International 2018a) was adopted in 2018, and its implementation began on January 11, 2019 (Yolo Habitat Conservancy 2020). 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.

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 May 2018 (Central Valley Regional Water Quality Control Board 2018). 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).

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.

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.

New Relevant Conservation Plans

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.

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, multibenefit, and multi-partner projects.*

- *13.1. Coordinate grant and loan programs across state agencies to make funding for multibenefit 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."*

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).

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.

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.

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 2020).

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.

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.

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 2020c). Building on years of work, the team has developed a science-driven framework that holds the promise to 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 water-year 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.

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 (ICF International 2018b), and the California Department of Fish and Wildlife (CDFW) approved the final document was in 2020 (ICF International 2020a). 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 (*Vireo bellii pusillus*), 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*).

Mid-Sacramento Valley Regional Conservation Investment Strategy

A public draft RCIS for the Mid-Sacramento Valley was released in 2019 (ICF International 2019), and CDFW approved the final document in 2020 (ICF International 2020b). 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.

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.

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.

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:
Magnitude of relationship between the CVFPP and other conservation plan or program 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 Communities 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 Garter-snake	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 Garter-snake	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

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 Garter-snake	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	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
	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

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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 Magnitude of relationship between the CVFPP and other conservation plan or program specified as follows:

Notes:
None = No relationship exists.

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NWR = National Wildlife Refuge
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PG&E = Pacific Gas and Electric Company
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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
MND	mitigated negative declaration
MOU	memorandum of understanding

Acronym	Definition
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

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 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
	State Water Resources Control Board—Sections 1200 and 1201 of the California Water Code	• Water right permit

Agency	Agency—Statute	Authorization or Approval Action
State Agencies	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

Federal Authorizations

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.

U.S. Army Corps of Engineers

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 to 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.

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.

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.

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 to 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.

U.S. Fish and Wildlife Service and National Marine Fisheries Service

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.

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 to 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.

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.

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 to 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.

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.

State Authorizations

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 the 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.

California Department of Fish and Wildlife

Lake andStreambed 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 to 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 to 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.

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.

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.

California Endangered Species Act

The 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 take of State-of-California (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 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 below.

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.

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.

California Fish and Game Code Section 2089.2–2089.26 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.

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.

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.

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.

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.

State Water Resources Control Board and Regional Water Quality Control Boards

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 only be confirmed by the courts.

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.

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 to 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.

State Office of Historic Preservation

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.

Central Valley Flood Protection Board

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.

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.

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 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.

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.

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
CVFPP	Central Valley Flood Protection Plan
DWR	California Department of Water Resources
RIBITS	Regulatory In-Lieu Fee & Bank Tracking System
SPFCC	State Plan of Flood Control

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 (DWR 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 wildlife resource 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 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.
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 currently being realized 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.

Project Title and Applicant	Proposal Process (Total Project Cost)	Project Description and Status as of November 1, 2020
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 4 ESU and steelhead) (NMFS and CDFW credits), floodplain (USACE, NMFS, and CDFW credits), riparian (USCACE, NMFS, and CDFW), and Swainson's hawk 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 over a period of time. DWR has received all 57.5 salmonid credits and several credits have been used by projects in the bank's service area.
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 mixed riparian habitats. This project is expected to generate advance mitigation credits from CDFW (for riparian habitat and possibly for western yellow-billed cuckoo) and USFWS (for valley elderberry longhorn beetle 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 (riparian to mitigate for Section 1600 impacts) and USFWS (VELB).

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
VELB = valley elderberry longhorn beetle

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 summarizes the mitigation credits available from conservation and mitigation banks in October 2021 for the target 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. These tables are based on the credits listed as available in the Regulatory In-Lieu Fee & Bank Tracking System (RIBITS) (U.S. Army Corps of Engineers 2021). Available credits change as projects purchase credits and as new banks are approved and credits released, but the credits available on October 22, 2021, summarized in Tables E-2 and E-3, indicate the general level of credit availability.

Table E-2. Available Compensatory Mitigation for Target Habitats and Federally Listed or State-listed Species Available at Mitigation and Conservation Banks

Category	Credit Type	Credits[a]	Notes
Species	Giant gartersnake	181	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	859	Laguna Creek Mitigation Bank (SV)[c], Meridian Ranch Mitigation Bank (SV)[c], Van Vleck Ranch Mitigation Bank (SV)[c]
	Swainson’s hawk nesting tree use (restored)	2	Bullock Bend Mitigation Bank (SV)
	Tricolored blackbird	17	Antonio Mountain Ranch Mitigation Bank (SV)[c], SMUD Nature Preserve Mitigation Bank (SV)[c]

Category	Credit Type	Credits[a]	Notes
Species	Valley elderberry longhorn beetle	1,060	Laguna Creek Mitigation Bank (SV), French Camp Conservation Bank (SJV), Nicolaus Ranch VELB Conservation Bank (SV), River Ranch VELB Conservation Bank (SV), Stillwater Plains Mitigation Bank (SV)[c] One credit is approximately 1,800 square feet
Habitats	Seasonal wetland[b]	31	Colusa Basin Mitigation Bank (SV), Grasslands Mitigation Bank (SJV), Laguna Creek 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)	Less than 1	Stillwater Plains Mitigation Bank (SV)[c]
	Emergent marsh (nonfederal)	Less than 1	Stillwater Plains Mitigation Bank (SV)[c]
	Emergent marsh creation	Less than 1	Stillwater Plains Mitigation Bank (SV)[c]
	Floodplain mosaic wetland (re-establishment)	4	Cosumnes Floodplain Mitigation Bank (SV)
	Freshwater emergent marsh (preservation)	8	Elsie Gridley Mitigation Bank
	Freshwater emergent marsh	1	Seigler Valley Wetland Mitigation (SV)[c]
	Freshwater marsh complex (creation)	8	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)	4	Markham Ravine – Western Placer County ILF Site, Seigler Valley Wetland Mitigation (SV)[c]
	Riparian floodplain forest	15	Fremont Landing Conservation Bank (SV)
	SRA (re-establishment)	13,803	Cosumnes Floodplain Mitigation Bank (SV) Credit units are linear feet

Category	Credit Type	Credits[a]	Notes
Habitats	SRA preservation	32,758	Cosumnes Floodplain Mitigation Bank (SV) Credit units are linear feet
Groups	Swainson's hawk and burrowing owl	177	Dolan Ranch Conservation Bank (SV), Elsie Gridley Mitigation Bank (SV)
	Delta smelt and longfin smelt	7	Liberty Island Conservation Bank (SV)
	Open water and tricolored blackbird	Less than 1	SMUD Nature Preserve Mitigation Bank (SV)[c]
	Perennial stream (CDFW enhancement) and tricolored blackbird habitat	2	Antonio Mountain Ranch Mitigation Bank (SV)[c]
	Salmonid, floodplain riparian, and Swainson's hawk nest buffer (enhanced)	10	Bullock Bend Mitigation Bank (SV)
	Salmonid, floodplain riparian, and Swainson's hawk nest buffer (re-established)	10	Bullock Bend Mitigation Bank (SV)
	Salmonid and riverine riparian (enhanced)	Less than 1	Bullock Bend Mitigation Bank (SV)
	Salmonid and riverine riparian (re-established)	18	Bullock Bend Mitigation Bank (SV)
	Salmonid, riverine riparian, and Swainson's hawk nest buffer (re-established)	35	Bullock Bend Mitigation Bank (SV)
	Swainson's hawk foraging and tricolored blackbird foraging	14	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 2021.

[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 by Target Habitats and Species

Habitat[a]	Species[a]	Credits[b]
Riparian Habitat	Acres	109
SRA Habitat	SRA—acres	9
	SRA—miles	8.8
Marsh and Other Wetlands Habitat	Marsh—acres	19
	Seasonal wetlands—acres	32
	Floodplain wetland mosaic—acres	4
Species—Acres	Delta button-celery	0
	Valley elderberry longhorn beetle[c]	1,060
	Green sturgeon	0
	Salmonids	135
	Delta smelt	7
	Giant gartersnake	181
	Bank swallow	0
	California black rail	0
	Greater sandhill crane	0
	Least Bell's vireo	0
	Tricolored blackbird	20
	Swainson's hawk—nest tree and nest buffer	57
	Swainson's hawk—foraging	1,050
	Western yellow-billed cuckoo	0
	Riparian brush rabbit	0
	Riparian woodrat	0

Source: U.S. Army Corps of Engineers 2021.

[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, the vast majority of 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.

References

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

U.S. Army Corps of Engineers. 2021. RIBITS: Regulatory In-Lieu Fee & Bank Tracking System. Viewed online: www.usace.com. Accessed: October 22, 2021.

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	nongovernment 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 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 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 that habitat loss.

F.2.1 Completed Projects

The four multi-benefit 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. These projects were funded through DWR's flood management programs and meet the CVFPP criteria for a multi-benefit 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 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)** increased the area of inundated floodplain and restored riparian habitat by constructing a setback levee along the west bank of the Sacramento River. A portion of this project may be used as a mitigation bank and therefore, 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 1000 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)** reduced a stressor (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 measurable objectives (and, potentially, 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, and shows 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
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 = nongovernment 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 removed (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 removed (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 removed (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 removed (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 removed (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: Compensatory mitigation and non-mitigation are displayed separately because using restored ecosystem processes as mitigation reduces progress toward the Conservation Strategy's goals.

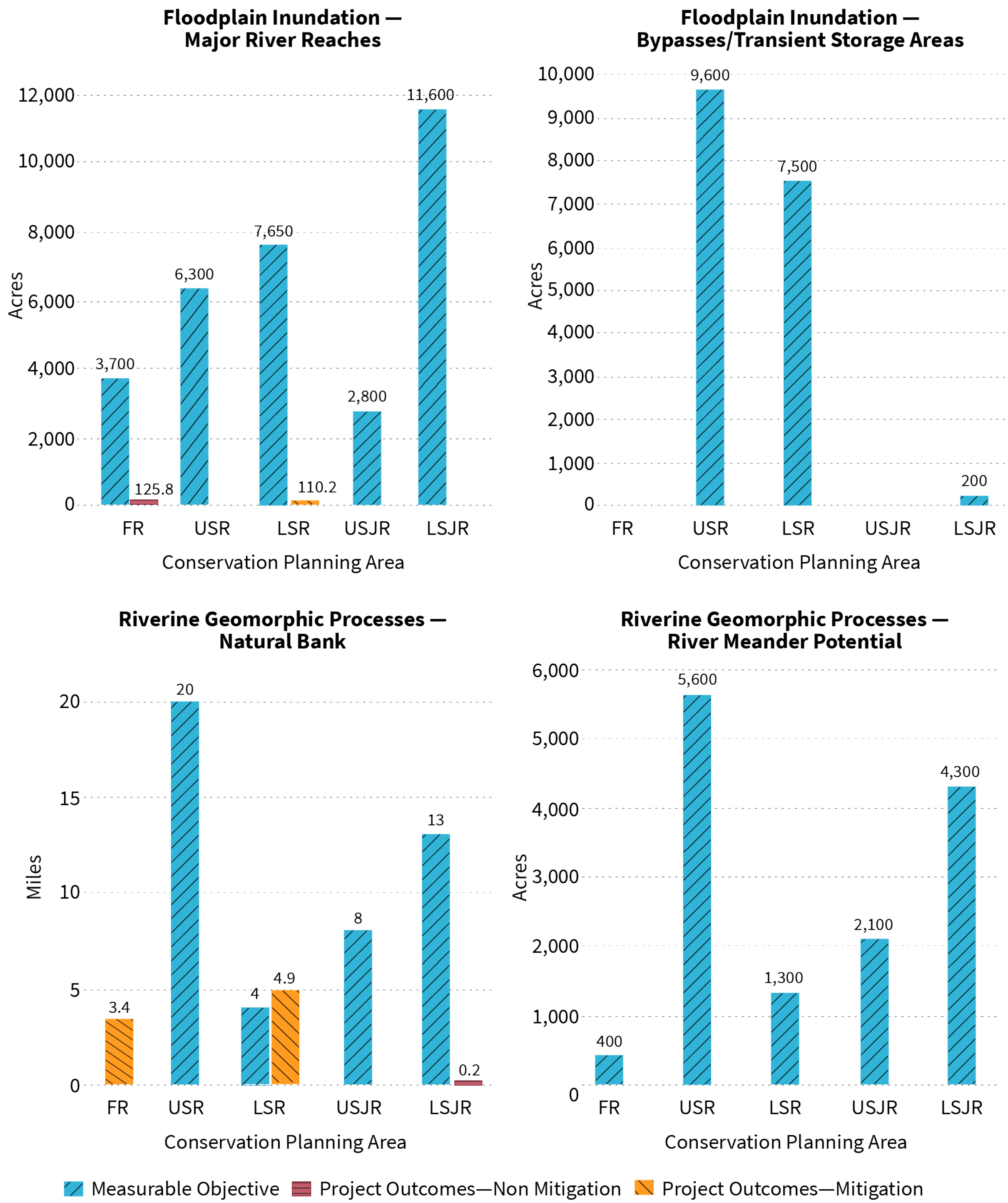


Figure F-2. Potential Contributions of Completed Projects to Habitat Objectives

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

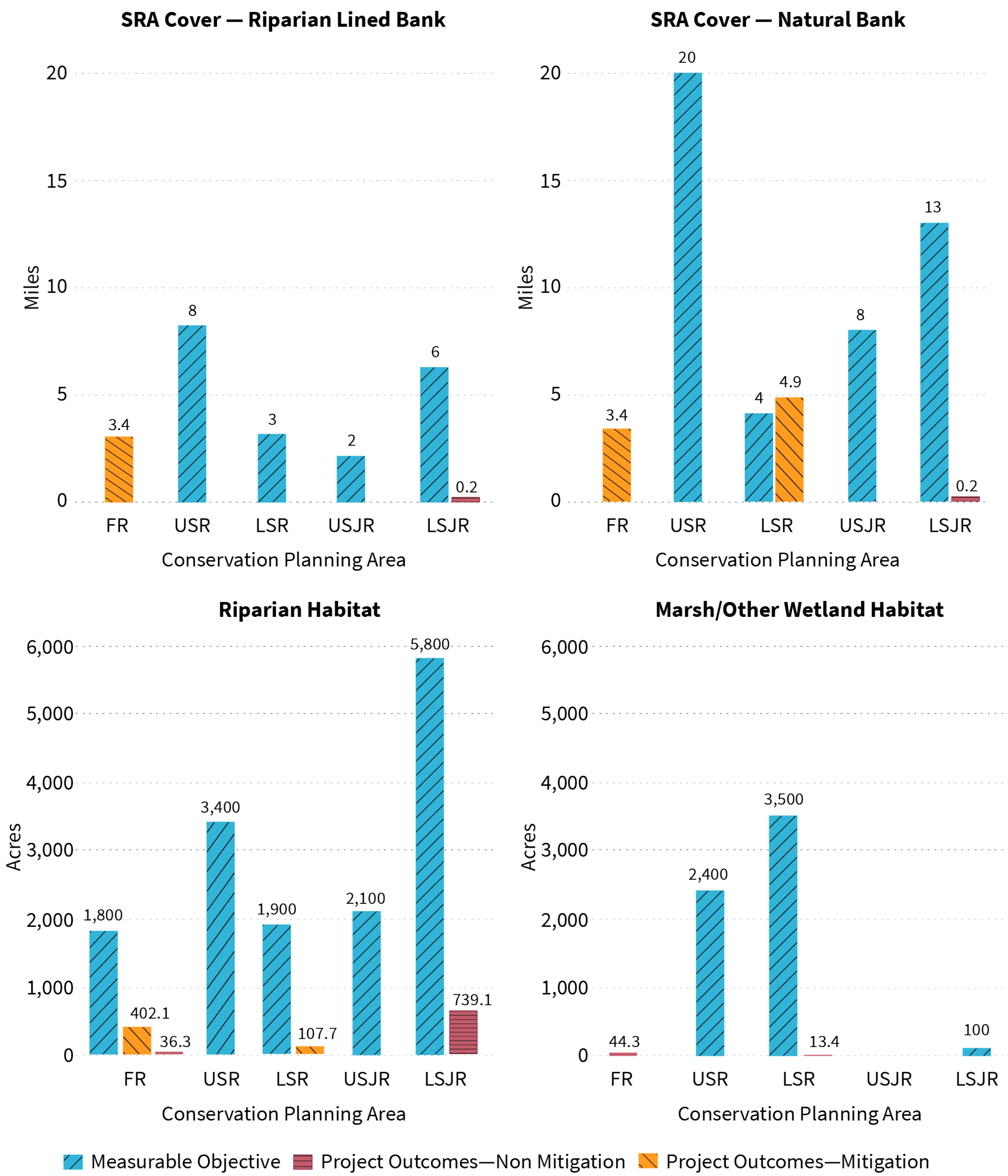
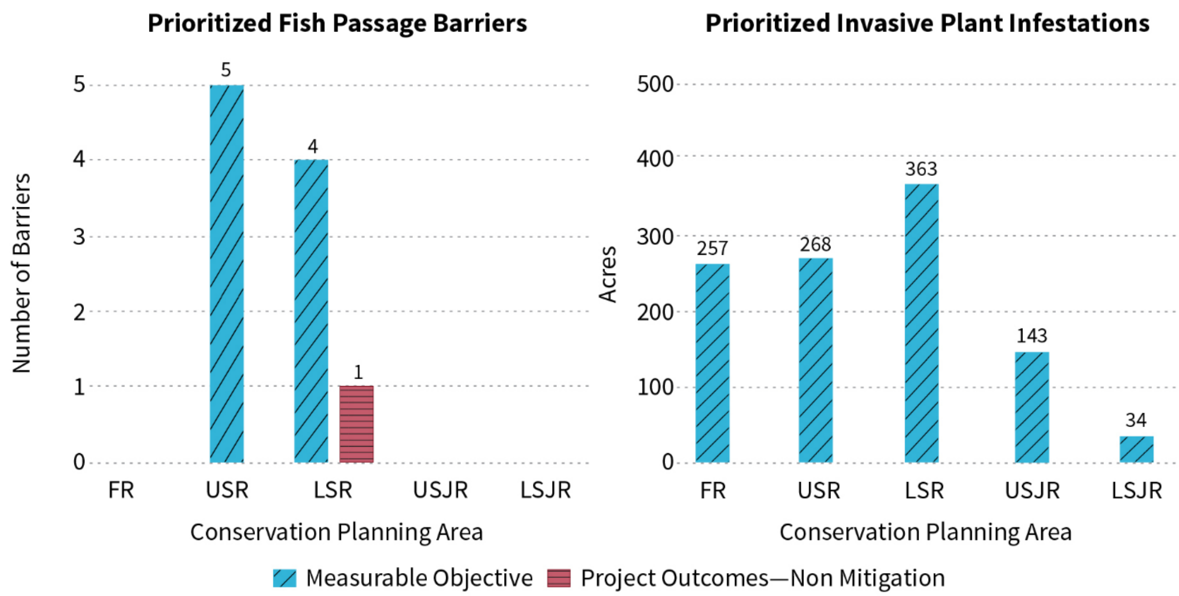


Figure F-3. Potential Contributions of Completed Projects to Stressor Objectives

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



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 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 followup 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 3.3.5, “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 the 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 channel-bank datasets (revetted and natural banks) 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. 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 t 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

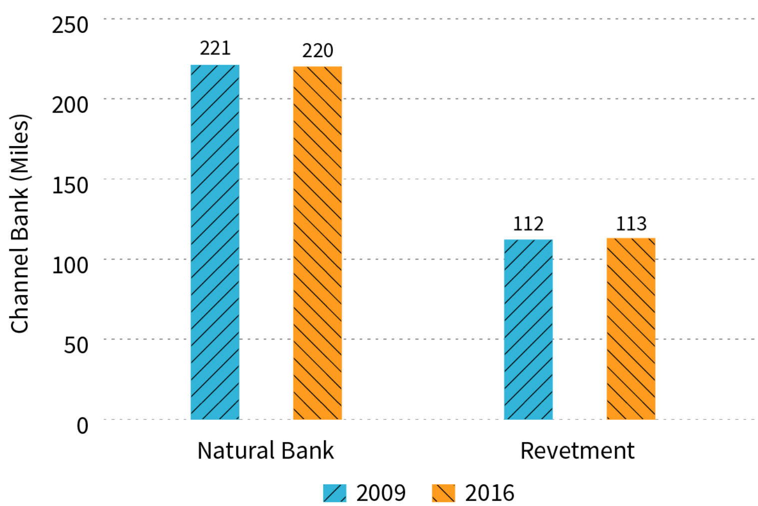


Table F-6. Length of Natural Bank and Revetment in the Upper Sacramento River Conservation Planning Area in 2009 and 2016

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 new priorities are provided in 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 has convened during the 2016 and 2021 period. However, DWR solicited advisory input from agencies, NGOs, and project proponents.

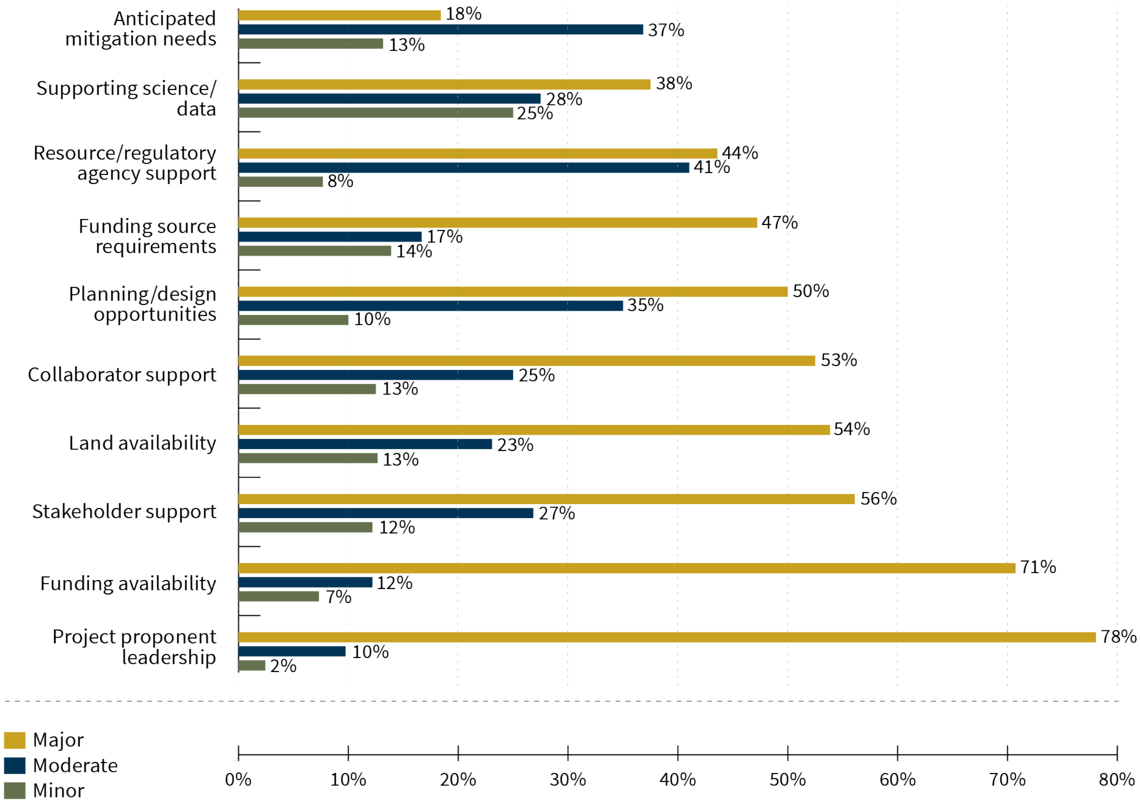
In addition to conducting its own assessment of implementation of this Conservation Strategy, DWR solicited input regarding implementation and applied the input to this update. Input was solicited from the Central Valley Flood Protection Board (CVFPB), other project proponents and maintainers, regulatory 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

A. Contributing Factors



B. Limiting Factors

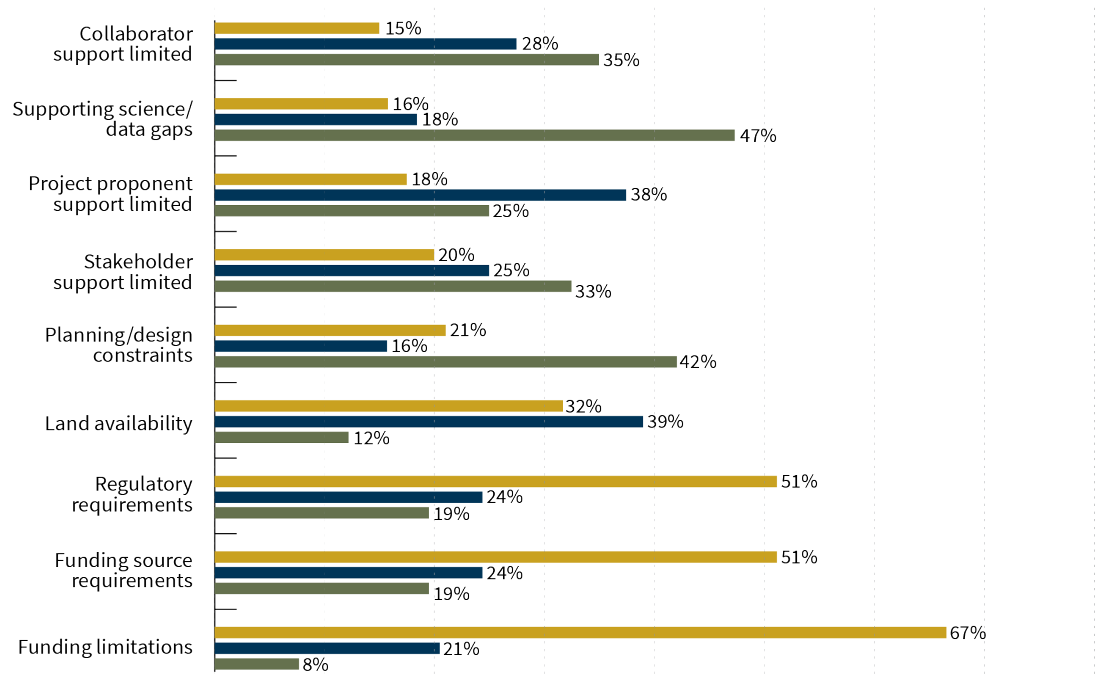


Table F-7. Survey Responses regarding Factors Limiting Ecosystem Improvements by Multi--benefit Projects

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 cross-cutting themes were finalized in January 2021 and formed the basis for a unified set of recommendations to DWR (provided in Appendix G).

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 (5th) project is described below because although it does not qualify as a multi-benefit project, it contributed 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 removed 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 Conservation Planning Area (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 removed 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.

Anticipated to be Proposed 2022 to 2027 Projects

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 proposed, meaning they 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 restore the weir to improve performance and provide passage for fish 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. 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 remove 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 proposed project would create tidal habitat for delta smelt and other salmonids by building a setback levee that will provide flood protection and improve climate resiliency in the region. Although this project is not being implemented under the CVFPP, it is located within the footprint of the Lower Sacramento River CPA and is expected to contribute towards the measurable objectives.

- **Lower Elkhorn Basin Levee Setback Project:** This project that is under construction is setting back levees and modifying SPFC facilities, thus 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 State Water Project as a mitigation requirement stipulated by the 2009 Biological Opinion 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 that is under construction would 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*) in order 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 proposed project would restore the historic floodplain and provide transient storage to more than 3,100 acres along 3 miles of the San Joaquin River.

- **Dos Rios Floodplain Expansion and Ecosystem Restoration Project and Hidden Valley Ranch Mitigation Project (Phase 2):** This proposed project would expand previous phases to include the Hidden Valley Ranch parcel and continue to reconnect and expand floodplain habitat.

- **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, reduce flood risk, and by improving physical processes will provide other benefits to Conservation Strategy habitats and species.

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	nongovernment organization
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 participate 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:

- Permitting.
- Performance Tracking.
- Implementation of Multi-benefit Projects.

Each Advisory Committee subgroup used specific guidance for the types of input requested to develop recommendations for the Conservation Strategy Update:

- 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.
- 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 implementation of multi-benefit projects.

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.

Table G-1 provides the list of recommendations from the Advisory Committee, along with how their incorporation is intended via the CVFPP planning process. The Advisory Committee submitted 79 recommendations to DWR, several of which contained various actions and were therefore placed in multiple categories. Some recommendations that are in several categories are also being considered (or are already being implemented) for various actions. Some of the recommendations are not within the scope of the CVFPP or not within the authorization of DWR. These have been placed in Category 6, along with a notation explaining this designation.

Category 1 recommendations can primarily be found in Table 3-8 of the Conservation Strategy Update, although some of these are incorporated in content. The statuses are defined as follows:

1. **Included in Conservation Strategy Public Draft.**

   This recommendation aligns with the purpose, scope, and content of the Conservation Strategy and is included in the 2022 Public Draft. This status also applies to recommendations whose overall intent aligns with the Strategy but contains specifics it may not be feasible to include to the full level of detail given.

2. **Considered for inclusion in CVFPP Public Draft.**

   This recommendation aligns with the purpose, scope, and content of the CVFPP and is considered for inclusion in the 2022 Public Draft. This status also applies to recommendations whose overall intent aligns with the CVFPP but contains specifics it may not be feasible to include to 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, 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, due to cost or 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, either due to jurisdictional or resource limitations. The recommendation may be beyond the authorization 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.

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.

We encourage the Advisory Committee members to continue to evaluate the advancement of these recommendations. Statuses are subject to change as both the CVFPP and the Conservation Strategy develop toward Final Drafts. It is also important to note that although DWR will attempt to make progress on the recommendations identified as Status 1 or 2 (considered for inclusion in the Conservation Strategy or CVFPP Updates), their inclusion does not guarantee implementation or adoption of the full suite of actions during the 2022 to 2027 planning cycle. Many of the Advisory Committee recommendations have been compiled for consideration in the 2022 CVFPP Update Public Draft, along with recommendations from the following other sources:

- 2017 CVFPP Update Recommendations.
- 2017 CVFPP Update Chapter 2 Areas of Agreement/Areas Continuing Conversation.
- 2016 Conservation Strategy.
- 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, the CVFPP planning team is synthesizing the recommendations into a manageable list for consideration and prioritization in the 2022 CVFPP Update Public Draft. The CVFPP planning team is considering these policies based on:

- The identification of relevant federal, State, and local partners that may be engaged for effective collaboration and implementation of policies.

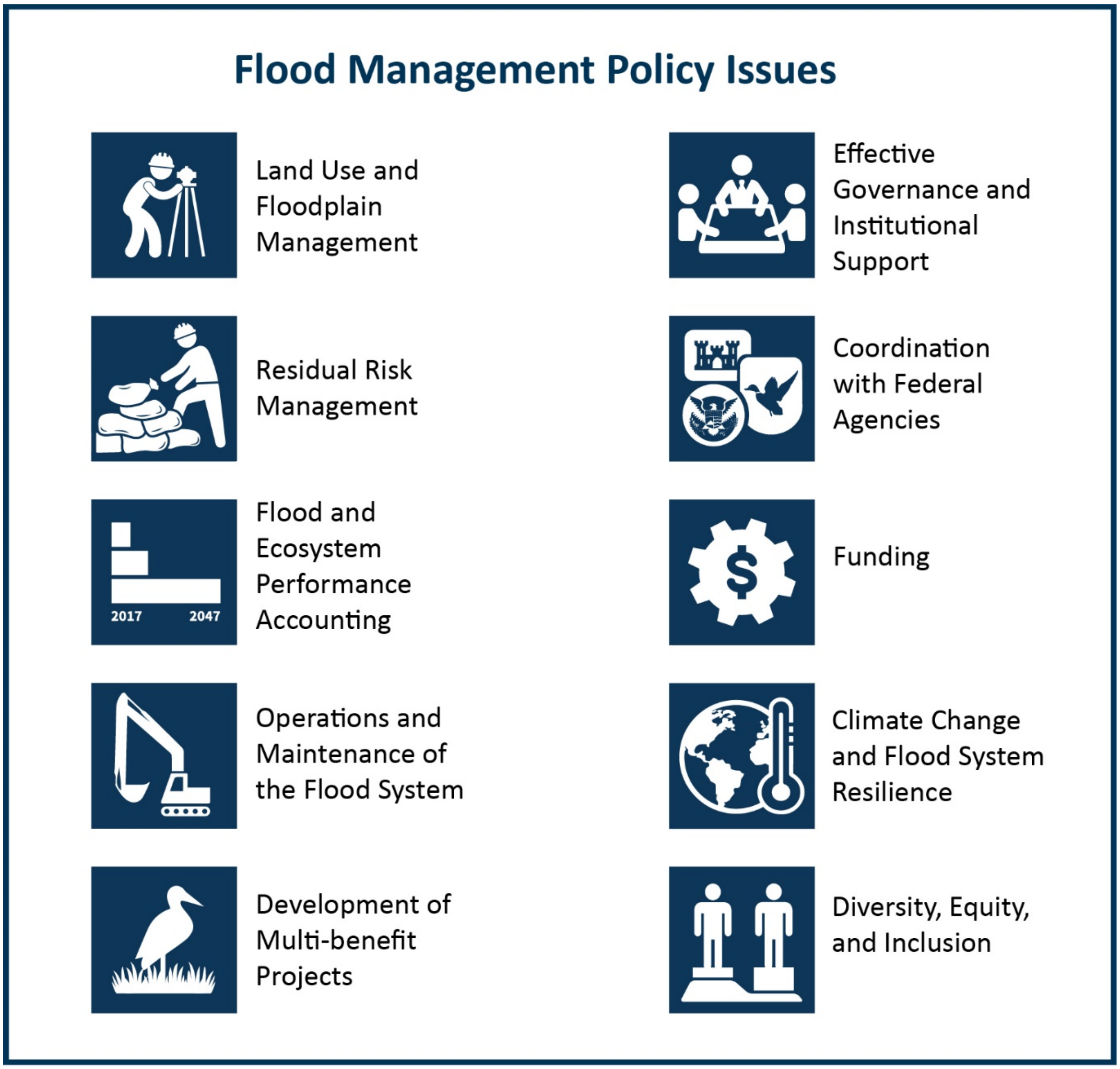
- The appropriateness of recommendations for the level of detail and ability to implement.

- Priority near-term (< 5 years) and longer-term (>+ 5 years) recommendations and the appropriate location for their documentation.

- The inclusion of range for consideration, based on cost and practicality.

The Working Draft of the 2022 CVFPP Update (released in September 2021) included a short list of high-priority policy recommendations. Draft recommendations are organized around 10 policy issue categories (Figure G-1). Two categories are new and developed through this process for the 2022 CVFPP Update: Climate Change and Flood System Resilience; and Diversity, Equity, and Inclusion.

Figure G-1. Policy Issue Categories



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Stakeholder feedback and input on the short list of high-priority recommendations are both needed to refine recommendations for the 2022 CVFPP Update Public Draft.

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Table G-1. CVFPB Advisory Committee Recommendations

Note: Recommendations were kept verbatim as received from the Advisory Committee.

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address 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 Public Draft. (Appendix F).	Conservation Strategy Appendix F provides examples of projects that meet various criteria relevant to the Conservation Strategy. (Refer to I11, 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 Public Draft.	Refer to I07a, 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 Regional Flood Management Program (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 - Considered for inclusion in CVFPP Public Draft.	Not Applicable	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 (S/L): • Encourage and support the establishment of centralized governance mechanisms with budgetary resources, such as joint powers authorities, designed to effectively engage in, sponsor, and coordinate regional flood management activities, improve regional planning, and support the regional implementation of flood and multi-benefit projects. • Continue to collaborate and coordinate on flood and multi-benefit projects within and across regions in each basin. • Establish regional technical advisory committees to improve coordination, landscape-scale connectivity, and the development of a regional vision for multi--benefit projects.

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address this Recommendation
I04	Each of the RFMPs to map regional opportunities for flood improvement, habitat, water supply, water quality, recreation, agriculture sustainability, etc.	4 - Already being implemented by other ongoing activities. 5 - Considered for future CVFPP planning cycles.	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	Not Applicable
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 - Considered for inclusion in CVFPP Public Draft.	Not Applicable	Not Applicable	(Table 3-3 #01) Establish an intra-agency, basin-specific task force of high-level decision makers and staff to (S): • Champion and manage agency coordination on multi-benefit project funding on or near SPFC facilities, facilitating interagency coordination before issuing guidelines to sync schedules, funding strategies, and priorities; and align various 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.	Promoting agency coordination is a priority of the CVFPP and efforts are ongoing, but directing actions of other agencies is outside the scope of the CVFPP. (Refer to P02, P03)	Not Applicable	(Table 3-3 #01) Establish an intra-agency, basin-specific task force of high-level decision makers and staff to (S): • Champion and manage agency coordination on multi-benefit project funding on or near SPFC facilities, facilitating interagency coordination before issuing guidelines to sync schedules, funding strategies, and priorities; and align various 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 actions of other agencies is outside the scope of the CVFPP.	Not Applicable	Not Applicable

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address this Recommendation
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.	Promoting agency coordination is a priority of the CVFPP and efforts are ongoing, but directing actions of other agencies is outside the scope of the CVFPP. (Refer to I05b, P02, P03)	Not Applicable	(Table 3-3 #01) Establish an intra-agency, basin-specific task force of high-level decision makers and staff to (S): • Review existing agency governance and authorities to identify overlapping authorities and propose meaningful recommendations for reconciliation between and among local, State, and federal levels of government to improve implementation of flood projects, particularly in rural and underserved communities.
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 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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft. 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/Conservati on Strategy. (Refer to I02, P02, 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 3-8 #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 (S/L): • Establish 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	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address 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 Public Draft. 3 - Considered for use as guidance or best management practices to inform other program or planning activities. 5 - Considered for future CVFPP planning cycles.	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, I02)	(Section 3.3.5) DWR has been developing internal data management and decision support tools to balance DWR's 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: they are forward-looking, comparing project data from the FPTS to forecasted needs and objectives across DWR programs.	Not Applicable
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
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

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address this Recommendation
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 agricultural lands and restored ecosystems, 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 - Considered for inclusion in CVFPP Public Draft.	Supporting the YB/Conservation Strategy Partnership aligns with the purpose of the CVFPP, but the specific implementation measures apply to other DWR programs.	Not Applicable	(Table 3-3 #07) Promote agricultural land stewardship and sustainability in multi-benefit project planning by leveraging regional flood management planning and partnerships to support the development and standardized use of relevant data and tools.
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 - Considered for inclusion in CVFPP Public Draft.	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 and partnerships to support the development and standardized use of relevant data and tools.
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, I08b	Not Applicable	Not Applicable

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address 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 Public Draft (Appendix F). 4 - Already being implemented by other ongoing activities.	A tracking system is under development. (Refer to I01, I07b, T09)	(Table 3-8) Develop guidance to help project proponents identify components in their projects that meet multi-benefit and Conservation Strategy measurable objectives. Project proponents can use this in the early design phase and through project permitting to optimize ecological features, and potentially expedite the regulatory process. Refer to content in 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 allows 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 Sutter-Tisdale Bypass Multi-Benefit Bypass 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.	5 - Considered for future CVFPP planning cycles.	This level of detail could be considered once additional resources became available.	Not Applicable	Not Applicable
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, P17	Not Applicable	Refer to I13
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, P17	Not Applicable	Refer to I13

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address this Recommendation
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 descriptions and regulatory applications.	Not Applicable

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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	2 - Considered for inclusion in CVFPP Public Draft. 3 - Considered as guiding principles or best management practices to inform other program or planning activities. 5 - Considered for future CVFPP planning cycles.	The CVFPP considers overarching recommendation to address challenges associated with long-term O&M, including funding, but some specifics from this recommendation may not be included.	Not Applicable	(Table 3-3 #09) Continue to prioritize actions that repair and rehabilitate existing system features by "taking care of what we have" (S/F/L): • Incorporate 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 management and multi-benefit projects, and encourage other project proponents to do the same. • Continue to provide financial and technical assistance for programs such as the FMAP to decrease deferred maintenance in the system. Encourage local maintaining agencies to participate in FMAP and consider amendments to FMAP guidelines as appropriate to allow work activities to span multiple funding years, expand list of covered OMRR&R activities, and pursue federal funding opportunities. • Continue to use FMAP to provide financial and technical assistance to local flood agencies to prepare SWIF applications, notice of intents, and SWIF implementation to regain Public Law 84-99 program eligibility to maximize federal cost-share. • Establish an interagency workgroup, in conjunction with California Silver Jackets, to investigate solutions for reducing the impact of encampments on levees and the associated operation and maintenance challenges that arise from inhabitance on the flood management infrastructure.

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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"	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.	This recommendation is being implemented by ongoing activities that apply to other DWR programs. (Refer to I17)	Not Applicable	Not Applicable
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 - Considered for inclusion in CVFPP Public Draft. 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 an intra-agency, basin-specific task force of high-level decision makers and staff to (S): • Champion and manage agency coordination on multi-benefit project funding on or near State SPFC) facilities, facilitating interagency coordination before issuing guidelines to sync schedules, funding strategies, and priorities; and align various 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 - Considered for inclusion in CVFPP Public Draft. 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 and multi-benefit for capital projects and ongoing investments in the SPFC by (S/F/L): • 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, I06a	Not Applicable	Refer to I05b

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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 - Considered for inclusion in CVFPP Public Draft. 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 and multi-benefit for capital projects and ongoing investments in the SPFC by (S/F/L): • New general obligation bond funding that promotes flexibility in funding flood management projects with single or multiple societal benefits.

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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 - Considered for inclusion in CVFPP Public Draft. 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 agency governance and authorities to identify overlapping authorities and propose meaningful recommendations for reconciliation between and among local, State, and federal levels of government to improve the implementation of flood projects, particularly in rural and underserved communities. (Table 3-3 #06) Obtain increased State and federal stable funding for flood management and multi-benefit for capital projects and ongoing investments in the SPFC. (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.

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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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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. Established permitting mechanisms such as HCPs, RCISs/MCAs, etc. 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) Explore, create, and implement regional-scale and long-term permitting mechanisms (administrative structures, protocols, interagency cooperative agreements, etc.) in conjunction with resource agencies, for the implementation and O&M of flood management activities, including 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.
P02	Encourage project proponents to engage in early coordination with regulatory agencies during conceptual design phase.	1 - Included in Conservation Strategy Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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 an intra-agency, basin-specific task force of high-level decision makers and staff to (S): • Champion and manage agency coordination on multi-benefit project funding on or near SPFC facilities, facilitating interagency coordination before issuing guidelines to sync schedules, funding strategies; and priorities; and align various funding programs to best advance multi-benefit projects. (Table 3-8 #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 (S/L): • Establish 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.

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P03	Develop agency workgroup with multiple agencies represented; encourage consistency among agencies where possible regarding permitting timelines and requirements.	1 - Included in Conservation Strategy Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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) Explore, create, and implement regional-scale and long-term permitting mechanisms (administrative structures, protocols, interagency cooperative agreements, etc.) in conjunction with resource agencies, for the implementation and O&M of flood management activities, including multi-benefit projects, considering the following (S/F/L): • Initiate memorandums of agreement or memorandums of understanding between the DWR and regulatory agencies (consistent with the "Cutting Green Tape" initiative) 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, 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 link. (Refer to P02)	Not Applicable	Not Applicable

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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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	Agency coordination is a key component of the CVFPP & / 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) Initiate MOAs or MOUs between the DWR and regulatory agencies (consistent with the "Cutting Green Tape" initiative) to standardize and streamline some permitting elements for multi-benefit projects and provide greater transparency of the regulatory process.
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 Public Draft. 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)	Develop guidance to help project proponents identify components in their projects that meet multi-benefit and Conservation Strategy measurable objectives. Project proponents 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
P06d	Regional permitting could result in better consistency in permit requirements	1 - Included in Conservation Strategy Public Draft. 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. Established permitting mechanisms, such as HCPs, RCISs/MCAs, etc. can facilitate coordinated planning of multi-benefit projects throughout a region or corridor, potentially expediting permitting and providing a mechanism to secure advance mitigation.	Not Applicable

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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 Public Draft.	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 link. (Refer to P02 &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
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 Public Draft. 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, P02 & P06c.)	(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. Project proponents 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
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

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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 Public Draft. 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.	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.	Not Applicable
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 were available.	Not Applicable	Not Applicable
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 - Considered for inclusion in CVFPP Public Draft.	The overarching goal of assisting underserved communities is included in the CVFPP.	Not Applicable	(Table 3-3 #01) Review existing agency governance and authorities to identify overlapping authorities and propose meaningful recommendations for reconciliation between and among local, State, and federal levels of government to improve the implementation of flood projects, particularly in rural and underserved communities.
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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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) Use mitigation banks or create mitigation credits through a mitigation credit agreement, as appropriate, and for opportunities to streamline costs such as purchasing or 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

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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 Public Draft.	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
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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	The 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) Explore, create, and implement regional-scale and long-term permitting mechanisms (administrative structures, protocols, interagency cooperative agreements, etc.) in conjunction with resource agencies, for the implementation and O&M of flood management activities, including multi-benefit projects. (Table 3-3 #09) Incorporate 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 management and 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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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

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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 - Considered for inclusion in CVFPP Public Draft.	Not Applicable	Not Applicable	(Table 3-3 #06) Obtain increased State and federal stable funding for flood management and multi-benefit for capital projects and ongoing investments in the SPFC.
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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	Not Applicable	(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 to develop protocols to find efficiencies among agencies as appropriate.	(Table 3-3 #08) Establish regional technical advisory committees to improve coordination, as well as landscape-scale connectivity, and develop 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 Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	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 best available science, tools, and data to improve understanding of the condition, performance, and response of floodplain and flood system for CVFPP updates, Conservation Strategy updates, and related performance tracking systems in collaboration with partners (S/F/L). (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.
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 best available science, tools, and data to improve understanding of the condition, performance, and response of floodplain and flood system for CVFPP updates, Conservation Strategy updates, and related performance tracking systems in collaboration with partners (S/F/L).

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P24	Continue to align other statewide plans – comprehensive approach not piecemeal or incremental approach to planning multiple benefit projects.	1 - Included in Conservation Strategy Public Draft. 2 - Considered for inclusion in CVFPP Public Draft.	Not Applicable	Refer to content in Section 3.4.1	(Table 3-3 #01) Champion and manage agency coordination on multi-benefit project funding on or near SPFC facilities, facilitating interagency coordination before issuing guidelines to sync schedules, funding strategies, and priorities; and align various funding programs to best advance multi-benefit projects. Review existing agency governance and authorities to identify overlapping authorities and propose meaningful recommendations for reconciliation between and among local, State, and federal levels of government to improve implementation of flood projects, particularly in rural and underserved communities.
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 Public Draft (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, I07)	Refer to content in Appendix F.	Not Applicable
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, P01)	Not Applicable	Not Applicable
P27	Ensure regular engagement of local communities throughout project development, design, and construction of projects.	4 - Already being implemented by other ongoing activities.	Refer to P26	Not Applicable	Not Applicable
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 Public Draft (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).	6 - Outside the scope of CVFPP and Conservation Strategy.	Tracking habitat and mitigation is a key component of the CVFPP; however, this level of detail is beyond the scope of the CVFPP/Conservation Strategy. (Refer to T03)	Not Applicable	Not Applicable

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address this Recommendation
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 T03a, T03b)	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
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 Public Draft (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.	(3.3.5) DWR has been developing internal data management and decision support tools to balance its DWR's compensatory mitigation needs and other habitat obligations, while working toward goals to increase the quantity and quality of habitats and contributing to species' recovery. These decision support tools complement the FPTS: 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 Public Draft (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 Public Draft (Appendix F). 4 - Already being implemented by other ongoing activities.	Refer to T03a	Refer to content in Appendix F.	Not Applicable

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address this Recommendation
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 not determined to contribute significantly toward 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 Public Draft (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
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.	4 - Already being implemented by other ongoing activities.	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	Not Applicable

No.	Recommendation	Status of Incorporation of Advisory Committee Recommendations [a]	Comments	How the Public Draft of the Conservation Strategy can address this Recommendation	How the Working Draft of the 2022 CVFPP Update can address 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 T03a	Not Applicable

[a]
1. Included in Conservation Strategy Public Draft.
2. Considered for inclusion in CVFPP Public Draft.
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:

& = and

AB = assembly bill

CAL EPA = California Environmental Protection Agency

CDFW = California Department of Fisheries and Wildlife

CEQA = California Environmental Quality Act

CESA = California Endangered Species Act

CNRA = California Natural Resources Administration

CS = Conservation Strategy

CVFPB = Central Valley Flood Protection Board

CVHE = Central Valley Habitat Exchange

DWR = California Department of Water Resources

EcoFIP = ecological floodplain inundation potential

F = federal

FESA = federal Endangered Species Act

FMAP = Flood Maintenance Assistance Program

FPTS = Flood Performance Tracking System

FROA = Floodplain Restoration Opportunity Analysis

HCP = habitat conservation plan

ITP = incidental take permit

MCA = mitigation credit agreement

MOA = memorandum of agreement

MOU = memorandum of understanding

O&M = operations and maintenance

OMRR&R = operations and maintenance, repair, replacement, and rehabilitation

RCIS = regional conservation investment strategy

RFMP = Regional Flood Management Program

SB = State Bill

Sec. = Section management

SPFC = State Plan for Flood Control

SRA = shaded riverine aquatic

SWIF = Systemwide Infrastructure Framework

WCB = Water Control Board

YB = Yolo Bypass

Appendix H
Climate Change Adaptation for the CVFPP Conservation Strategy Update Memorandum

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Contents

Attachment

Tables

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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 for the CVFPP Conservation Strategy Update Memorandum
Portfolio	Water Resilience Portfolio
RCP	representative concentration pathway
SPA	systemwide planning area
SPFC	State Plan for 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 hydrologic and geomorphic processes	In the context of river systems, the dynamic processes of water flow subsurface, overland, and in rivers and the resulting entrainment, transport, and storage of sediment in river channels and on floodplains.

Glossary Term	Definition
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 California Department of Water Resources 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 California Department of Water Resources 2018.)
shaded riverine aquatic 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.

Glossary Term	Definition
State Plan of Flood Control	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	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 California Department of Water Resources 2018.)

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CHAPTER 1

Introduction

The Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy, or Strategy) (California Department of Water Resources 2016) provides 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 to ecosystem structures and functions (Trenberth and Hurrell 2019, Saether et al. 2019).

This Climate Change Adaptation for the CVFPP Conservation Strategy Update Memorandum (Memorandum)(i.e., 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.

A companion study, entitled “Climate Change Adaptation Measures Report,” is in progress and describes the climate change risks, vulnerabilities, uncertainties, and adaptation approaches for the overall CVFPP planning area; climate change modeling data and information on risks, vulnerabilities, and adaptation approaches are being shared between these two efforts (California Department of Water Resources 2022a). This memorandum is consistent with, and supports the implementation of, the climate change adaptation measures described by Governor Gavin Newsom’s Water Resilience 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 document is intended to inform the 2022 update to the Conservation Strategy, provide the basis to re-evaluate or refine measurable objectives in future updates, and more broadly, provide 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 2

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. These sources are included within the Climate Change Adaptation Measures Report of the 2022 CVFPP Update, which further discusses climate change impacts (California Department of Water Resources 2022a). 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
Climate Change Adaptation Measures Report – California Department of Water Resources (2022)	The Climate Change Adaptation Measures Report (in progress) will discuss the projected changes in temperature, precipitation, snowpack, and hydrology; vulnerabilities for upper watersheds, major reservoirs, rivers and floodplains, groundwater, and the Delta; and the development and application of adaptation strategies to address the impacts of climate change on the Central Valley. Additionally, the Climate Change Adaptation Measures Report will include some discussion of projected impacts to ecosystems and habitats, as well as their associated vulnerabilities. To assess the projected impacts of climate change, three climate change scenarios are assessed and compared: low, median, and high. This approach aids in identifying vulnerabilities that result from these changes, and it helps to frame the adaptation strategies included in the report. Projected changes exhibit differing trends for each hydrometeorological component. In general, temperatures are expected to increase under all future climate scenarios. Average annual precipitation trends vary between climate scenarios, with decreases shown for the low and median scenarios, but an increase for the high climate scenario. Extreme precipitation is projected to increase under all scenarios. Increased temperatures will lead to precipitation falling more as rain rather than snow in higher elevations, leading to decreased snowpack and earlier spring snowmelt. These changes will shift peak flows and timing, increasing flood management concerns in the wet season while creating water availability risks in the dry season. In combination with sea level rise, levee infrastructure, particularly in the Delta, will be under increased stress.	A reference will be provided once the document has been completed.

Document Title and Author	Description	Reference
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 § 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 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 to 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

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CHAPTER 3

Projected Hydroclimate Changes and Ecosystem Responses

3.1 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 results is provided in the following section; more detail can be found in the Climate Change Analysis Technical Memorandum (California Department of Water Resources 2022a), which is currently under development.

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

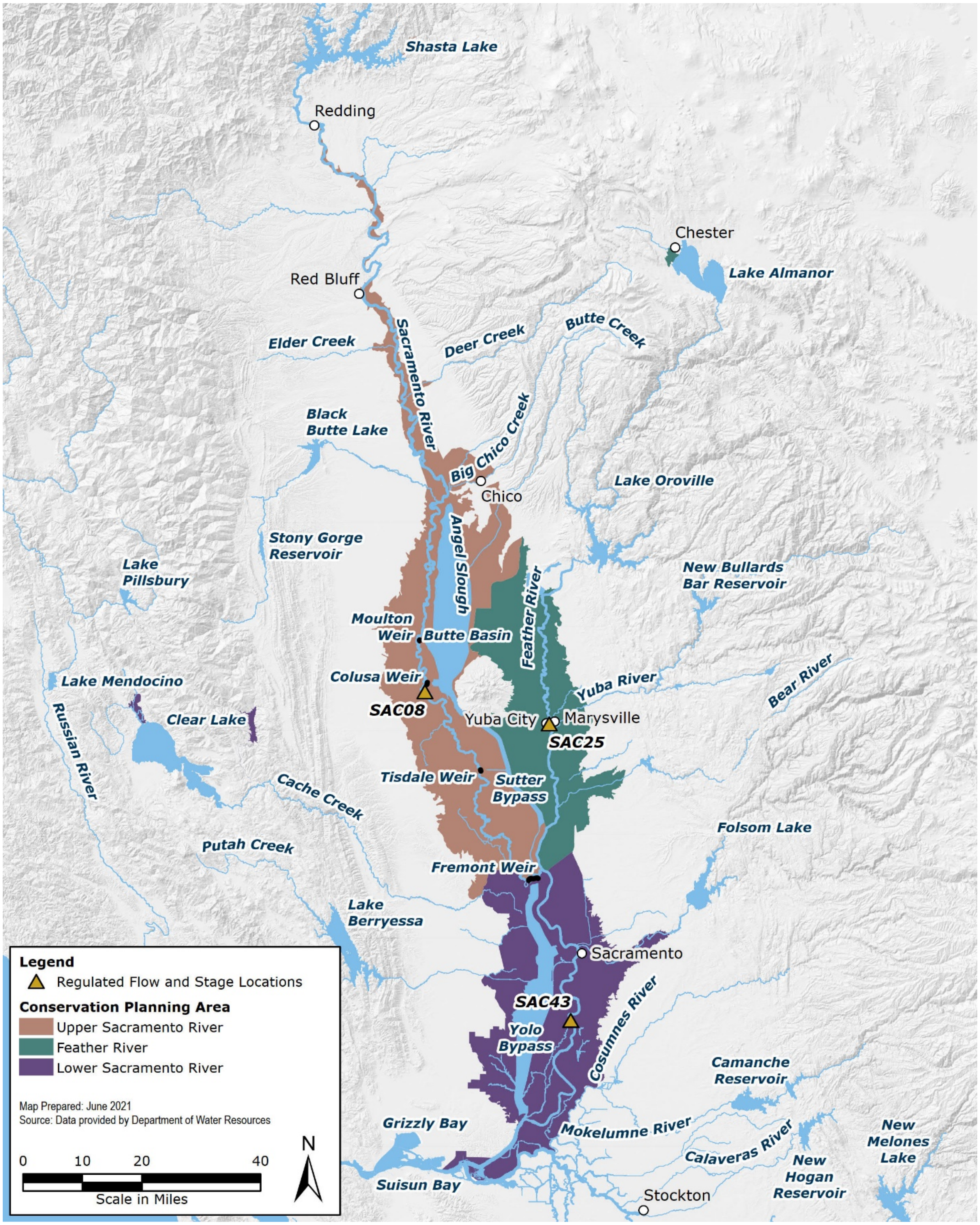
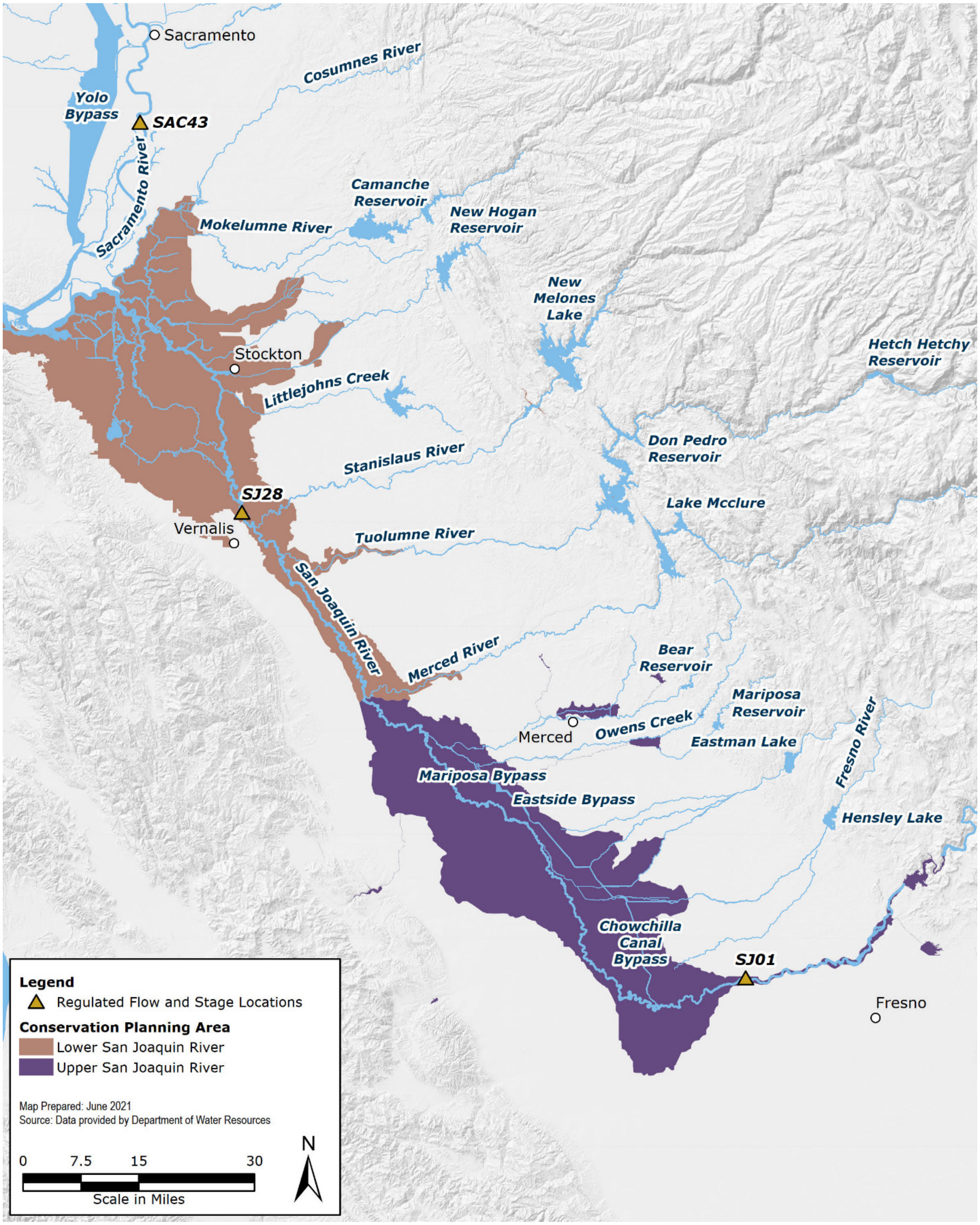


Figure H-2. San Joaquin River Basin Conservation Planning Areas and Analysis Locations

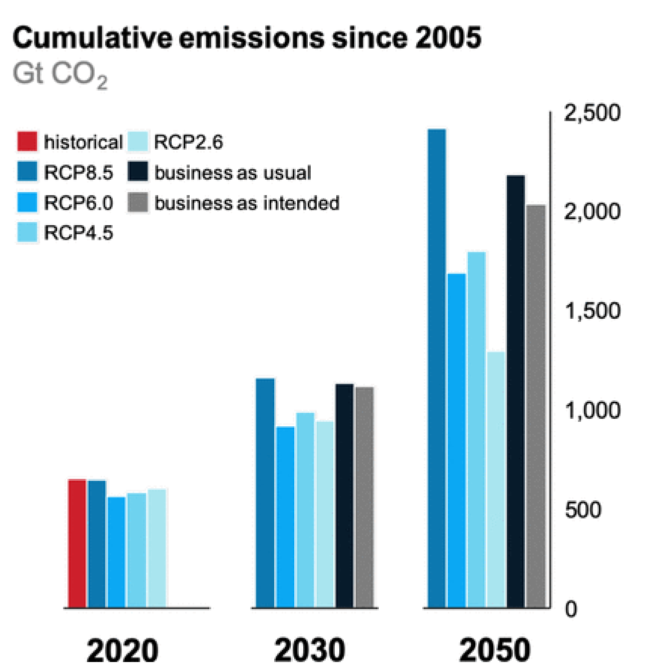


3.1.1 Climate Scenarios

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; California Department of Water Resources 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, median, 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 (California Department of Water Resources 2022a). Ensemble members are plotted based on the projected change in precipitation and temperature. The median scenario was developed from the 32 climate projections nearest to the median 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 (California Department of Water Resources 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, median, 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 (California Department of Water Resources 2022a).

3.1.2 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. (3.1.3)
Extreme Temperature	Extreme temperatures to increase under all three climate scenarios for all CPAs. (3.1.3)
Mean Monthly Temperature	Increased temperatures throughout the year, with greater divergence from historical temperatures in the summer. (3.1.3)

Climate Change Component	Projected Change[b]
Mean Annual Precipitation	Variable, depending on climate change scenario used (decreases under low and median; increases under high). (3.1.4)
Extreme Precipitation	Annual average three-day maximum precipitation to decrease under the low climate scenario and increase under the median 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. (3.1.4)
Mean Monthly Precipitation	Variable, depending on climate change scenario used for winter months (decreases under low; increases under median and high). Decreased mean monthly precipitation during the remainder of the year. (3.1.4)
Snowpack	Reduced snowpack due to changing form of precipitation (rain than snow) and earlier spring snowmelt. (3.1.6)
Streamflow Seasonality and Timing	Shift in streamflow to the earlier months because of earlier spring snowmelt runoff and more precipitation as rain than snow. (3.1.7)
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. (3.1.8)
Sea Level Rise	Increasing rate of sea level rise as warming conditions continue. Increased water levels and salinity in the Delta. (3.1.9)
Groundwater	Greater stress on groundwater supplies from decreased surface water quantities and evapotranspiration in summer months (3.1.10)
Wildfires	More severe wildfires in upper watersheds under increased warming conditions. Increased peak flows, debris flows, and contaminant presence downstream of burned areas. (3.1.11)

[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

3.1.3 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

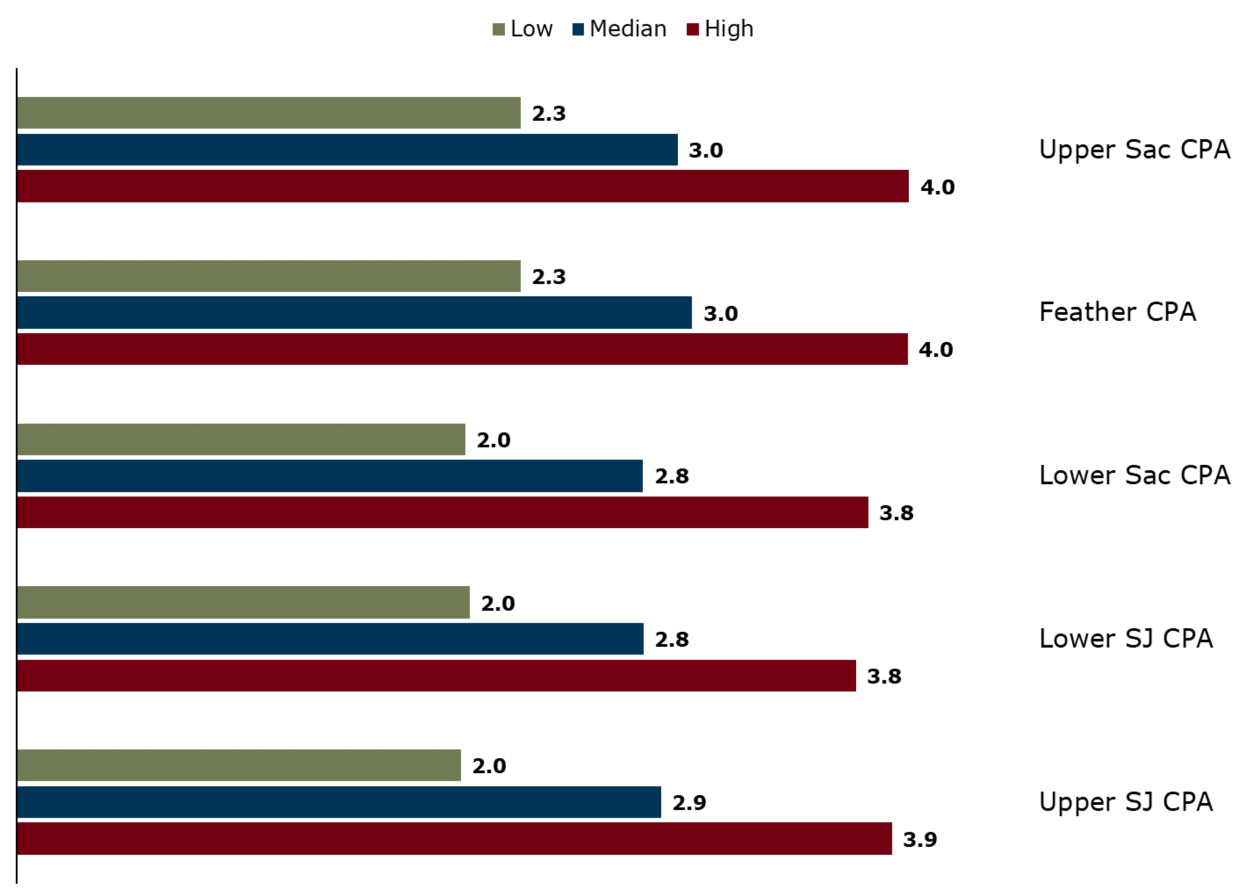
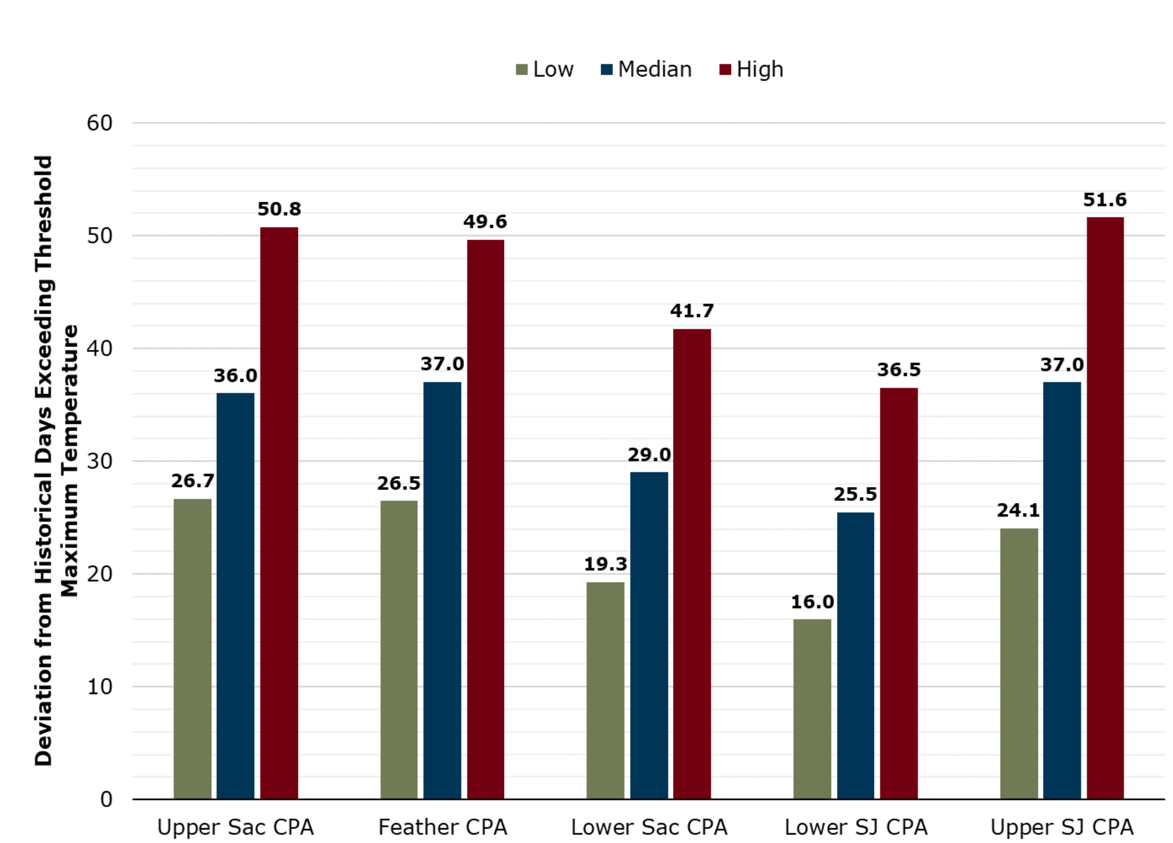


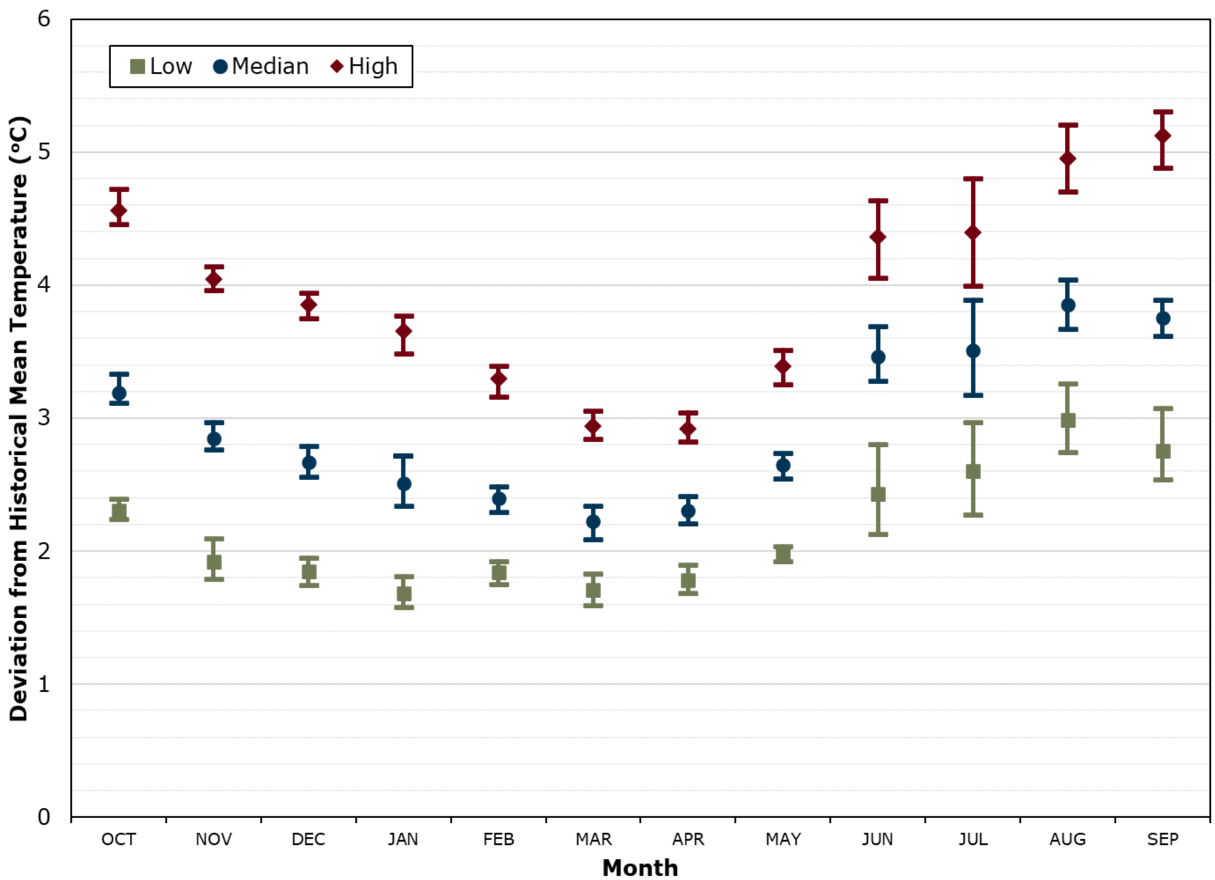
Figure H-5 examines maximum temperature changes for all CPAs. For this analysis, a threshold temperature was determined using the 98th percentile of daily maximum temperature between January 1, 1971 and December 31, 2000. This historical reference period was selected to be consistent with the approach 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 to 102.9 degrees Fahrenheit). 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, median, 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 (Lower Sacramento and Lower San Joaquin) 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 3.3 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, median, 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.1-1 through H.1-5).

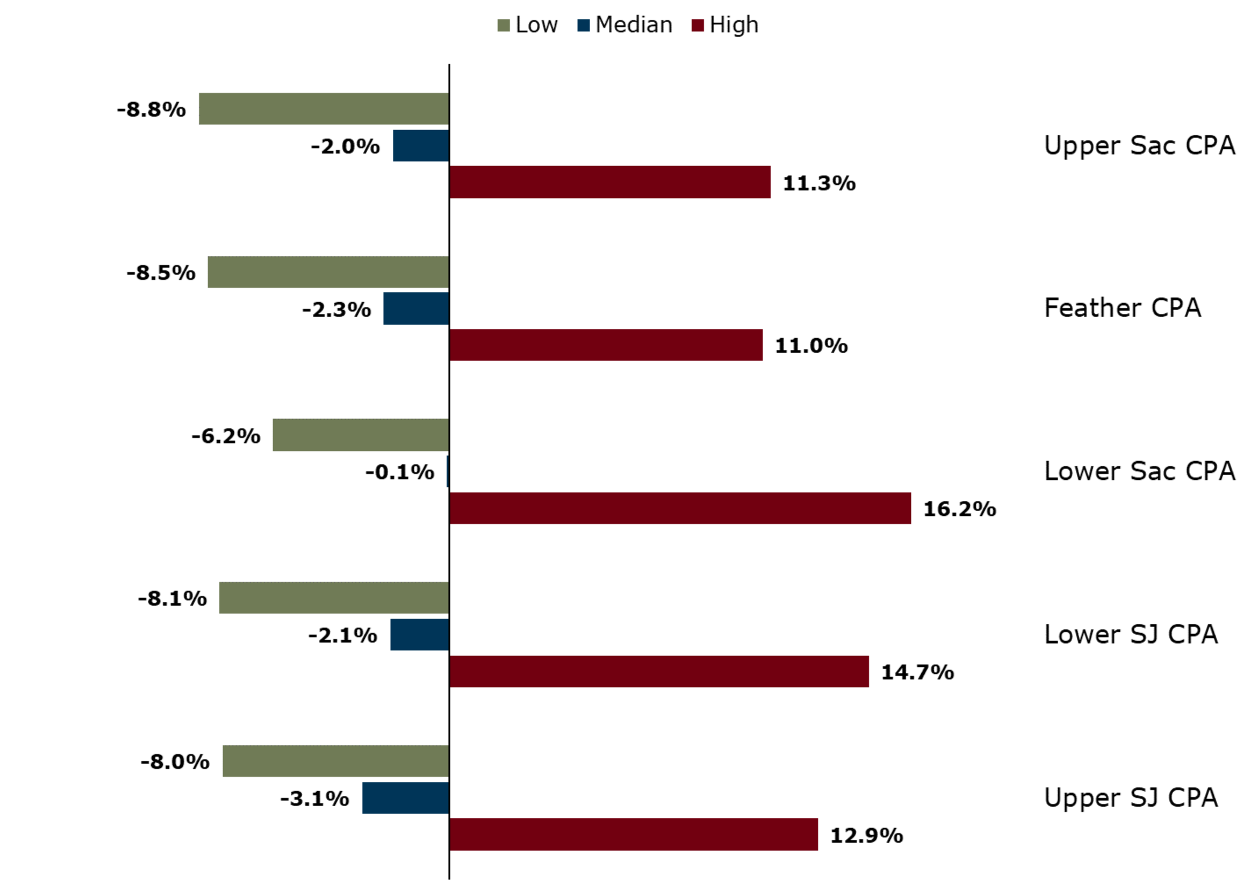
Figure H-6. Range of Projected Changes in Mean Monthly Temperature for all CPAs



3.1.4 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 median 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

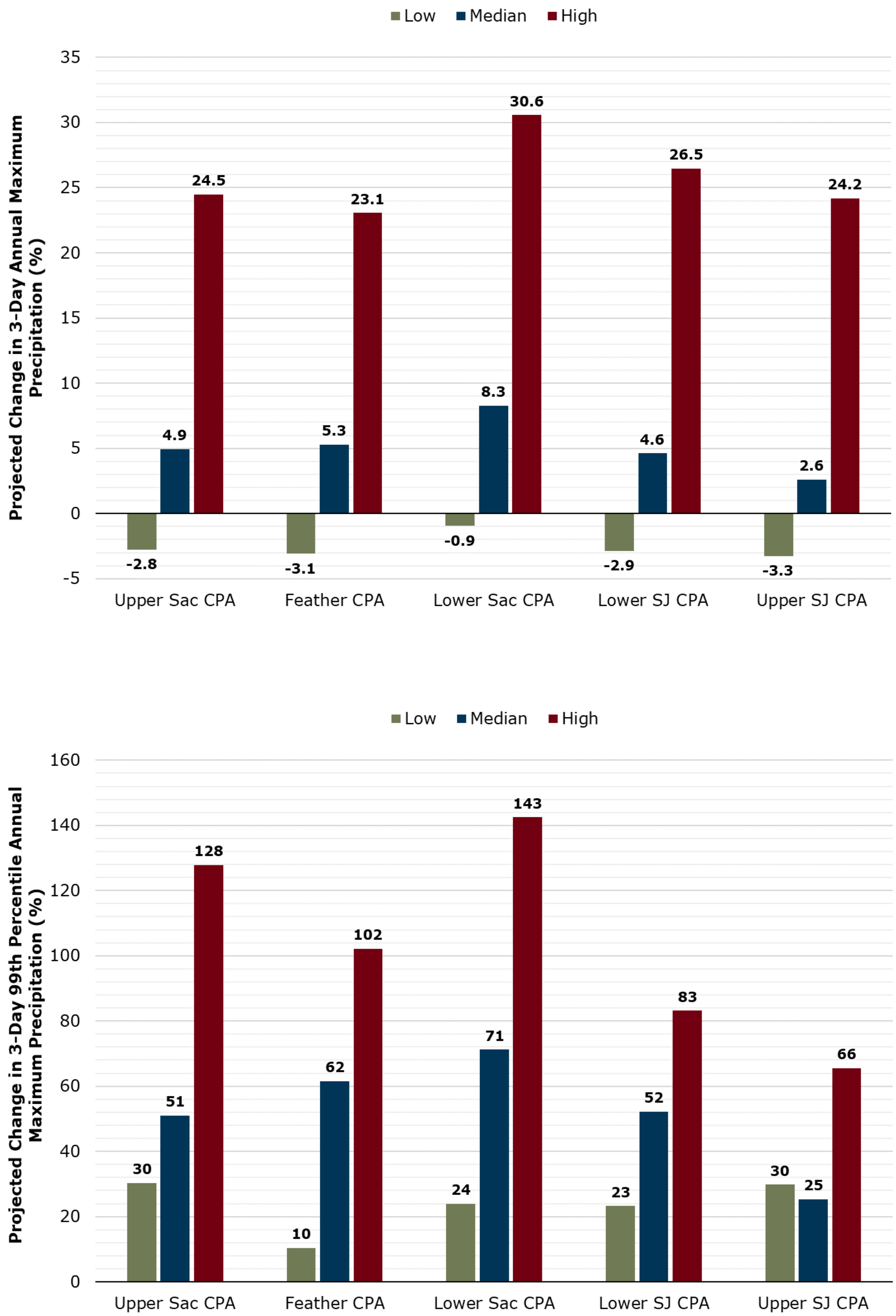


The annual maximum precipitation amounts for the historical period of water years between 1916 and 2011 were compared to the low, median, and high climate change scenarios. The three-day average (shown on the first panel of Figure H-8) and 99th percentile (shown on the second panel of Figure H-8) annual 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 median 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.

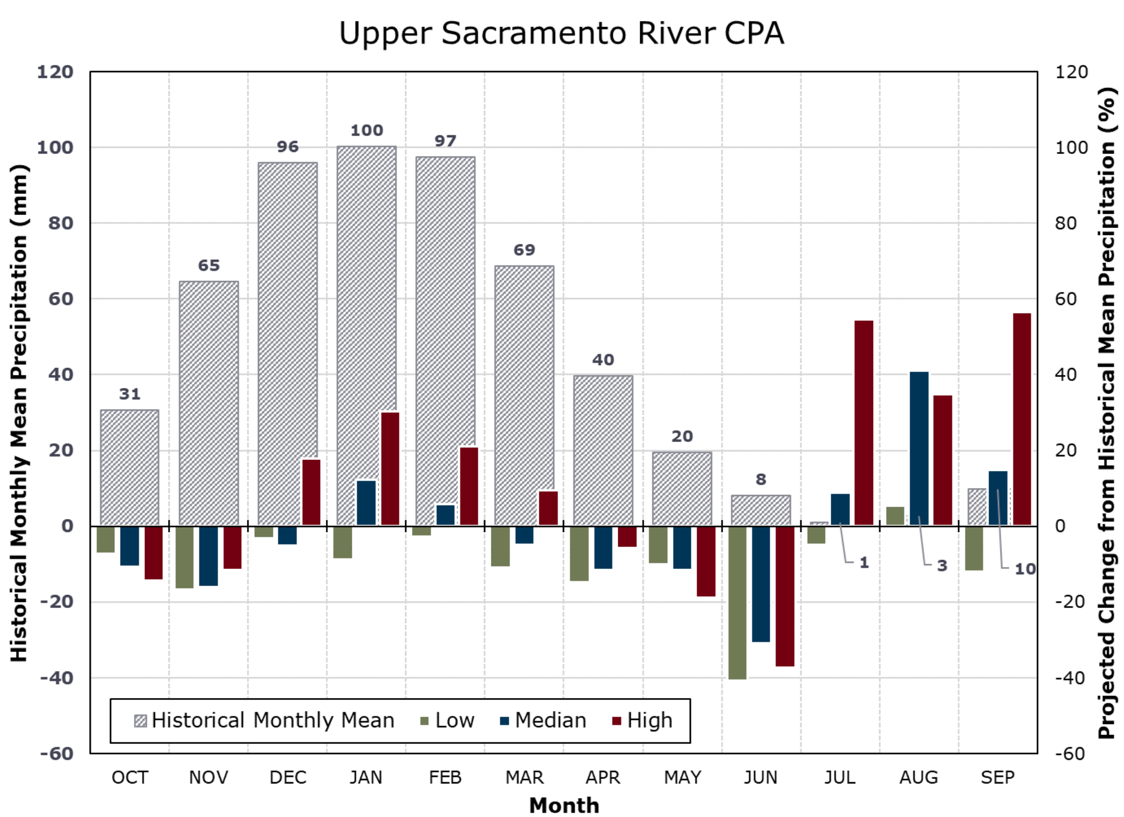
The increase in three-day 99th percentile annual maximum precipitation can be attributed to more intense atmospheric river (AR; a long narrow, band of condensed water vapor that transports moisture from in the atmosphere) precipitation events. AR events have historically contributed between roughly one-third 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).

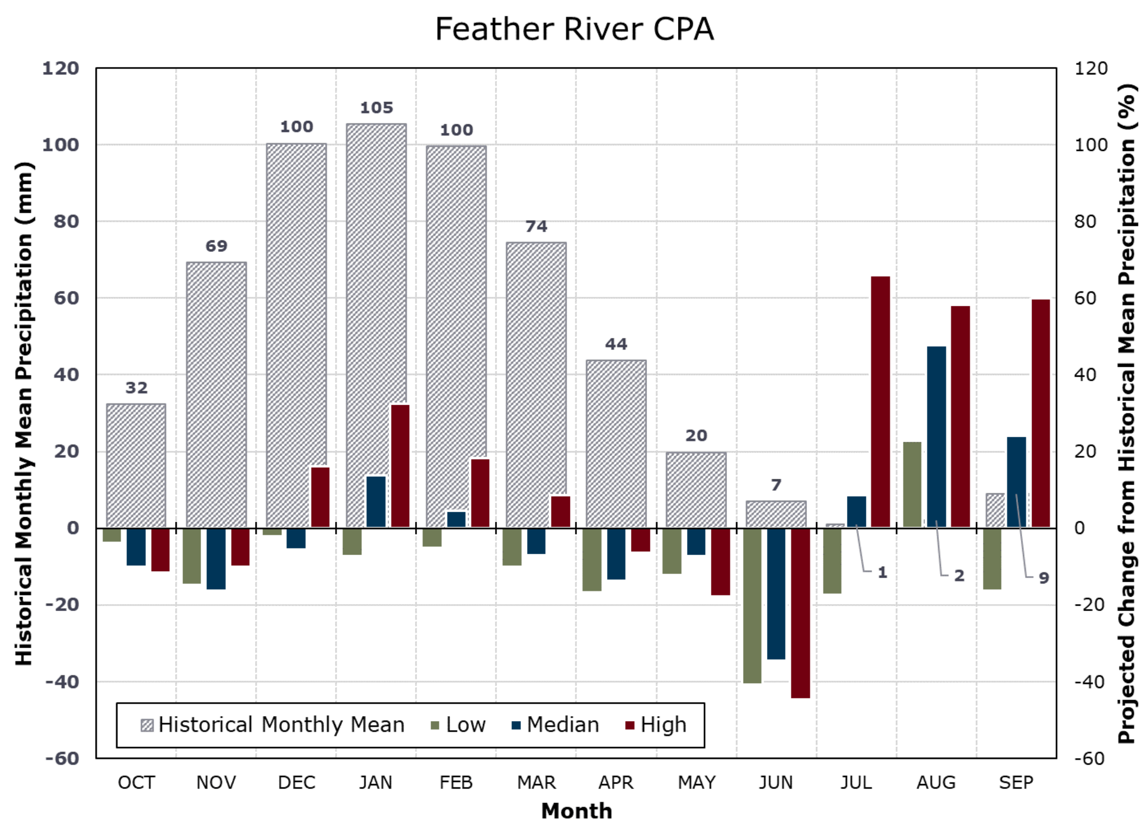
Figure H-8. Projected Change in Three-day Mean (first panel) and 99th Percentile (second panel) Annual Maximum Precipitation by CPA

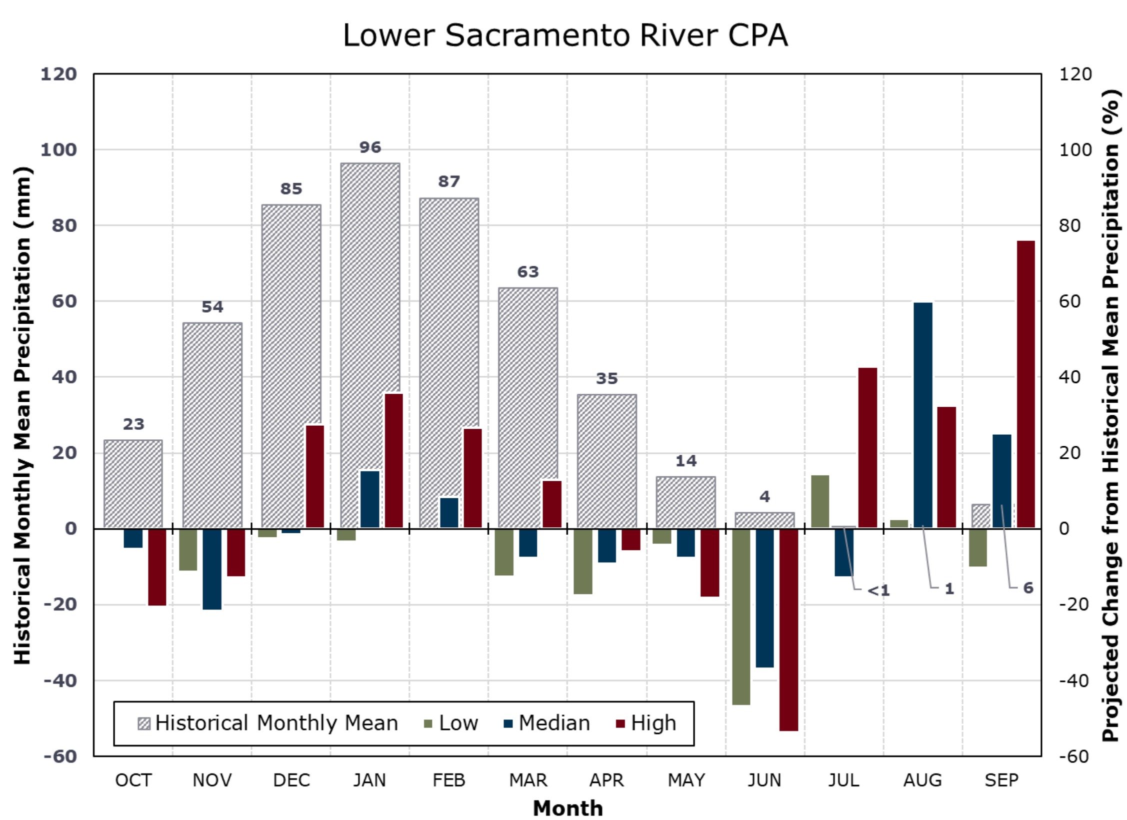


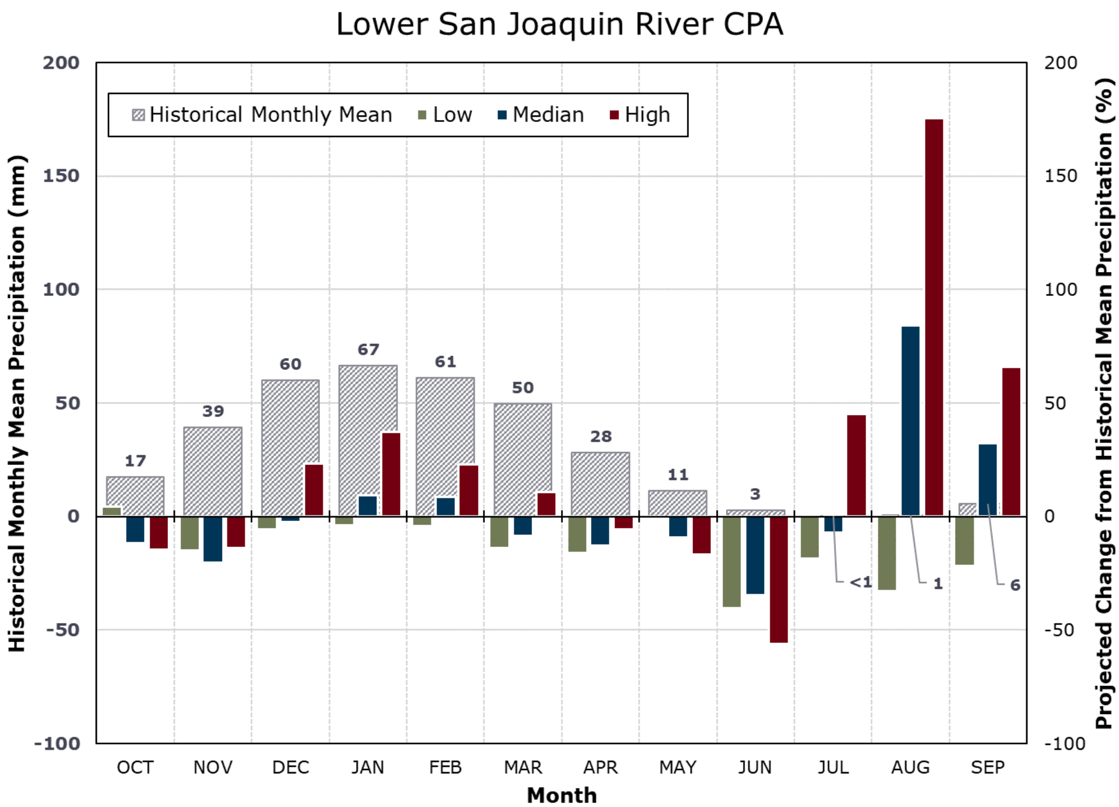
As depicted with the monthly projected changes in mean temperature, all CPAs show similar precipitation trends over the course of the year. Figure H-9 highlights the change in average monthly precipitation for all CPAs under each of the climate change scenarios, as well as baseline quantities (values labeled on the plots). During wetter months (December through March), the high and median 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 median 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.

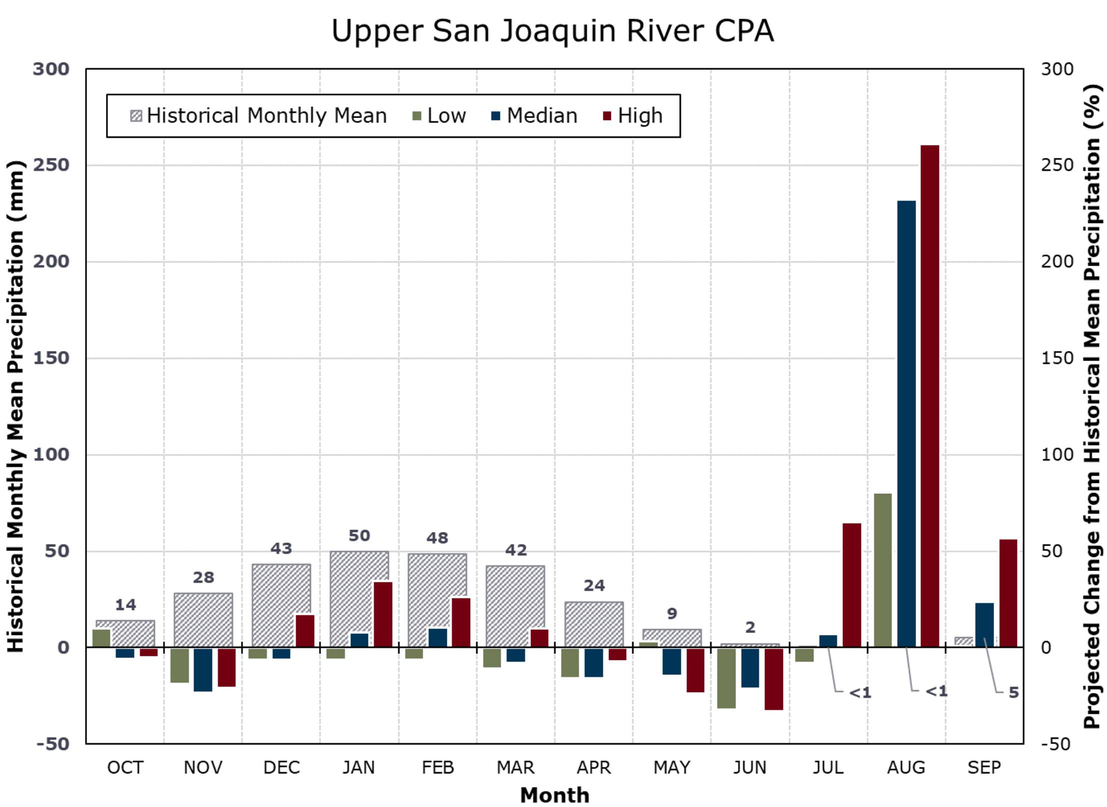
Figure H-9. Projected Changes in Mean Monthly Precipitation by CPA




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
Median
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
Median
High
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Month


Lower San Joaquin River CPA
Historical Monthly Mean
Low
Median
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
Median
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
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JUL
AUG
SEP
Month

3.1.5 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 are used to assess changes in hydrologic variables described in Sections 3.1.6 and 3.1.8.

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). The *2022 CVFPP Update Evaluation Scenarios and Analysis Setup memorandum* (California Department of Water Resources 2022b) provides more details. Scenarios reflect watershed-specific assumptions for climate change, and both of the 2072 projections are presented for the median climate change scenario.

3.1.6 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 (California Department of Water Resources 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.

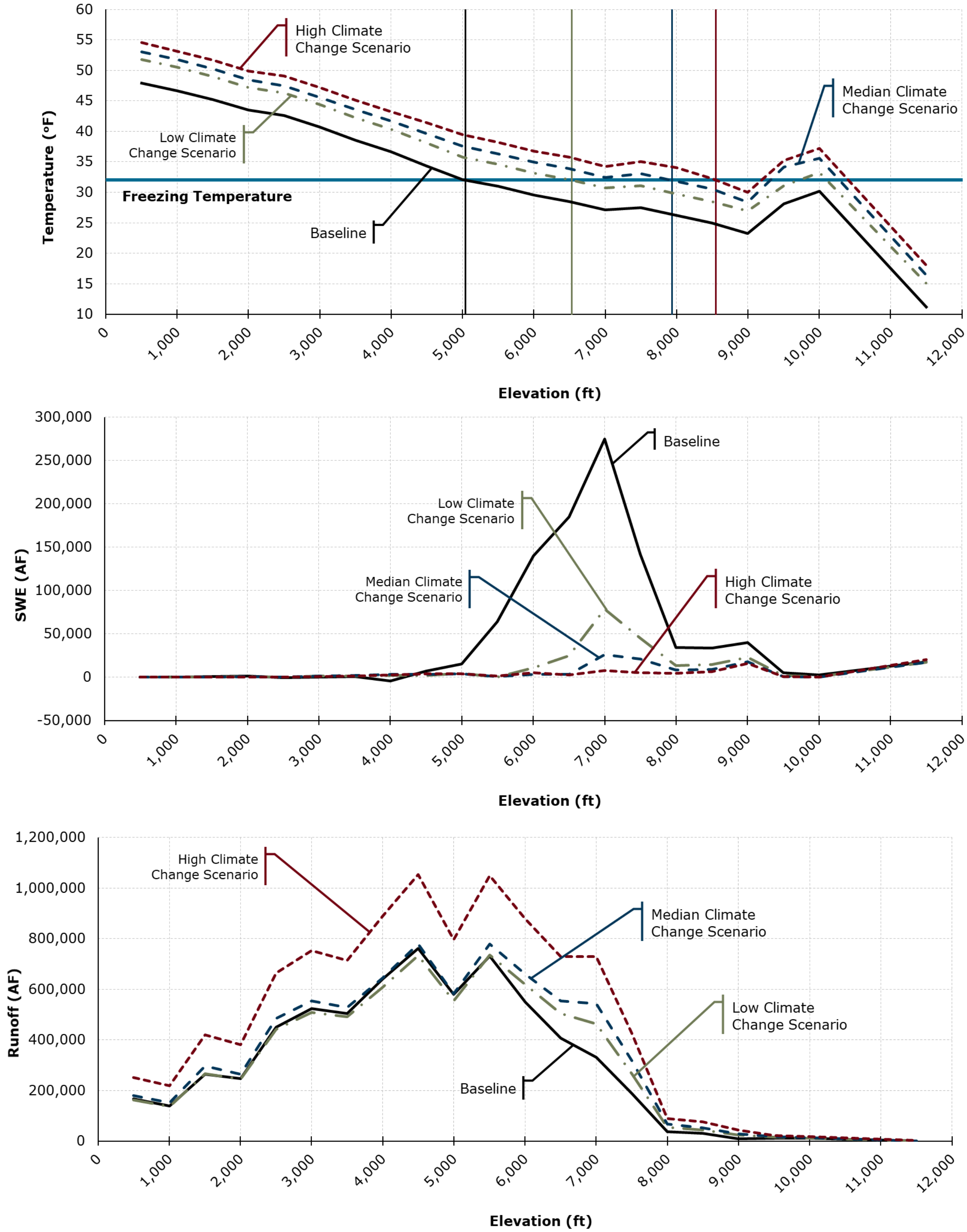
However, given the changes to both temperature and precipitation, the timing of snowmelt and composition of snowpack is projected to change, ultimately altering runoff characteristics (Pierce et al. 2018). Figures H-10 and H-11 display the change in the 1997 flood event average temperature (top panel), snow water equivalent (SWE; middle panel), and runoff (bottom panel) under the low, median, 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 (California Department of Water Resources 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, median, 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, median, 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 (California Department of Water Resources 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 (California Department of Water Resources 2022a).

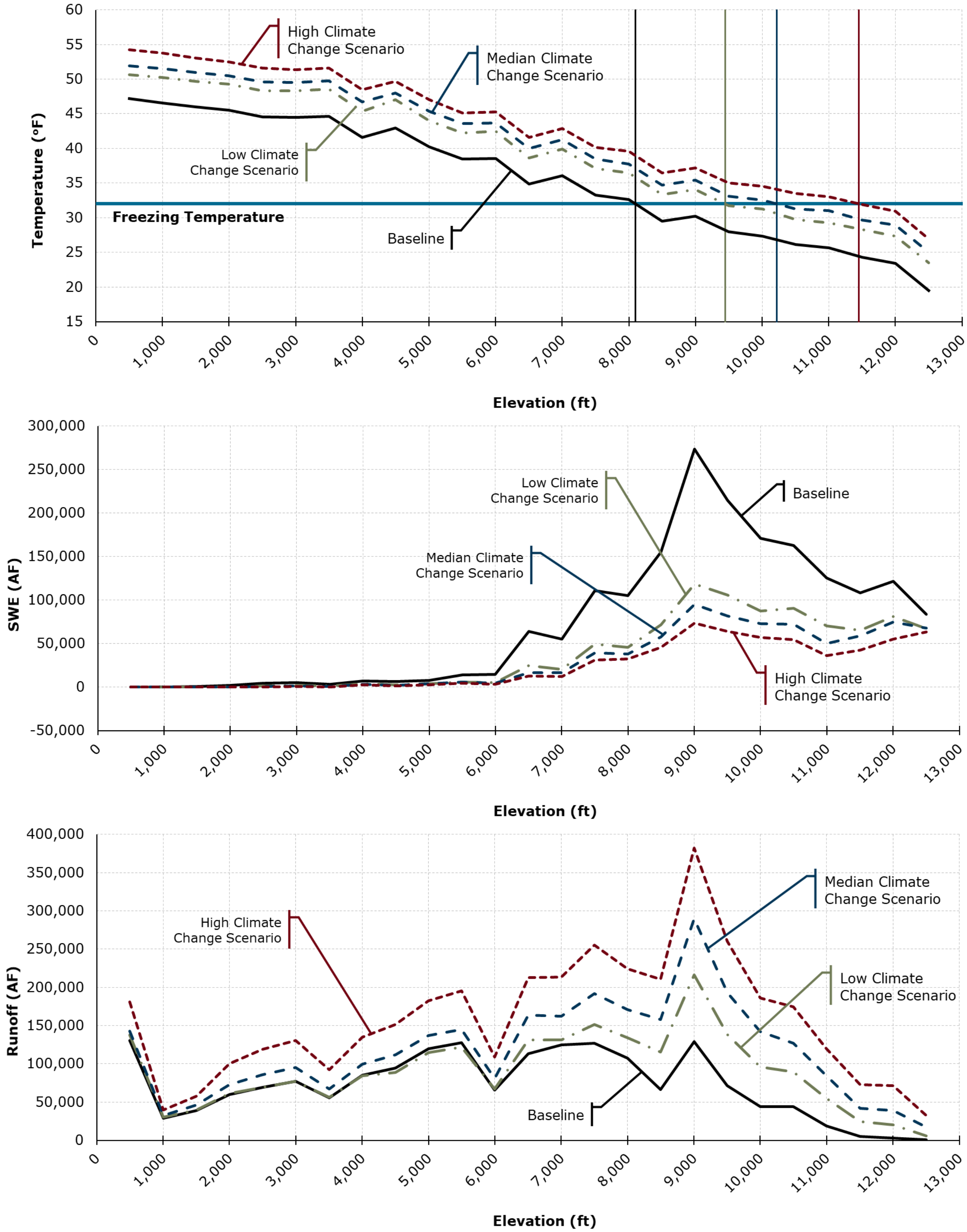
As a result of the overall decrease in snowpack, SWE, and timing of snowmelt, water networks will experience higher runoff flows earlier in the year, which are likely to induce increased flood risks and changes to water management operations. Under the high climate change scenario, runoff volumes are 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 median 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)

3.1.7 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 late-spring to early-summer (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.

3.1.8 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 median 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 (California Department of Water Resources 2022a). 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 Analysis Report: Climate Change Volume Frequency Analysis (California Department of Water Resources 2022c).

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 3.1.5). 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-percentincrease 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, a 3.0-foot and 2.8-foot increase 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

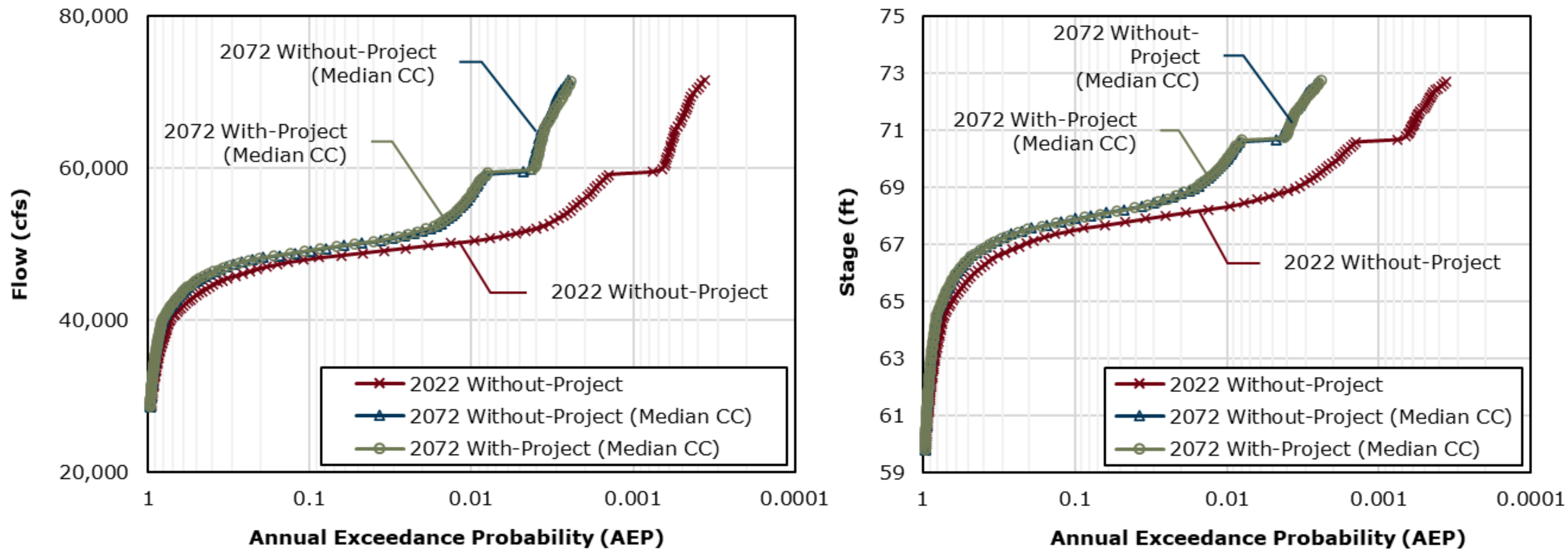


Table H-4. SAC08 (Upper Sacramento River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Median CC) Flow (cfs)	2072 With-project (Median 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 (ft)**	**2072 Without-project (Median CC) Stage (ft)**	**2072 With-project (Median CC) Stage (ft)**	**2022 Without-project vs 2072 Without-project Difference (ft)**	**2022 Without-project vs 2072 With-project Difference (ft)**	**2072 Without-project vs 2072 With-project Difference (ft)**
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
ft = foot (feet)
vs = versus

Figure H-13. SAC25 (Feather River CPA) Regulated Flow (Left) and Stage (Right)- frequency Curves

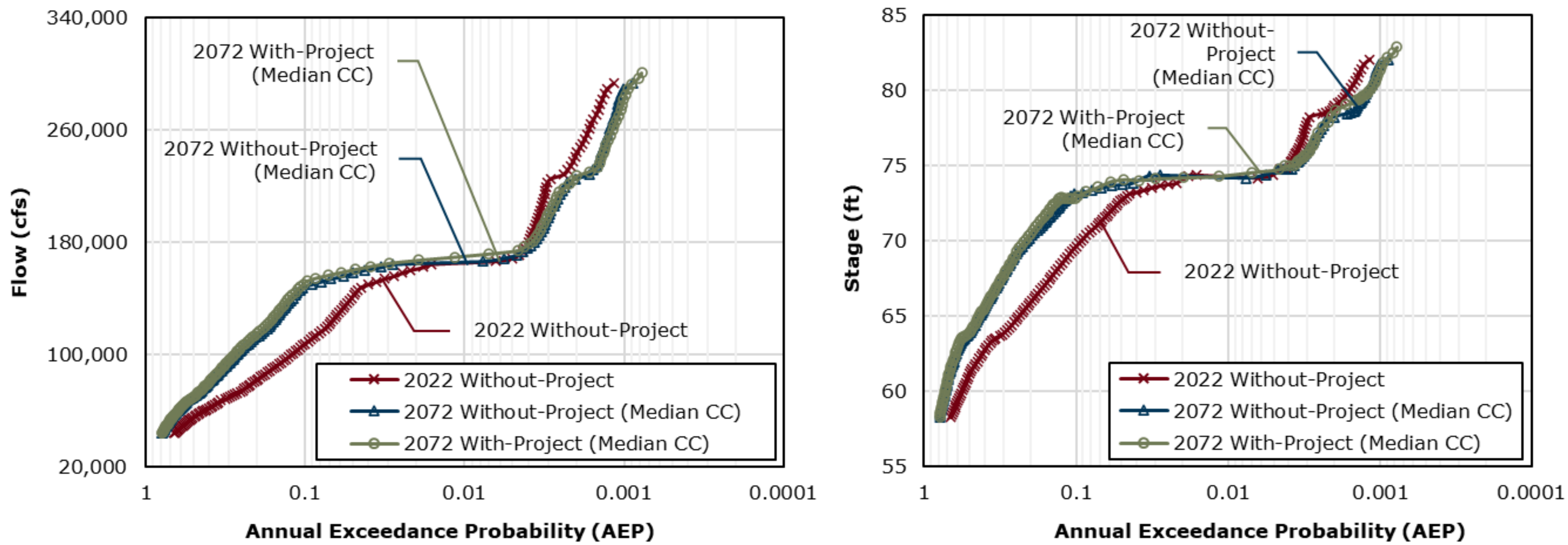


Table H-5. SAC25 (Feather River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Median CC) Flow (cfs)	2072 With-project (Median 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 (ft)**	**2072 Without-project (Median CC) Stage (ft)**	**2072 With-project (Median CC) Stage (ft)**	**2022 Without-project vs 2072 Without-project Difference (ft)**	**2022 Without-project vs 2072 With-Project Difference (ft)**	**2072 Without-project vs 2072 With-project Difference (ft)**
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
ft = foot (feet)
vs = versus

Figure H-14. SAC43 (Lower Sacramento River CPA) Regulated Flow (Left) and Stage (Right)-frequency Curves

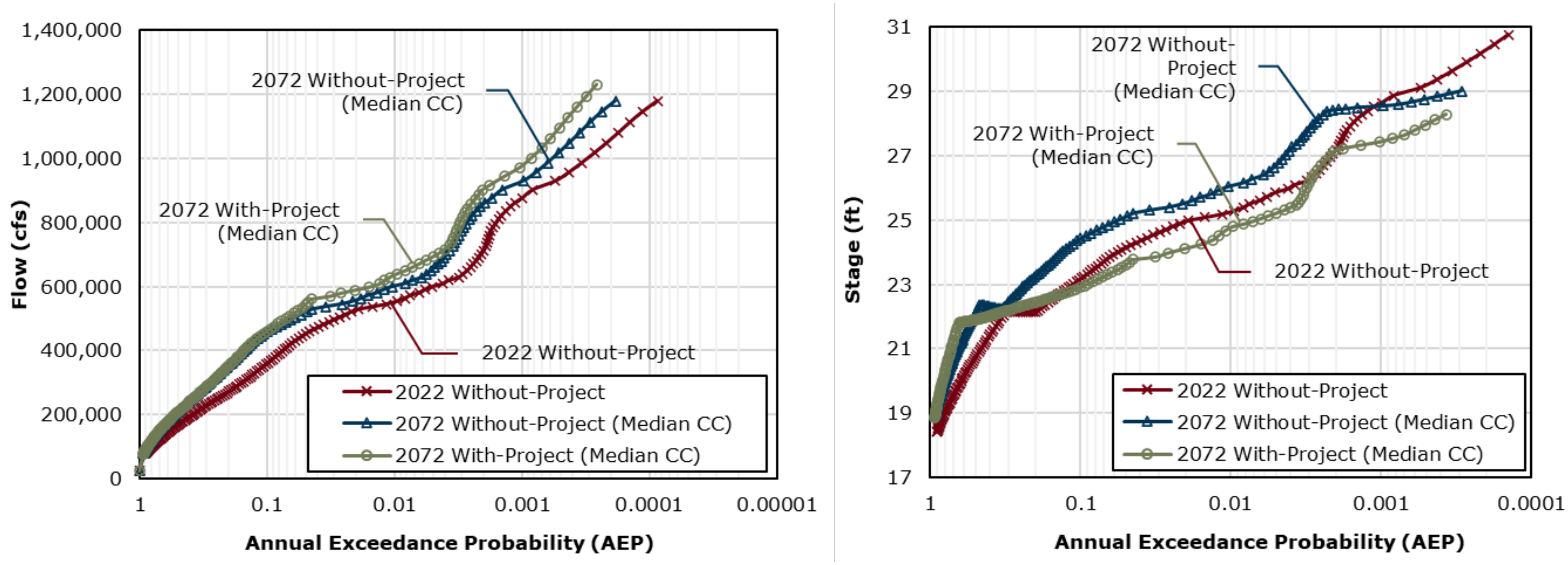
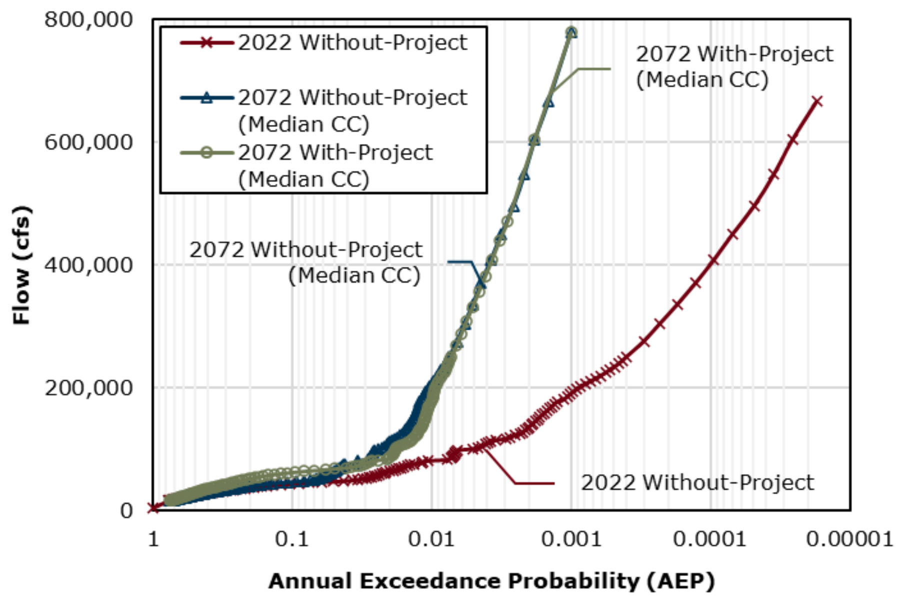


Table H-6. SAC43 (Lower Sacramento River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Median CC) Flow (cfs)	2072 With-project (Median 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 (ft)**	**2072 Without-project (Median CC) Stage (ft)**	**2072 With-project (Median CC) Stage (ft)**	**2022 Without-project vs 2072 Without-project Difference (ft)**	**2022 Without-project vs 2072 With-project Difference (ft)**	**2072 Without-project vs 2072 With-project Difference (ft)**
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
ft = foot (feet)
vs = versus

Figure H-15. SJ28 (Lower San Joaquin River CPA) Regulated Flow (Left) and Stage (Right)-frequency Curves



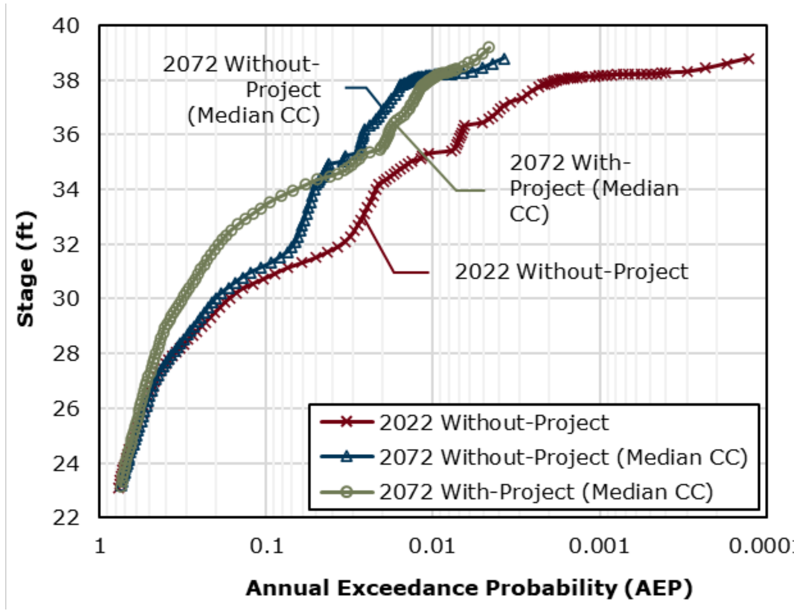


Table H-7. SJ28 (Lower San Joaquin River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Median CC) Flow (cfs)	2072 With-project (Median 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 (ft)**	**2072 Without-project (Median CC) Stage (ft)**	**2072 With-project (Median CC) Stage (ft)**	**2022 Without-project vs 2072 Without-project Difference (ft)**	**2022 Without-project vs 2072 With-project Difference (ft)**	**2072 Without-project vs 2072 With-project Difference (ft)**
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
ft = foot (feet)
vs = versus

Figure H-16. SJ01 (Upper San Joaquin River CPA) Regulated Flow (Left) and Stage (Right)-frequency Curves

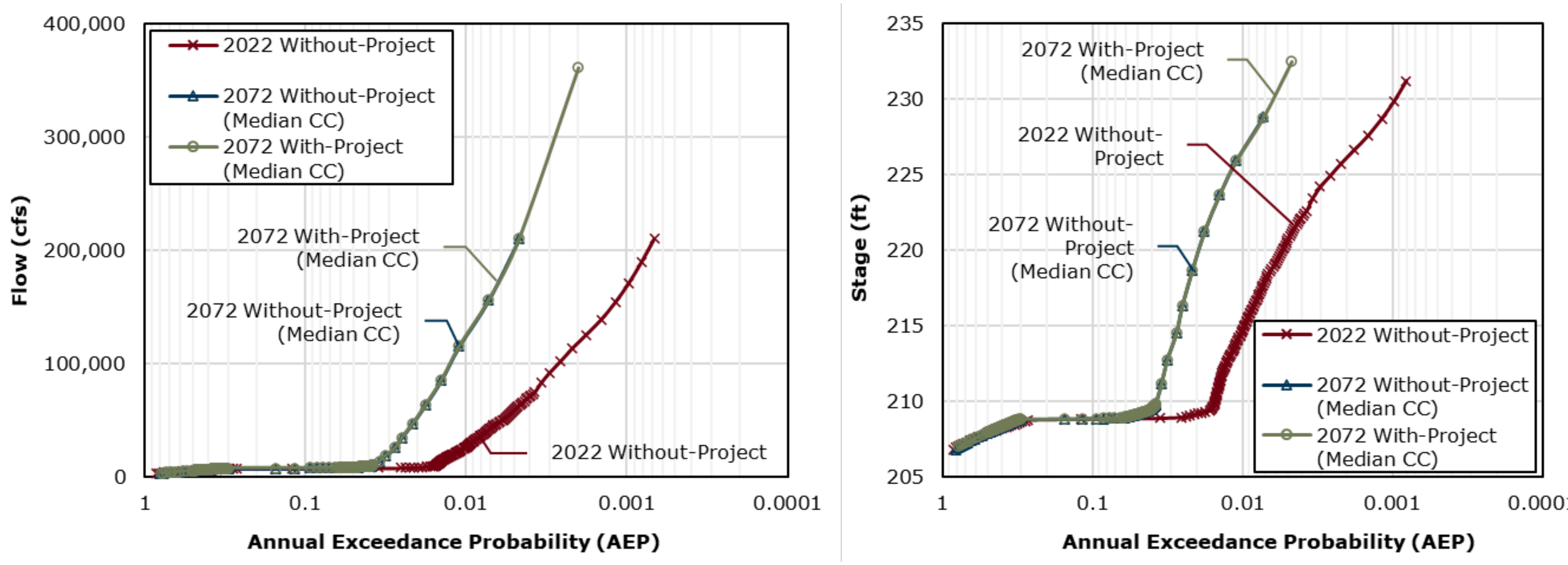


Table H-8. SJ01 (Upper San Joaquin River CPA) 10-year and 100-year Flow and Stage Quantities

AEP	2022 Without-project Flow (cfs)	2072 Without-project (Median CC) Flow (cfs)	2072 With-project (Median 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 (ft)**	**2072 Without-project (Median CC) Stage (ft)**	**2072 With-project (Median CC) Stage (ft)**	**2022 Without-project vs 2072 Without-project Difference (ft)**	**2022 Without-project vs 2072 With-project Difference (ft)**	**2072 Without-project vs 2072 With-project Difference (ft)**
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
ft = foot (feet)
vs = versus

3.1.9 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 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 to 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).

3.1.10 Changes in Groundwater

As described, temperatures are projected to increase under the low, median, 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 (California Department of Water Resources 2013a).

In the Central Valley alone, groundwater storage levels declined by 13 million acre-feet between 2005 and 2010 (California Department of Water Resources 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 (California Department of Water Resources 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).

3.1.11 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).

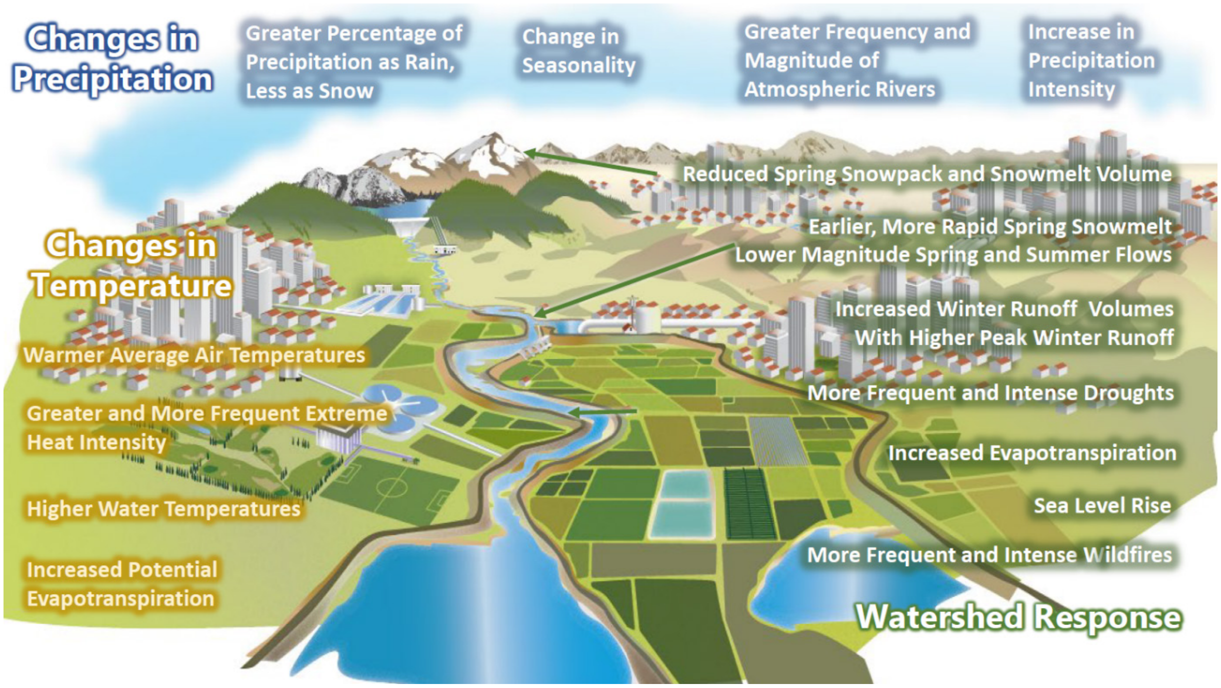
Wildfires are not only associated with substantial damages to property, infrastructure, lives, and ecosystems; they can also lead to downstream impacts. Because most fires in California occur in upper watersheds where there are the greatest number of forested areas, debris and other wildfire-related 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.

3.2 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 3.1 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.

3.3 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.

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 (U.S. Department of the Interior, 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: Valley Elderberry Longhorn Beetle (VELB)	The impacts of climate change on the VELB depend largely on the impacts to 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 a 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 postbreeding 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 4

Potential Adaptation Strategies and Measures

This chapter is organized into two key parts:

1. 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.

2. An overarching climate change adaptation strategy, along with five corresponding adaptation measures.

    a. The first measure consists of direct modifications to the flood control system, grouped into landscape-scale measures, and habitat- and species-specific measures.

    b. 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.

4.1 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 3.1 are outside the range of the natural variability current ecosystems in the Central Valley have historically occurred under. In addition, the increased climatic extremes also increases 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.

4.2 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 2).

2. Analyze the latest climate change modeling to determine probable climatic changes in each CPA (refer to Section 3.1).

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 3.3).

4. Identify regional climate change risks and potential opportunities within each CPA (refer to Chapter 5).

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.

4.2.1 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.

4.2.1.1 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.

a) **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 to 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.

b) **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.

c) **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.

d) **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).

e) **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.

f) **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.

g) **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.

h) **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.

i) 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, they may also increase groundwater recharge, which provides regional ecosystem and water supply benefits consistent with other State and regional water management programs.

4.2.1.2 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

a) **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.

b) **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 giant garter snake, California black rail, riparian brush rabbit, and woodrat.

c) **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: Shaded Riverine Aquatic (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)**

Conservation Strategy Targets	Adaptation Measures
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)**
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)**

Conservation Strategy Targets	Adaptation Measures
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-1)**
Species: Valley Elderberry Longhorn Beetle (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)**

<table>
<tr><th>Conservation Strategy Targets</th><th>Adaptation Measures</th></tr>
<tr><td rowspan="2">Species: Giant Garter Snake (GGS)</td><td>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)</td></tr>
<tr><td>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)</td></tr>
</table>

<table>
<tr><th>Conservation Strategy Targets</th><th>Adaptation Measures</th></tr>
<tr><td>Species: Bank Swallow</td><td>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)</td></tr>
</table>

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)**
Species: Greater Sandhill Crane	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)**

<table>
<tr><th>Conservation Strategy Targets</th><th>Adaptation Measures</th></tr>
<tr><td>Species: Least Bell’s Vireo and Yellow-breasted Chat</td><td>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).</td></tr>
<tr><td>Species: Swainson’s Hawk</td><td>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)</td></tr>
</table>

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 of suitable habitat across the Sacramento River (5 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**)

4.2.2 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.

a) **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.

b) **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.

c) **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.

d) **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.

4.2.3 Adaptation Measure 3: Perform More Detailed Analyses of Climate Change Impacts to 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 to climate change are often due to changes in lower-magnitude, higher-frequency hydrologic events. Further analyses of climate change impacts to ecologically-relevant flows are required to better understand risks and adaptation opportunities.

a) **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, median, and low climate change scenarios were evaluated for the entire period of modeled climate scenarios (present to 2099). This continuous dataset that better captures interannual and intra-annual variability would be invaluable to assess 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 only be calculated 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.

b) **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 (California Department of Water Resources 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.

c) **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.

4.2.4 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 (California Department of Water Resources 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.

a) **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.

b) **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.

4.2.5 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.

a) **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.

b) **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.

c) **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 5

Summary of Regional Climate Change Adaptation Strategies

Building on the potential adaptation measures identified in Chapter 4, 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 (California Department of Water Resources 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 Slough thistle Tricolored blackbird Western yellow-billed cuckoo Yellow-breasted chat
Riparian (restored)	Delta button-celery Least Bell's vireo Riparian brush rabbit Riparian woodrat Swainson's hawk Western yellow-billed cuckoo Yellow-breasted chat Valley elderberry longhorn beetle
Perennial wetland (restored)	Black rail Giant garter snake Greater sandhill crane Slough thistle Tricolored blackbird

[a] Species associations vary by CPA and reach, as shown in the tables within Sections 5.1 to 5.5.

Note:
SRA = shaded riverine aquatic

5.1 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
	SALMONID	Green Sturgeon	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
	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 4.2.1.2, “Habitat and Species-specific Adaptation Measures.”

Notes:
SRA = shaded riverine aquatic

Figure H-18. Lower Sacramento River CPA Reach 1

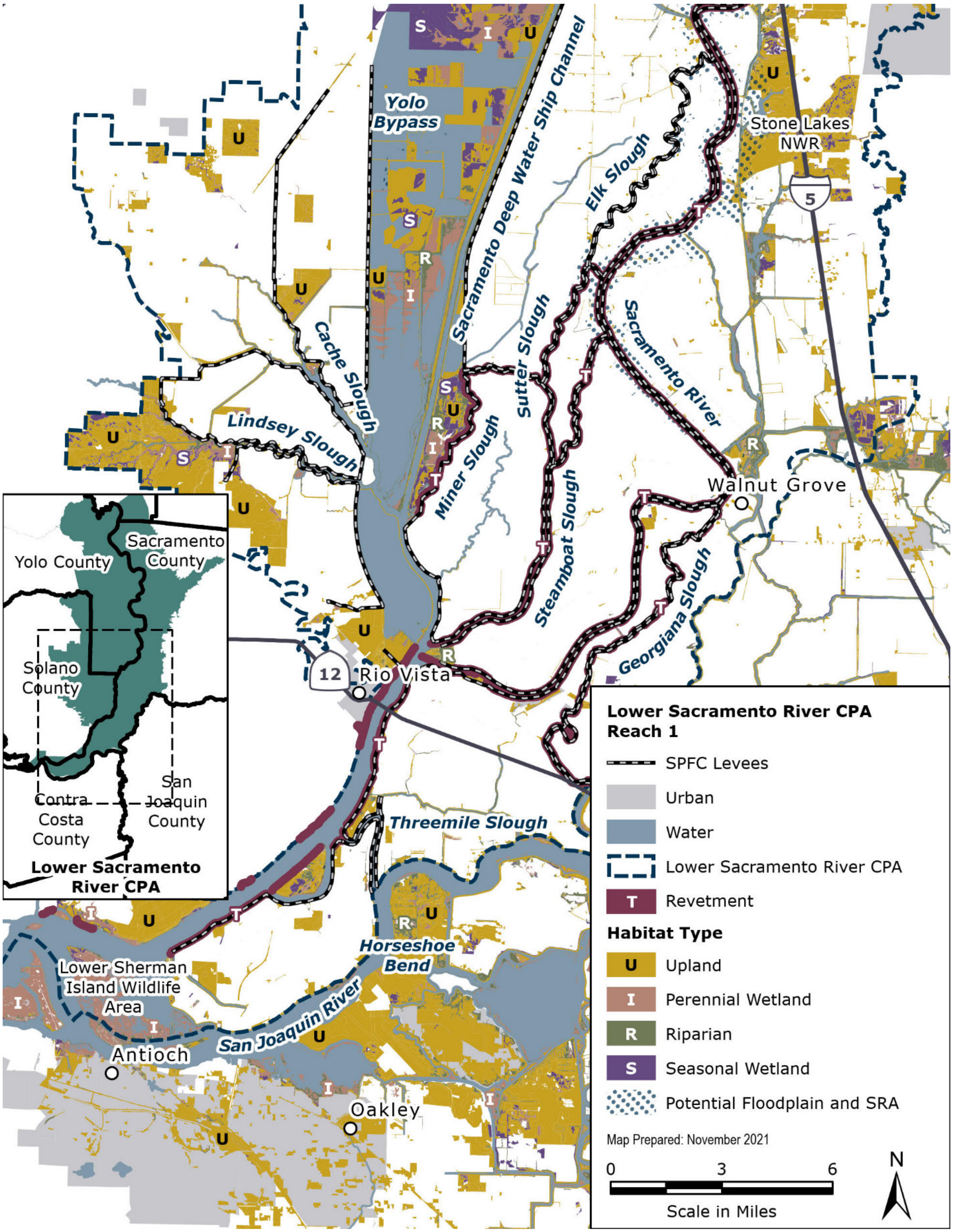
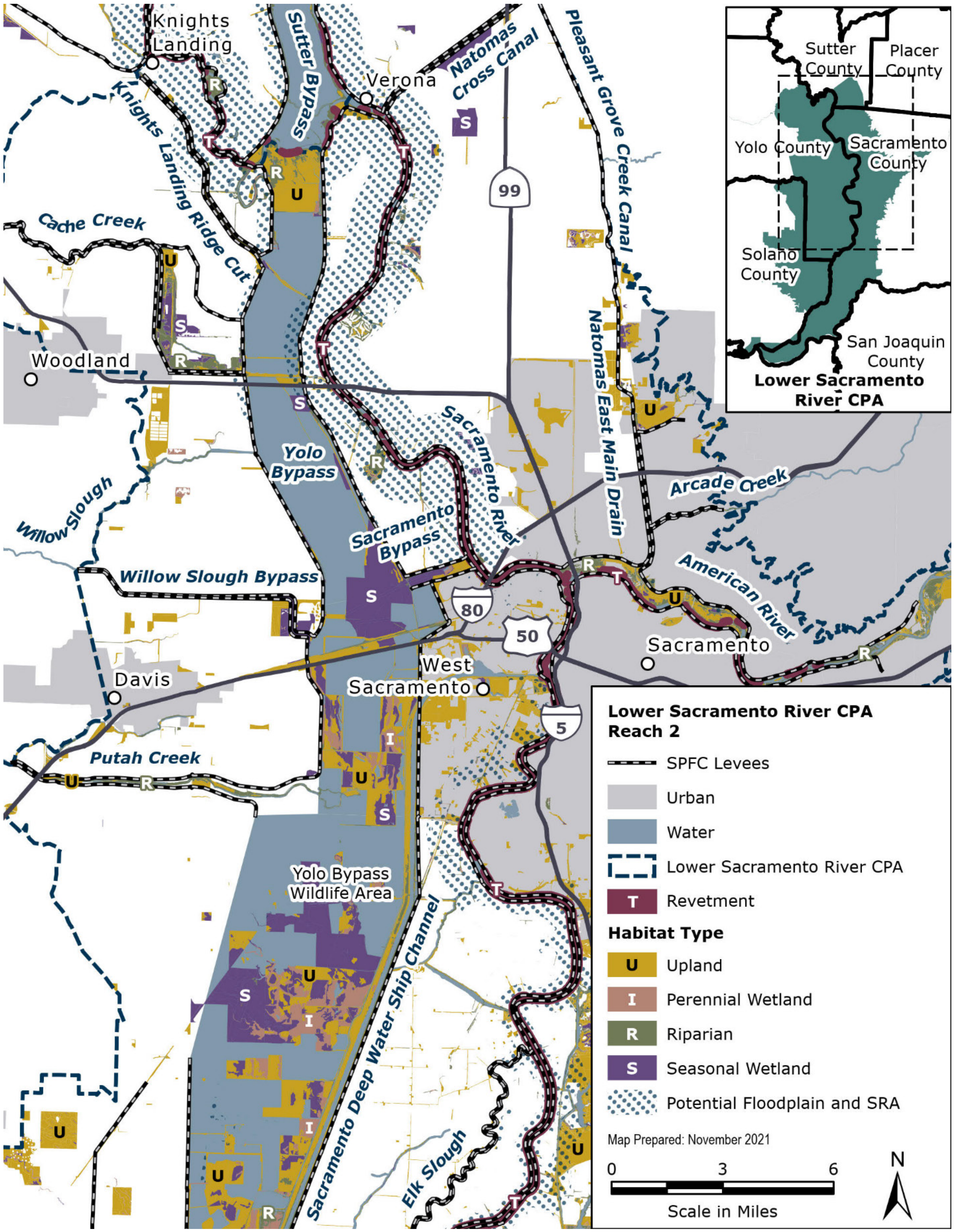


Figure H-19. Lower Sacramento River CPA Reach 2



5.1.1 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-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	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.

Adaptation Strategy[a] Habitat-related	Adaptation Strategy[a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
RIP-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.
	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 valley elderberry longhorn beetle 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.

Adaptation Strategy[a] Habitat-related	Adaptation Strategy[a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
RIP-1	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.
	SALMONID-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 amount of areas in the Yolo Bypass that are suitable for creating and enhancing marsh habitat suitable for giant gartersnakes.

Adaptation Strategy[a] Habitat-related	Adaptation Strategy[a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
WET-1	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.
	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.

Adaptation Strategy[a] Habitat-related	Adaptation Strategy[a] Species-specific	Adaptation Potential Reach 1	Adaptation Potential Reach 2
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 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

5.2 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
	SALMONID	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	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 4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Figure H-20. Upper Sacramento River CPA Reach 1

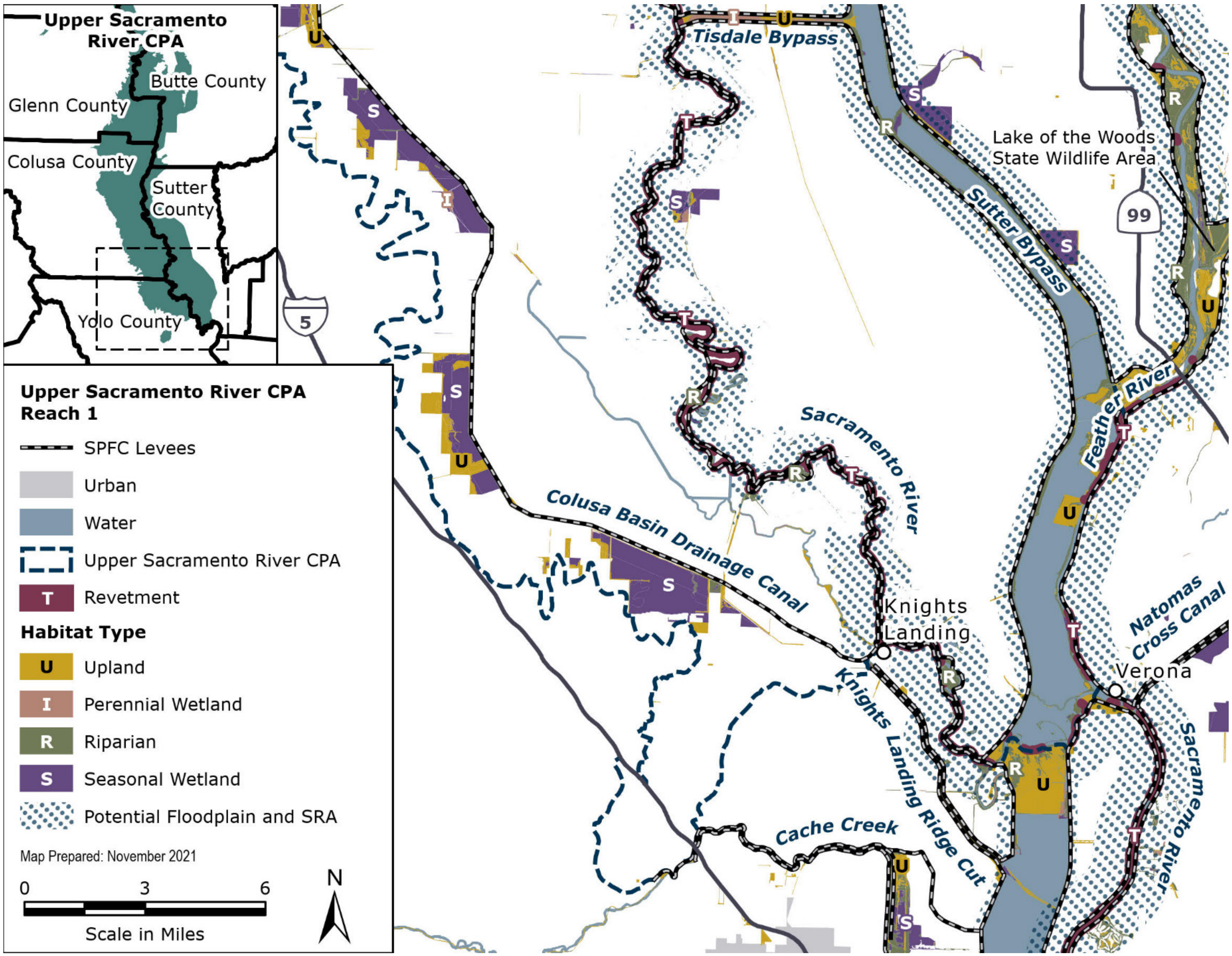


Figure H-21. Upper Sacramento River CPA Reach 2

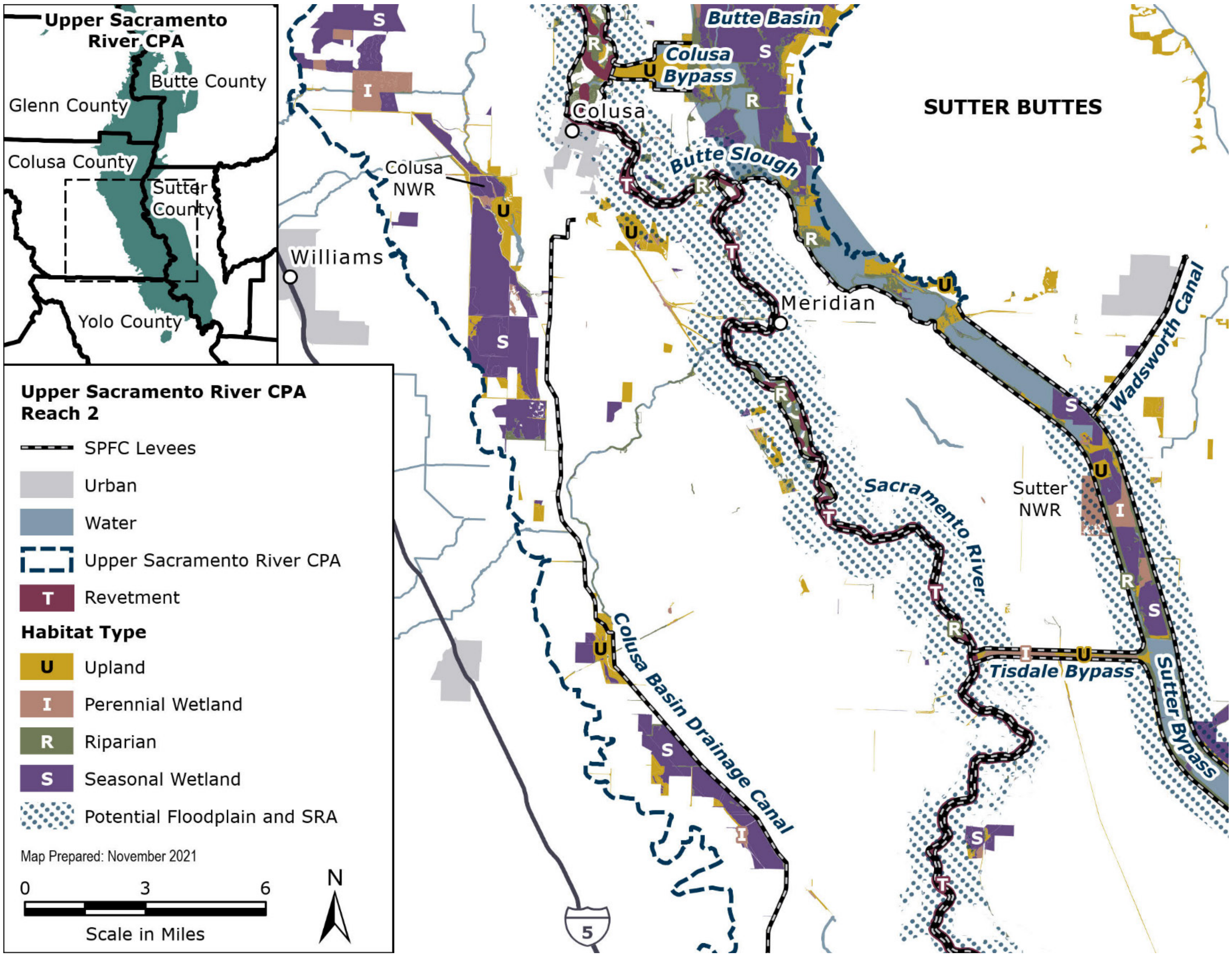


Figure H-22. Upper Sacramento River CPA Reach 3

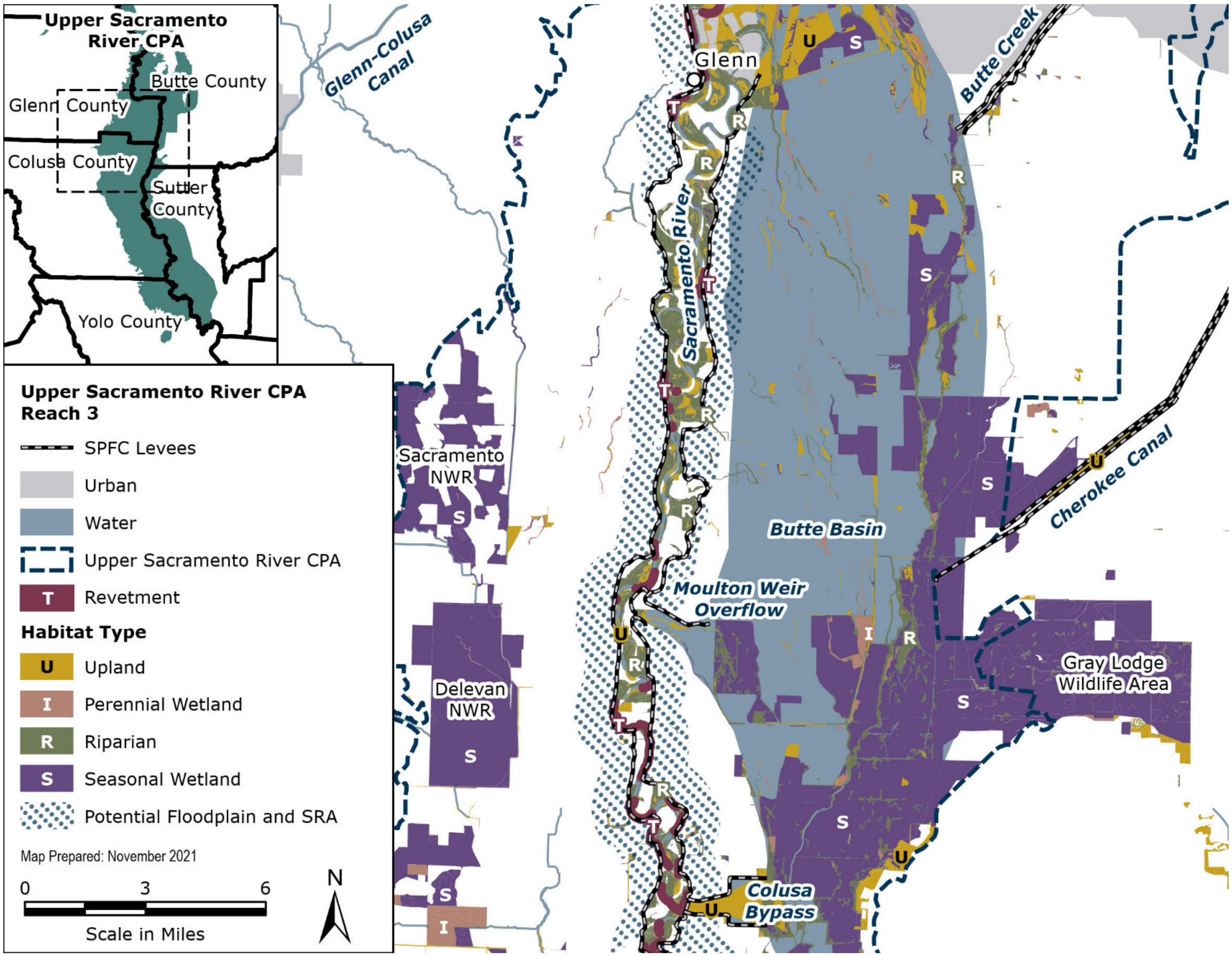


Figure H-23. Upper Sacramento River CPA Reach 4

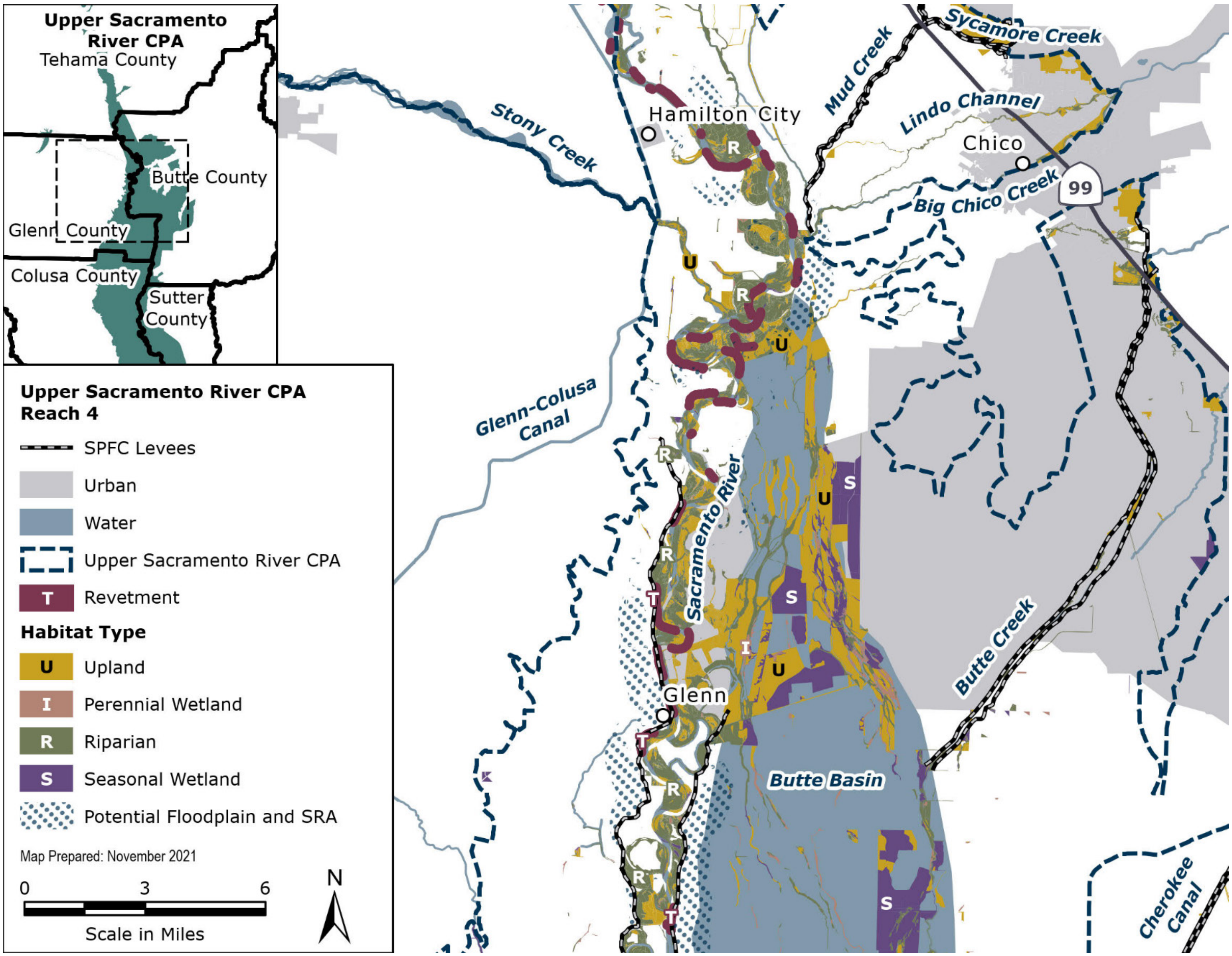


Figure H-24. Upper Sacramento River CPA Reach 5

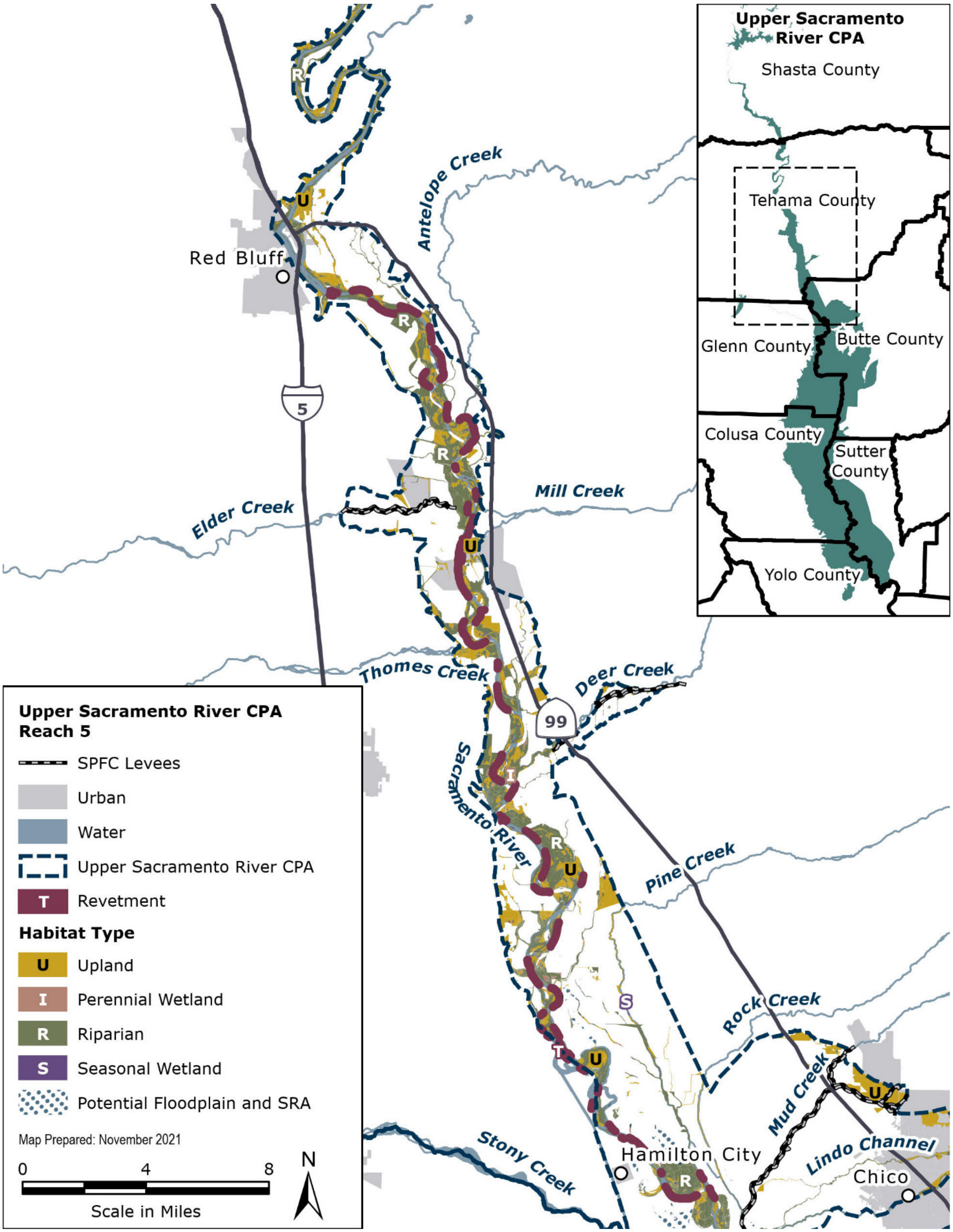
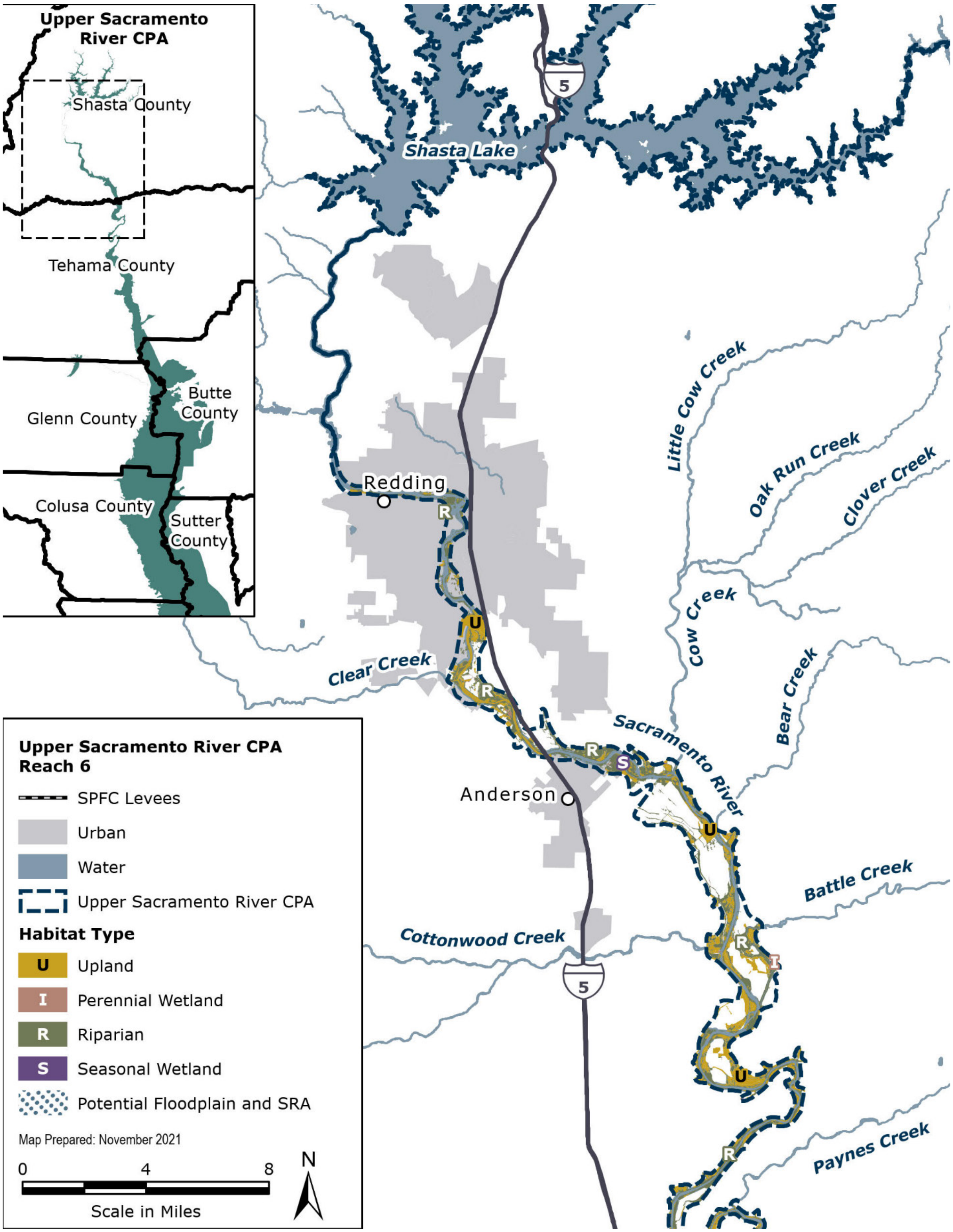


Figure H-25. Upper Sacramento River CPA Reach 6



5.2.1 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 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-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 re-colonization 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.
RIP-1	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.

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	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.
	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.

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	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.
	SALMONID-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

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5.3 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
	SALMONID	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
	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 4.2.1.2, "Habitat and Species-specific Adaptation Measures."

Figure H-26. Feather River CPA Reach 1

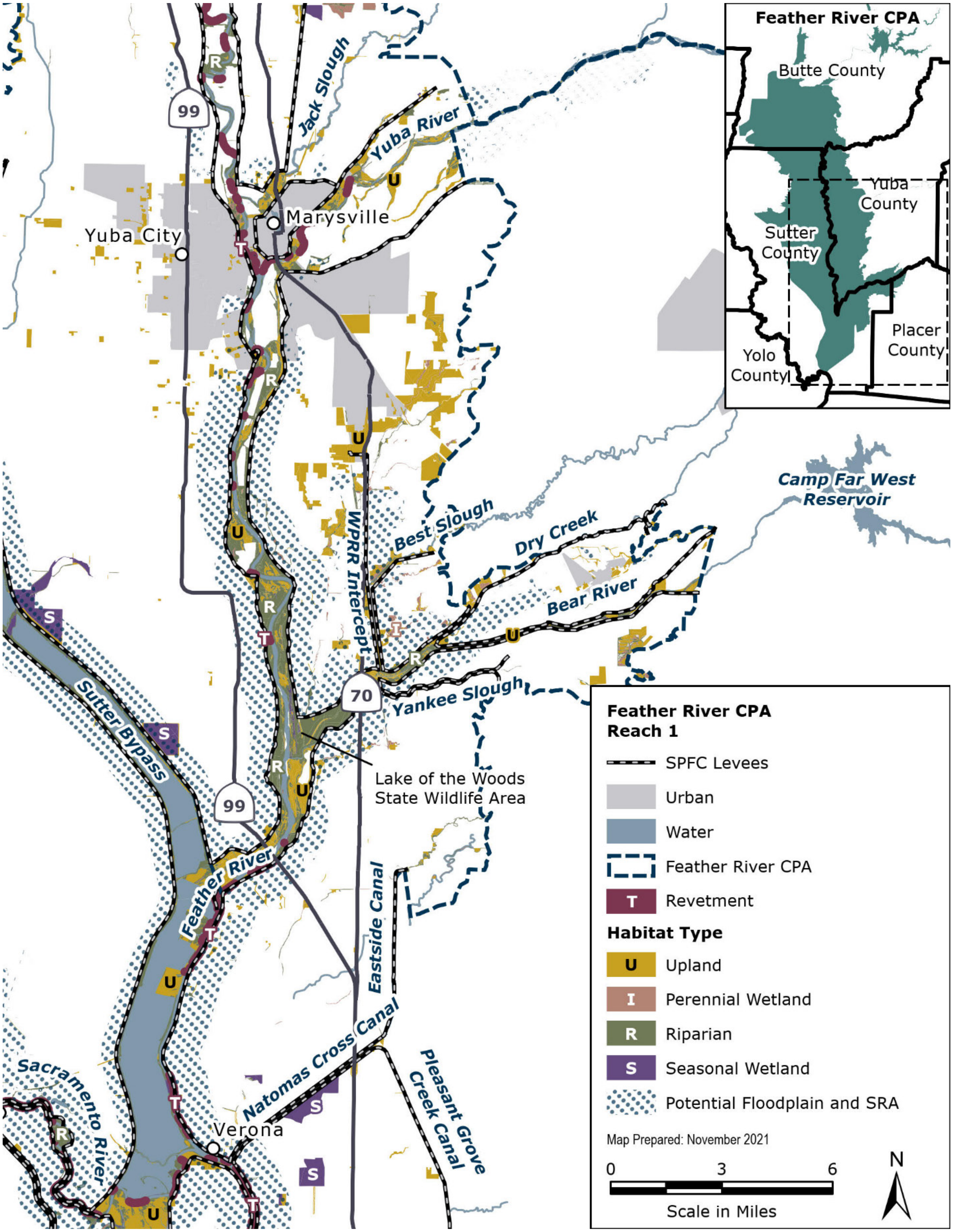
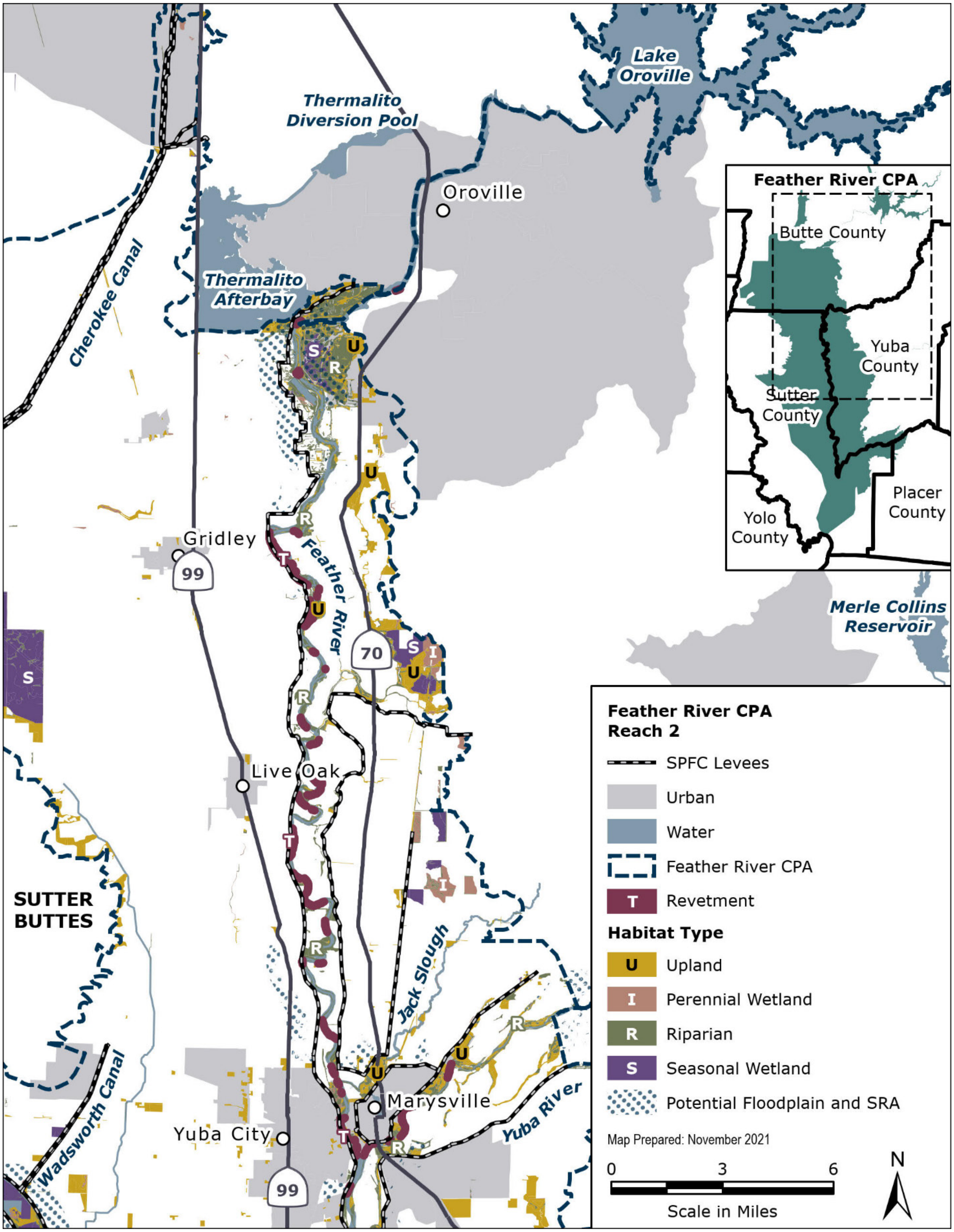


Figure H-27. Feather River CPA Reach 2



5.3.1 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 State Plan of Flood Control 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 State Plan of Flood Control 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-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 re-colonization of Least Bell's vireo, and both species would benefit as described for the Upper Sacramento River CPA.	Moderate – There are a moderate amount 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 he 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 amount 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	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 valley elderberry longhorn beetle 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-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.

5.4 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/SRA	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
	SALMONID	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
	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
SRA = systemwide planning area

Figure H-28. Lower San Joaquin River CPA Reach 1

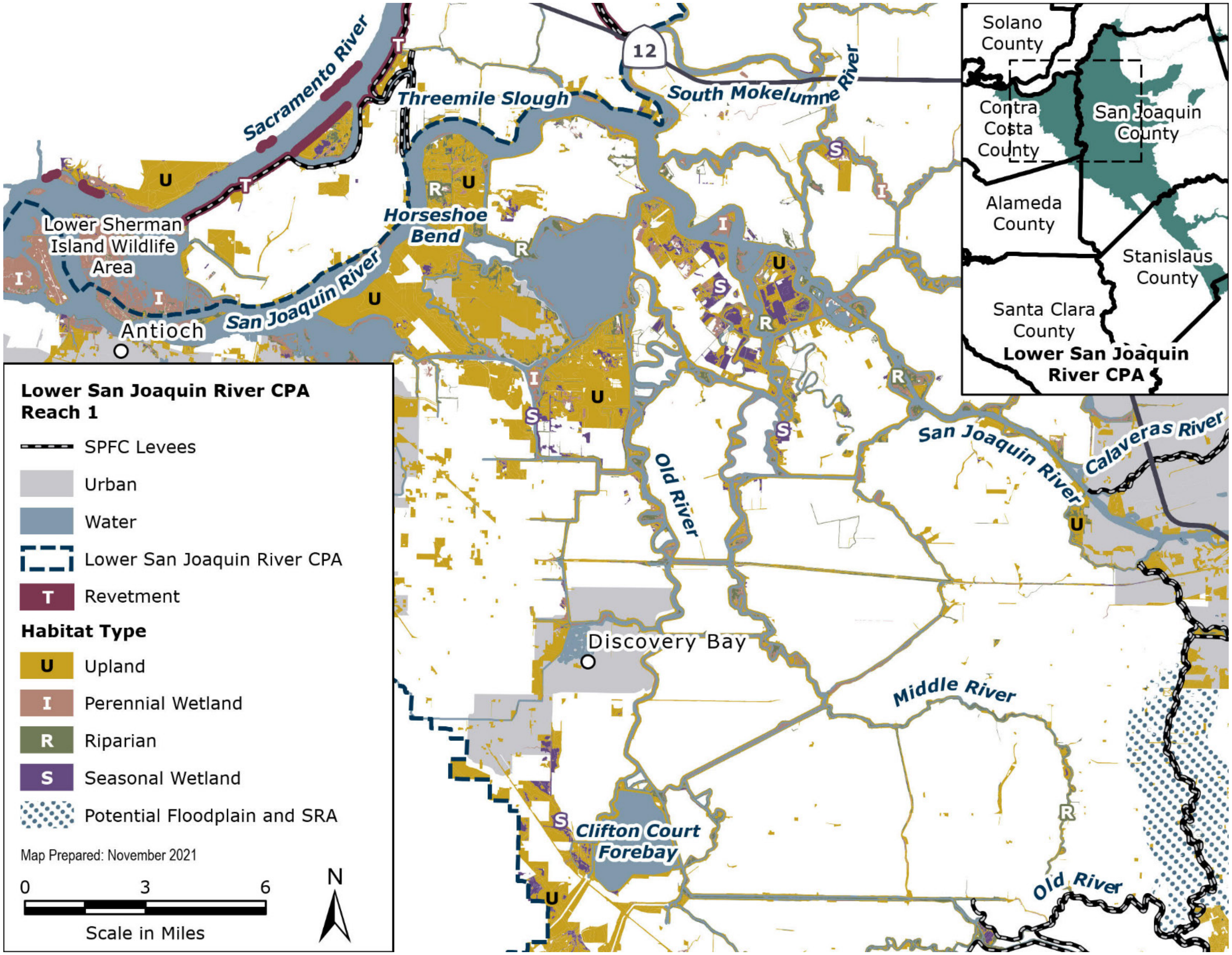


Figure H-29. Lower San Joaquin River CPA Reach 2

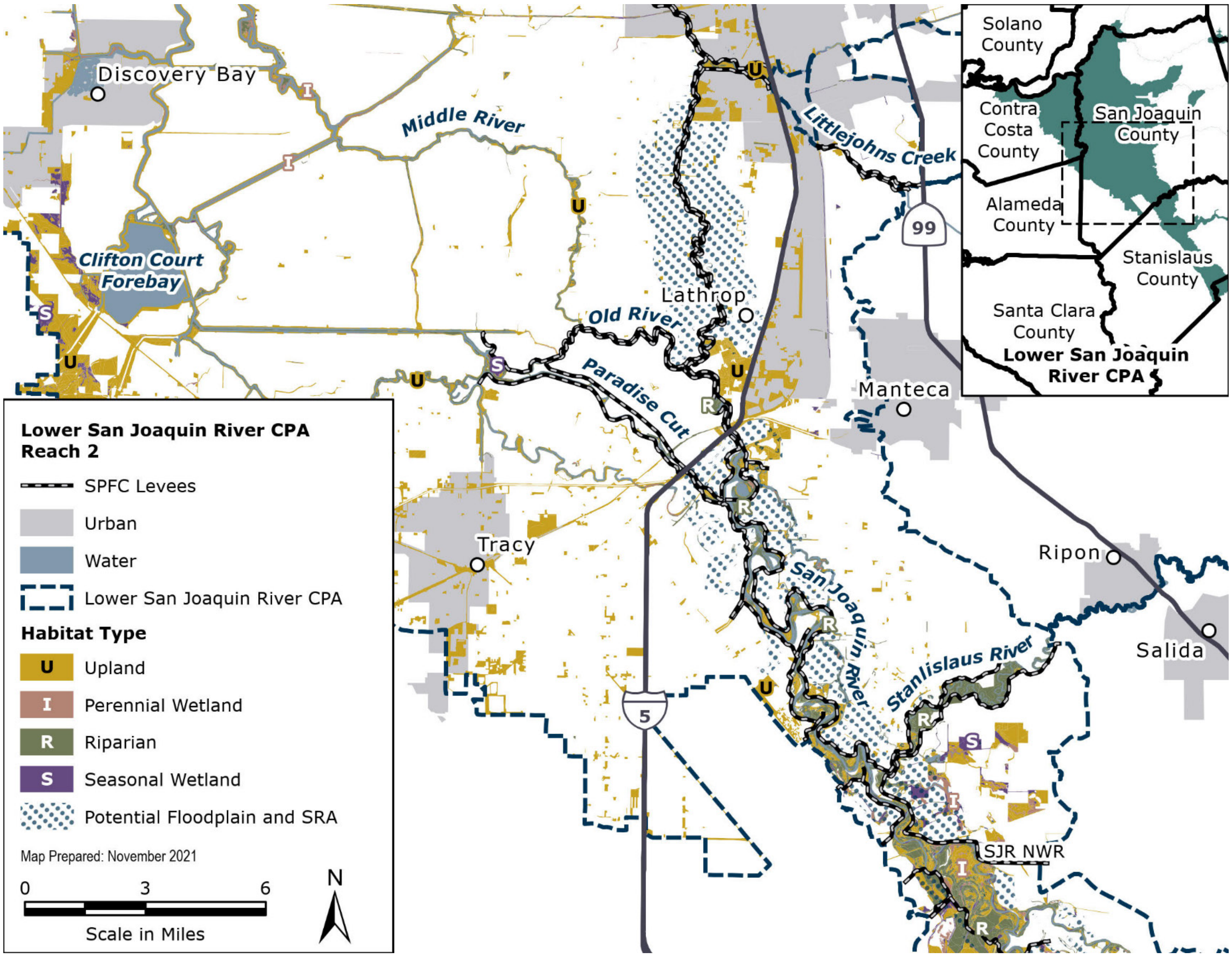
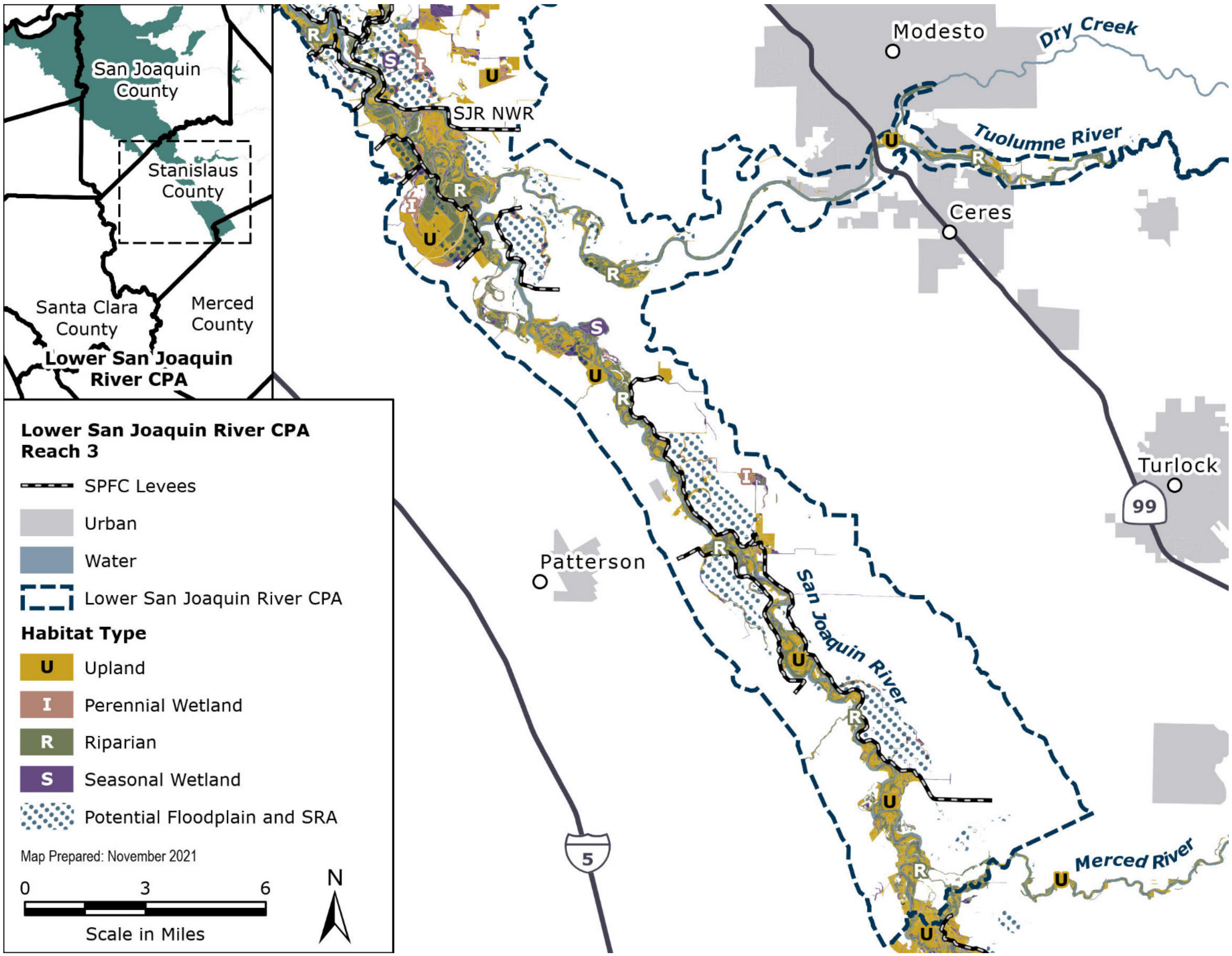


Figure H-30. Lower San Joaquin River CPA Reach 3



5.4.1 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-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.

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 valley elderberry longhorn beetle 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-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

5.5 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
	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

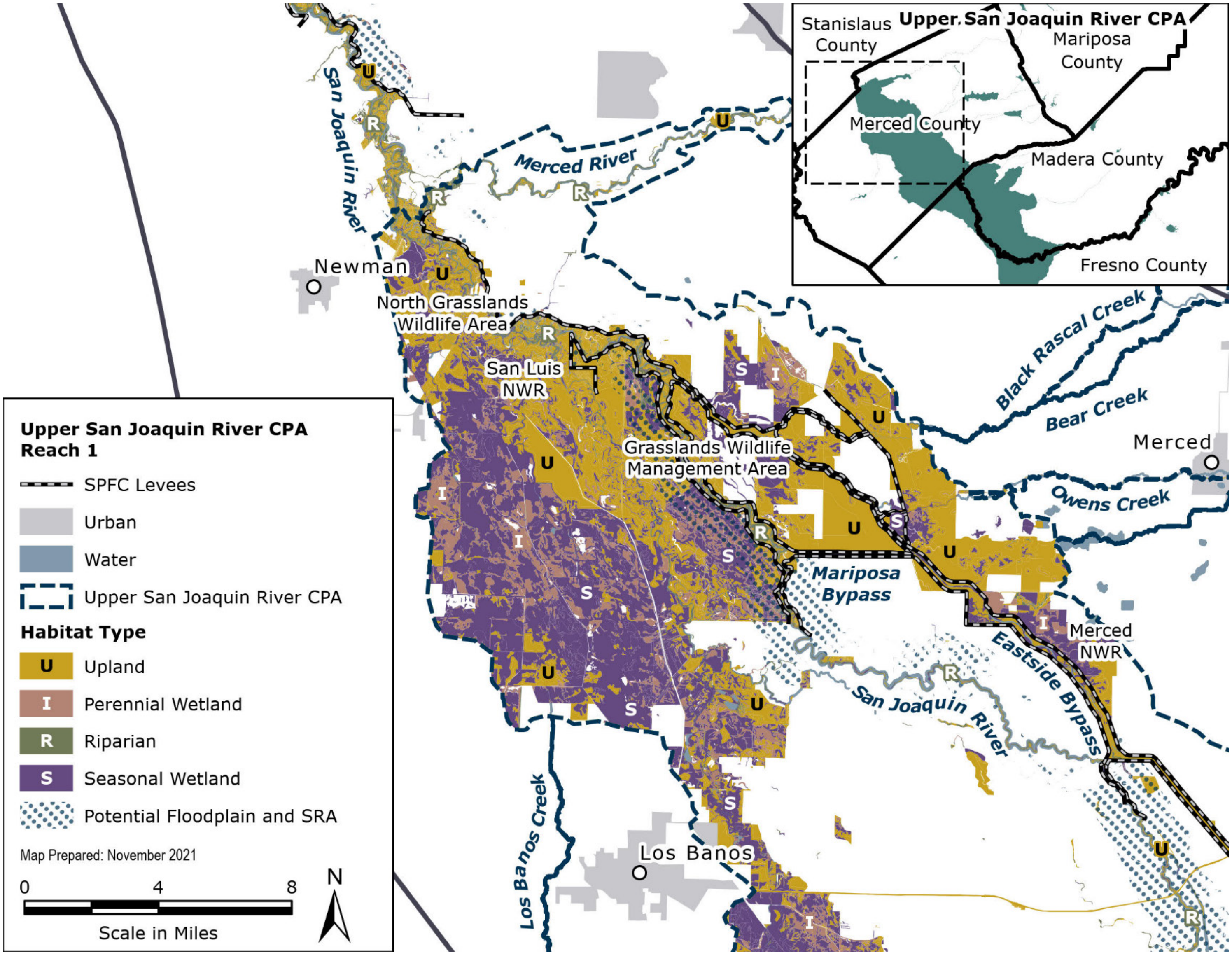


Figure H-32. Upper San Joaquin River CPA Reach 2

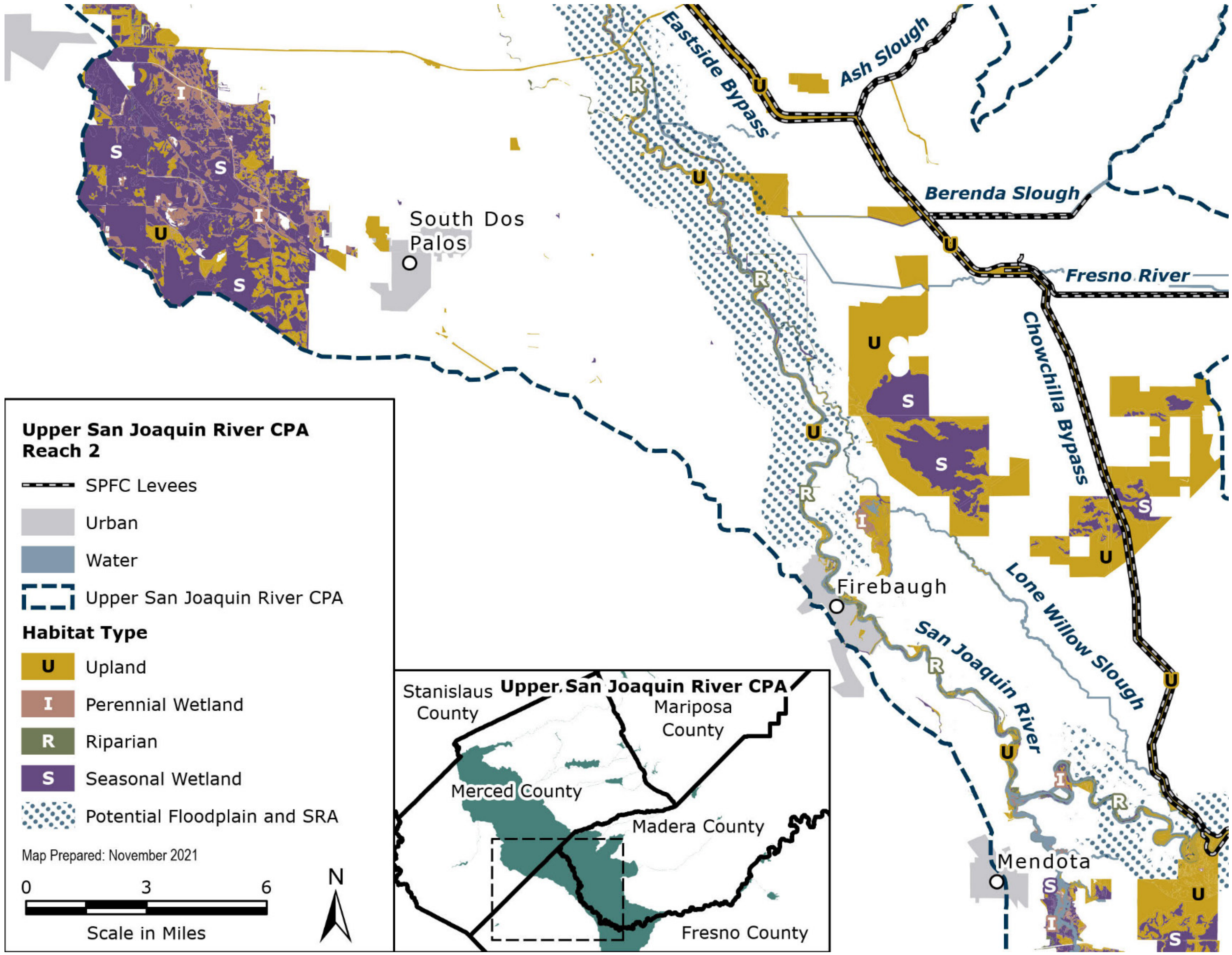


Figure H-33. Upper San Joaquin River CPA Reach 3

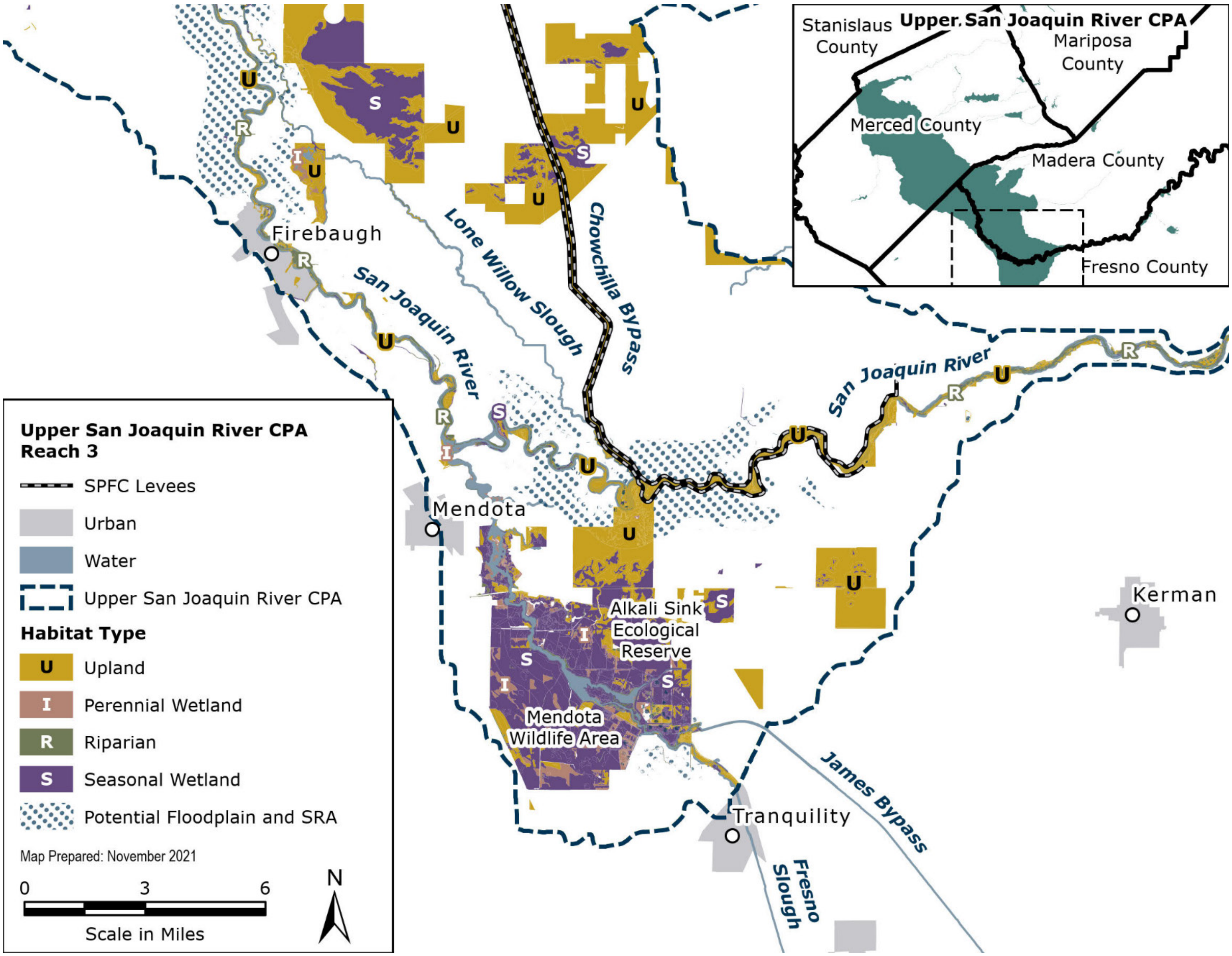
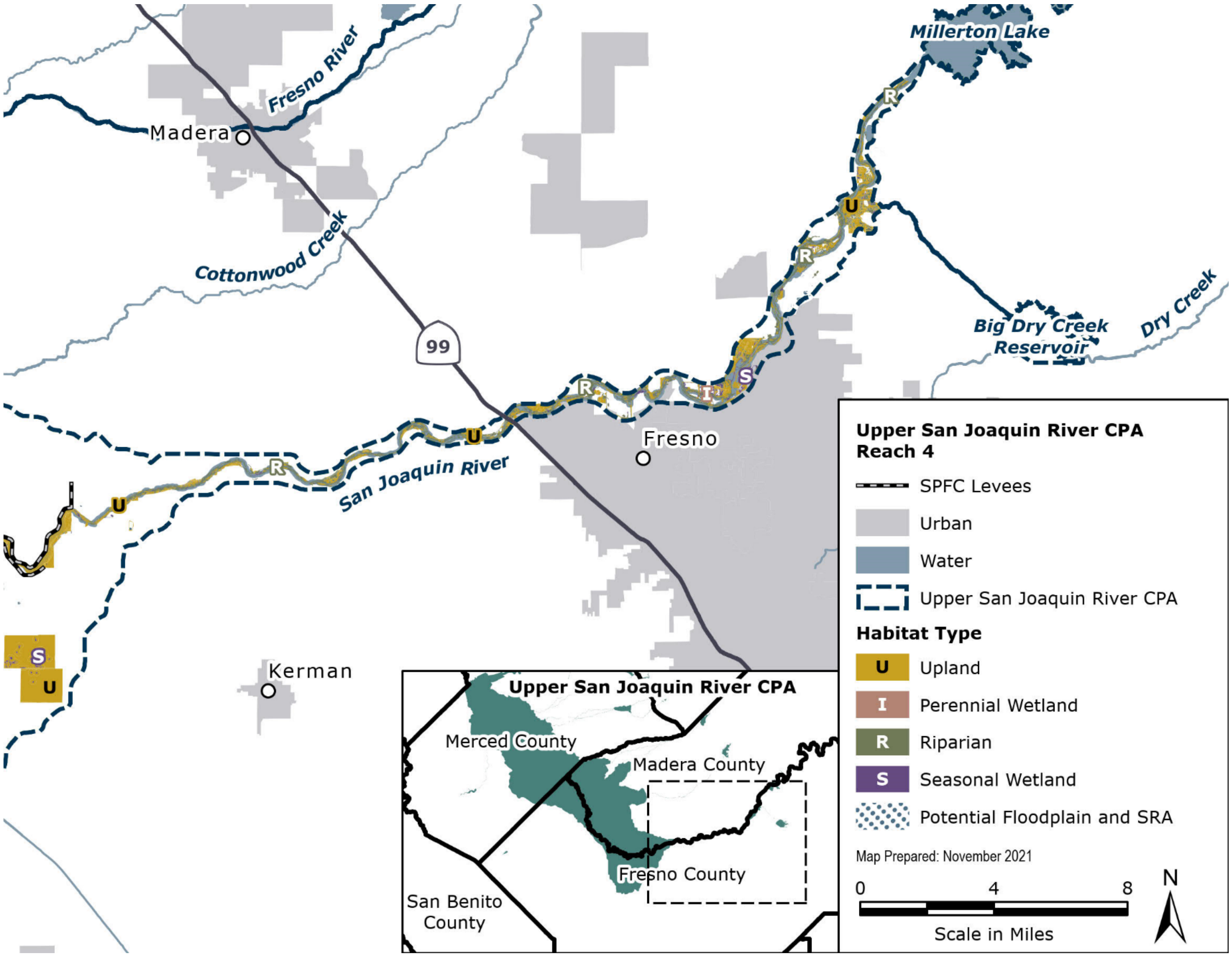


Figure H-34. Upper San Joaquin River CPA Reach 4



5.5.1 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 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.

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 valley elderberry longhorn beetle 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 6

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 to, 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 7

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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 Moller 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 to 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 to 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 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

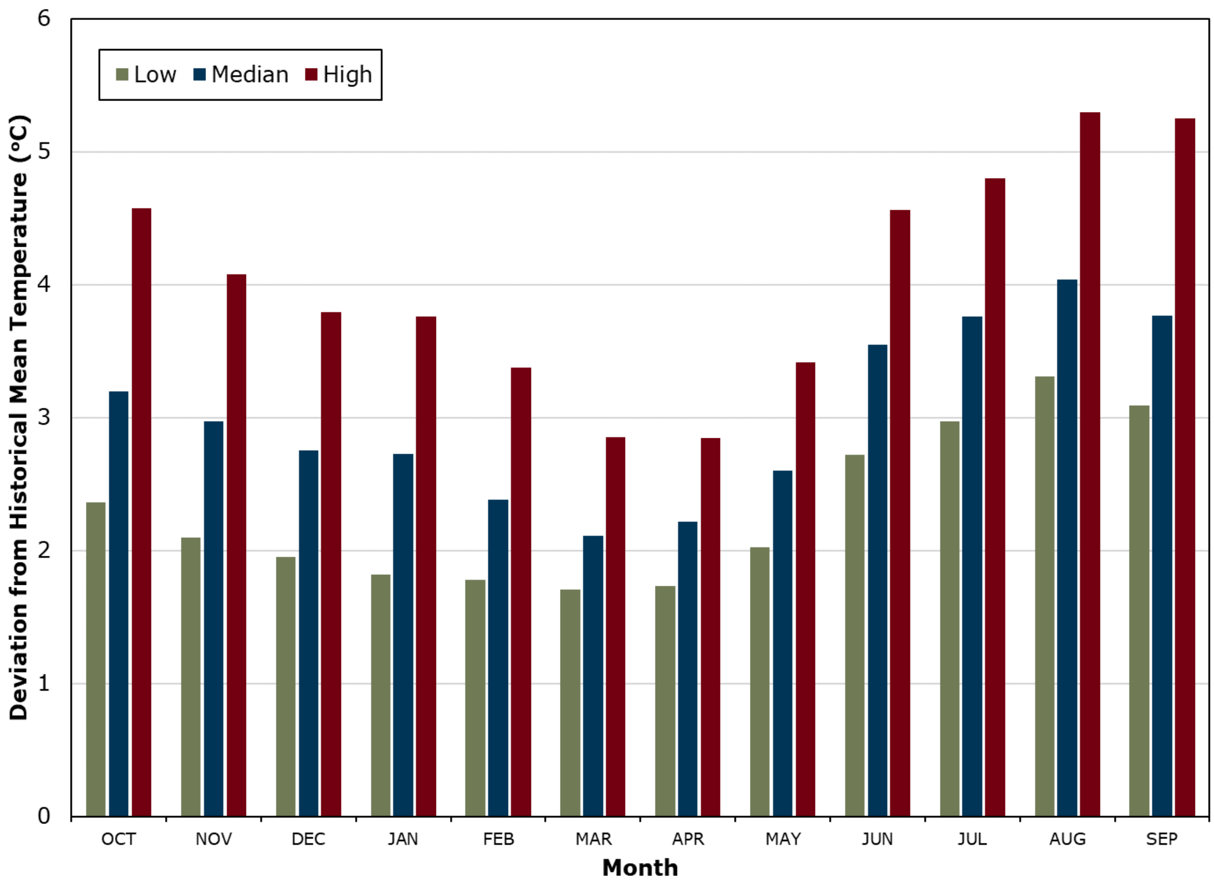


Figure H.1-2. Projected Changes in Mean Monthly Temperature – Feather River CPA

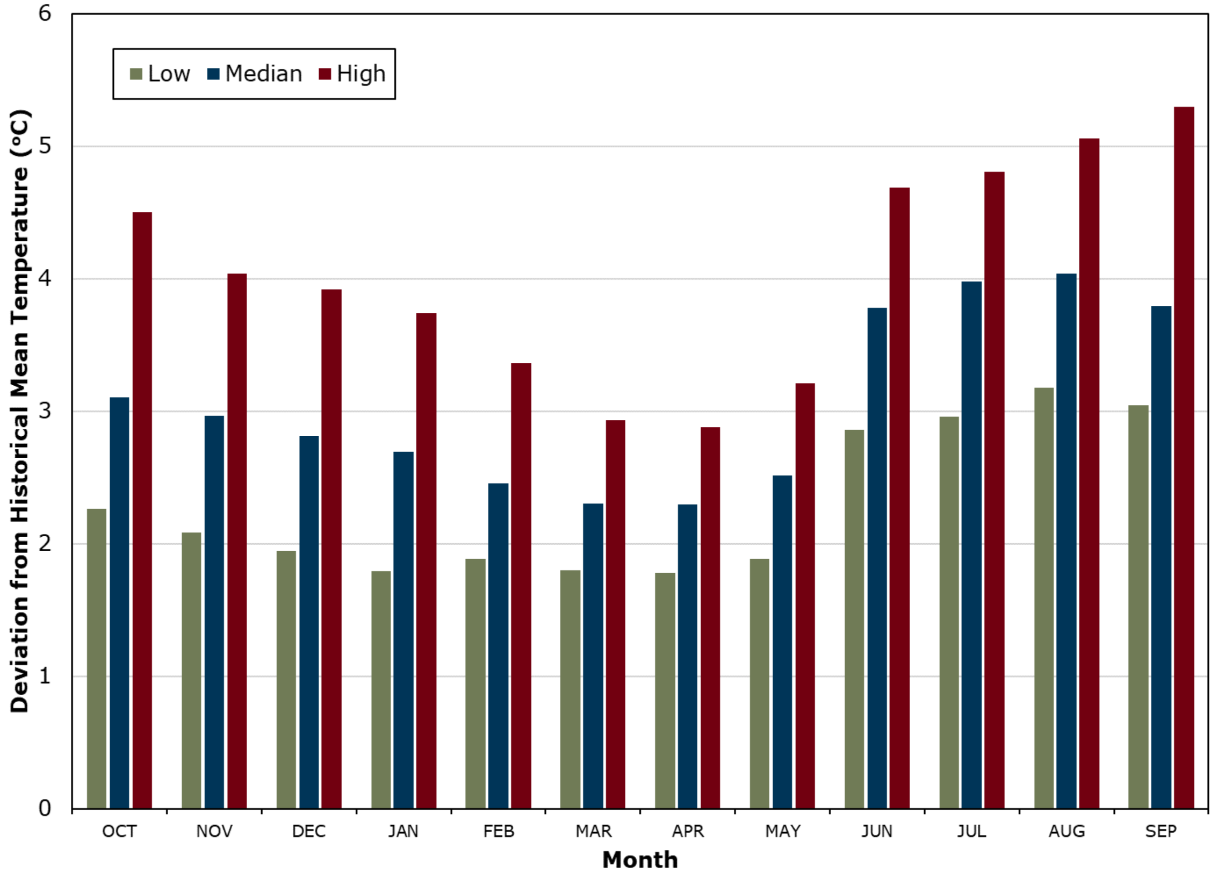


Figure H.1-3. Projected Changes in Mean Monthly Temperature – Lower Sacramento River CPA

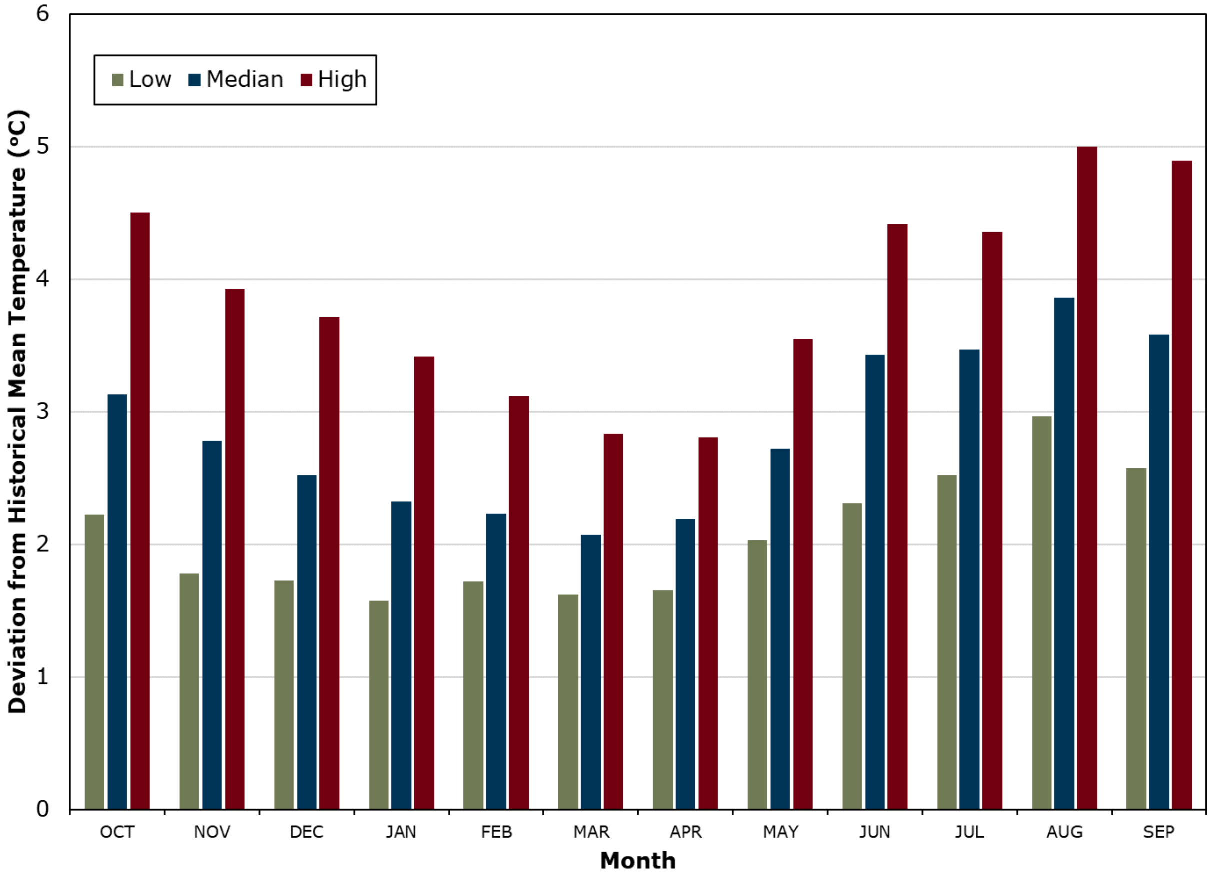


Figure H.1-4. Projected Changes in Mean Monthly Temperature – Lower San Joaquin River CPA

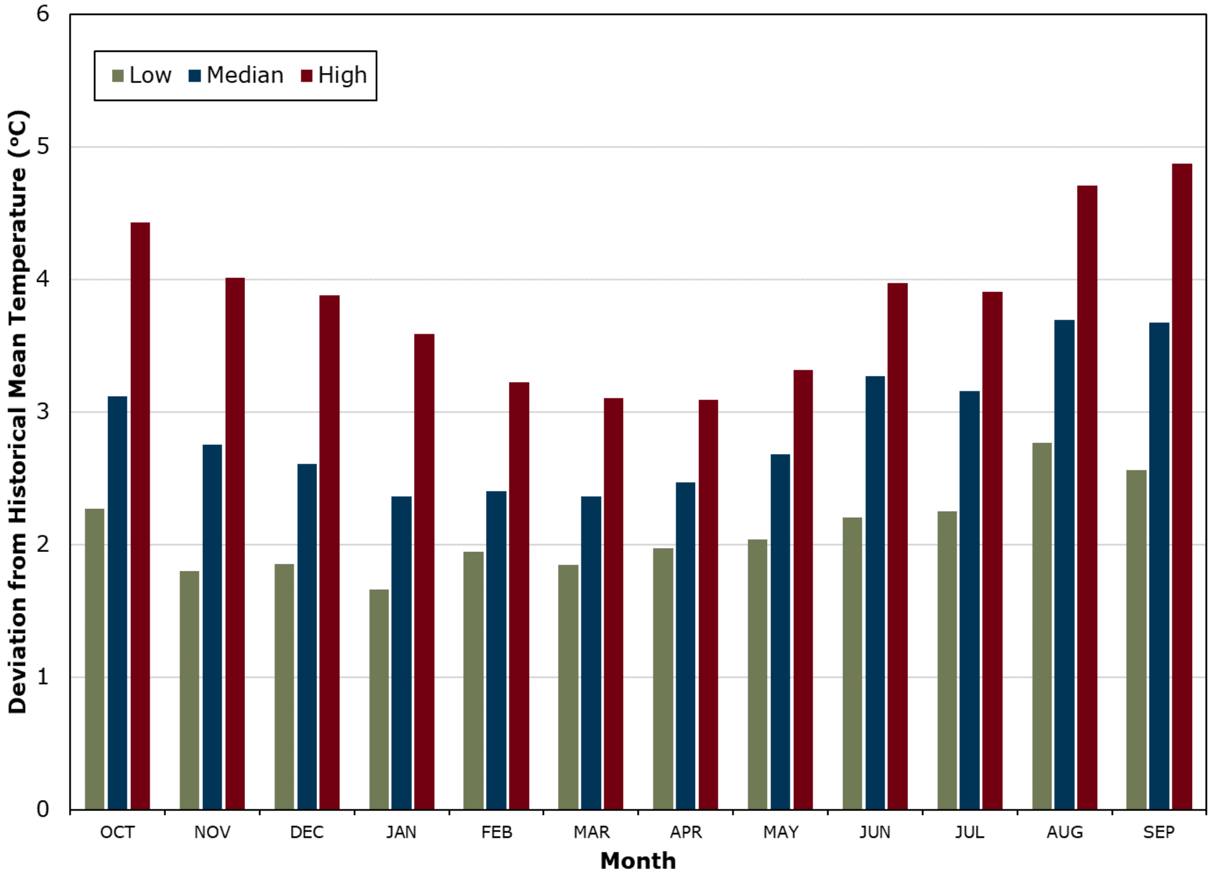


Figure H.1-5. Projected Changes in Mean Monthly Temperature – Upper San Joaquin River CPA

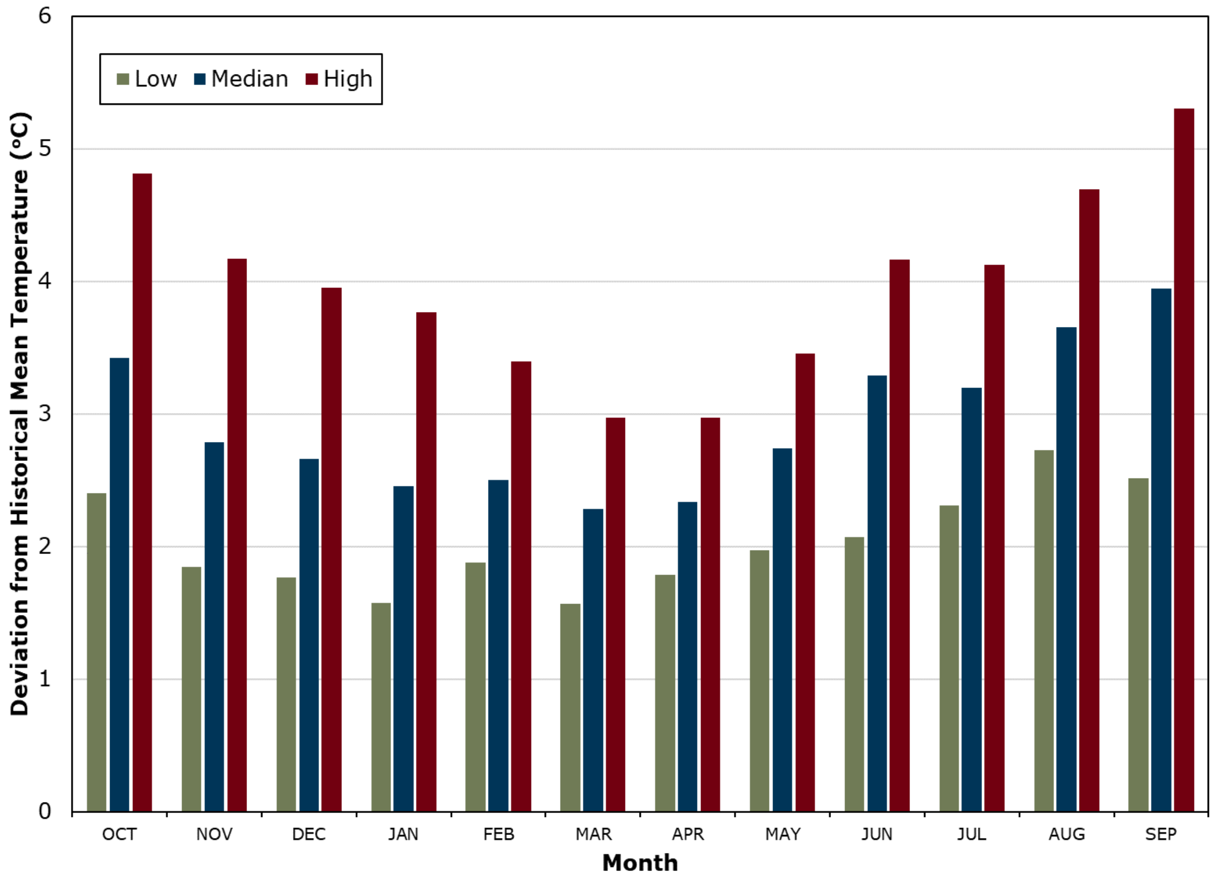
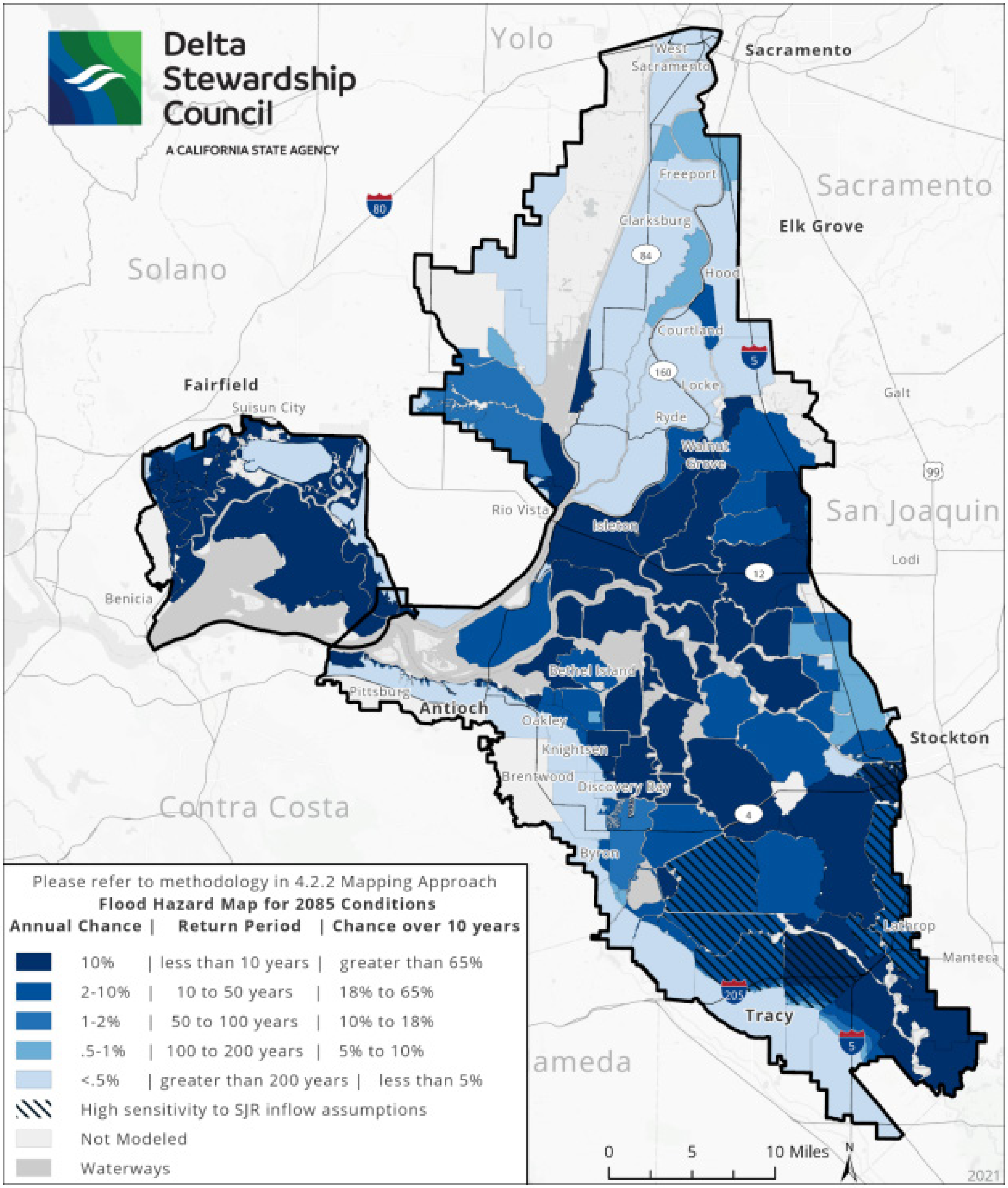
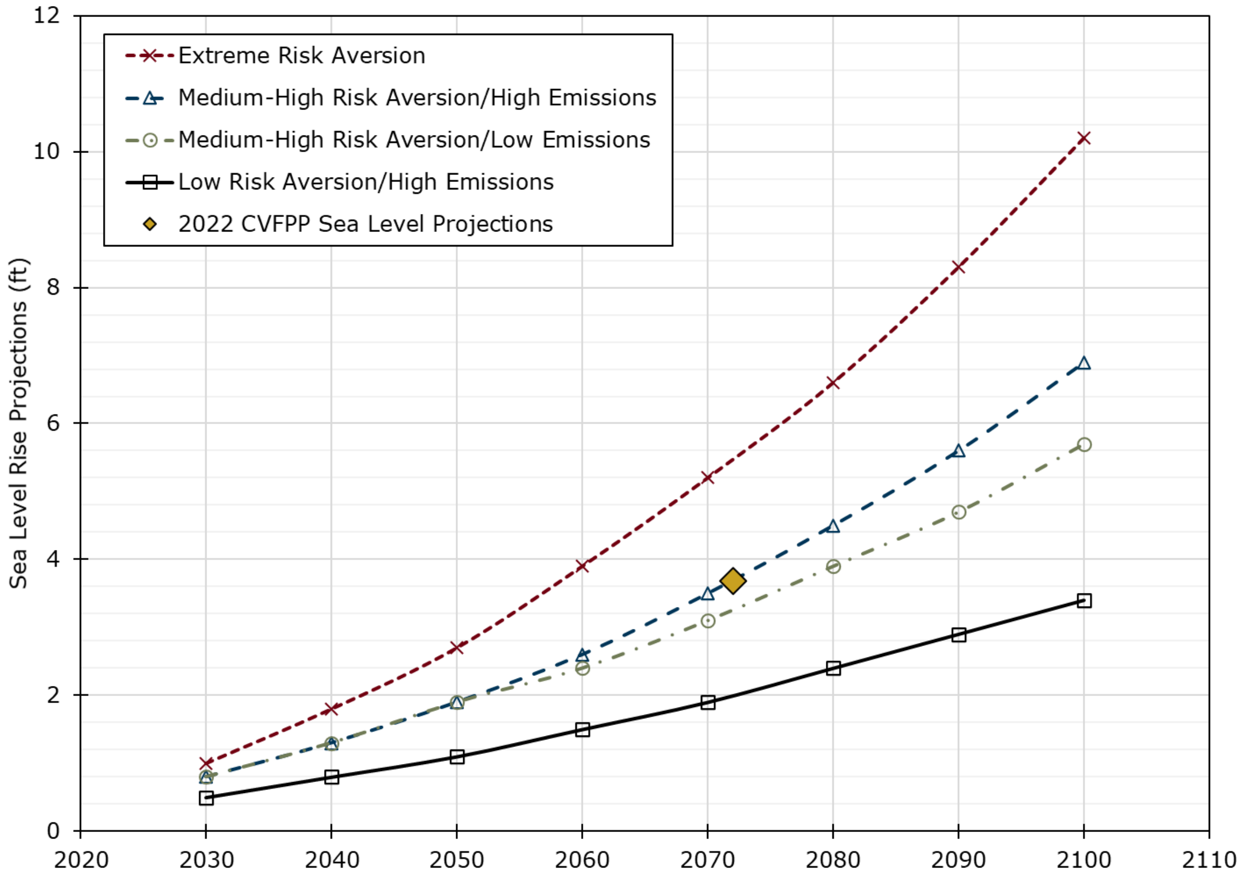


Figure H.1-6. Flood Hazard Map for 2085 Conditions



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)