

**PUBLIC REVIEW DRAFT**

# **Towards the Protection, Restoration, and Enhancement of the Delta Ecosystem: A Synthesis**

## **Appendix A: Summary of Existing Habitat and Species-Specific Plans, Strategies, and Management Approaches**

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**DELTA  
STEWARDSHIP  
COUNCIL**



*A California State Agency*

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**For further assistance interpreting the content of this document, please  
contact Delta Stewardship Council staff.**

**[accessibility@deltacouncil.ca.gov](mailto:accessibility@deltacouncil.ca.gov)**

**Phone: 916-445-5511**

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## 1. Introduction

In addition to the frequently cited goal of “protecting, restoring, and enhancing the Delta ecosystem,” the Delta Reform Act established several ecosystem-related objectives which the Delta Plan is directed to help achieve, including “restore large areas of interconnected habitats within the Delta and its watershed by 2100,” “establish migratory corridors for fish, birds, and other animals along selected Delta river channels,” and “promote self-sustaining, diverse populations of native and valued species by reducing the risk of take and harm from invasive species.” These objectives are a major challenge to achieve, however, the extensive work of other concurrent planning and management efforts, such as recovery plans, species-specific resiliency strategies, and conservation strategies have contributed to making progress towards these ecosystem objectives. Most of these efforts are narrowly focused on benefiting a single species or suite of similar species (e.g., wintering waterfowl), collectively, these plans provide valuable insight into the scale of habitat preservation, enhancement, and restoration necessary to benefit the wide multitude of species which rely upon the Delta ecosystem. The scopes of these various plans, strategies, and management approaches are provided below, and if applicable, the habitat preservation and/or restoration targets established by these efforts are summarized below in **Table A-1**. It is important to note that many of plans and strategies include duplicative actions (e.g., tidal marsh restoration).

## 2. Recovery Plans

A recovery plan is one of the most important tools in the species recovery process. It provides a sound scientific foundation and guides decision-making for partners implementing the plan and its actions. Recovery plans provide guidance and are voluntary; they do not have the force of law. As such, the success of recovery efforts ultimately depends on partnerships and cooperation to ensure that the right actions are implemented to advance long-term species’ recovery.

### 2.1 Central Valley Chinook Salmon and Steelhead Recovery Plan

In 2014, the National Marine Fisheries Service (NMFS) adopted a plan to recover Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*), Central Valley Spring-Run Chinook Salmon, and Central Valley Steelhead (*Oncorhynchus mykiss*). This recovery plan sets goals and prioritizes actions for the Sacramento-San Joaquin Delta and its watersheds, laying out steps to achieve the species’ recovery. It provides a framework for targeting conservation efforts and modifying actions based on new science and changing circumstances.

An approach for measuring the viability of salmonid populations, called Viability of Salmon Population (VSP), is described by Lindley et al. (2007) and applied in the Recovery Plan for Central Valley salmonids (NMFS 2014). The VSP is informed by the four parameters of abundance, productivity, spatial structure, and diversity. NMFS (2014) defines measurable biological goals to track viability for each of the four parameters for steelhead and spring-run and winter-run Chinook Salmon.

Key recovery actions defined in NMFS (2014) include the following:

- reintroducing populations into key watersheds;
- conducting landscape-scale restoration throughout the Delta;
- incorporating ecosystem restoration into Central Valley flood control plans, including breaching and setting back levees;
- restoring flows throughout the Sacramento and San Joaquin River basins and the Delta;
- reducing biological impacts of exporting water through Jones and Banks pumping plants;
- meeting water quality criteria established in the Central Valley Water Quality Control Plan for all potential pollutants;
- annually reviewing impacts from commercial and recreational fisheries and modifying regulations as necessary to allow for species to recover;
- implementing projects to minimize predation at artificial structures; and
- implementing the recommendations of the California Hatchery Scientific Review Group.

The recovery plan is guided by the best available science. It includes a range of actions to restore winter- and spring-run Chinook salmon, steelhead, and their habitats. It sets priorities to guide investments and incorporates an adaptive management approach to make adjustments based on new information.

### **2.1.1 Status**

While little progress has been made towards reintroducing populations into new watersheds, most of the other recovery actions described in NMFS (2014) are part of on-going conservation efforts. For example, landscape-scale restoration efforts are underway through the California EcoRestore program (described in more details below) that is being implemented in coordination with state and federal agencies to advance the restoration of at least 30,000 acres of Delta habitat by 2020. Also, the Phase I and Phase II update process of Bay-Delta Water Quality Control Plan to define flow requirements in the Delta and tributaries is currently underway.

## **2.2 Tidal Marsh Recovery Plan**

The United States Fish and Wildlife Service (USFWS) Tidal Marsh Recovery Plan focuses on recovery of tidal marsh habitat in California, with an emphasis on the San Francisco estuary (USFWS 2013). The Plan also covers smaller marshes along the California coastline from Humboldt Bay to Morro Bay. The USFWS Tidal Marsh Recovery Plan is focused on five endangered species: Ridgway's rail (*Rallus obsoletus*), salt marsh harvest mouse (*Reithrodontomys raviventris*), Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*), soft bird's-beak (*Chloropyron molle* ssp. *molle*), and

California sea-blite (*Suaeda californica*) – but the plan also covers other plant and wildlife species which rely upon tidal marsh habitats. The Recovery Plan identified that the common threats to all these species includes habitat loss and fragmentation due to development, agricultural land use and diking; altered hydrology and salinity; invasive species; and sea level rise.

The main purpose of the Tidal Marsh Recovery Plan is to identify recommended actions which will contribute to the conservation of those species. In the previous decades, the management focus was to acquire lands restorable to tidal marsh habitat. The most recent Tidal Marsh Recovery Plan places a greater emphasis on restoration and management of those lands that have been acquired. The Recovery Plan has five recovery units, including one with overlap with the legal Delta: the Suisun Bay Recovery Unit.

The habitat specific target developed for recovery of Ridgway's rail includes a minimum of 5,000 acres of contiguous high-quality tidal marsh habitat. For salt marsh harvest mouse, the goal is to create viable habitat units (VHAs) which consists of muted or full tidal marsh with suitable high-tide refugia (e.g., tall vegetation that remains at least partially unsubmerged during highest tides). The Recovery Plan calls for availability of VHAs in five different "Marsh Complexes" of the Suisun Bay Recovery Area, including Western Suisun/Hill Slough (1,000 acres), Suisun Slough/Cutoff Slough (1,000 acres), Nurse Slough/Denverton Slough (1,000 acres); Grizzly Slough Marsh Complex (1,500 acres), and Contra Costa County Shoreline (500 acres).

### **2.3 Giant Garter Snake Recovery Plan**

The giant garter snake (*Thamnophis gigas*) is federally listed as threatened. This species was known to inhabit freshwater marshes, streams, and wetlands throughout central California, but now only five percent of its historical wetland habitat remains. The USFWS (2017a) recently released the latest final Recovery Plan for giant garter snake, and it identifies nine populations of the species that are isolated from one another with no protected dispersal corridors. The focus of the USFWS Recovery Plan for giant garter snake is to preserve existing, occupied habitat and identify and protect areas for future habitat restoration and enhancement that are needed to provide connectivity between populations.

The Recovery Plan for giant garter snake identifies specific criteria for restoration of habitat to benefit giant garter snake. Habitats meant for giant garter snake are to have block pairings of habitat patches, consisting either of one 240-hectare (593 acres) continuous buffered perennial wetland and one 639-hectare (1,579 acres) block of continuous active ricelands separated by fewer than five miles, or two 240-hectare (593 acres) buffered perennial wetlands separated by fewer than five miles. Additionally, these pairs of habitat blocks are to be connected with other pairs of habitat blocks with corridors through which giant garter snake individuals can migrate.

### **2.4 California Tiger Salamander – Central California DPS Recovery Plan**

All California tiger salamanders (*Ambystoma californiense*) are federally listed, although there are three Distinct Population Segments (DPSs): Central California DPS, Sonoma

County DPS, and Santa Barbara Country DPS. The USFWS (2017b) recovery plan for California tiger salamander – Central California DPS principally focuses on preservation of existing habitat which provides suitable breeding habitat and adjacent upland dispersal habitat for this species. The three objectives of the Recovery Plan are to: 1) secure self-sustaining populations of Central California DPS California tiger salamander across its full range; 2) ameliorate or eliminate threats to the species that caused its listing; and 3) restore and conserve a health ecosystem supportive of the species.

The California tiger salamander Recovery Plan establishes that habitat preserves for this species should be a minimum of 3,398 acres and contain at least four suitable breeding ponds (if more breeding ponds are present, a small total surface area of ponds is required). Most of the habitat focus is on areas outside/upstream the Delta. The Central Valley Recovery Unit does have limited overlap with the Delta; of this recovery unit's 12 management units, two of them have at least some overlap with the Delta: Jepson Prairie Management Unit and the Concord/Livermore Management Unit. The goal for the entire Jepson Prairie unit is four preserves while the goal for the Concord/Livermore unit is five preserves.

## **2.5 Vernal Pool Recovery Plan**

The USFWS Vernal Pool Recovery Plan for California and southern Oregon features 33 species of plants and wildlife that exclusively or primarily utilize vernal pool habitats, including 20 species which are federally listed (USFWS 2005). The principal threats to these species are habitat loss and fragmentation because of development, agricultural conversion, invasive species, grazing, and altered hydrology.

The USFWS's Vernal Pool Recovery Plan focuses on preservation of existing vernal pool areas, particularly those already known to provide habitat for listed vernal pool species. The Recovery Plan mentions that restoration of vernal pools may be an option, but cautions this approach must be "adaptive" given high level of uncertainty about how to successfully restore vernal pool habitats. The Recovery Plan identifies different vernal pool "regions"; within each region are "core areas" that are specific sites the USFWS considers important to recover listed vernal pool species – including two with at least partial overlap with the legal Delta. The Solano-Colusa region has three core areas which overlap with the Suisun Marsh: Jepson Prairie, Suisun Marsh, and Collinsville.

## **3. Conservation Strategies/Frameworks**

Several conservation planning efforts are underway for the Delta ecosystem which generally address multiple species, including many native but non-listed species (e.g., migratory waterfowl). The goal of these planning efforts is typically not recovery of species (although sometimes they may); instead they often include more short- to intermediate-term targets such as increasing habitat for listed species through multi-benefit projects or stabilizing declining population trends.

### 3.1 Central Valley Joint Venture

The Central Valley Joint Venture (CVJV) is a coalition of 21 state and federal agencies, non-governmental conservation organizations and a utility, which collectively set conservation objectives for birds in the Central Valley. In 2017, the CVJV released a series of peer-reviewed articles in a special edition of the San Francisco Estuary and Watershed Science Journal, which provide quantitative goals for habitat restoration or enhancements to benefit different bird groups which utilize Central Valley habitat. Five of those articles presented specific habitat goals targeted for different suites of avian species. The articles also describe the approaches used to set the conservation objectives. Population and habitat use statistics for bird species in the Central Valley is relatively limited, and when available is typically focused on special-status bird species. As such, much of the analysis in the CVJV analysis focused on these special-status species. When sufficient population estimates were available, the population objectives were typically targeted to enhance populations to “viable” (>10,000 individuals) or “large” (>50,000 individuals) levels, with habitat objectives set accordingly. Most long-term goals (100-year horizon) were generally to double bird species populations; if populations were considered already large enough (>50,000 individuals), the target objective was to maintain the population. The CVJV also provided short-term (10 years) goals that represented a straight 10% of the long-term goals, in order to provide periodic checkpoints during which to evaluate progress toward long-term goals.

DiGaudio et al. (2017) provided grassland and oak savannah conservation objectives based on needs for a suite of 12 landbird species which primarily breed in these habitat types (grassland bird species: burrowing owl (*Athene cunicularia*), grasshopper sparrow (*Ammodramus savannarum*), horned lark (*Eremophila alpestris*), northern harrier (*Circus cyaneus*), western meadowlark (*Sturnella neglecta*); oak savannah bird species: acorn woodpecker (*Melanerpes formicivorus*), American kestrel (*Falco sparverius*), lark sparrow (*Chondestes grammacus*), loggerhead shrike (*Lanius ludovicianus*), western bluebird (*Sialia mexicana*), western kingbird (*Tyrannus verticalis*), and yellow-billed magpie (*Pica nuttalli*). The analysis determined that existing grassland should be maintained, but estimated that no additional grassland habitat was necessary within a planning area which encompassed the floor of the Central Valley. For oak woodland, DiGaudio et al. (2017) established that the long-term goal would be to increase the extent of that habitat type by 75%. Dybala et al. (2017a) evaluated riparian habitat goals, subdividing the Central Valley floor into five different planning region. For the Yolo-Delta Planning Region, the long-term goal for restoration was 23,889 hectares (59,031 acres), approximately a 180% increase relative to baseline conditions.

Strum et al. (2017) developed habitat goals for breeding shorebirds, which include creating semi-permanent wetlands. Suitable habitat for breeding shorebirds include open and shallow-water habitat with suitable nesting substrate available April-July, with suitable substrate meaning islands with bare ground and adequate slope surrounding by deep enough water to provide some protection from terrestrial predators. The long-term goals for the Yolo-Delta Basin were 28,965 hectares (71,574 acres), a 1,785% increase relative to existing conditions.

Dybala et al. (2017b) developed a bioenergetics approach for estimated habitat needs for non-breeding shorebirds if populations were to be doubled. Suitable habitat for these species include shallow wetlands or flooded agricultural fields containing a water depth of less than 10 cm (0.32 feet). It was determined that existing food supplies from existing habitats (e.g., wetlands, flooded corn and rice fields) would be insufficient to fully meet energetic demands to maintain such population levels. Based on the bioenergetics modelling, it was estimated that the long-term goal for providing sufficient habitat to double breeding shorebird populations would be to create an additional 51,598 hectares (127,501 acres) of suitable wetlands in the fall and 46,920 hectares (115,942 acres) in the spring. Other strategies to enhance food resources habitat may be necessary to ensure sufficient food resources for non-breeding resources, since maintaining seasonal wetlands at less than 10cm (0.32 feet) could result in depletion of food resources by spring.

Shuford and Dybala (2017) developed habitat goals for wintering and breeding waterbirds in the Yolo-Delta basin. These goals were more subjective in nature, but were based on expert opinion understanding of habitat losses from historical conditions and population trends. The long-term goals for restoration in the Yolo-Delta basin are 7,948 hectares (19,640 acres) of seasonal wetlands in the winter; 921 hectares (2,276 acres) of semi-permanent and summer seasonal wetlands, and 573 hectares (1,416 acres) of riparian forest that are placed in proximity to habitat known to be used by winter and breeding waterbirds. If acreage of seasonal summer wetlands only occurs very infrequently (e.g., solely during years of heavy runoff), then the CVJV states that the habitat goal should be adjusted accordingly. Additionally, there is a long-term goal for winter-flooded rice and corn of 7,610 hectares (18,805 acres) and 21,370 hectares (52,806 acres), respectively.

### **3.1.1 Status**

In 1990, the Joint Venture partnership developed its first strategic plan to deliver partnership-based waterfowl conservation, the Central Valley Habitat Joint Venture Implementation Plan. The 2006 Central Valley Joint Venture Implementation Plan incorporates new information and broadens the scope of conservation activities to include objectives for shorebirds, waterbirds, and riparian songbirds.

The 2006 Plan brings together research, monitoring data and evaluation from many sources, and represents the combined expertise of a wide range of professionals from conservation organizations, state and federal agencies, and the private sector. Their knowledge and experience comprise the foundation for this plan.

The Implementation Plan is currently being revised and is slated for release in 2018. The new Implementation Plan will update existing information and will include additional chapters including Oak Savannah/Grassland Birds, Social Science/Human Dimensions, and Conservation Strategies based on the work products described above.

## **3.2 Central Valley Flood Protection Plan (CVFPP) Conservation Strategy**

The Central Valley Flood Protection Plan (CVFPP) provides a framework for prioritization of investments within the State Plan of Flood Control (SPFC), with a

primary goal of improved flood risk management in a way that helps make progress towards ancillary benefits such as promoting ecosystem functions. The CVFPP Conservation Strategy is meant to support implementation of the CVPPP; it focuses on approaches for how improved ecological functions can be achieved through integration of habitat restoration efforts with flood risk reduction projects within the SPFC (DWR 2016).

The CVFPP Conservation Strategy identifies habitat-based target needs, based on a review of available conservation plans, recovery plans, and targets set by conservation groups such as the CVJV. Since many of the habitat or species habitat targets cover planning areas much larger areas (e.g., CVJV covers the entire Central Valley), targets listed in the Conservation Strategy were adjusted downward proportionally to reflect extent of overlap between CVFPP Planning Area and those conservation plan planning areas, in acknowledgement that potential opportunities within the SPFC area are by themselves insufficient to result in meet all species and habitat needs for the Central Valley. The Conservation Strategy divided up its planning focus to five regional areas, two of which have overlap with the legal Delta. The Lower Sacramento River Conservation Planning Area (CPA) includes the Sacramento River and tributaries from the Fremont Weir to Isleton. The Lower San Joaquin River CPA covers the San Joaquin River and tributaries from Merced River downstream to the Delta.

Along the lower Sacramento River, the Conservation Strategy identified a target of 1,500 acres of riparian habitat on the active floodplain of the Lower Sacramento River. This target was principally based on the 2006 CVJV Implementation Plan's short-term objectives. Additionally, the Conservation Strategy identified a target of 6,600 acres of marsh and other wetlands in the Lower Sacramento CPA based on identified CVJV 2006 Implementation Plan targets. The Conservation Strategy identifies need for 57 additional miles of riparian-lined bank along lower Sacramento River, based on interpretation of the habitat needed to address the Anadromous Fish Restoration Program doubling goal, although there is high uncertainty regarding this target. For the lower Sacramento River CPA, the Conservation Strategy identifies 4 additional miles of natural bank needed, calculated by dividing the acres of additional riparian habitat needed by the average acres of river meander per mile of bank, and multiplying that by the percentage of banks containing revetment. The Conservation Strategy identifies a need for 1,300 additional acres of river meander potential for the lower Sacramento River CPA, calculated as a product of the area of additional riparian habitat and average percentage of floodplain with river meander potential that is currently only constrained by existing revetment or levees. The Conservation Strategy also estimates 50,500 acres of additional inundated floodplain habitat is needed to support the doubling goal.

For the lower San Joaquin River CPA, the Conservation Strategy has targets of 8,800 additional acres of riparian habitat; 6,500 additional acres of marsh and other wetlands; 60 additional miles of riparian-lined bank; 13 additional miles of natural bank; 4,300 additional acres of river meander potential; and 25,700 additional acres of floodplain.

### **3.2.1 Status**

A number of projects and programs are advancing under the Conservation Strategy including advanced mitigation projects, a regional permitting program, and regional advanced mitigation planning (RAMP). Additional status updates can be found at: <http://www.water.ca.gov/conservationstrategy/>.

### **3.3 Suisun Marsh Plan**

The Suisun Marsh Habitat Management, Preservation and Restoration Plan (SMP) was finalized in 2014 and represents a 30-year comprehensive plan which balances tidal wetland restoration with protection and enhancement of managed wetlands used by waterfowl hunting clubs. The SMP was developed and will be overseen by the Suisun Principal Agencies, which include USFWS; U.S. Department of Interior, Bureau of Reclamation (Reclamation); California Department of Fish and Wildlife (CDFW); California Department of Water Resources (DWR); National Marine Fisheries Services (NMFS); Suisun Resource Conservation District (SRCD); and the Delta Stewardship Council. The SMP includes habitat-based objectives over the course of its 30-year implementation timeframe including restoration of 5,000 to 7,000 acres of tidal marsh to contribute to recovery of threatened and endangered species, and protection and enhancement of 40,000 to 50,000 acres of managed wetlands, primary to benefit migratory waterfowl (Reclamation et al. 2013). It is important to note that tidal marsh restoration in Suisun Marsh being implemented pursuant to other efforts, such as Eco-Restore, may also count towards the 5,000-7,000 acre target of the SMP.

#### **3.3.1 Status**

Since the plan was adopted, the SMP agencies have organized the Adaptive Management Advisory Team (AMAT) which acts to guide restoration projects in a way that supports adaptive management and effective implementation of SMP goals. Tidal marsh restoration projects such as the Tule Red Restoration Project have benefited from tiering off the SMP environmental documentation. Additional information about the SMP is available at: <https://www.wildlife.ca.gov/Regions/3/Suisun-Marsh>.

### **3.4 Delta Conservation Framework 2017-2050**

The Delta Conservation Framework is a planning framework for integrating ecosystem conservation efforts to achieve resilient Delta landscapes and communities by 2050. The Delta Conservation Framework provides a collaborative platform for multiple agencies to work together, including: California Natural Resources Agency (CNRA), CDFW, Delta Stewardship Council, Delta Conservancy, DWR, and Delta Protection Commission. A wide range of stakeholders contributed to the development of the Delta Conservation Framework including Delta residents, the Delta Counties Coalition, the Central Valley Joint Venture, federal and regional agencies, non-profit organizations, and consulting firms. The framework is based on feedback received from individual meetings, presentations, and a series of six public workshops.

The Delta Conservation Framework provides a conservation vision with goals, strategies and objectives for integrating ecosystem conservation and management with the needs of the Delta community and stakeholders. As a long-term, high-level framework, it is based on a foundation of direct stakeholder input, a wide variety of

existing plans, and science. It also serves as the framework to support existing initiatives, including California EcoRestore and the Central Valley Flood Protection Plan Conservation Strategy (see above) and initiatives that follow. Going forward, the Delta Conservation Framework will inform the amendment of the ecosystem elements of the Delta Plan and state funding priorities in the Delta.

### **3.4.1 Status**

The Delta Conservation Framework will be completed in 2018 and will guide Delta conservation efforts to 2050. Delta Conservation Framework Public Draft Documents (9/26/2017) are available for download at:

<https://www.wildlife.ca.gov/conservation/watersheds/dcf>.

## **4. Restoration Programs**

The State has invested in major efforts to facilitate construction of habitat restoration projects in the Delta within the next few years. Most of these near-term restoration efforts are focused on creating new tidal marsh habitat as well as increasing the inundation extent and duration in the Yolo Bypass, pursuant to the mitigation requirements for ongoing water operations of the State Water Project (SWP) and the Central Valley Project (CVP). These focused restoration efforts are briefly summarized below.

### **4.1 California EcoRestore**

California EcoRestore is a CNRA initiative implemented in coordination with state and federal agencies to advance the restoration of at least 30,000 acres of Delta habitat by 2020. Driven by world-class science and guided by adaptive management, California EcoRestore will pursue habitat restoration projects with clearly defined goals, measurable objectives, and financial resources to help ensure success. The types of habitat targeted include tidal wetlands, floodplain, upland, riparian, fish passage improvements and others.

The California EcoRestore program is focused on implementing a comprehensive suite of habitat restoration actions to support the long-term health of the Delta and its native fish and wildlife species. Specifically, the program aims to achieve:

- 30,000 acres of Delta habitat restoration and protection:
  - 3,500 acres of managed wetlands
  - 17,500+ acres of floodplain restoration
  - 9,000 acres of tidal & sub-tidal habitat restoration
  - 1,000+ acres of Proposition 1 and 1E funded restoration projects

#### 4.1.1 Status

As of 2017, restoration projects totaling greater than 1,900 acres have been initiated, including tidal marsh, tidal wetlands, multi-benefit floodplain projects, as well as fish passage improvements in the Yolo Bypass. Additional status updates can be found at: <http://resources.ca.gov/ecorestore/>.

#### 4.2 Fish Restoration Program Agreement

Signed on October 18, 2010, the Fish Restoration Program Agreement (FRPA) is an agreement between CDFW and DWR that addresses specific habitat restoration requirements of the USFWS and NMFS Biological Opinions (BiOps) for the SWP and CVP Coordinated Long-term Operations (LTO), and the habitat restoration requirements of the CDFW Longfin Smelt (*Spirinchus thaleichthys*) Incidental Take Permit (ITP) for SWP Delta Operations. The primary objective of FRPA is to implement specific Reasonable and Prudent Alternatives (RPA) from the BiOps and Conditions from the ITP in the Delta, Suisun Marsh, and Yolo Bypass with a focus on restoring 8,000 acres of intertidal and associated subtidal habitat for the Delta Smelt (*Hypomesus transpacificus*) and Chinook Salmon, including 800 acres of intertidal and associated subtidal mesohaline habitat for Longfin Smelt. Other future actions benefiting salmonids are also allowed within FRPA.

The specific actions and mitigation acreage that will be implemented through FRPA are contained in the regulatory documents:

- USFWS LTO BiOp for Delta Smelt Biological Opinion  
RPA Component 4 ("DWR to restore minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh")
- NMFS LTO BiOp for Chinook Salmon  
RPA Action 1.2.6 (participate in the restoration of Battle Creek)  
RPA Actions 1.6 and 1.7 (funding and technical assistance for Yolo Bypass, Liberty Island and Lower Cache Slough fish passage improvement)
- CDFW LTO ITP for Longfin Smelt  
CDFW LTO ITP Condition 7 (800 acres of intertidal and associated subtidal wetland habitat in the mesohaline part of the Delta estuary)

#### 4.2.1 Status

A number of specific actions are currently being planned and implemented under FRPA. Status updates can be found at: <https://www.wildlife.ca.gov/Conservation/Watersheds/FRPA>.

## 5. Resiliency Strategies

In July, 2016, State and federal agencies released the Delta Smelt Resiliency Strategy (CNRA 2016) and Central Valley Salmon Resiliency Strategy (CNRA 2017a) aimed at rapidly improving conditions for these species. Both of these strategies are summarized below.

### 5.1 Delta Smelt Resiliency Strategy

The Delta Smelt Resiliency Strategy (Smelt Strategy) is a science-based document that has been prepared by the State of California (CNRA) to voluntarily address both immediate and near-term needs of Delta Smelt, to promote their resiliency to drought conditions as well as future variations in habitat conditions. The Strategy relies on the Interagency Ecological Program Management, Analysis, and Synthesis Team (MAST) Report and Conceptual Models (IEP MAST 2015) to articulate a suite of actions that can be implemented in the next few years that are intended to benefit Delta Smelt. Although the feasibility and effectiveness of each action included in the Strategy requires further exploration and study, the Strategy is an aggressive approach to implementing any actions that can be implemented in the near term, can be implemented by the State with minimal involvement of other entities, and have the potential to benefit Delta Smelt. State agencies that could implement this Strategy include DWR, CDFW, and California Division of Boating and Waterways (DBW). Several of the actions identified in this Strategy could also benefit other species, and coordination across various resource management agencies as appropriate may allow for benefits beyond Delta Smelt. All of the actions will be in compliance with applicable laws, including the Federal Endangered Species Act (FESA), California Endangered Species Act (CESA), California Environmental Quality Act, National Environmental Policy Act, and the Federal Clean Water Act. The Collaborative Science and Adaptive Management Program (CSAMP; see below) will be used to determine the appropriate research approach to designing and assessing the outcomes of these management actions individually and synergistically. Additionally, it is expected that Reclamation would participate in the implementation of this Strategy, including providing enhanced outflows as a near-term action, as described below.

#### 5.1.1 Objective

The primary objective of the Smelt Strategy is to improve the status of Delta Smelt (e.g., generating a Delta Smelt population growth rate  $>1$ ). The relatively positive response of the Delta Smelt population in 2011 suggests that it retains some ability to respond to improved conditions (Interagency Ecological Program 2015). The specific goals to achieve the primary objective consist of the following.

Goal 1: Improved Delta Smelt vital rates, including:

- Higher growth rates.
- Higher fecundity levels.

Goal 2: Improved habitat conditions, including:

- Increased spawning and rearing habitat area
- Improved habitat quality.
- Increased food resources.
- Higher turbidity.
- Reduced levels of invasive species (e.g., aquatic weeds, nonnative predators).
- Reduced levels of harmful algal blooms.

### **5.1.2 Proposed Actions**

The following lists, in no particular order, are the proposed management actions meant to address as many Environmental Drivers and Habitat Attributes in the MAST conceptual models as possible. A brief summary of each management action with a status update (2017) is provided below.

- **Aquatic Weed Control**

Summary of Action: DWR will coordinate with DBW to increase the treatment of aquatic weeds in the Delta to ensure the Strategy would provide maximum benefits to Delta Smelt habitat. The action will take place during 2017–2018 in locations permitted by USFWS and determined to be beneficial to Delta Smelt. In addition to Franks Tract, likely treatment areas would include Sherman Lake, Decker Island, and Cache Slough Complex.

Status (2017): DWR, CDFW, and DBW built on the state’s existing herbicide treatment program for invasive weeds to target nearly 200 acres of Delta Smelt habitat at Decker Island in the western Delta and in the Cache Slough complex in the north Delta. Field studies have begun to evaluate the effect of herbicide treatment on the habitat, including the Delta Smelt’s food web.

- **North Delta Food Web Adaptive Management Projects**

Summary of Action: DWR will augment flow in the Yolo Bypass by closing Knights Landing Outfall Gates and route water from Colusa Basin into Yolo Bypass in July 2016 and in July and/or September in 2017 and 2018 to promote food production and export into areas where Delta Smelt are known to occur.

Status (2017): DWR and CDFW partnered with many agencies and farmers in the summer of 2016 to direct water through a wetland and tidal slough corridor of the Sacramento River system and into the Delta. Close monitoring showed that the nutrient-rich “pulse flow” successfully generated a phytoplankton bloom and enhanced zooplankton growth and egg production. DWR will continue to work with Sacramento Valley water districts and others to repeat such flows and enhance Delta food production.

- **Outflow Augmentation**

Summary of Action: This adaptive management effort will occur in the spring and summer of 2017 and 2018. In 2016, Reclamation will provide 85 thousand acre-feet (TAF) to 200TAF additional outflow above what is required under D-1641 for release in the summer. In the spring and summer of 2017 and 2018, DWR and/or Reclamation will provide up to an additional 250 thousand acre-feet of outflow above D-1641 requirements.

Status (2017): Additional outflows were not necessary in water year 2016-17, one of the wettest on record. State scientists are studying how the massive outflow affects ecosystem and species.

- **Reoperation of the Suisun Marsh Salinity Control Gates**

Summary of Action: DWR will operate the Suisun Marsh Salinity Control Gates to reduce salinity in the Suisun Marsh during summer months. This management action may attract Delta Smelt into the high quality Suisun Marsh habitat and reduce their use of the less food-rich Suisun Bay habitat.

Status (2017): State Water Contractors have prepared an adaptive management plan on the reoperation of the gates, which restrict the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retain lower salinity Sacramento River water from the previous ebb tide. DWR has also initiated a feasibility study that and pilot reoperation could begin in 2018.

- **Sediment Supplementation in the Low Salinity Zone**

Summary of Action: DWR will assess the feasibility of sediment supplementation in the low salinity zone to promote turbidity corresponding to outflow actions (described above for Outflow Augmentation).

Status (2017): The State Water Contractors evaluated whether sediment supplementation was a feasible action to effectively increase turbidity in the low-salinity zone. Modeling was done to assess whether sediment supplementation is feasible, what magnitude of supplementation would be required in order to affect turbidity, and the spatial and temporal extent to which sediment supplementation would affect turbidity. Results are under review.

- **Spawning Habitat Augmentation**

Summary of Action: DWR will evaluate the availability of suitable spawning substrates in Suisun Marsh and Cache Slough in 2016. If suitable substrate is determined to be absent or limiting, DWR will introduce sand and other likely-favored spawning substrates in key areas of Suisun Marsh and Cache Slough (i.e., where pre-spawning adults have been found in higher densities than in other parts of the estuary).

Status (2017): DWR and the Delta Science Program are compiling data on the current status of substrates in order to consider targeted supplementation of sediment.

- **Roaring River Distribution System Food Production**

Summary of Action: DWR will install drain gates on the western end of the Roaring River Distribution System that can be used for most months of the year to drain food-rich water from the canal into Grizzly Bay to augment Delta Smelt food supplies in that area.

Status (2017): The Governor's proposed budget for 2017-18 includes \$1 million for implementation of this project.

- **Coordinate Managed Wetland Flood and Drain Operations in Suisun Marsh**

Summary of Action: Based on the findings of a study on Joice Island, DWR will coordinate with the SRCD and CDFW to develop a management plan for managed wetland flood and drain operations that can promote food export from the managed wetlands to adjacent tidal sloughs and bays.

Status (2017): DWR and San Francisco State University are in the midst of a field evaluation of the food web effects of such an approach.

- **Adjust Fish Salvage Operations during Summer and Fall**

Summary of Action: DWR and Reclamation will adjust summer salvage operations so that nonnative salvaged fish will not be returned to the Delta.

Status (2017): DWR used historical fish data to evaluate this proposal and found that the quantity of nonnative fish potentially removed would be modest compared to total predator populations in the Delta. The Bay Delta Office within DWR is currently working on predation projects and studies that could influence future actions.

- **Stormwater Discharge Management**

Summary of Action: The State will provide funding to entities such as the Sacramento Stormwater Quality Partnership, and/or counties and cities whose stormwater discharges to Delta waterways under National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System stormwater permits to enable the entities to implement additional actions to reduce contaminant loading in the Delta.

Status (2017): The Governor's proposed 2017-18 budget includes \$90 million for the State Water Resources Control Board's Storm Water Grant Program, which funds storm water and dry weather runoff projects that best advance the goals of improving water quality and realizing multiple benefits from the use of storm water and dry weather runoff as a resource.

- **Rio Vista Research Station and Fish Technology Center**

Summary of Action: A new Delta field station in Rio Vista that will consolidate existing IEP Delta Smelt monitoring and research activities, and will include a new Fish Technology Center (FTC) is expected to be completed in 2019. The FTC will be designed to house a refuge population for Delta Smelt to be used for conservation and research.

Status (2017): This project is in the planning stages and the environmental review document was released. Additional planning activities are proceeding.

- **Near-term Delta Smelt Habitat Restoration**

Summary of Action: DWR and other state agencies are planning restoration projects that are likely to benefit Delta Smelt. Details on the timing and characteristics can be found at: <http://resources.ca.gov/ecorestore>. In addition to these projects, the State's EcoRestore program has committed to implementing restoration of 9,000 acres of inter-tidal wetland habitat in the Delta and Suisun Marsh by the end of 2018 and to initiate work to enhance fish habitat in the Yolo Bypass.

Status (2017): State, local, and federal agencies and private interests broke ground in fall of 2016 on the Tule Red project, which will reopen 400 acres of former duck hunting club lands in Suisun Marsh to daily tidal action. DWR also launched a first-of-its-kind approach to speeding the pace of restoration by soliciting project proposals from private companies, non-profit groups, and individuals. Two projects involving approximately 700 acres have been selected, with a second solicitation expected soon. Construction is expected to begin on restoration projects in the coming year.

- **Franks Tract Restoration Feasibility Study**

Summary of Action: Franks Tract is located near the confluence of the Sacramento and San Joaquin Rivers, and could support low salinity zone habitat. CDFW will conduct a conceptual plan and feasibility study for restoring Franks Tract to reduce invasive aquatic weeds, reduce predation on Delta Smelt, increase turbidity, and improve food webs.

Status (2017): A conceptual restoration design has been prepared for evaluation. The conceptual plan would convert a portion of Franks Tract to inter-tidal marsh and modify hydraulic connections between False River and Old River through Franks Tract and associated channels.

## **5.2 Sacramento Valley Salmon Resiliency Strategy**

The Sacramento Valley Salmon Resiliency Strategy (Salmon Strategy) is a science-based document that has been prepared by the State to address specific near- and long-term needs of Sacramento River Winter-Run Chinook Salmon (winter-run), Central Valley Spring-Run Chinook Salmon (spring-run), and California Central Valley

Steelhead (steelhead). The Strategy mirrors the approach taken with the Delta Smelt Resiliency Strategy: science-driven, focused, and designed to provide resource agencies, the public, Congress, and the California State Legislature with information critical to collaborative approaches to species resiliency.

The Salmon Strategy relies heavily on the NMFS Final Recovery Plan for winter-run Chinook, spring-run Chinook, and steelhead (NMFS 2014; see above), and is guided by conceptual models of factors driving winter-run Chinook population dynamics at key life stages developed by the salmon and sturgeon assessment of indicators by life-stage (SAIL) teams (Johnson et al. 2016; Heublein et al. 2017). The actions are also supported, where indicated, by other salmonid recovery planning documents and efforts.

### 5.2.1 Goals and Objectives

The goal of this Strategy is to promote actions that address specific life-stage stressors and thus significantly contribute to the achievement of overall viability of Sacramento Valley salmonids. Specifically, the Salmon Strategy focuses on known stressors associated with spawning habitat, rearing habitat, through-Delta survival, and adult fish passage in order to contribute to these high-level objectives:

- Central Valley Project Improvement Act (CVPIA) salmonid doubling goals<sup>1</sup>

Sacramento River natural production goals

230,000 fall-run

68,000 late fall-run

110,000 winter-run

59,000 spring-run

- Recovery criteria identified in the Final Recovery Plan for winter-run, spring-run, and steelhead (NMFS 2014)<sup>2</sup>

Specific biological objectives have been identified for the Sacramento River that support the general need to increase survival and productivity of salmonids in the Sacramento Valley and to increase life history and genetic diversity. A summary of these biological objectives:

- Increase productivity by improving spawning and incubation conditions (habitat and water quality).
- Increase productivity by increasing juvenile salmonid survival.

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<sup>1</sup> <https://www.usbr.gov/mp/cvp/docs/A-CENTRAL-VALLEY-PROJECT-IMPROVEMENT-ACT-IMPLEMENTATION-PLAN-FOR-FISH-PROGRAMS-July-22-2015-Public-Draft.pdf>.

<sup>2</sup> [http://www.westcoast.fisheries.noaa.gov/publications/recovery\\_planning/salmon\\_steelhead/domains/california\\_central\\_valley/final\\_recovery\\_plan\\_07-11-2014.pdf](http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/california_central_valley/final_recovery_plan_07-11-2014.pdf).

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- Support the full range of juvenile migration conditions to maintain life history diversity.
- Support the full range of adult migration conditions to maintain life history diversity.
- Maintain genetic integrity by limiting genetic influence from hatchery-produced fish and interbreeding of genetically or behaviorally distinct runs.

*Proposed Actions*

The actions included in the Salmon Strategy represent a suite of habitat restoration management actions deemed necessary to improve the immediate and long-term resiliency of Sacramento Valley salmonids. Actions included in the Salmon Strategy are listed by relative geography, beginning with rearing habitat in the upper watersheds and tributaries. Those actions in the Plan area (highlighted in **bold**) include summary descriptions.

- Implement Multiple Actions on Battle Creek
- Complete Battle Creek Salmon and Steelhead Restoration Project
- Implement Battle Creek Reintroduction Plan
- Remove Battle Creek Natural Barrier
- Implement McCloud Reintroduction Pilot Plan
- Provide Instream Flows to Support Chinook Salmon and Steelhead in Mill, Deer, Antelope, and Butte Creeks
- Restore Fish Passage and Habitat in Upper Sacramento Tributaries
- Restoration of Instream Habitats in Upper Sacramento River
- Improve Fish Passage by Removing Sunset Pumps Rock Dam on the Feather River
- Restore Off-Channel Rearing, Streambank, and Riparian Habitats and Migratory Conditions along Upper/Middle/Lower Reaches of the Sacramento River
  - Action and objectives: Restore 6,000 acres of floodplain and riparian ecosystems along both banks of the upper, middle, and lower Sacramento River – including within the Sutter Bypass, if feasible – at scale necessary to provide abundant and diverse salmonid rearing habitat and improved migratory conditions.
- Complete Fish Screen Construction on Major Diversions along the Sacramento River

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- Improve Sutter Bypass and Associated Infrastructure to Facilitate Adult Fish Passage and Improved Stream Flow Monitoring
- Improve Yolo Bypass Adult Fish Passage
  - Action and objectives: Improve adult salmonid and sturgeon passage through the Yolo Bypass – including the Fremont Weir – by modifying or removing barriers.
- Increase Juvenile Salmonid Access to Yolo Bypass, and Increase Duration and Frequency of Yolo Bypass Floodplain Inundation
  - Action and objectives: Increase juvenile salmonid access to the Yolo Bypass and improve adult fish passage by constructing an operable gated structure in the Fremont Weir. Operate facility to increase duration and frequency of Yolo Bypass inundation between November 1 and mid-March. Enhance 17,000 or more acres of floodplain habitat.
- Construct Permanent Georgiana Slough Non-Physical Barrier
  - Action and objectives: Increase overall through-Delta survival by reducing juvenile salmon entry into the interior Delta.
- Restore Tidal Habitat in the Delta
  - Action and objectives: Restore 11,000 acres of tidal habitat for improved rearing and reduced reverse tidal flows in critical migratory channels. Action includes existing USFWS BO requirements for tidal habitat restoration, additional California EcoRestore tidal habitat restoration goals, and restoration pursuant to California WaterFix Proposed Action.

*Additional Actions to Improve Salmon Resiliency in the Sacramento Valley and Beyond*

- Continue and enhance various ongoing actions to improve salmon hatchery operations, practices, and fishery activities to benefit wild populations as well as commercial fisheries.
- Evaluate opportunities for improved survival, minimized impingement, and improved salvage operations at state and federal Delta pumping facilities to reduce vulnerabilities related to predation and other related stressors.
- Where applicable, implement policies and state funding guidance to incentivize multi-benefit infrastructure (e.g. flood management) project outcomes that include improved habitat conditions for Central Valley salmonids and other at-risk species.
- Evaluate impacts and mechanisms of predation on rearing and out-migrating juvenile Chinook Salmon along the upper, middle, and lower Sacramento River.

## **6. Hatchery Management Focused on Conservation and Viability**

Hatcheries for anadromous salmonids have been in place for decades to mitigate for loss of historic spawning habitat following construction of the large rim dams. These hatcheries are important to bolster populations of salmonids to ensure continued commercial and recreational fishing. A Delta Smelt conservation hatchery has been setup to create a refuge population, in the event this species is extirpated from the wild. The latest details related to improving hatchery management for salmonids and Delta Smelt are described below.

### **6.1 Anadromous Salmonids**

Threats to the genetic integrity of Central Valley salmonids has been identified as a serious concern for the recovery of these species (NMFS 2014). Artificial propagation programs have resulted in genetic introgression with naturally spawning fish. Such introgressions introduce maladaptive genetic changes to the wild-origin Winter-run Chinook Salmon stocks and may reduce overall fitness (Myers et al. 2004; Araki et al. 2007). It is now recognized that Central Valley hatcheries are a significant and persistent threat to wild-origin steelhead populations and fisheries (NMFS 2009), leading to introgression by hatchery-origin fish that spawn naturally and interbreed with local wild-origin populations.

In 2012, a hatchery program review for California was conducted by the California Hatchery Scientific Review Group (California HSRG), made up of qualified fishery scientists and biologists. The primary goal of their review was to ensure that hatchery programs are managed to help recover and conserve naturally spawning salmon and steelhead populations (California HSRG 2012). Currently, goals for anadromous fish hatchery facilities in California are described as ‘mitigation’ and measured only in terms of numbers of juvenile fish to be produced and released annually (California HSRG 2012). The California HSRG (2012) stresses that while supporting fisheries in a primary goal of hatcheries and an important goal for state and federal resource management agencies, efforts to augment harvest must also be balanced against impacts of fisheries on natural salmon and steelhead populations.

The HSRG (2012) provides recommended statewide standards for operating salmonid hatchery programs. In addition to providing hatchery-specific recommendations for management, the HSRG (2012) provides detailed recommendations on the following five key hatchery topics: 1) Broodstock Management, 2) Program Size and Release Strategies, 3) Incubation, Rearing, and Fish Health Management, 4) Monitoring and Evaluation, and 5) Direct Effects on Local Habitat and Aquatic or Terrestrial Organisms. One of the primary recommendations made by the HSRG (2012) under the Monitoring and Evaluation topic is the need for a Hatchery and Genetic Management Plan (HGMP) for each California Hatchery Program. An HGMP is used by NMFS to evaluate the impacts on anadromous salmon and steelhead under the FESA. The primary goal of the HGMP is to devise biologically based artificial propagation management strategies that ensure the conservation and recovery of listed ESUs. HGMPs include a description of hatchery facilities, operational protocols and benefits derived from each hatchery

propagation, as well as assessments of the effects of the program on naturally produced fish.

### **6.1.1 Status**

Many of the recommendations of the HSRG (2012) are not currently in place, but progress is on-going. For example, HGMPs have been developed for some hatcheries (Feather River, Nimbus) but not for others (Coleman, Merced River). Other HSRG recommendations have yet to be enacted, such as the HSRG's recommendation for 100% tagging of hatchery salmonids in the Central Valley.

## **6.2 Delta Smelt**

Unlike Central Valley salmonids that have integrated populations of hatchery and wild individuals, Delta Smelt hatchery management consists of a refuge population at the UC Davis Fish Conservation and Culture Laboratory (FCCL) which acts as an "insurance policy" in the event of species extinction in the wild. The goal of genetic management is to maintain a captive population that is genetically (and therefore phenotypically) similar to the wild population. This way, in the event of the need to reintroduce Delta Smelt, the hatchery population will be best-poised to survive and thrive. This goal is achieved through making single pair crosses (one male x one female) each year that 1) minimize inbreeding, 2) incorporate wild fish into the broodstock, and 3) maximize overall population genetic diversity using the aquaculture facilities at FCCL.

### **6.2.1 Status**

The FCCL is currently expanding and renovating existing facilities, increasing the capacity for culture and research purposes. One of the recent tasks is to develop culture methods for threatened Longfin Smelt.

## **7. Monitoring and Adaptive Management**

Monitoring strategies in the Delta are constantly evolving to reflect latest science and to take advantage of new techniques and technologies. Collaborative adaptive management groups are using the latest monitoring and scientific data to help guide new management approaches for the Delta. These various efforts are described in more detail below.

### **7.1 IEP Tidal Wetlands Monitoring**

The Tidal Wetland Monitoring Framework was developed by the Interagency Ecological Program Tidal Wetland Monitoring Project Work Team for the Upper San Francisco Estuary as a resource to facilitate the development of scientifically sound project-specific plans for monitoring the effectiveness of tidal wetland restoration in providing benefits to at-risk fish species (IEP TWM PWT 2017). A monitoring plan that draws its components from this monitoring framework will contain hypotheses, metrics, and sampling methods that have been developed and vetted by a multi-disciplinary team of scientists embodying decades of research in this system.

The primary goal of this monitoring framework is to facilitate the accumulation of comparable and well-documented data across many restoration projects and monitoring

efforts (IEP TWM PWT 2017). The larger goal of the majority of tidal wetland restoration in the Upper Estuary is to promote recovery of populations of at-risk fish species. Just as a single restoration site is but a piece of the larger network of wetlands that will surely be necessary to achieve that goal, a single monitoring program will provide only part of the data necessary to detect restoration benefits. The system-wide collection of such data may be used to assess the effectiveness of the entire system of tidal wetland restoration in the Delta and Suisun Marsh in increasing available habitat and food supplies for at-risk fish species.

### **7.1.1 Status**

The Tidal Wetland Monitoring Framework was created in 2017, and is therefore is in its early stages of implementation. Once this plan is put into action, it should be periodically re-evaluated within an adaptive management context to evaluate whether monitoring methods, site management, and/or site goals should be adjusted (IEP TWM PWT 2017).

## **7.2 Enhanced Delta Smelt Monitoring (EDSM) Program**

A new sampling program initiated by the USFWS in November 2016, The Enhanced Delta Smelt Monitoring (EDSM) Program, is a year-round weekly sampling program that samples nearly all life stages of Delta Smelt and produces weekly estimates of abundance for several spatially-defined, and temporally dynamic, strata (Newman et al. 2017). The EDSM attempts to fix a lot of the problems associated with other IEP monitoring efforts that target Delta Smelt by: 1) conducting continuous year-round sampling instead of different seasonal efforts, 2) weekly sampling frequency instead of monthly, 3) spatially stratified sampling by randomly selecting locations weekly using a probabilistic procedure aimed at providing unbiased measures of population metrics across the Estuary, and 4) attempting to avoid false zero samples by making additional tows until fish are caught or a maximum tow count is reached (e.g. 8 tows).

### **7.2.1 Status**

EDSM monitoring has been on-going since November of 2016. The first year of sampling results were summarized in Newman et al. (2017).

## **7.3 Chinook Salmon Tagging and Marking**

Current marking programs for Chinook Salmon in the Central Valley consist of a constant fractional marking program in which 25 percent of fish produced are released with adipose fin-clip and coded-wire tag (CWT). While this program allows for reasonable statistical estimation of proportion of hatchery fish on natural spawning grounds and in hatchery returns, it does not allow real-time identification of all hatchery fish as being of hatchery origin (California HSRG 2012). The California HSRG (2012) recommended an expanded marking and tagging program to facilitate better hatchery management. The HSRG (2012) recommended that all Chinook Salmon (100 percent) should be tagged with CWT and that 25 percent should be adipose fin-clipped to allow real-time identification of hatchery-origin fish (using electronic CWT detection devices). The California HSRG (2012) states that 100% tagging is essential for the following management purposes: to enable improved monitoring of hatchery and natural intersections throughout the entire life cycle; to enable culling of undesirable hatchery

matings between out-of-subbasin and local stocks; to enable improved management of hatchery broodstock (incorporation of known numbers of natural fish); and to monitor and potentially control spawner composition in natural spawning areas.

### **7.3.1 Status**

The Central Valley marking and tagging program for Chinook Salmon has not changed since the recommendations by the California HSRG (2012) called for an enhanced tagging program to improve hatchery management practices.

## **7.4 Next Generation Techniques**

### **7.4.1 SmeltCam**

To attempt to overcome the challenge of sampling for a rare and endangered species, the Delta Smelt, an underwater video camera codend for trawled nets was created, called SmeltCam (Feyrer et al. 2013). The SmeltCam functions as an open-ended codend that automatically collects information on the number and species of fishes that pass freely through a trawled net without handling (Feyrer et al. 2013). Feyrer et al. (2013) applied the SmeltCam to study the fine-scale distribution of juvenile Delta Smelt in the water column in the upper San Francisco Estuary. With the application of the SmeltCam Feyrer et al. (2013) increased the survival of individual Delta Smelt by 72% compared to using a traditional codend, where all of the fish would have likely died due to handling stress. The SmeltCam improved upon similar previously developed silhouette photography or video recording devices and demonstrated how new technology could be developed to address important questions in conservation biology as well as lessen the negative effects associated with traditional sampling methods on imperiled species (Feyrer et al. 2013).

#### *Status*

The SmeltCam is currently being applied in research studies to identify the mechanistic processes driving sub-adult Delta Smelt distribution and movements before and during upstream dispersal and migration (<https://ca.water.usgs.gov/projects/2015-34.html>).

## **7.5 Environmental DNA**

Monitoring the distribution and abundance of endangered and rare species is critical to assess the status of species recovery and help guide conservation efforts (Laramie et al. 2015). The low detection probability of rare and imperiled species, coupled with increasing handling restrictions of federal and State protections, has led to the demand for less stressful sampling methods that at the same time provide greater sensitivity of detection. Environmental DNA (eDNA) is an emerging sampling method that has been used successfully for detection of rare species, and does not require direct contact with the organism (Janosik and Johnston 2015; Rees et al. 2014). Aquatic organisms release DNA into their surrounding environment by leaving behind indicators such as slime, scales, epidermal cells or feces (Janosik and Johnston 2015). Environmental DNA has been used to detect the presence of many rare or endangered organisms including Green Sturgeon (*Acipenser medirostris*) (Bergman et al. 2016), Chinook Salmon (Laramie et al. 2015, Asian Carp (*Hypophthalmichthys spp.*) (Jerde et al. 2011), Slackwater Darter (*Etheostoma boschungii*) (Janosik and Johnston 2015), giant

salamanders (*Andrias japonicus*)(Fukumoto et al. 2015; Goldberg et al. 2011), and various arthropods (Thomsen et al. 2012). Environmental DNA analysis provides a more cost-effective and less-invasive sampling method compared to traditional survey techniques (Rees et al. 2014). Because field sampling only requires collecting a water sample, eDNA analysis can have considerable time and cost benefits over traditional sampling, allowing for greater spatial distribution of effort.

Much study is still needed in order to apply eDNA to answer questions beyond presence/absence of fish species (Rees et al. 2015). Much is still unknown about estimating fish biomass using eDNA, making more traditional survey methods still important for estimating population size (Rees et al. 2015). Studies have found quantity of eDNA to be correlated with species density for Common Carp (*Cyprinus carpio*) (Takahara et al. 2012), Bigheaded Carp (*Hypophthalmichthys nobilis*) (Klymus et al. 2015), and Rocky Mountain Tailed Frogs (*Ascaphus montanus*) and Idaho Giant Salamanders (*Dicamptodon aterrimus*)(Pillod et al. 2013). While these studies are promising, there is limited knowledge of how conditions such as fish behavior (DNA shedding rates), hydrologic conditions, water chemistry, UV-B exposure, and water temperature affect eDNA concentration (Rees et al. 2015). For eDNA analysis to be a useful tool for estimating fish biomass, experimental studies are needed to understand how these factors influence eDNA concentration and resulting biomass estimates.

### **7.5.1 Status**

Numerous studies are currently underway to better refine eDNA methodology and address the uncertainties associated with the application of eDNA for fisheries management in the Central Valley.

## **7.6 Collaborative Science and Adaptive Management Program (CSAMP)**

The Collaborative Science and Adaptive Management Program (CSAMP) was launched following a decision by the United States District Court for the Eastern District of California on April 9, 2013. The decision entitled “Memorandum Decision and Order regarding Motion to Extend Remand Schedule” (Court Order) was issued in response to a motion to extend the court-ordered remand schedule for completing revisions to salmonid and Delta Smelt Biological Opinions (BiOps). The CSAMP is structured as two-tiered organization comprised of: (1) a Policy Group made up of agency directors and top-level executives from the entities involved in the litigation, and (2) the Collaborative Adaptive Management Team (CAMT) including designated managers and scientists to serve as a working group functioning under the direction of the Policy Group. Technical support is provided by two scoping teams, one for Delta Smelt and one for salmon, comprised of scientists representing the CAMT members (CAMT 2015).

The CSAMP represents an opportunity to test, on a limited scale, the type of collaborative, integrated science described in the Delta Science Plan, by implementing proposed actions and approaches outlined in the Delta Science Plan (Connor 2013). The CSAMP is a potential pilot for implementing the portions of the Delta Science Plan that include adaptive management, conflict resolution, engagement of decision makers in setting research and monitoring priorities, and a governance structure similar to the one in the draft plan. The CSAMP could model how new information would be used to

promote a reduction in the multiple stressors of endangered fish species, optimize habitat restoration designs, and provide reliability for State Water Project and Central Valley Project operations.

## **7.7 Collaborative Adaptive Management Team**

The CAMT is the scientific wing of the CSAMP (CAMT 2015). The goal of the CAMT is to produce information through a collaborative process that is directly relevant to management actions in the Delta. This information is intended to be used to affect management operations that protect fish while providing for greater water supply reliability. This includes examining the science underlying specific actions contained in the current BiOps, developing new information, and examining information that has become available in the years since the BiOps were developed.

### **7.7.1 Status**

Currently, the technical investigations that are being undertaken by CSAMP include the application of Delta Smelt survey data, fall outflow management for Delta Smelt, Old and Middle River Management and Delta Smelt entrainment, and south Delta salmonid survival.

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**Table A-1. Planning Efforts that Set Preservation and Restoration Targets for the Delta and Suisun Marsh**

Planning Effort	Habitat Type	Target Species/Community	Preservation Objective	Preservation Target Region	Restoration Objective	Restoration Target Region	Notes	Source <sup>1</sup>
Central Valley Flood Protection Plan (CVFPP) Conservation Strategy	Freshwater marsh	Various	-	-	Additional 6,600 ac	Lower Sacramento CPA (Fremont Weir to Isleton)		CVFPP Conservation Strategy, Appendix L
CVFPP	Freshwater marsh	Various	-	-	Additional 6,500 ac	Lower San Joaquin CPA (Merced River to Delta)		CVFPP Conservation Strategy, Appendix L
CVFPP	Inundated Floodplain	Juvenile salmonids	-	-	Additional 50,500 ac	Lower Sacramento CPA (Fremont Weir to Isleton)	Assumes floodplains provide rearing habitat of intermediate suitability (17.5%)	CVFPP Conservation Strategy, Appendix L
CVFPP	Inundated Floodplain	Juvenile salmonids	-	-	Additional 25,700 ac	Lower San Joaquin CPA (Merced River to Delta)	Assumes floodplains provide rearing habitat of intermediate suitability (17.5%)	CVFPP Conservation Strategy, Appendix L

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Planning Effort	Habitat Type	Target Species/Community	Preservation Objective	Preservation Target Region	Restoration Objective	Restoration Target Region	Notes	Source <sup>1</sup>
CVFPP	Natural Bank	Anadromous fish, riparian wildlife	-	-	Additional 4 miles	Lower Sacramento CPA (Fremont Weir to Isleton)		CVFPP Conservation Strategy, Appendix L
CVFPP	Natural Bank	Anadromous fish, riparian wildlife	-	-	Additional 13 miles	Lower San Joaquin CPA (Merced River to Delta)		CVFPP Conservation Strategy, Appendix L
CVFPP	Riparian	Riparian birds	-	-	Additional 1,500 ac	Lower Sacramento CPA (Fremont Weir to Isleton)		CVFPP Conservation Strategy, Appendix L
CVFPP	Riparian	Riparian birds	-	-	Additional 8,800 ac	Lower San Joaquin CPA (Merced River to Delta)		CVFPP Conservation Strategy, Appendix L
CVFPP	Riparian-lined bank	Juvenile salmonids	-	-	Additional 57 miles	Lower Sacramento CPA (Fremont Weir to Isleton)		CVFPP Conservation Strategy, Appendix L
CVFPP	Riparian-lined bank	Juvenile salmonids	-	-	Additional 60 miles	Lower San Joaquin CPA (Merced River to Delta)		CVFPP Conservation Strategy, Appendix L
CVFPP	River Meander Potential	Anadromous fish, riparian wildlife	-	-	Additional 1,300 ac	Lower Sacramento CPA (Fremont Weir to Isleton)		CVFPP Conservation Strategy, Appendix L
CVFPP	River Meander Potential	Anadromous fish, riparian wildlife	-	-	Additional 4,300 ac	Lower San Joaquin CPA (Merced River to Delta)		CVFPP Conservation Strategy, Appendix L

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Planning Effort	Habitat Type	Target Species/Community	Preservation Objective	Preservation Target Region	Restoration Objective	Restoration Target Region	Notes	Source <sup>1</sup>
Central Valley Joint Venture (CVJV)	Semi-permanent wetlands	Breeding Shorebirds	-	-	71,574 ac (1,785% relative increase)	Yolo-Delta Basin	Existing habitat: 4,011 ac	Strum et al. 2017
CVJV	Shallow wetlands (principally managed wetlands)	Non-breeding Shorebirds	-	-	127,501 ac in fall; 115,942 ac in spring	Delta Region (note: this region is larger than legal Delta)	Existing habitat: 13,022 ac Managed wetlands: 13,022 ac Rice: 5,214 ac Corn: 213,926 ac Other: 183,125 ac	Dybala et al. 2017a
CVJV	Riparian	Riparian birds	-	-	59,031 ac (180% relative increase)	Yolo-Delta Basin	Existing habitat: 32,870 ac	Dybala et al. 2017b
CVJV	Grassland	Grassland-Dependent Birds	-	-	0 ac (0% relative increase)	Central Valley Floor	Existing habitat: 3,872,770 ac	DiGaudio et al. 2017
CVJV	Oak Woodland	Oak Woodland-Dependent Birds	-	-	84,829 ac (75% relative increase)	Central Valley Floor	Existing habitat: 112,712 ac	DiGaudio et al. 2017

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Planning Effort	Habitat Type	Target Species/Community	Preservation Objective	Preservation Target Region	Restoration Objective	Restoration Target Region	Notes	Source <sup>1</sup>
Giant Garter Snake Recovery Plan	Perennial wetlands	Giant Garter Snake	Five habitat block pairs	Yolo Bypass	If needed, restore habitat to achieve target of five habitat block pairs in Yolo Bypass	Yolo Bypass	Each habitat block pair consists of a contiguous 593-ac perennial wetland separated by no more than five miles from a contiguous 1,578-ac riceland (or another 593-ac perennial wetland)	USFWS 2017a
Giant Garter Snake Recovery Plan	Perennial wetlands	Giant Garter Snake	Ten habitat block pairs	Delta (at least two pairs in Stone Lakes, White Slough, Stockton, Tracy)	If needed, restore habitat to achieve target of 10 block pairs in Delta	Delta Region	Each habitat block pair consists of a contiguous 593-ac perennial wetland separated by no more than five miles from a contiguous 1,578-ac riceland (or another 593-ac perennial wetland)	USFWS 2017a

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Planning Effort	Habitat Type	Target Species/Community	Preservation Objective	Preservation Target Region	Restoration Objective	Restoration Target Region	Notes	Source <sup>1</sup>
Suisun Marsh Habitat Management, Preservation, and Restoration Plan	Tidal Marsh	Threatened and endangered species (e.g., Delta Smelt, Ridgway's rail)	-	-	Total 5,000-7,000 ac in Suisun Marsh	<ul style="list-style-type: none"> <li>Region 1 (Western) 1,000-1,500 ac</li> <li>Region 2 (Central) 920-1,380 ac</li> <li>Region 3 (Northeast) 360-540 ac</li> <li>Region 4 (Southwest) 1,720-2,580 ac</li> </ul>		USBR, USFWS and CDFG 2013
Suisun Marsh Habitat Management, Preservation, and Restoration Plan (cont.)	Managed Wetlands	Migratory waterfowl	40,000-50,000 ac	Suisun Marsh	-	-		USBR, USFWS and CDFG 2013
Tidal Marsh Recovery Plan	Tidal Marsh	Tidal Marsh Species (e.g., Ridgway's Rail, Salt marsh harvest mouse)	5,000 ac of contiguous marsh	Suisun Bay (Suisun Marsh and Contra Costa Shoreline)	Restoration in Suisun Bay area to reach target, if necessary	<ul style="list-style-type: none"> <li>1000 ac Western Suisun/Hill Slough</li> <li>1000 ac Suisun Slough/Cutoff Slough</li> <li>1000 ac Nurse Slough/Denverton Slough</li> <li>1500 ac Grizzly Island</li> <li>500 ac Contra Costa County Shoreline</li> </ul>		USFWS 2013

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Planning Effort	Habitat Type	Target Species/Community	Preservation Objective	Preservation Target Region	Restoration Objective	Restoration Target Region	Notes	Source <sup>1</sup>
Tidal Marsh Recovery Plan	Tidal Marsh	Tidal Marsh Rare Plants	Preserve up to 9,000 ac (includes restored habitat)	Suisun Bay (Suisun Marsh and Contra Costa Shoreline)	Restoration in Suisun Bay area to reach target, if necessary	Encompass a minimum of 80% of rare plant populations in Suisun Bay (Suisun Marsh and Contra Costa Shoreline)		USFWS 2013
EcoRestore	Tidal Marsh	Delta Smelt, Longfin Smelt	-	-	9,000 ac	Delta/Suisun Marsh		California Natural Resources Agency 2017
EcoRestore	Seasonal Floodplain	Salmonids	-	-	17,500 ac	Delta/Suisun Marsh		California Natural Resources Agency 2017
EcoRestore	Managed Wetlands	-	-	-	3,500+ ac	Delta/Suisun Marsh	Goals for these managed wetlands projects are principally subsidence reversal and carbon sequestration	California Natural Resources Agency 2017
EcoRestore	General	-	-	-	1000+ ac	Delta/Suisun Marsh	Proposition 1 and 1E Funded Restoration Projects	California Natural Resources Agency 2017

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**Table A-1. Planning Efforts that Set Preservation and Restoration Targets for the Delta and Suisun Marsh (contd.)**

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