CHAPTER 3. CONSERVATION STRATEGY

[***Note to Reviewers****: This is a revised version of BDCP Chapter 3, Conservation Strategy prepared by the Consultant. The drafts of various subsections of Chapter 3 were provided by the Consultant to the Steering Committee between July 2009 and November 2010. This version of Chapter 3 combines the various subsections for the first time. Revisions to draft subsections have been made throughout the text to address comments received, to clarify concepts, and to bring the document up to date with the progress on the subsections. The BDCP Steering Committee members have submitted comments to various drafts subsections of this chapter during development, which may or may not have been incorporated into this November 18, 2010 draft. While the text of this chapter is subject to change and revision as the BDCP planning process progresses, the chapter has been drafted and formatted to appear as it may in a completed draft HCP/NCCP. Although the chapter includes declarative statements (e.g., the Implementation Office will…), it is nonetheless a "working draft" that will undergo further modification based on input from the BDCP Steering Committee, state and federal agencies, and the public.*

Chapter 3 includes statements that describe the anticipated results of the Effects Analysis. As stated in the note to reviewer in Chapter 5, Effects Analysis, the effects analysis is not complete and is ongoing. Statements in Chapter 3 regarding the Effects Analysis may need to be revised once the Effects Analysis is complete. The Steering Committee may revise, add, or delete one or more conservation measures to better achieve goals specified in the planning agreement and objectives may be revised or developed through the logic chain process.

The most recent draft of the Terrestrial Resources Conservation Strategy was provided to the Steering Committee on November 4, 2010. Work is continuing with Steering Committee representatives to further refine the Terrestrial Resource Goals and Objectives and Conservation Strategy. Due to the ongoing development and refinement of the Terrestrial Conservation Strategy, the terrestrial effects analysis will need to be revisited to reflect any changes in the strategy.]

3.1 INTRODUCTION

This chapter sets out the BDCP Conservation Strategy, which consists of multiple components that are designed collectively to achieve the BDCP overall planning goals and objectives of ecosystem restoration and water supply and reliability. The chapter further describes the Plan's intended biological outcomes and details the means by which these outcomes will be achieved. The Conservation Strategy includes the BDCP's biological goals and objectives, and identifies a set of conservation measures necessary to provide for the conservation and management of covered species and natural communities upon which they depend, and to avoid, minimize, and compensate for the potential impacts of covered activities on these resources (*see* Chapter 4, *Description of Covered Activities and Associated Federal Actions*). The Conservation Strategy also includes comprehensive programs for monitoring, research, and adaptive management. The

BDCP Conservation Strategy has been developed to meet the regulatory standards of Sections 7 and 10 of the federal Endangered Species Act (ESA), the state's Natural Community Conservation Planning Act (NCCPA), and, as appropriate, the California Endangered Species Act.

The Conservation Strategy responds to the challenge of restoring key ecosystem functions in the highly altered environment of the Delta. The Delta was once a vast marsh and floodplain intersected by meandering channels and sloughs that provided habitat for a rich diversity of fish, wildlife, and plants. The Delta of today is a system of artificially channeled and dredged waterways constructed into static geometries, initially designed to support farming and, later, urban development. These channels also serve to convey water supplies across the Delta for export to cities and farms in the San Francisco Bay Area, San Joaquin Valley and southern California. Physical disturbances within the Delta, the introduction of nonnative species that have disrupted the foodweb, and multiple other environmental challenges to the ecosystem have contributed to declines in native fish, wildlife, and plant species and other organisms. In recent years, these factors have caused a significant drop in the population of key native fish species.

There is a growing urgency to address the challenges of the Delta from both an ecological and water supply perspective. At-risk species have become further imperiled, litigation contesting the adequacy of existing approaches to meet conservation and water supply objectives has intensified and regulatory requirements governing the water system have continuously shifted in response, resulting in increasing unpredictability. To further compound these challenges, fundamental changes to the Delta are certain to occur, as the Delta is not a static ecological system. The anticipated effects of climate change will result in elevated sea levels, altered annual and inter-annual hydrological cycles, changed salinity and water temperature regimes, and accelerated shifts in species composition and distribution in and around the Delta. In addition, the risk of significant flood events has greatly increased, in part because of the likelihood that significant seismic events will occur over the next several decades. These expected environmental changes add to the difficulty of resolving the increasingly intensifying conflict between the ecological needs of a range of at-risk Delta species and natural communities and the need to provide adequate and reliable water supplies for people, communities, agriculture, and industry. Anticipating, preparing for, and adapting to these changes are key underlying drivers for the BDCP.

The approach embodied in the BDCP and its Conservation Strategy reflects a significant departure from the manner in which at-risk Delta fish species and their habitats have been managed in the past. The BDCP will contribute to the restoration of the health of the Delta's ecological systems by focusing on ecological functions and processes at a broad landscape scale, rather than by focusing on discrete parts. Unlike past regulatory approaches that have relied almost exclusively on iterative adjustments to the operations of the State Water Project (SWP) and the Central Valley Project (CVP), including those reflected in recent biological opinions issued by the U.S. Fish and Wildlife Service (USFWS)[1] the National Marine Fisheries Service (NMFS),[2] the BDCP proposes actions that will allow for fundamental, systemic, long-term physical changes to the Delta, including substantial alterations to water conveyance infrastructure and water management regimes and extensive restoration of habitat. These ecosystem-wide changes are intended to enhance substantially the productivity of ecological processes and advance the conservation of multiple species and communities that depend upon them.

The geographic scope of the BDCP Plan Area includes the statutory Sacramento-San Joaquin Delta, as defined in California Water Code Section 12220; Suisun Marsh; and the Yolo Bypass (see Section 1.4.1 *Geographic Scope of the Plan Area*). The boundaries of the Plan Area may also encompass over time additional areas within Delta counties that are protected through BDCP actions to advance the Plan's goals and objectives for terrestrial species and habitats. Because the state and federal water infrastructure operates as an integrated system, the effects of the BDCP will extend beyond the Plan Area, both upstream and downstream, and will implicate both water operational parameters and species and their habitats. Therefore, the BDCP will take into account these upstream and downstream effects, both positive and negative, to ensure that the overall effects of the BDCP are fully analyzed and understood.

While the initial focus of the BDCP was to address the conservation of Delta fish species that are currently at very low population levels, such as delta smelt, longfin smelt, winter-run Chinook salmon, spring-run Chinook salmon, and green sturgeon, the Conservation Strategy has evolved to include measures to address a broad range of species and habitats. The Conservation Strategy will provide for the conservation and management of 63 species of fish, wildlife, and plants (Section 1.4.3, *Covered Species*) and 14 natural communities (Section 1.4.2, Covered *Natural Communities*) in the Plan Area. The strategy sets forth actions to reduce the effects of environmental stressors on these biological resources at various ecological scales, including ecosystem-level actions to address physical and chemical processes and foodwebs; natural community-level actions to address the habitats of many species, and species-level actions to address individual populations and occurrences of species.

The Conservation Strategy is built upon and reflects the extensive body of scientific investigation, study, and analysis of the Delta compiled over several decades (see The State of Bay-Delta Science, 2008). The BDCP Steering Committee, for instance, took into account the results and findings of numerous studies initiated under the CALFED Bay-Delta Science program (now the Delta Science Program) and Ecosystem Restoration Program (ERP), the long-term monitoring programs conducted by the Interagency Ecological Program (IEP), research and monitoring conducted by state and federal resource agencies, and research contributions of academic investigators. In addition, the Steering Committee considered a number of other recent

[1] Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP) (U.S. Fish and Wildlife Service 2008).

[2] Biological Opinion and Conference Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan (National Marine Fisheries Service 2004, 2009).

reports on the Delta, including reports of the Governor's Delta Vision Blue Ribbon Task Force (January and October 2008) and several recent reports of the Public Policy Institute of California.[3] Many elements of the BDCP Conservation Strategy parallel the recommendations of these other reports and reflect broad agreement that the Delta is dysfunctional from both an ecological and water supply reliability perspective and that fundamental change is necessary.

To ensure that the BDCP would be based on the best scientific and commercial data available, the BDCP Steering Committee also undertook a rigorous process to develop new and updated information and to evaluate a wide variety of issues and approaches as it formulated a cohesive, comprehensive Conservation Strategy. This effort included an evaluation, early in 2009, conducted by multiple teams of experts of BDCP conservation options using the CALFED Bay-Delta Ecosystem Restoration Program's DRERIP[4] evaluation process (results are provided in Appendix F, *DRERIP Evaluation Results*). Reflecting the requirements of the NCCPA planning process, the Steering Committee also sought and utilized independent scientific advice at several key stages of the planning process, enlisting well-recognized experts in ecological and biological sciences to produce recommendations on a range of relevant topics, including approaches to conservation planning for both aquatic and terrestrial species, establishing adaptive management and monitoring programs, and devising biological goals and objectives (see Appendix G, *Independent Science Advisors Reports*).[5]

In the fall of 2009, the Steering Committee conducted a "mini" effects analysis that focused on the expected effects of draft water operations conservation measures on salmonids, smelt, and sturgeon. The results of the mini effects analysis informed decisions to revise proposed water operations criteria to further increase benefits to fish species consistent with water supply goals. Early in 2010, the BDCP Steering Committee initiated a full analysis of the likely effects of the draft Conservation Strategy and proposed covered activities on species and habitats covered by the Plan (see Chapter 4, *Description of Covered Activities*). The BDCP effects analysis was comprehensive in scope, identifying the beneficial and adverse effects that would be expected to occur through the implementation of covered activities and conservation measures (Chapter 5, *Effects Analysis*). Through an iterative process, the results and conclusions from the effects analysis provided the basis for multiple adjustments, modifications, and revisions to be made to the conservation measures to enhance their likely effectiveness.

This chapter sets out the Conservation Strategy for the BDCP. The chapter begins with a description of the overall approach to the development of a strategy sufficient to provide for the conservation and management of key Delta species and their habitats (Section 3.2). In Section 3.3, the biological goals and objectives of the Plan are identified. Section 3.4 sets out the specific conservation measures that will be implemented to achieve those biological goals and objectives. Section 3.5 identifies "potential conservation measures" that may later be adopted

[3] Envisioning Futures for the Sacramento-San Joaquin Delta (Lund et al. 2007); Comparing Futures for the Sacramento-San Joaquin Delta (Lund et al. 2008).

[4] Delta Regional Ecosystem Restoration Implementation Plan

[5] Insert citation to additional information identifying experts.

through the adaptive management program to further address the adverse effects of various stressors on the aquatic system. The biological monitoring and research program is described in Section 3.6, and the adaptive management program is described in Section 3.7.

3.1.1 Biological Goals and Objectives

The BDCP biological goals and objectives reflect the expected ecological outcomes of the Plan. The biological goals set out the broad principles that were established to guide the development of the Conservation Strategy; the biological objectives express specific, measurable targets that the conservation measures are designed to meet. Progress toward achieving objectives will be generally measured on the basis of outcomes related to ecological processes, habitat conditions, and species distribution.

BDCP biological goals and objectives are expressed in an ecological-scale hierarchy with ecosystem-level, natural community-level, and species-specific goals and objectives. For example, the Plan includes an ecosystem goal to "improve hydrodynamic conditions to support the movement of adult life stages of native fish species to natal spawning habitats"; a natural community goal to "protect, enhance, and restore natural communities to provide habitat and ecosystem functions to increase the natural production (reproduction, growth, and survival), abundance, and distribution of native Delta species;" and a species goal to "create conditions that support a self-sustaining population of delta smelt in the Delta and Suisun Bay." As such, the goals and objectives reflect the comprehensive scope of the BDCP, including its focus on both broad-scale ecological processes and species-specific needs.

3.1.2 Conservation Measures

The BDCP conservation measures comprise the specific actions that will be implemented to achieve the biological goals and objectives of the Plan. The conservation measures have been grouped into the same ecological hierarchy as the biological goals and objectives. Ecosystem-level conservation measures are designed to improve the method, timing, and amount of flow and quality of water into and through the Delta for the benefit of covered species and covered natural communities. They are also focused on the establishment of an interconnected system of conservation lands across the Plan Area. Natural community-level conservation measures include actions to restore physical habitat to expand the extent and quality of intertidal, floodplain, and other habitats. Species-level "other stressors" conservation measures are designed to reduce the adverse effects of various stressors on covered species, including toxic contaminants, nonnative predators, illegal harvest, and genetic threats. This comprehensive suite of actions is expected to significantly contribute to the conservation of covered species and to the restoration of ecosystem processes in the Delta, while providing for a reliable water supply for human use.

The conservation measures were developed in the context of the time frame governing the implementation of the BDCP, which has been designed as a fifty year conservation plan. Under the scope of the BDCP, the type of water conveyance infrastructure for SWP and CVP operations serves to demarcate near-term and long-term components of the Plan. Specifically, the near-term component of the BDCP encompasses those actions related to the operations of the projects under existing water conveyance infrastructure, including conservation measures associated with this operational framework. The long-term component of the BDCP comprises those actions related to project operations under new isolated conveyance infrastructure, including the construction of and operation of the infrastructure and the implementation of an array of conservation measures. A number of conservation measures cannot be implemented until the north Delta diversion is operational and therefore are considered to be long-term actions. Those measures that are not dependent on operations of the new facilities will largely be initiated in the near-term phase. These actions include habitat restoration to accelerate new productivity in the Delta, the installation of non-physical barriers to divert young salmonids from high risk areas, removal of habitat features that promote nonnative predators, and enhancement of the Yolo Bypass floodplain habitat. Prompt and decisive implementation of these measures pending the completion of systemic changes in the water conveyance system is likely to be central to the success of the BDCP Conservation Strategy.

The conservation measures address biological needs on a broad spatial scale, an important feature of the overall Conservation Strategy. The Delta-wide focus of the Plan requires that restoration actions be implemented in proper sequence and timing across the northern, western, eastern and southern regions of the Delta. These restoration actions must also be closely integrated with the measures affecting water facilities and operations to ensure that the flow and physical habitat parameters are all met.

Under the BDCP, certain conservation measures are also covered activities. In some cases, actions that are intended to advance the biological objectives of the Plan may also result in the incidental take of covered species. Certain activities may provide benefits for some covered species, and have either no effect or some limited negative effect on other species. For instance, the restoration of tidal habitats to provide new physical habitat and enhanced food production for covered fish species and certain covered wildlife and plants, will necessarily remove terrestrial habitat that supports other covered wildlife and plant species. Another example is the proposed construction and operation of a new isolated conveyance system, which may provide substantial benefits to certain aquatic species over the existing system, but will also entail adverse impacts on terrestrial wildlife and plants. Consequently, these conservation measures are characterized as covered activities to ensure their coverage under the regulatory authorizations issued under the BDCP and enable their implementation.

This chapter also identifies "potential conservation measures," which do not qualify as conservation measures at present, but may during the implementation of the BDCP be adopted as conservation measures through the adaptive management program. The efficacy of these potential conservation measures will be evaluated over time by the Implementation Office to determine whether they should be incorporated into the Conservation Strategy as conservation measures (see Section 3.5, *Potential Conservation Measures to Address Other Stressors*).

3.1.3 Monitoring, Research, and Adaptive Management

The monitoring, research and adaptive management components of the Conservation Strategy are intended to inform decision-making during plan implementation, provide indicators of progress, enable modifications to be made to improve the efficiency and effectiveness of the conservation measures in achieving the BDCP biological goals and objectives, and to allow for adjustments to be made to conservation measures as more is learned about the Delta. The monitoring and research program, described in Section 3.6, *Monitoring and Research Program*, includes a combination of system-wide and conservation measure-specific monitoring and research to provide information on the effectiveness of conservation actions.

Adaptive management is central to the success of the Plan. The adaptive management program described in Section 3.7, *Adaptive Management Program*, will integrate new data, knowledge, and scientific information to enhance the efficacy of the BDCP conservation measures. The adaptive management program will provide the mechanism by which conservation measures can be modified or discontinued in response to results from BDCP monitoring and research programs and other new scientific information.

3.2 METHODS AND APPROACHES USED TO DEVELOP THE CONSERVATION STRATEGY

This section describes the methods and the approaches used to develop the BDCP Conservation Strategy. Section 3.2.1, *Framework for the Conservation Strategy,* describes the regulatory and temporal contexts for the Conservation Strategy. It also describes the role of the adaptive management and monitoring programs in reinforcing the effectiveness of the Conservation Strategy over time. The Conservation Strategy addresses two ecologically interconnected categories of species, habitats, and natural communities: aquatic resources, encompassing the aquatic ecosystem and the covered fish species, and terrestrial resources, encompassing nontidal natural communities and covered wildlife and plant species. The approach to the development of the aquatic resources component of the Conservation Strategy is described in Section 3.2.3, *Development of the Aquatic Resources Component of the Conservation Strategy*. The approach to the development of the terrestrial resources component is described in Section 3.2.4, *Development of the Terrestrial Resources Component of the Conservation Strategy*. While these approaches are described separately, the two are closely interrelated and together are reflected in the overall BDCP Conservation Strategy. Background on the planning process for the major elements of Conservation Strategy is provided Appendix D, *Background on the Process of Developing the BDCP Conservation Measures*.

3.2.1 Framework for the Conservation Strategy

The Conservation Strategy is designed to meet the regulatory requirements of federal ESA and the NCCPA. Consistent with the requirements of the NCCPA, the Conservation Strategy will provide for the conservation and management of covered species through the protection, restoration, and enhancement of ecosystem processes, natural communities, and species habitat. Specifically, the Conservation Strategy will achieve the following:

- Conserve, restore, and provide for the management of representative natural and seminatural[6] landscapes;
- Establish reserves that provide for conservation of covered species within the BDCP geographic area and linkages to adjacent habitat outside the study area;
- Protect and maintain habitat areas that are large enough to support sustainable populations of covered species;
- Incorporate in the reserves, a range of environmental gradients and high habitat diversity to provide for shifting species distributions in response to changing circumstances; and
- Sustains the effective movement and interchange of organisms between habitat areas in a manner that maintains the ecological integrity of the system of BDCP conservation lands.

Of the 63 species covered under the BDCP (see descriptions of these species in Appendix A, *Covered Species Accounts*), 11 are fish and 52 are wildlife and plants (including 6 mammal species, 12 birds species, 5 reptile and amphibian species, 8 invertebrate species, and 21 plant species). The Conservation Strategy, which is based on the best scientific and commercial data available (see Chapter 2, *Existing Ecological Conditions*, and Appendix A, *Covered Species Accounts*), has been developed to achieve BDCP biological goals and objectives for ecosystems, natural communities, and covered species. Biological goals and objectives for aquatic resources were developed using an approach that took into account desired biological outcomes as well as an assessment of feasible conservation measures that would meet the dual objectives of the Plan[7] (see Section 3.2.3.1, *Aquatic Resources Conservation Strategy Development Process*). With respect to terrestrial species, goals and objectives were developed using approaches that appear in several recently-approved terrestrial HCPs and NCCPs and following technical guidance provided by DFG and USFWS.

The BDCP Conservation Strategy reflects a multi-scale ecological approach to conservation guided by principles of conservation biology. At the broadest scale, biological goals and objectives were developed that describe intended outcomes related to ecological processes, environmental gradients, biological diversity, and regional landscape connectivity. Conservation measures were developed to achieve these large scale, or “ecosystem-level,” goals and objectives. At the middle of the ecological scale, biological goals and objectives and conservation measures were developed for natural communities, many of which are focused on the enhancement, restoration, and management of physical habitat. This middle-level scale is referred to as the “natural community level.” At the smallest scale, biological goals and

[6] A seminatural landscape is defined as one that is disturbed by human activity but still provides important habitat for a variety of native species.

[7] The “logic chain” is a process relationship of linkages among the various components of the conservation strategy, including environmental stressors, biological goals and objectives, metrics, conservation measures, and expected outcomes developed specifically for the BDCP covered fish species.

objectives and conservation measures were identified for covered species. These "species-level" conservation actions were developed to supplement actions that are directed at ecosystem-level and natural community-level goals and objectives to ensure that the needs of covered species are addressed. This framework is discussed in greater detail in Section 3.3, *Biological Goals and Objectives*.

Biological goals and objectives and conservation measures were developed at the ecosystem level first to take into account the needs of the broadest array of covered natural communities and covered species as practicable. Next, each natural community was examined to determine additional conservation measures that would advance the biological goals and objectives for natural communities. Finally, each covered species was evaluated to determine whether species-specific measures would provide additional benefits to the species beyond those that would result from the ecosystem-level and natural-community-level conservation measures. Using this hierarchical approach, conservation measures associated with the ecosystem and natural community levels were generally considered to be sufficient to provide for the conservation of the individual covered species. In certain case, species-specific measures were adopted to ensure that the goals and objectives for the species would be met.

The BDCP conservation measures are set out in Section 3.4, *Conservation Measures*, and have been categorized by ecosystem level, natural community level, and species level. The Conservation Strategy includes several types of conservation measures, as decribed below:

- Water operations measures, through the management of flows, will support ecosystem functions associated with aquatic resources;
- Habitat protection measures will afford protection of existing functioning natural communities that are not currently protected;
- Habitat restoration/creation measures will provide for the physical restoration of natural communities in areas that do not currently support those communities;
- Habitat enhancement measures will result in improvements to habitat functions within existing natural communities;
- Habitat management measures will provide for ongoing management of natural communities and habitat to maximize the functional values of BDCP conservation areas over the long term;
- Other stressors measures will reduce the adverse effects of various stressors on fish species (aside from habitat and operations-related stressors), including the impacts of predation, toxic contaminants, and illegal harvest; and
- Avoidance and minimization measures will ensure that adverse effects of covered activities on covered species will be avoided or minimized to the maximum extent practicable.

All of the BDCP conservation measures have been developed at a sufficient level of detail and specificity to ensure their implementation. Because of the broad scope of the BDCP and its extended timeframe for implementation, a degree of flexibility has been built into many of the measures to accommodate changes in conditions and methods over time. For example, natural community–level actions provide broad management guidelines and principles such that land managers may implement specific techniques on the ground best suited to site conditions. Preserving this flexibility is an important part of the Conservation Strategy and is articulated in Section 3.7, *Adaptive Management Program*.

Implementation of habitat protection, enhancement, and restoration conservation measures will require the preparation of site-specific implementation documents. These site plans, as well as any additional environmental documentation, will be prepared in accordance with the schedule for the implementation of specific actions.

3.2.1.1 The Importance of Adaptive Management, Monitoring, and Research

Monitoring and adaptive management will play important roles in the implementation of the BDCP because of the inherently dynamic nature of the Delta ecosystems, the expected changes in these dynamics over time (e.g., effects of climate change on sea level and watershed hydrology), and uncertainties related to the likely response of certain covered species to certain conservation measures. To further support plan implementation, the BDCP provides for the establishment of a research program that will yield data and information over time that support adjustments and modifications to the conservation measures to increase their effectiveness.

The Conservation Strategy anticipates the potential for changes to occur in Delta conditions that result from climate change, seismic events, changes in land use, and other factors. The BDCP recognizes that monitoring, research, and adaptive management are necessary to allow for the incorporation of any new information and insight regarding actual changes and new projections of changing futures into plan implementation. As more is understood about the Delta ecosystem, refinements to the BDCP conservation measures may be necessary to enhance their effectiveness.

Information gathered through the BDCP monitoring and research program (Section 3.6, *Monitoring and Research Program*) and other research efforts will guide decision-making during implementation. The BDCP monitoring and research program is designed to establish cause and effect relationships between implementation of specific conservation measures and the type and magnitude of species and ecosystem responses to those measures, as well as species and ecosystem responses to the implementation of combinations of conservation measures. Should strong cause and effect relationships be established, adaptive management will provide the mechanism to concentrate efforts on the implementation of conservation measures that have been demonstrated to be more effective and to de-emphasize or discontinue implementation of conservation measures that prove to be less effective at achieving the BDCP biological goals and objectives.

As described in Section 3.7, *Adaptive Management Program*, all conservation measures will be implemented using an adaptive management approach that is informed by monitoring and research (Section 3.6, *Monitoring and Research Program*).

3.2.1.2 The Timing and Interrelatedness of Conservation Measures

The Conservation Strategy is divided into near-term and long-term implementation stages. The near-term implementation lasts until the north Delta diversion and tunnel/pipeline conveyance facilities are constructed and operational. This division of the implementation period was used because dual operation of separate diversions in the north and south Delta will bring significant flexibility and ecological changes to the system; hence, the interrelatedness of many of the conservation measures with operations of the new conveyance facility.

The implementation of conservation measures associated with the near-term will provide for immediate responses to degraded ecological conditions, while building the foundation to improve long-term ecological productivity. These near-term measures include early restoration actions for tidal habitats, implementation of conservation measures that address other stressors on covered fish species, and acquisition of terrestrial and wetland habitat to provide conservation for covered wildlife and plant species.

Completion and operation of the north Delta intakes and isolated tunnel/pipeline conveyance facility will facilitate the implementation of other key conservation measures, including restoration of tidal and floodplain habitat in the east and south Delta associated with the Mokelumne, Cosumnes, Middle, Old, and San Joaquin rivers. The close integration of conservation actions across both time and geography is central to the success of the BDCP Conservation Strategy. A complex web of important interrelationships exists among the conservation measures. There are interrelationships and interdependencies among all the water operations parameters because changes in water operations in any one part of the Delta affect hydrodynamics in other parts of the Delta. For example, diversions in the north Delta reduce Delta outflow but also reduce the need to export at the south Delta diversions, thereby reducing reverse flows in Old and Middle rivers. The coordinated operations of new and existing water facilities in a flexible and adaptable plan will allow for the optimal combination of improvements to aquatic habitat and reliability of water supply.

Restoration of large portions of the Delta to tidal habitat will affect the hydrodynamics and water quality in immediately surrounding channels and, in some cases channels distant from the restoration site, by increasing the tidal prism and reducing the tidal range. For example, restoration of tidal habitats in the Cache Slough area is projected to result in reduced tidal range and greater unidirectional flows in Sutter and Steamboat sloughs, which may reduce the risk of predation on juvenile salmonids migrating through these sloughs by speeding transport time. The reduction in contaminants, such as pesticides and herbicides that will result from restoring habitat on agricultural lands, is expected to interact synergistically with improvements in organic and nutrient input from restored tidal marsh and floodplains to benefit the aquatic food web. Hence, understanding the interconnections amongst the BDCP conservation measures across program elements, across the wide geography of the Delta, and across time is an important aspect of the strategy. In short, the Conservation Strategy is intended to be more than the sum of its parts.

The BDCP Implementation Office will also time and sequence the acquisition of conservation lands to protect and restore habitats to ensure that these conservation actions occur in a manner that is roughly proportional to and temporally aligned with the impacts of covered activities (see Chapter 6, *Plan Implementation*).

3.2.2 Identifying Conservation Zones and Restoration Opportunity Areas

To facilitate development of habitat protection and restoration elements of the Conservation Strategy, the Plan Area was subdivided into 11 Conservation Zones within which conservation targets for natural communities and covered species' habitats were established (Figure 3-1). Conservation Zones were delineated based on conservation opportunities afforded by different geographic locations.

Conservation Zones were delineated primarily on the basis of landscape characteristics and logical geographic or landform divisions to create a more structured organizational approach to how and where conservation actions will be carried out within the Plan Area. Conservation Zones were used as a planning tool to ensure that targets identified for natural communities and covered species habitat will be spatially distributed to achieve biological goals.

Criteria used to establish each Conservation Zone included:

- Distribution of covered species within and adjacent to the Plan Area;
- Distribution of natural communities supporting covered species habitats;
- Differences in the function of covered species habitats supported by natural communities in different portions of the Plan Area (e.g., high, medium, and low function as habitat for covered species);
- Natural features (e.g., watercourses);
- Locations of barriers to covered species movement among habitats; and
- Connectivity with existing habitat areas adjacent to the Plan Area.

A different set of planning units, Restoration Opportunity Areas (ROAs), were also established to assist in the development of the Conservation Strategy (Figure 3-2). ROAs are different from, but overlap with, the Conservation Zones. ROA's encompass those locations considered to be the most appropriate for the restoration of tidal habitats within the Plan Area and within which restoration goals for tidal and associated upland natural communities will be achieved (see Section 3.4.3.1, *CM4 Tidal Habitat Restoration*, for a description of ROAs and tidal habitat restoration conservation actions).

The extent of each natural community and covered species habitat in each of the Conservation Zones is presented in Tables 3-1a-c and Tables 3-2a-c, respectively. The existing distribution of natural communities within each of the Conservation Zones is presented in Figure 3-3 through Figure 3-8.

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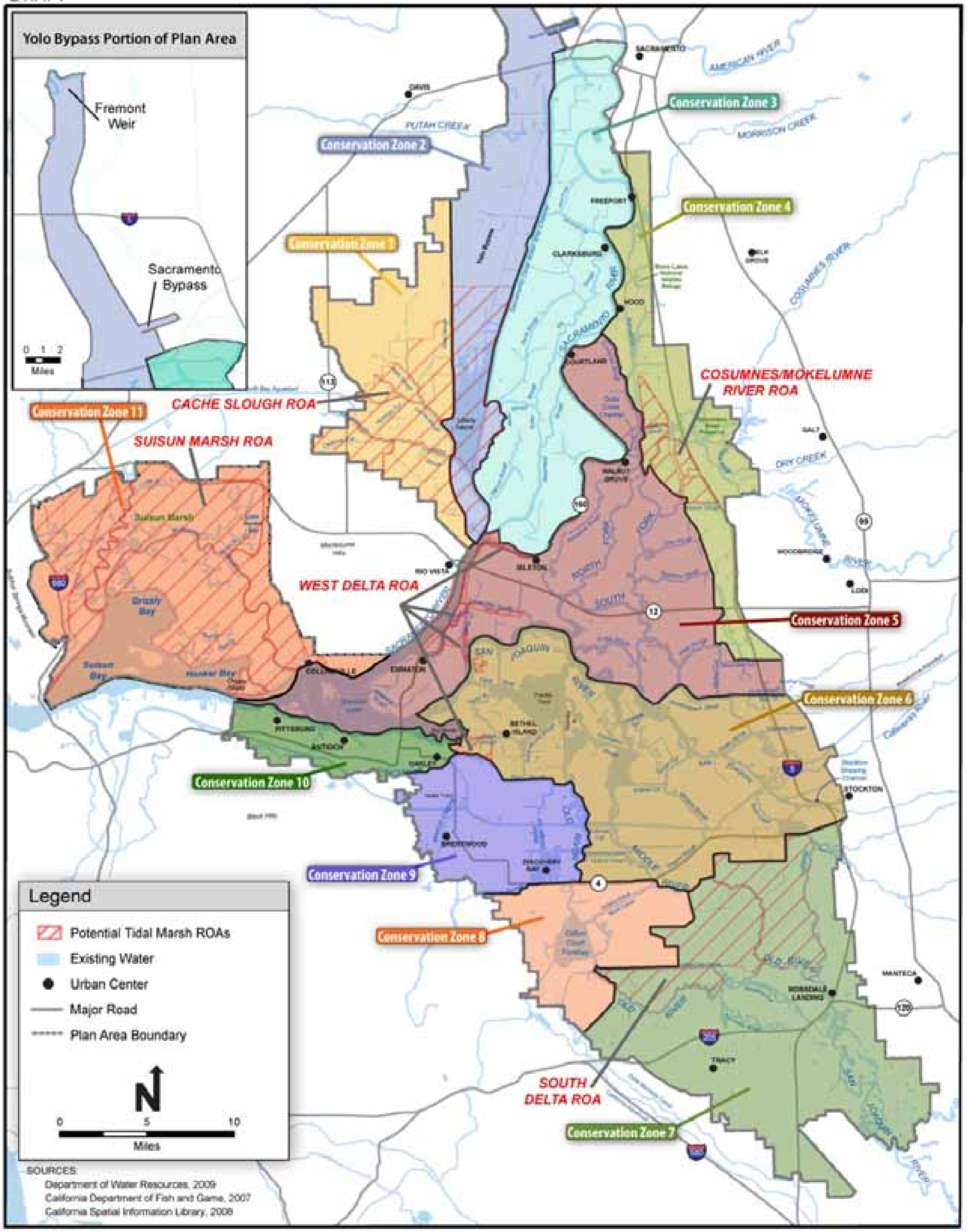


Figure 3-1. Conservation Zones and Restoration Opportunity Areas (ROAs)

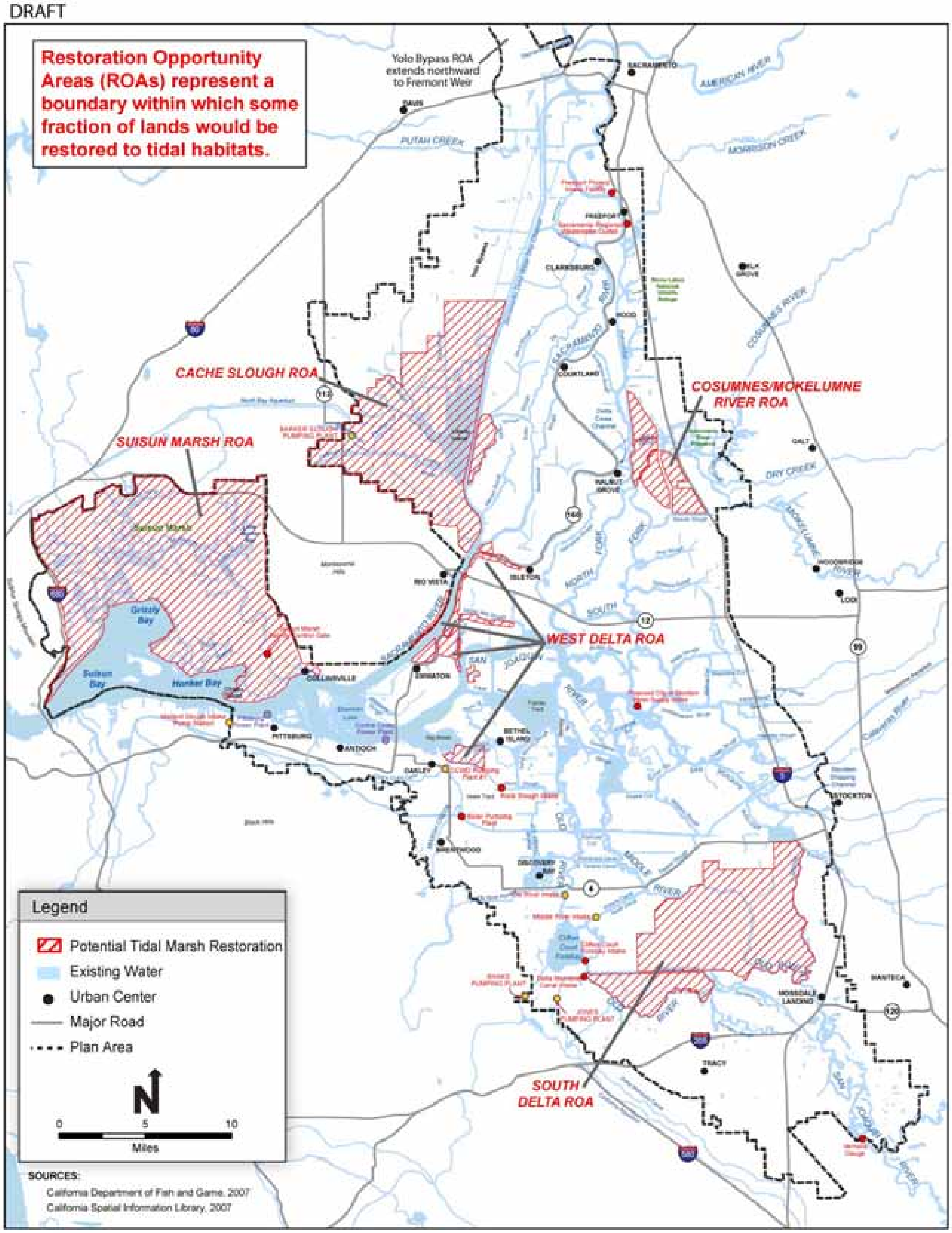


Figure 3-2. Restoration Opportunity Areas (ROAs)

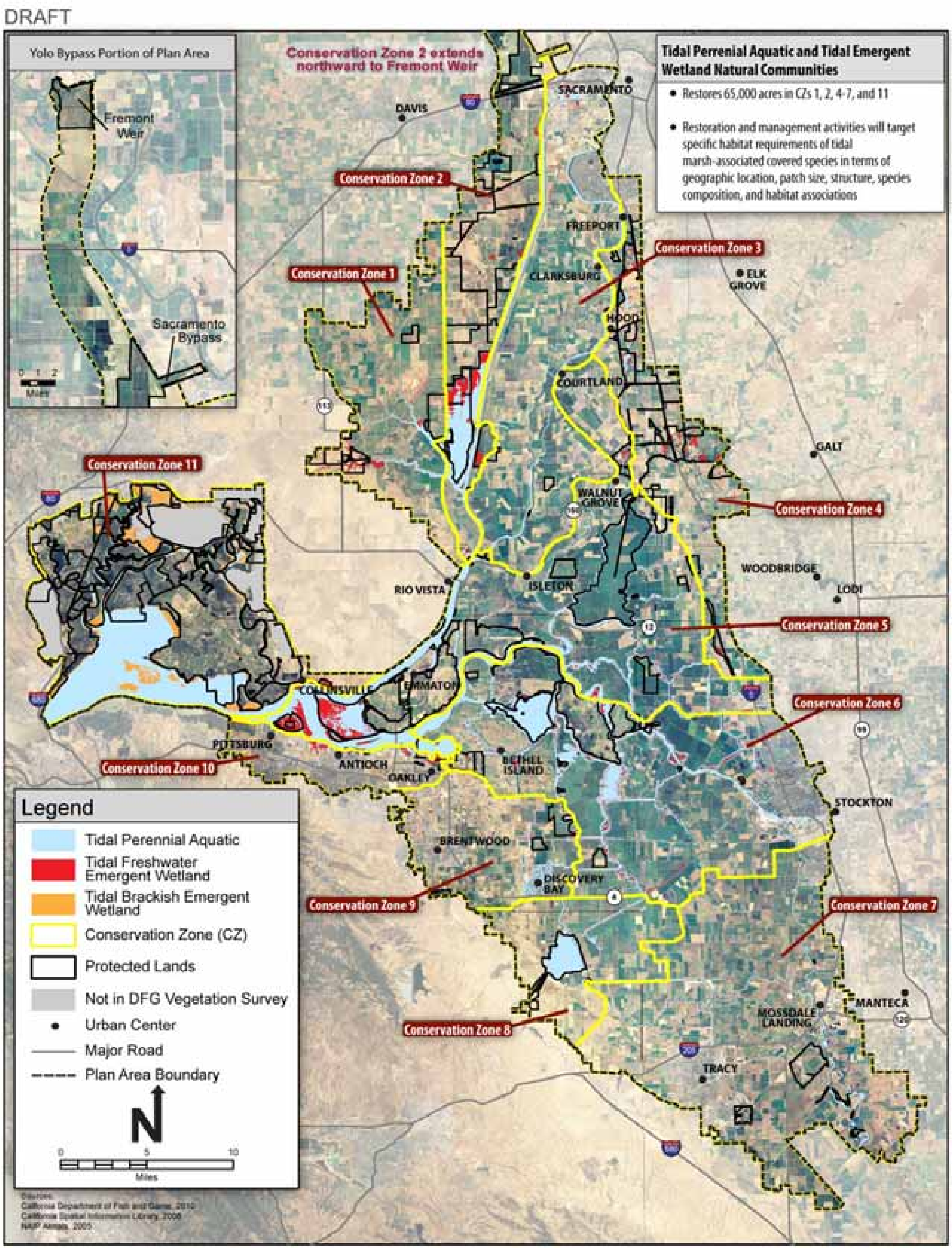


Figure 3-3. Tidal Perennial Aquatic and Tidal Emergent Wetland Natural Communities Distribution and Conservation Strategy

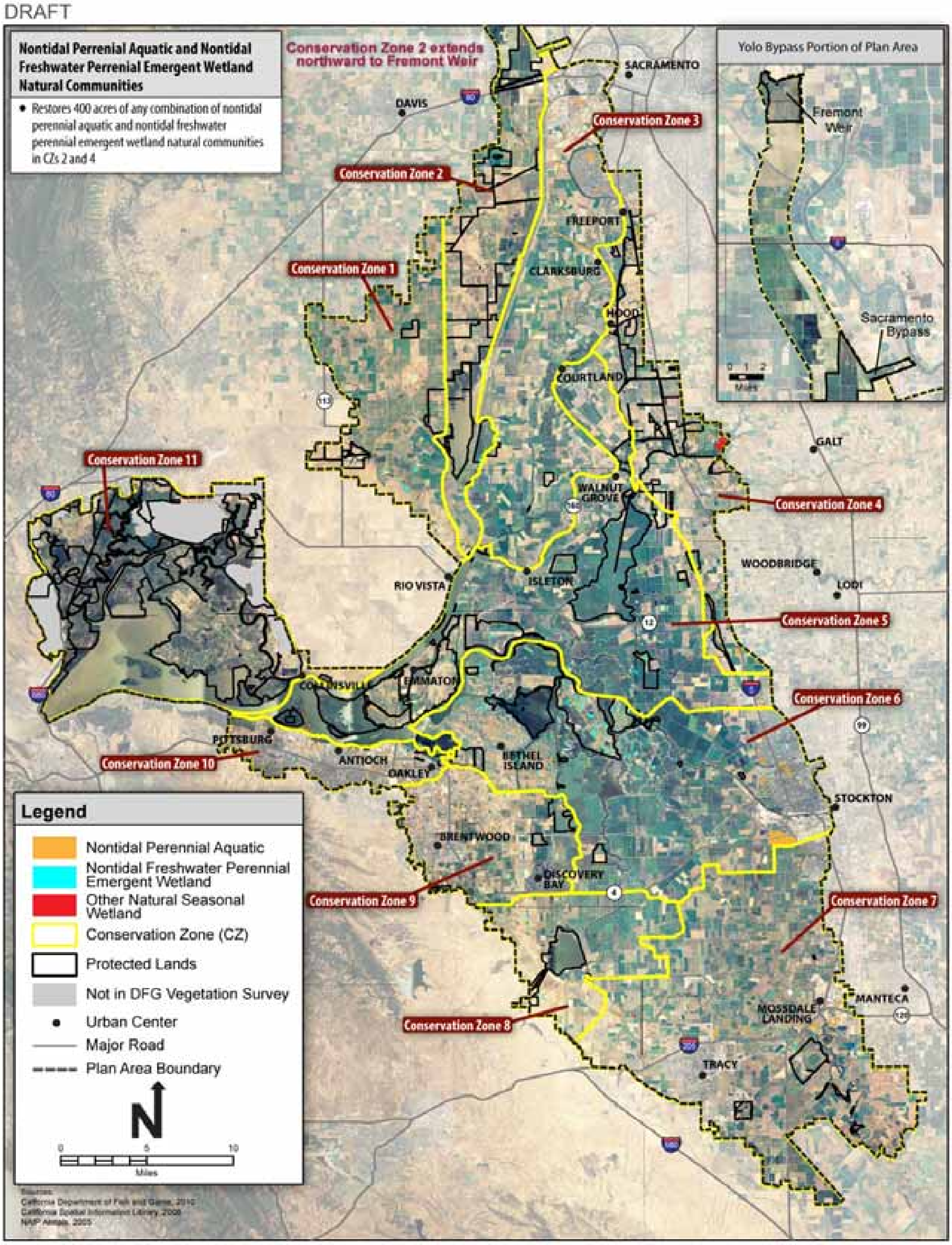
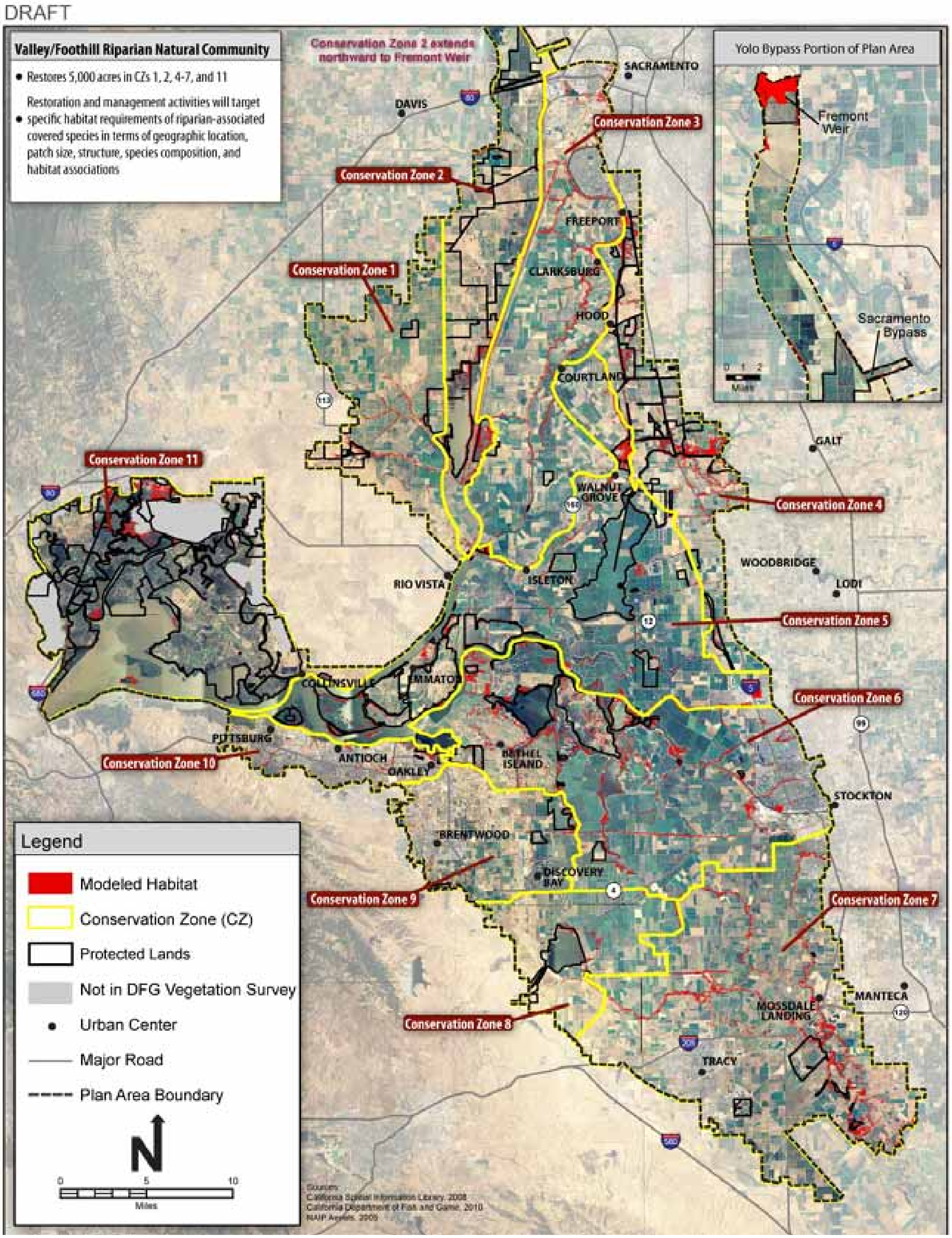


Figure 3-4. Nontidal Perennial Aquatic and Nontidal Freshwater Perennial Emergent Wetland Natural Communities Distribution and Conservation Strategy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Valley/Foothill Riparian Natural Community
Restores 5,000 acres in CZs 1, 2, 4-7, and 11
Restoration and management activities will target specific habitat requirements of riparian-associated covered species in terms of geographic location, patch size, structure, species composition, and habitat associations
Conservation Zone 2 extends northward to Fremont Weir
Yolo Bypass Portion of Plan Area
Fremont Weir
Sacramento Bypass
Conservation Zone 1
Conservation Zone 2
Conservation Zone 3
Conservation Zone 4
Conservation Zone 5
Conservation Zone 6
Conservation Zone 7
Conservation Zone 8
Conservation Zone 9
Conservation Zone 10
Conservation Zone 11
SACRAMENTO
DAVIS
FREEPORT
CLARKSBURG
HOOD
COURTLAND
GALT
WALNUT GROVE
WOODBRIDGE
LODI
RIO VISTA
ISLETON
COLLINSVILLE
EMMATON
PITTSBURG
ANTIOCH
OAKLEY
BETHEL ISLAND
STOCKTON
BRENTWOOD
DISCOVERY BAY
MANTECA
MOSSDALE LANDING
TRACY
Legend
Modeled Habitat
Conservation Zone (CZ)
Protected Lands
Not in DFG Vegetation Survey
Urban Center
Major Road
Plan Area Boundary
N
0 5 10
Miles

Figure 3-5. Valley/Foothill Riparian Natural Community Habitat Distribution and Conservation Strategy

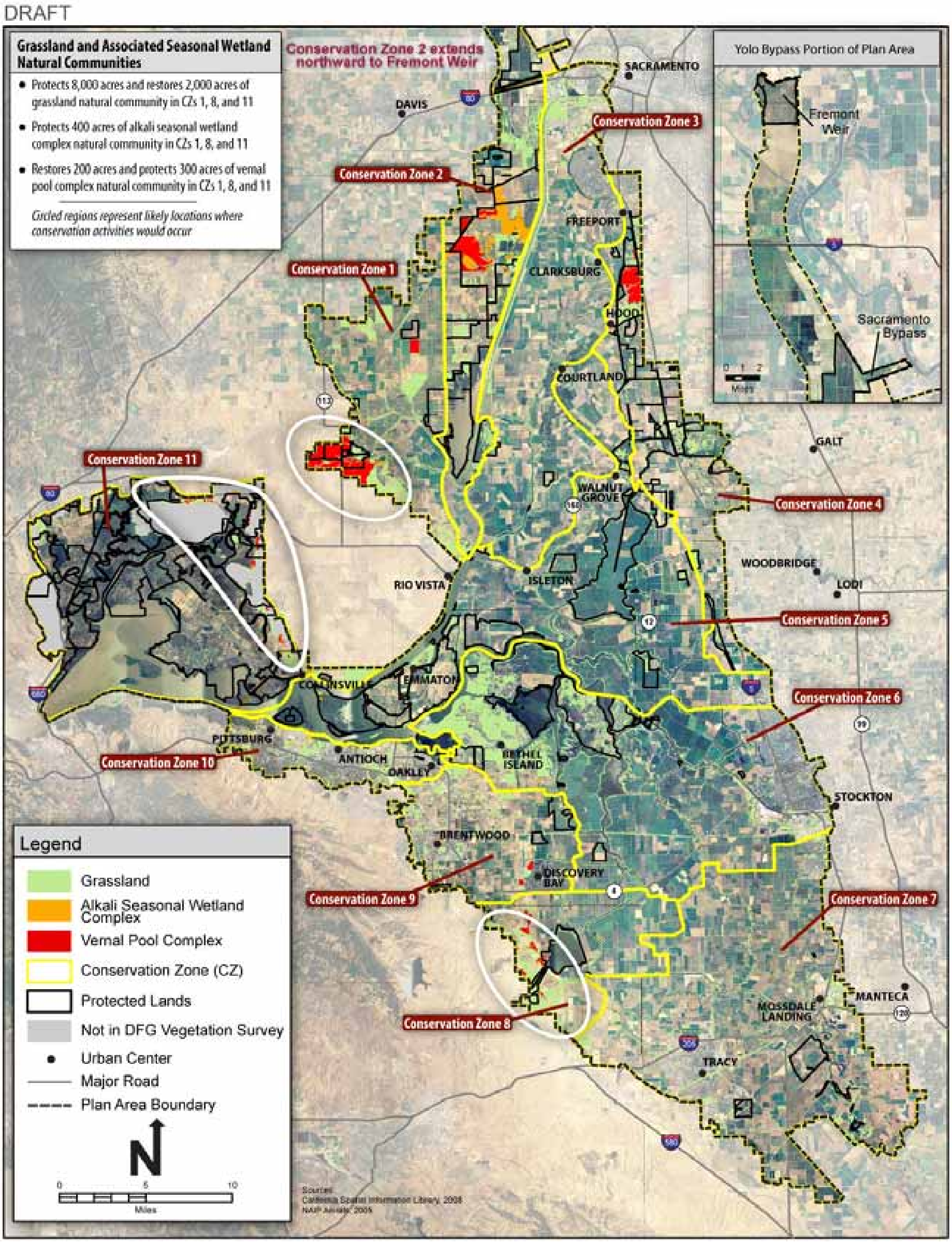

Figure 3-6. Grassland and Associated Seasonal Wetland Natural Communities Distribution and Conservation Strategy

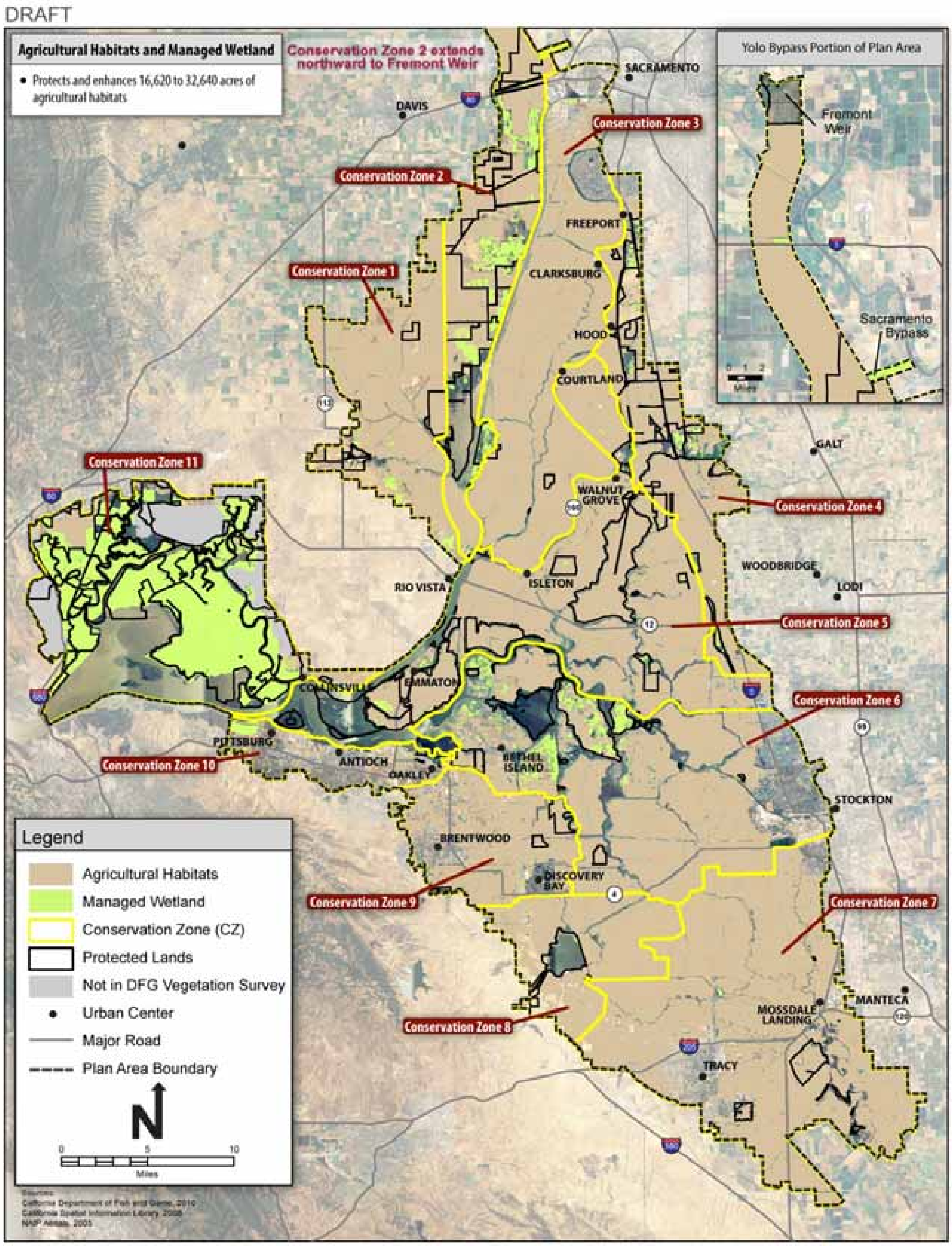

Figure 3-7. Agricultural Habitats and Managed Wetland Distribution and Conservation Strategy

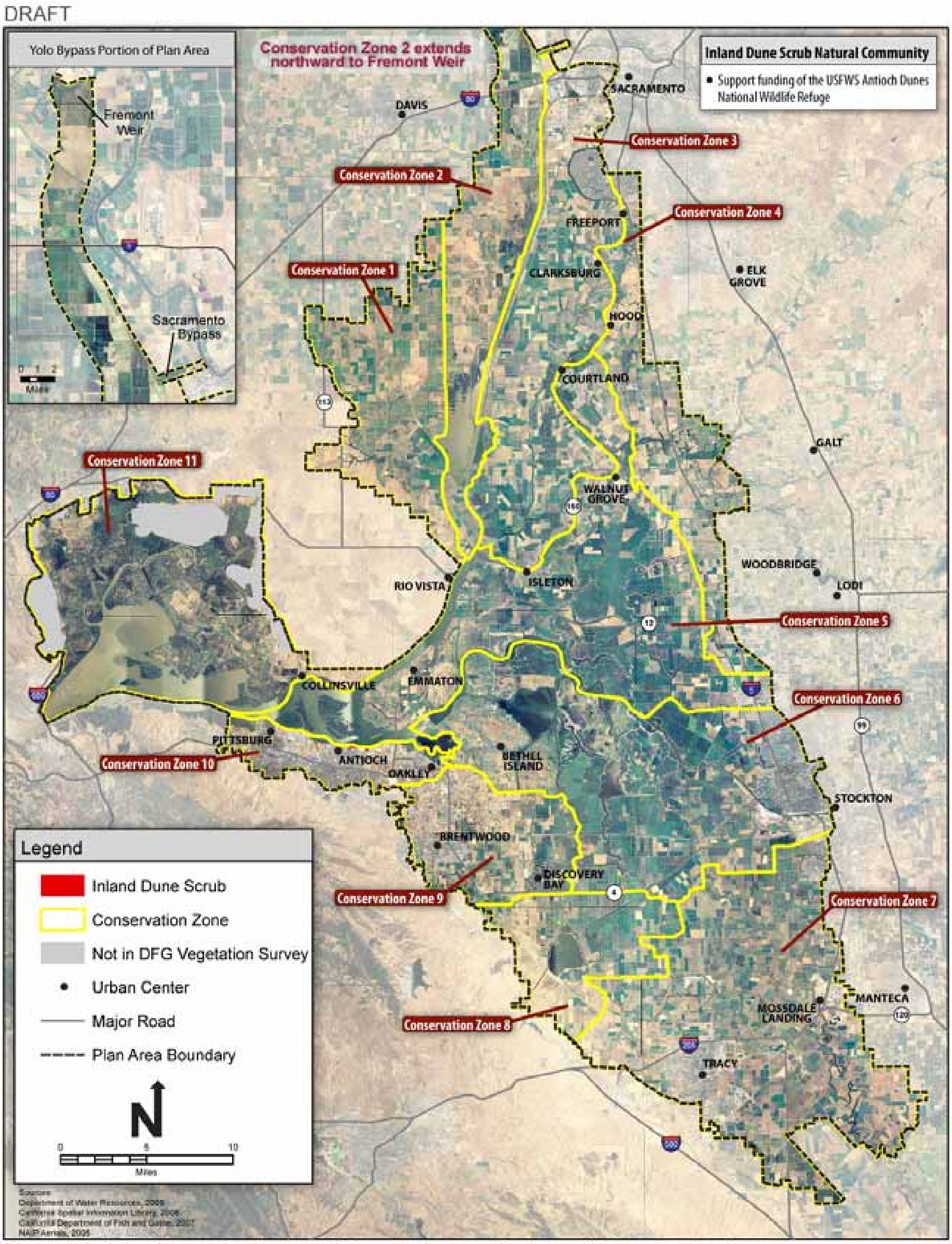

Figure 3-8. Inland Dune Scrub Natural Community Distribution and Conservation Strategy

Table 3-1a. Total Extent of Existing and Protected Natural Communities within BDCP Conservation Zones 1-11 (acres)

Natural Communities	*Total Extent*	*Total Existing Protected*	*Percent Existing Protected*
Tidal perennial aquatic	86,240	18,080	21%
Tidal mudflat[1]	Not available.	Not available.	Not available.
Tidal brackish emergent wetland	8,351	5,102	61%
Tidal freshwater emergent wetland	8,947	4,990	56%
Valley/foothill riparian	17,337	5,338	31%
Grassland	62,880	14,984	24%
Alkali seasonal wetland complex	3,723	2,769	74%
Vernal pool complex	6,958	4,379	63%
Other natural seasonal wetland	265	205	77%
Nontidal freshwater perennial emergent wetland	1,134	408	36%
Nontidal perennial aquatic	5,341	1,239	23%
Managed wetland	64,844	52,676	81%
Agricultural habitats	503,779	57,168	11%
Alfalfa	82,283	3,665	5%
Irrigate Pasture	49,693	12,748	26%
Vineyard	28,901	2,476	9%
Orchard	18,020	343	2%
Rice	12,637	2,202	17%
Other Cultivated Crops	229,828	24,736	11%
Subtotal: Cropland only	421,361	46,171	11%
Other Agricultural lands	82,418	10,997	13%
Subtotal: All agricultural land	503,779	57,168	11%
Total	**769,799**	**167,338**	**22%**

Table 3-1b. Current Extent of Existing and Protected Natural Communities in BDCP Conservation Zones 1-5

Natural Communities	*Conservation Zones (acres)*									
	1		**2**		**3**		**4**		**5**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Tidal perennial aquatic	1,011	52	6,703	4,804	4,967	9	1,200	740	21,965	3,546
Tidal mudflat[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tidal brackish emergent wetland	0	0	0	0	0	0	0	0	0	0
Tidal freshwater emergent wetland	454	160	1,710	1,633	167	4	648	545	3,585	2,305
Valley/foothill riparian	357	107	2,427	1,674	2,080	20	2,575	1,711	2,718	1,065
Grassland	6,091	620	7,007	5,271	5,524	15	4,800	3,201	5,828	2,138
Alkali seasonal wetland complex	258	30	2,773	2,632	0	0	17	16	42	42
Vernal pool complex	3,355	1,425	1,738	1,716	0	0	1,082	1,082	0	0
Other natural seasonal wetland	38	9	8	8	0	0	193	187	1	0
Nontidal freshwater perennial emergent wetland	70	1	49	46	12	0	11	11	176	55
Nontidal perennial aquatic	289	23	718	343	692	0	645	510	437	133
Managed wetland	714	0	6,936	6,343	122	2	1,089	1,053	1,030	737
Agricultural habitats										
Alfalfa	5,909	0	1,703	412	14,556	155	4,896	747	6,872	1,726
Irrigated Pasture	18,107	390	10,178	5,703	2,033	57	2,688	991	7,311	4,874
Vineyard	0	0	0	0	10,233	0	8,330	2,319	5,065	11
Orchard	64	0	73	0	5,143	0	1,072	116	3,065	83
Rice	0	0	9,802	2,202	0	0	0	0	1,738	0
Other Cultivated Crops	9,741	353	12,714	3,783	28,583	1	12,466	3,945	54,243	12,205
Subtotal: Cropland only	33,821	743	34,470	12,101	60,549	213	29,452	8,158	78,294	18,899
Other Agricultural lands	7,605	1,276	4,364	3,126	9,131	197	7,119	2,800	9,602	1,999
Subtotal: All agricultural land	41,426	2,019	38,834	15,228	69,681	410	36,571	10,959	87,896	20,898
Total	54,061	4,443	68,904	39,697	83,246	460	48,832	20,014	123,679	30,919

Table 3-1c. Current Extent of Existing and Protected Natural Communities in BDCP Conservation Zones 6-11

Natural Communities	***Conservation Zones (acres)***											
	6		**7**		**8**		**9**		**10**		**11**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Tidal perennial aquatic	16,721	3,521	2,355	77	3,475	2,295	1,443	5	738	195	25,662	2,837
Tidal mudflat[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tidal brackish emergent wetland	0	0	0	0	0	0	0	0	0	0	8,351	5,102
Tidal freshwater emergent wetland	1,415	156	83	1	102	1	150	5	477	136	154	45
Valley/foothill riparian	3,702	506	2,671	120	256	23	185	10	279	73	86	30
Grassland	13,603	3,774	5,951	194	4,517	763	3,692	100	2,536	70	3,333	926
Alkali seasonal wetland complex	35	0	12	0	188	7	22	0	105	0	270	42
Vernal pool complex	0	0	0	0	381	27	120	0	0	0	282	130
Other natural seasonal wetland	0	0	18	1	0	0	3	0	5	0	1	0
Nontidal freshwater perennial emergent wetland	628	264	69	0	39	2	33	17	37	5	9	6
Nontidal perennial aquatic	1,517	146	720	20	149	9	137	14	36	0	0	0
Managed wetland	4,530	1,890	71	7	57	17	73	40	624	2	49,597	42,585
Agricultural habitats												
Alfalfa	10,426	0	28,235	526	7,862	6	1,823	93	0	0	0	0
Irrigated Pasture	3,324	572	3,466	0	1,311	0	726	5	0	0	550	155
Vineyard	496	146	2,679	0	698	0	946	0	454	0	0	0
Orchard	402	1	5,776	126	61	0	2,339	17	23	0	0	0
Rice	1,097	0	0	0	0	0	0	0	0	0	0	0
Other Cultivated Crops	42,738	1,928	46,755	1,302	11,815	0	10,678	1,179	93	0	1	0
Subtotal: Cropland only	58,483	2,647	86,911	1,955	21,748	6	16,511	1,295	570	0	551	155
Other Agricultural lands	10,137	1,083	17,873	311	4,864	19	8,056	146	934	13	2,733	26
Subtotal: All agricultural land	68,620	3,730	104,785	2,266	26,612	26	24,567	1,441	1,505	13	3,284	181
Total	**110,771**	**11,939**	**116,734**	**2,686**	**35,776**	**3,170**	**30,426**	**1,632**	**6,342**	**494**	**91,027**	**51,885**

Table 3-2a. Extent of Existing and Protected Covered Species' Habitat Types within Conservation Zones 1-11 (acres)

Covered Species	*Total Extent*	*Total Existing Protected*	*Percent Existing Protected*
San Joaquin kit fox			
Breeding, foraging, and dispersal habitat	5,217	638	12%
Foraging and dispersal habitat	20,573	151	0.7%
Riparian woodrat	1,539	97	6%
Salt marsh harvest mouse			
Wetland habitat	11,124	9,600	86%
Upland habitat	2,815	2,334	83%
Riparian brush rabbit	2,894	138	5%
Townsend's western big-eared bat			
Primary foraging habitat	10,880	3,641	34%
Roosting and primary habitat	6,892	1,876	27%
Secondary foraging habitat	753,408	162,668	22%
Suisun shrew	28,741	22,590	79%
Tricolored blackbird			
Nesting habitat	24,036	14,372	60%
Foraging habitat: non-agriculture	99,587	40,818	41%
Foraging habitat: agriculture	275,937	33,097	12%
Suisun song sparrow	26,959	21,177	79%
Yellow-breasted chat			
Primary nesting and migratory habitat[1]	8,640	3,125	36%
Secondary nesting and migratory habitat	5,530	1,896	34%
Least Bell's Vireo	14,139	5,008	35%
Western burrowing owl			
High-value habitat	78,447	26,261	34%
Moderate value habitat	52,800	16,214	31%
Low-value habitat	243,129	27,833	11%
Western Yellow-Billed Cuckoo			
Breeding Habitat	6,826	2,763	41%
Migratory Habitat	4,891	1,325	27%
California Least Tern			
Foraging habitat	86,240	18,080	21%
Greater sandhill crane			
Roosting/Foraging habitat	11,829	6,743	57%
Foraging habitat	184,257	33,259	18%
California black rail	33,563	24,593	73%
California clapper rail	7,895	5,013	64%
Swainson's hawk			
Foraging habitat	436,417	75,743	17%
Nesting habitat	10,149	3,258	32%
White-tailed kite			
Breeding habitat	13,714	4,518	33%
Foraging habitat	478,251	101,068	21%

Table 3-2a. Extent of Existing and Protected Covered Species' Habitat Types within Conservation Zones 1-11 (acres) (continued)

Covered Species	*Total Extent*	*Total Existing Protected*	*Percent Existing Protected*
Giant garter snake			
Aquatic breeding, foraging and movement	19,824	5,725	29%
Upland aestivation and movement	190,805	31,954	17%
Western pond turtle			
Aquatic habitat	78,511	30,591	39%
Dispersal habitat	579,334	109,348	19%
Upland nesting and overwintering	54,880	19,738	36%
California red-legged frog			
Aquatic habitat	117	4	3%
Upland cover and dispersal habitat	4,984	640	13%
Dispersal habitat	19,572	151	0.8%
Western spadefoot toad			
Aquatic breeding habitat	6,791	4,256	63%
Terrestrial cover and aestivation habitat	14,352	5,071	35%
California tiger salamander			
Aquatic breeding habitat	6,772	4,255	63%
Terrestrial cover and aestivation habitat	14,352	5,071	35%
Valley elderberry longhorn beetle			
Riparian vegetation	17,130	5,310	31%
Non-riparian channels and grasslands	16,022	4,168	26%
Lange's metalmark butterfly	1,108	67	6%
Vernal pool shrimp species (*Vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid valley fairy shrimp, and California linderiella*)			
Vernal Pool Complex	6,821	4,319	63%
Degraded Vernal Pool Complex	2,493	683	39%
Vernal pool plant species (*Alkali milk-vetch, San Joaquin spearscale, Boggs Lake hedge-hyssop, Heckard's peppergrass, dwarf downingia, and legenere*)			
Vernal Pool Complex	6,958	4,380	63%
Degraded Vernal Pool Complex	2,493	683	39%
Heartscale and brittlescale	496	127	26%
Slough thistle	1,831	188	10%
Suisun thistle and soft bird's-beak	1,225	869	71%
Delta button celery	3,345	270	8%
Contra Costa Wallflower	20	17	85%
Carquinez goldenbush	1,032	391	38%
Delta tule pea and Suisun Marsh aster	5,948	3,699	62%
Mason's lilaeopsis and delta mudwort	6,931	1,717	25%
Antioch Dunes evening primrose	20	17	85%
Side-flowering skullcap	2,495	701	28%
Caper-fruited tropidocarpum	1,410	21	2%

Table 3-2b. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 1-5

Covered Species	*Conservation Zones (acres)*									
	1		**2**		**3**		**4**		**5**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
San Joaquin kit fox										
Breeding, foraging, and dispersal habitat	0	0	0	0	0	0	0	0	0	0
Foraging and dispersal habitat	0	0	0	0	0	0	0	0	0	0
Riparian woodrat	0	0	0	0	0	0	0	0	0	0
Salt marsh harvest mouse										
Wetland habitat	0	0	0	0	0	0	0	0	26	26
Upland habitat	0	0	0	0	0	0	0	0	12	12
Riparian brush rabbit	0	0	0	0	0	0	0	0	0	0
Townsend's western big-eared bat										
Roosting and primary foraging habitat	60	2	717	459	1,306	11	1,415	779	788	279
Primary foraging habitat	309	105	1,711	1,215	784	9	1,163	933	1,973	803
Secondary foraging habitat	53,693	4,336	66,509	38,023	81,156	439	46,254	18,302	120,918	29,837
Suisun shrew	0	0	0	0	0	0	0	0	2,648	2,004
Tricolored blackbird										
Nesting habitat	606	200	2,079	1,887	535	6	1,015	829	3,991	2,391
Foraging habitat: non-agriculture	10,455	2,083	18,462	15,969	5,646	17	7,180	5,538	6,902	2,918
Foraging habitat: agriculture	31,251	721	15,097	7,406	36,077	219	12,872	2,713	57,402	17,536
Suisun song sparrow	0	0	0	0	0	0	0	0	2,093	1,531
Yellow-breasted chat										
Primary nesting and migratory habitat[1]	219	47	1,753	1,219	890	8	1,309	911	1,048	378
Secondary nesting and migratory habitat	112	60	496	416	405	7	601	460	1,144	580
Least Bell's Vireo	320	102	2,248	1,634	1,293	15	1,900	1,366	2,183	954

Table 3-2b. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 1-5 (continued)

Covered Species	*Conservation Zones (acres)*									
	1		**2**		**3**		**4**		**5**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Western burrowing owl										
High-value habitat	10,364	2,043	11,231	9,546	5,922	15	5,846	4,249	5,836	2,146
Moderate- value habitat	17,855	409	11,595	6,944	1,473	57	2,678	997	6,568	5,295
Low-value habitat	14,559	460	7,791	4,372	34,934	162	11,521	2,867	52,322	12,937
Western Yellow-Billed Cuckoo										
Breeding Habitat	99	63	1,623	1,178	527	3	886	724	939	461
Migratory Habitat	198	28	477	325	520	12	587	361	878	309
California Least Tern	1011	52	6,703	4,804	4,967	9	1,201	740	21,965	3,546
Greater sandhill crane										
Roosting/Foraging habitat	0	0	0	0	0	0	2,153	2,105	7,259	3,684
Foraging habitat	0	0	135	135	40,751	233	23,423	9,676	64,627	17,606
California black rail	515	157	1,782	1,658	169	4	647	545	3,488	2,188
California clapper rail	0	0	0	0	0	0	0	0	2,617	1,974
Swainson's hawk										
Foraging habitat	43,725	2,821	40,595	23,942	49,953	233	25,829	10,617	70,334	20,890
Nesting habitat	148	12	1,608	1,131	1,510	15	1,924	1,219	1,221	388
White-tailed kite										
Breeding habitat	297	90	2,096	1,498	1,744	18	2,209	1,421	1,970	776
Foraging habitat	43,959	2,825	48,467	24,075	50,333	234	26,104	10,724	70,907	21,070
Giant garter snake										
Aquatic breeding, foraging and movement	523	159	12,129	4,215	178	4	655	552	2,574	224
Upland aestivation and movement	17,583	1,430	11,630	7,168	27,267	157	13,660	4,620	38,913	13,026

Table 3-2b. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 1-5 (continued)

Covered Species	***Conservation Zones (acres)***									
	1		**2**		**3**		**4**		**5**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Western pond turtle										
Aquatic habitat	1,818	234	9,131	6,779	3,891	12	2,494	1,795	10,987	1,718
Dispersal habitat	45,905	2,897	53,486	28,394	72,459	434	41,635	14,658	92,517	22,866
Upland nesting and overwintering	5,874	1,312	6,014	4,475	4,564	13	4,543	3,550	4,588	1,716
California red-legged frog										
Aquatic habitat	0	0	0	0	0	0	0	0	0	0
Upland cover and dispersal habitat	0	0	0	0	0	0	0	0	0	0
Dispersal habitat	0	0	0	0	0	0	0	0	0	0
Western spadefoot toad										
Aquatic breeding habitat	3,368	1,425	1,743	1,721	0	0	1,082	1,082	0	0
Terrestrial cover and aestivation habitat	4,659	477	2,536	2,202	0	0	1,879	1,760	0	0
California tiger salamander										
Aquatic breeding habitat	3,368	1,425	1,743	1,721	0	0	1,082	1,082	0	0
Terrestrial cover and aestivation habitat	4,659	477	2,536	2,202	0	0	1,879	1,760	0	0
Valley elderberry longhorn beetle										
Riparian vegetation	357	107	2,276	1,651	2,048	20	2,558	1,706	2,718	1,065
Non-riparian channels and grasslands	1,252	201	1,374	766	2,224	14	1,312	883	2,779	841
Lange's metalmark butterfly	0	0	0	0	0	0	0	0	0	0
Vernal pool shrimp species (*Vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid valley fairy shrimp, and California linderiella*)										
Vernal Pool Complex	3,355	1,425	1,738	1,716	0	0	1,082	1,082	0	0
Degraded Vernal Pool Complex	1,786	0	0	0	0	0	686	683	0	0

Table 3-2b. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 1-5 (continued)

Covered Species	*Conservation Zones (acres)*									
	1		**2**		**3**		**4**		**5**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Vernal pool plant species (*Alkali milk-vetch, San Joaquin spearscale Boggs Lake hedge-hyssop, Heckard's peppergrass, dwarf downingia, and legenere*)										
Vernal Pool Complex	3,355	1,425	1,738	1,716	0	0	1,082	1,082	0	0
Degraded Vernal Pool Complex	1,786	0	0	0	0	0	686	683	0	0
Heartscale and brittlescale	190	69	0	0	0	0	0	0	0	0
Slough thistle	0	0	0	0	0	0	0	0	0	0
Suisun thistle and soft bird's-beak	0	0	0	0	0	0	0	0	37	37
Delta button celery	0	0	0	0	0	0	0	0	0	0
Contra Costa wallflower	0	0	0	0	0	0	0	0	0	0
Carquinez goldenbush	226	68	0	0	0	0	0	0	0	0
Delta tule pea and Suisun Marsh aster	49	14	81	72	39	0	85	68	187	79
Mason's lilaeopsis and delta mudwort	216	21	480	292	480	6	446	259	1,522	488
Antioch Dunes evening primrose	0	0	0	0	0	0	0	0	0	0
Side-flowering skullcap	139	19	200	123	253	5	183	127	743	323
Caper-fruited tropidocarpum	0	0	0	0	0	0	0	0	0	0

Table 3-2c. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 6-11

Covered Species	*Conservation Zones (acres)*											
	6		7		8		9		10		11	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
San Joaquin kit fox												
Breeding, foraging, and dispersal habitat	0	0	356	0	3,873	618	594	19	394	0	0	0
Foraging and dispersal habitat	0	0	4,554	0	10,593	16	4,991	135	434	0	0	0
Riparian woodrat	10	0	1,487	94	40	3	1	0	0	0	0	0
Salt marsh harvest mouse												
Wetland habitat	0	0	0	0	0	0	0	0	0	0	11,098	9,574
Upland habitat	0	0	0	0	0	0	0	0	0	0	2,803	2,322
Riparian brush rabbit	26	0	2,626	120	238	18	4	0	0	0	0	0
Townsend's western big-eared bat												
Roosting and primary foraging habitat	610	97	1,628	70	36	2	58	1	29	15	245	160
Primary foraging habitat	3,156	409	1,066	50	234	21	137	9	255	58	92	30
Secondary foraging habitat	107,004	11,433	114,041	2,566	35,506	3,147	30,231	1,622	6,071	438	92,023	52,524
Suisun shrew	0	0	0	0	0	0	0	0	157	1	25,937	20,585
Tricolored blackbird												
Nesting habitat	2,945	433	468	26	268	20	247	29	518	179	11,365	8,371
Foraging habitat: non-agriculture	18,169	3,577	6,052	202	5,142	814	3,910	140	3,270	72	14,400	9,489
Foraging habitat: agriculture	46,958	2,480	47,872	781	17,731	9	10,396	1,183	39	0	243	50
Suisun song sparrow	0	0	0	0	0	0	0	0	86	1	24,779	19,645
Yellow-breasted chat												
Primary nesting and migratory habitat[1]	1,186	173	1,485	91	152	13	113	3	148	62	339	241
Secondary nesting and migratory habitat	1,978	312	568	24	62	5	63	7	64	9	39	16
Western Yellow-Billed Cuckoo												
Breeding Habitat	1,319	213	1,267	89	49	0	50	1	54	28	12	4
Migratory Habitat	1,218	213	633	22	121	13	107	4	130	28	21	12

Table 3-2c. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 6-11 (continued)

Covered Species	*Conservation Zones (acres)*											
	6		**7**		**8**		**9**		**10**		**11**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Western burrowing owl												
High-value habitat	13,600	1,709	5,972	194	4,717	765	3,815	100	1,701	70	9,442	5,425
Moderate- value habitat	3,554	604	3,244	1	1,311	6	739	3	0	0	3,784	1,898
Low-value habitat	47,876	3,557	45,675	806	16,689	34	9,832	1,215	43	0	1,886	1,423
Greater sandhill crane												
Roosting/Foraging habitat	327	0	0	0	0	0	2,091	953	0	0	0	0
Foraging habitat	52,141	5,319	0	0	0	0	3,180	291	0	0	0	0
California black rail	1,958	403	134	1	121	3	175	22	418	135	24,156	19,478
California clapper rail	0	0	0	0	0	0	0	0	157	1	5,121	3,039
White-tailed kite												
Breeding habitat	2,161	341	2,413	113	192	13	149	5	202	70	281	173
Foraging habitat	71,367	5,810	81,117	2,061	25,746	822	16,472	1,436	1,784	70	41,995	31,942
Swainson's hawk												
Foraging habitat	70,203	5,720	80,318	2,042	25,624	821	16,199	1,416	1,656	64	11,982	7,178
Nesting habitat	1,189	213	2,110	92	61	3	70	1	49	17	259	167
Least Bell's Vireo	3,163	485	2,052	116	214	18	175	10	211	71	378	237
California Least Tern	16,721	3,521	2,356	77	3,475	2,295	1,443	5	738	195	25,662	2,837
Giant garter snake												
Aquatic breeding, foraging and movement	3,049	409	144	1	131	3	178	22	264	135	0	0
Upland aestivation and movement	37,434	3,903	28,160	659	10,730	325	5,280	646	148	22	0	0
Western pond turtle												
Aquatic habitat	20,043	4,008	3,221	98	3,767	2,308	1,760	41	809	321	20,590	13,278
Dispersal habitat	79,041	6,133	100,381	2,396	28,021	100	24,545	1,371	2,551	87	38,794	30,011
Upland nesting and overwintering	11,130	1,677	3,150	191	3,716	763	1,475	81	748	68	9,080	5,891

Table 3-2c. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 6-11 (continued)

Covered Species	*Conservation Zones (acres)*											
	6		**7**		**8**		**9**		**10**		**11**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
California red-legged frog												
Aquatic habitat	0	0	13	0	86	4	19	0	0	0	0	0
Upland cover and dispersal habitat	0	0	341	0	3,830	619	462	21	351	0	0	0
Dispersal habitat	0	0	3,990	0	10,578	16	4,851	135	154	0	0	0
Western spadefoot toad												
Aquatic breeding habitat	0	0	0	0	381	27	122	0	0	0	94	1
Terrestrial cover and aestivation habitat	0	0	289	0	3,463	619	14	0	87	0	1,426	13
California tiger salamander												
Aquatic breeding habitat	0	0	0	0	381	27	122	0	0	0	76	1
Terrestrial cover and aestivation habitat	0	0	289	0	3,463	619	14	0	87	0	1,426	13
Valley elderberry longhorn beetle												
Riparian vegetation	3,702	506	2,656	120	256	23	185	10	279	73	95	30
Non-riparian channels and grasslands	3,281	562	1,524	99	1,097	294	487	69	92	15	601	422
Lange's metalmark butterfly	0	0	0	0	0	0	0	0	1,108	67	0	0
Vernal pool shrimp species (*Vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid valley fairy shrimp, and California linderiella*)												
Vernal Pool Complex	0	0	0	0	381	27	120	0	0	0	145	69
Degraded Vernal Pool Complex	0	0	0	0	22	0	0	0	0	0	0	0
Vernal pool plant species (*Alkali milk-vetch, San Joaquin spearscale Boggs Lake hedge-hyssop, Heckard's peppergrass, dwarf downingia, and legenere*)												
Vernal Pool Complex	0	0	0	0	381	27	120	0	0	0	282	130
Degraded Vernal Pool Complex	0	0	0	0	22	0	0	0	0	0	0	0
Heartscale and brittlescale	0	0	6	0	83	11	16	7	20	0	180	40
Slough thistle	0	0	1,831	188	0	0	0	0	0	0	0	0
Suisun thistle and soft bird's-beak	0	0	0	0	0	0	0	0	0	0	1,129	830

Table 3-2c. Current Extent of Existing and Protected Covered Species' Habitat Types in BDCP Conservation Zones 6-11 (continued)

Covered Species	*Conservation Zones (acres)*											
	6		**7**		**8**		**9**		**10**		**11**	
	Total Extent	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*	*Total Extent*	*Total Existing Protected*
Delta button celery	0	0	1,917	188	1,103	83	323	0	1	0	0	0
Contra Costa wallflower	0	0	0	0	0	0	0	0	20	17	0	0
Carquinez goldenbush	0	0	0	0	0	0	0	0	0	0	806	323
Delta tule pea and Suisun Marsh aster	245	40	31	0	23	2	22	1	35	9	5,151	3,415
Mason's lilaeopsis and delta mudwort	1,630	141	540	23	388	59	171	5	127	27	931	396
Antioch Dunes evening primrose	0	0	0	0	0	0	0	0	20	17	0	0
Side-flowering skullcap	841	95	77	2	8	0	35	2	15	4	1	0
Caper-fruited tropidocarpum	0	0	574	0	193	6	634	5	9	0	0	0

3.2.3 Development of the Aquatic Resources Component of the Conservation Strategy

The aquatic component of the BDCP Conservation Strategy is designed to support the restoration of ecological productivity of the Delta and adjacent areas to contribute to the conservation of covered fish species and the tidal natural communities upon which they depend, consistent with the water supply and reliability goals of the Plan. Over the course of the BDCP planning process, the Steering Committee convened independent scientists on several occasions to solicit their advice and recommendations regarding a number of concepts that were used to help guide the Conservation Strategy for aquatic resources, including:

- Land use changes within the Delta have reduced the quality and availability of aquatic habitat suitable for various life stages of covered fish – the conservation strategy should contribute to an increase in the quality, availability, spatial diversity, and complexity of aquatic habitat within the Delta.
- Achieving the goals of the BDCP will require more than manipulation of Delta flow patterns alone. A number of key ecosystem drivers are unrelated to freshwater flow patterns, and these drivers must also be addressed directly.
- The conservation strategy should improve connectivity among aquatic habitats, facilitate migration and movement of covered fish among habitats, and provide transport flows for the dispersal of planktonic material (organic carbon), phytoplankton, zooplankton, macroinvertebrates, and fish eggs and larvae.
- Synchrony between environmental cues and conditions and the life history of covered fish and their food resources within the upstream rivers, Delta, and Suisun Bay is important. The conservation strategy should consider hydrologic seasonal synchrony within the watershed, seasonal water temperature gradients, salinity gradients, turbidity, and other environmental cues.
- There are currently a number of stressors and sources of mortality affecting covered fish within the Delta – the conservation strategy should identify and implement actions to reduce sources of direct mortality and other stressors on the covered fish and the aquatic ecosystem within the Delta.
- Hydrology and SWP and CVP operations within the Delta are integrated with conditions both upstream and downstream of the Delta – the conservation strategy should consider effects on habitat conditions for covered fish in upstream river reaches, within the Delta, and downstream within the low salinity zone of the estuary in Suisun Bay.
- To the extent possible, the conservation strategy should rely on natural physical habitat and biological processes to support and maintain covered fish species and their habitat.

These concepts informed the development of the aquatic component of the Conservation Strategy. Underlying the BDCP Conservation Strategy is the widely-accepted assumption that the existing water conveyance system is fundamentally flawed and that continued reliance on the system as it currently exists is incompatible with the long-term restoration needs of the Delta. Given the inability of the existing conveyance system to meet ecological and water supply goals, and in light of the ongoing and anticipated changing conditions of the Delta brought on by climate change, anticipated seismic events, nonnative species, and other stressors, the BDCP provides for wholesale, systemic modifications to the Delta. Modifying the water conveyance infrastructure to allow for both north and south Delta diversions is essential to creating new opportunities to restore the ecological health of the Delta and to achieve improvements in water supply reliability. The BDCP provides for dual operations of north and south Delta intakes that allow for flexibility of operations to:

- Improve passage of fish within and through the Delta by improving hydrodynamic and water quality conditions that can create barriers to movement;
- Allow for restoration of tidal habitats in the east and south Delta by reducing the risk for entrainment of food produced in restored habitat and life stages of covered fish species using this habitat; and
- Reduce the risk of entrainment of covered fish species by conveying water from either the north or south Delta, depending on the seasonal distribution of their sensitive life stages.

The Conservation Strategy for aquatic resources identifies conservation actions to be implemented under both existing and future water conveyance facilities and operational regimes that can effectively reverse or reduce the adverse effects of environmental stressors on the aquatic ecosystem, covered fish species, and other native aquatic organisms. In addition to the water facilities and operations, the Conservation Strategy provides for habitat restoration actions to improve rearing, spawning, and migration habitat conditions for the covered fish species and to improve aquatic food web processes and actions to address specific stressors on the covered fish species, including impediments to fish passage, sources of unnatural mortality, and the adverse effects on the genetic integrity of covered fish species.

To improve habitat and food web conditions for the covered fish species, the Conservation Strategy provides for the restoration of 75,000 acres of tidal habitats, seasonally inundated floodplains, and adjacent transition uplands; 20 miles of channel margin habitat; and enhancement of seasonally inundated floodplain habitats of the Yolo Bypass through operation of a modified Fremont Weir. These restored natural communities will account for a substantial increase in the extent and quality of physical habitat available for covered fish species. For example, the ROAs described in Section 3.2.2, *Identifying Conservation Zones and Restoration Opportunity Areas*, (see Figure 3-2) were selected specifically to encompass areas most suitable for the restoration of tidal habitats and the most beneficial locations for covered fish species that use main channels, distributaries, and sloughs of the Sacramento, San Joaquin, and Mokelumne rivers and the channels and sloughs of Suisun Marsh. Prior to completion of the new conveyance facility, tidal habitat restoration actions will be focused on the Cache Slough and

Suisun Marsh ROAs, which are minimally affected by through-Delta conveyance operations. Expansion of tidal habitat in these ROAs will benefit delta smelt and longfin smelt. The expansion of tidal area will affect flows in the Sacramento River and its distributaries to the benefit of Sacramento River salmonids. Constructing the new north Delta diversions and isolated tunnel/pipeline facility will open up significant additional tidal habitat restoration opportunities that do not now exist. Accordingly, the long-term phase of the physical habitat restoration program will emphasize restoration of tidal and floodplain habitats in the northeast and south Delta to benefit San Joaquin, Mokelumne, and Cosumnes river salmonids as well as sturgeon, splittail, and lamprey. As described in Section 3.2.4, *Development of the Terrestrial Resources Component of the Conservation Strategy*, these restoration actions will also benefit covered wildlife and plant species that use tidal marsh and riparian habitats.

A third component of the aquatic strategy consists of actions to reduce the direct and indirect adverse effects of other stressors on the ecological functions of the Delta and the covered fish species. A number of factors have been identified that adversely affect covered fish species, either directly or by affecting food resources or habitat quality. Many of these conservation measures address other stressors that are not related directly to water operations or habitat restoration activities, but offer significant opportunities to reduce adverse impacts on covered species and otherwise improve productivity. These other stressors include poor water quality (e.g., low dissolved oxygen), nonnative predator species, illegal harvest activities, and the genetic effects of hatchery-raised fish. Implementation of conservation measures addressing these other stressors is expected to reduce adverse effects on covered species productivity.

Because there are some uncertainties regarding the likely responses of the aquatic ecosystem and covered fish species to some of the measures to address these other stressors, the monitoring and adaptive management programs will be used to ensure that such measures can be refined over time to improve their effectiveness.

3.2.3.1 Aquatic Resources Conservation Strategy Development Process

The process of developing the BDCP Conservation Strategy was complicated by the challenges associated with ecological requirements that vary among the covered fish species, the physical complexity of the Delta, and uncertainties about the nature and strength of certain cause-effect relationships operating in this aquatic ecosystem. Furthermore, the ecosystem experiences ongoing changes, some of which are relatively well understood (e.g., sea level rise), others incompletely understood (e.g., pelagic organism decline), and some that are entirely unknown. As part of the process of developing the Conservation Strategy, the linkages between key plan elements were identified in process referred to as the “logic chain,” which was used to help organize and address the elements of this complex system. Biological goals and objectives for the covered fish species were identified and monitoring metrics were assigned to assess the effectiveness of conservation actions toward achieving the biological goals and objectives.

The logic chain is intended to add specificity and clarity with respect to the relationships between stressors affecting covered fish species, biological goals and objectives, the assumptions underlying conservation approaches, the conservation measures and their projected outcomes, and the appropriate metrics to monitor the success of the Conservation Strategy. Understanding these key linkages helped to facilitate the evaluation of the Plan components and their likely effectiveness as they are implemented over time. As a result, the Conservation Strategy uses a comprehensive approach that accounts for the relationships between what the BDCP is trying to accomplish and how it intends to achieve its objectives.

3.2.3.2 Stressors Affecting Covered Fish Species

A key step in the development of the Conservation Strategy for aquatic resources was the identification of significant environmental stressors on each of the covered fish species. Biological objectives for the Conservation Strategy were developed on the basis of identified stressors on covered fish species and their habitats. Conservation measures were developed to address the biological goals and objectives. Table 3-3 identifies the primary stressors on covered fish species and indicates those stressors that will be addressed by BDCP conservation measures and those that will not.

Table 3-3. Stressors on Covered Fish Species and their Relationship to Biological Objectives

No.	*Applicable species*	*Stressors*	*Description*	*Biological objectives that Address the Stressor*[2]
Stressors on Covered Fish Species Addressed by BDCP Objectives				
1	CHSA STEE SASP GRST WHST RILA PALA	Habitat loss and modification	Changes in the extent access to and or quality of key natural in-Delta habitats for specific life history stages, including habitat variability and food.	CHSA1.1 CHSA1.2 STEE1.1 STEE1.2, SASP1.1 SASP1.2 GRST1.1 WHTST1.1 PALA1.1 RILA1.1
2	SASP	Food limitation	Food availability and food web disruptions due to altered co-occurrence with prey or due to effects of foraging by overbite clam.	SASP1.2
3	CHSA STEE GRST WHST RILA PALA	Altered flows	Altered distribution due to diversions and gate operations; modifications to Delta inflow and outflow rates and hydrodynamics resulting in deviations from migration pathways delays reduced survival and adult straying; rapid changes in flows and water levels affecting rearing habitat and outmigration success; directionality of flows thru the Delta (Note: It is not known to what extent altered flows are a stressor for splittail)	DESM1.4 CHSA1.5 STEE1.4 GRST1.1 WHST1.1 PALA1.4 RILA1.4

Table 3-3. Stressors on Covered Fish Species and their Relationship to Biological Objectives (continued)

No.	*Applicable species*[8]	*Stressors*	*Description*	*Biological objectives that Address the Stressor*[2]
4	CHSA STEE GRST WHST RILA PALA	Passage impediments/ barriers	Barriers to migration (upstream and downstream); factors within the Planning Area that reduce or eliminate access to key habitats.	CHSA1.4 STEE1.3 GRST1.5 WHST1.5 PALA1.3 RILA1.3
5	CHSA STEE SASP GRST WHST RILA PALA	Water quality (toxics DO temperature).	Effects of contaminants and toxic compounds on all life stages; effect of water temperature on productivity; effect of microcystis blooms on productivity; effect of water quality on distribution migration growth rate and reproductive success and survival (including predation).	DESM1.3 DESM1.4 LOSM1.2 CHSA1.6 STEE1.5 GRST1.3 GRST1.4 WHTST1.3 WHST1.4 PALA1.5 RILA1.5
6	CHSA SASP GRST WHST	Entrainment	Direct mortality due to entrainment or impingement at project and non-project diversions.	DESM1.4 DESM1.5 LOSM1.4 CHSA1.7 STEE1.6 SASP1.4 GRST1.6 WHST1.6
7	CHSA STEE SASP	Predators/non-native invasive species.	Predation losses including effects of structures and habitat alterations that promote predators including population effects from predation by introduced species (Note: this is a low impact stressor – little information available for splittail); Competition predation or alteration of habitat characteristics from nonnative invasive species.	DESM1.1 CHSA1.9 STEE1.8 SASP1.5
8	CHSA STEE SASP GRST WHST	Illegal harvest	Direct mortality due to illegal harvest; population effects from illegal harvest.	CHSA1.8 GRST1.7 STEE1.7 WHST1.7

[8] See note at the bottom of this table for species abbreviations

Table 3-3. Stressors on Covered Fish Species and their Relationship to Biological Objectives (continued)

No.	Applicable species[8]	Stressors	Description	Biological objectives that Address the Stressor[2]
9	SASP RILA PALA	Stranding	Effects on productivity and abundance from incidences of stranding associated with water management activities. Splittail are floodplain spawners. Design of the restored floodplain may influence potential for stranding.	PALA1.2 RILA1.2 SASP1.1 SASP1.3
10	GRST WHST	Dredging	Disturbance of benthos and direct and indirect effects of physical disturbances of substrates used for rearing from dredging activities associated with BDCP construction and maintenance activities.	GRST1.6 WHST1.6
Stressors Not Addressed by BDCP biological Objectives[9]				
11	CHSA STEE	Access to historical spawning habitat	Barriers to historical spawning habitat are predominately located outside of the BDCP planning area. In-delta migration and barriers addressed in Stressor # 4 above.	NA
12	CHSA STEE	Climate Change	Increases in ambient air temperatures resulting in increased water temperatures with negative effects on habitat suitability. Effects of climate change are considered but no specific objectives proposed. Changes in water temperature as applicable to BDCP covered activities are addressed under stressor # 5 above.	NA
13	RILA PALA	Disease	Disease may influence lamprey health with effects on reproduction and survival.	NA
14	RILA PALA	Ocean conditions	Reductions in the availability of host/food species may be affecting lamprey survival and growth.	NA

[1] Species abbreviations are defined as follows:
Note: objectives for Delta Smelt and Longfin Smelt are not included
CHSA = Chinook salmon all runs
STEE = Central Valley steelhead
SASP = Sacramento splittail
GRST = Green sturgeon
WHST = White sturgeon
RILA = River Lamprey
PALA = Pacific Lamprey
[2] Species-specific objectives are presented in Section 3.3, *Biological Goals and Objectives.*

3.2.3.3 Water Facilities and Operations

The BDCP Conservation Strategy includes conservation measures that provide for the development and operation of new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities. Central to the

[9] Stressors not addressed by BDCP objectives are associated with conditions outside the Plan Area and/or not under the control of BDCP Authorized Entities

Conservation Strategy is the development and operation of new north Delta facilities that will be located along the Sacramento River and divert water to the south Delta through an isolated tunnel/pipeline. The combination of moving freshwater via an isolated tunnel/pipeline facility in conjunctions with the existing south Delta facilities (referred to as “dual operations”) is expected to provide flexibility sufficient to substantially improve conditions for covered fish species. The operation of these dual facilities as set out in the BDCP is expected to benefit different species at different times and under a variety of conditions. Dual operation of new and existing diversion facilities is expected to reduce levels of entrainment of native fish at the south Delta SWP/CVP facilities, particularly delta and longfin smelt.

To minimize the potential for entrainment of fish (particularly juvenile Sacramento River salmonids and splittail) at the new diversion facilities on the Sacramento River, state-of-the-art positive-barrier fish screens will be constructed at each of five intakes and flexible operational methods in the timing and rate of diversion will be coordinated among the intake facilities. Constructing state-of-the-art positive barrier fish screens on in-river and on-river intakes along the Sacramento River and employing flexible operational scenarios will ensure that fish mortality at the new north Delta diversion sites is minimized to the maximum extent practicable. The positive barrier fish screens will be designed and operated in accordance with design criteria (e.g., screen mesh size, approach velocity) currently used by CDFG, NMFS, and USFWS. These operational measures have been devised to ensure that any potential risks to migrating salmonids from the operation of the new north diversion facility will be avoided or otherwise minimized.

The water operations conservation measures establish parameters for water diversion rates and bypass flows in the Sacramento River at the diversions that reflect seasonal movement patterns of covered fish species, including specific responses during periods in which fish species are present in the vicinity of the diversions. These parameters have been developed to better reflect seasonal synchrony with hydrologic conditions within the river and upstream watersheds. Bypass criteria set out in the water operations conservation measures reflect the variation in the seasonal periods of hydrology. The criteria includes “pulse flow” operations, minimum river flow requirements, and flow requirements based on a percentage of the river flow that would pass by the diversions (“bypass flows”). Extensive hydrologic simulation modeling has been used to evaluate and develop the range of water diversion criteria included in the Conservation Strategy. Detailed information on the Sacramento River bypass and diversion operations criteria is presented in Section 3.4.2.1, *CM1 Water Facilities and Operation*.

Proposed water operations measures include actions to improve flows through the Yolo Bypass floodplain, ensure sufficient water for fish transport in the Sacramento River (i.e., north Delta diversion or Hood “bypass flows”), prevent fish from being drawn into the central Delta through the Delta Cross Channel, provide quality habitat for delta smelt and longfin smelt in the Delta and Suisun Bay, and minimize entrainment of fish at the south Delta SWP/CVP diversions. The flexibility associated with the operation of dual facilities in the north and south Delta is expected to allow for physical habitat restoration to be implemented in the western, eastern, and southern

Delta. Some of the enhanced production of carbon, zooplankton and phytoplankton generated from these restored habitats is expected to pass through the interior Delta, while some should also be consumed by fish within and adjacent to the marshes. The flexibility of this dual approach will also allow for substantial reductions in fish entrainment at the south Delta facilities, while meeting the water supply and reliability goals of the BDCP.

The BDCP conservation measures also include the modification of Fremont Weir (lowering a portion of the weir and installing an operable gate facility) and changes to its operations to improve the inundation regime in the Yolo Bypass. Research suggests that covered fish species, particularly splittail and Chinook salmon, would benefit significantly from optimizing the frequency, duration, and timing of seasonal inundation of the Yolo Bypass floodplain habitat (Sommer et al. 1997, 2001a, 2001b, 2004a, 2004b). In addition, the measures is also designed to increase levels of phytoplankton, zooplankton, and other organic material transported from the Yolo Bypass floodplain to Cache Slough, the lower Sacramento River, the western Delta, and Suisun Bay, which will increase the food supply for delta smelt and longfin smelt in those areas.

The BDCP also includes operational criteria that set seasonal limits based on Old and Middle River (OMR) reverse flows. To reduce the risk that south Delta SWP and CVP exports cause direct losses or salvage of covered fish or increases in the export of nutrients and food resources produced in restored southern and eastern Delta marshes, the water operations conservation measures provide for seasonally adjusted year-round limits on OMR reverse flows. Detailed information on OMR operations criteria is presented in CM1 *Water Facilities and Operations,* in Section 3.4, *Conservation Measures.*

The western Delta and Suisun Bay system functions as an estuarine mixing zone for freshwater passing downstream from the tributary rivers and saltwater intrusion from coastal waters through San Francisco Bay. Suisun Bay and the western Delta serve as the low salinity mixing area that has been found to be important rearing and foraging habitat for the covered fish species. The estuarine habitat is also important to the production of phytoplankton and zooplankton as well as many other fish that are the prey of covered fish. The dynamics of the estuarine zone are determined largely by tides and the balance of the magnitude of Delta inflow and Delta outflow. Habitat conditions and salinity gradients in the Suisun Bay and western Delta are most important to covered fish species during the winter and spring months. Consequently, the Conservation Strategy includes, as part of the water operations conservation measures, seasonally adjusted Delta flows designed to better maintain the functions of the estuarine habitat.

3.2.3.4 Physical Habitat Restoration

A second major component of the Conservation Strategy for aquatic resources is the protection, enhancement, and restoration of habitats and natural communities that support covered species. Habitat restoration actions will involve both the reestablishment of habitat in locations that historically supported such habitat and the creation of habitat on altered landscapes where no such habitat previously existed. Habitat enhancement refers to the improvement of ecological functions of existing habitat; habitat protection refers to the preservation of existing habitat susceptible to changes in use by human activity.

The habitat restoration conservation measures include commitments to restore natural habitats at a substantial scale. These actions will restore natural habitat mosaics and gradients to levels that have not been present in the Delta for at least 70 years. Specifically, these conservation measures provide for the restoration of 65,000 acres of tidal wetland and associated estuarine and upland habitats distributed across the Delta, but primarily located within Suisun Marsh and the north Delta Cache Slough complex; restoration of 10,000 acres of new floodplain habitat along major channels; and enhancement of floodplain in the Yolo bypass. ROAs have been identified within the Delta and Suisun Marsh that are characterized by physical conditions suitable for tidal marsh restoration (see Figure 3-2). The ROAs encompass potential restoration areas that could support covered fish species that use main channels, distributaries, and sloughs of the Sacramento, San Joaquin, and Mokelumne rivers in the Delta and the channels and sloughs of Suisun Marsh. Within the floodplain and tidal restoration areas, 5,000 acres of riparian habitat restoration will be implemented. These conservation actions will result in the restoration of large tracts of Delta tidal marsh, estuarine, and seasonal floodplain habitats of sufficient size to substantially increase the extent of physical habitat for covered species (including cover, rearing habitat, nesting habitat, and food resources) and improve overall food web productivity in the restoration areas and adjacent aquatic habitat.

3.2.3.5 Measures to Address Other Stressors

An important third component of the Conservation Strategy for aquatic resources consists of measures to reduce the direct and indirect adverse effects of other stressors on the ecological functions of the Delta and on covered species and natural communities. A number of factors have been identified that adversely affect covered fish species and their habitats. These other stressors include nonnative predators, localized low dissolved oxygen, and genetic issues in hatchery fish.

Specific other stressors conservation measures include actions to reduce predator levels through removal of predator habitat, such as submerged and floating aquatic vegetation and abandoned structures and vessels, particularly in reaches important to juvenile salmonid migration. New non-physical barriers are proposed to direct certain covered species away from areas that pose a higher risk of predation and entrainment. Other measures include actions to improve dissolved oxygen conditions in specific problem areas important to salmonid migration, and to develop new and expanded conservation hatcheries for delta smelt and longfin smelt for the purpose of establishing refugial populations.

3.2.4 Development of the Terrestrial Resources Component of the Conservation Strategy

The Conservation Strategy for terrestrial resources comprises a comprehensive program that provides for the protection of existing functioning natural communities, restoration of new areas of specific natural communities, enhancement of the function of natural communities for covered species habitat, establishment and long term management of geographically distributed conservation lands, and monitoring and adaptive management actions. The Conservation Strategy reflects well-established principles of conservation biology. The approach is designed to maximize opportunities to preserve and restore natural communities sufficient to achieve the goals and objectives for the terrestrial covered species. The natural community level measures include specific targets for habitat protection and restoration, including requirements relating to preserve size, habitat corridors and linkages, and preserve management. Where the goals and objectives for a covered species are may not be fully achieved through implementation of the natural community conservation measures, species-specific conservation measures have been included to ensure appropriate outcomes for species and habitats.

Because of the diverse species habitat requirements and highly altered nature of the Delta, the covered wildlife and plant species are distributed unevenly in the Plan Area, often in discrete, disconnected patches of habitat. A few of the wildlife and plant species are distributed broadly across the Plan Area, but many of the covered wildlife and plant species are found only at the margins of the Plan Area or in local parts of the Plan Area. For some of these species, the Plan Area includes only low-quality or marginal habitat and for others the Plan Area provides the key resources required for conservation. Hence, the conservation approaches for covered wildlife and plant species vary because of the large variation in the importance and quality of habitat in the Plan Area for these species.

Each natural community supports habitat for multiple covered wildlife and plant species, and the suite of species' habitats supported by some communities are similar. Conservation of each natural community is addressed based on the specific spatial, temporal and structural attributes of those communities.

The Conservation Strategy includes measures to provide connectivity between areas that are important for sustaining and improving ecosystem functions and providing for species conservation. For some species and natural communities this interconnection will be achieved through large-scale restoration of aquatic and wetland communities, such as tidal habitats concentrated in the Delta and Suisun Marsh and riparian forest and scrub. For covered species that occur in terrestrial natural communities along the periphery of the Plan Area (e.g., San Joaquin kit fox, California red-legged frog), opportunities for habitat interconnection will be mostly between existing and newly protected terrestrial habitat in the Plan Area and protected terrestrial habitat adjacent to the Plan Area (mostly associated with adjacent or surrounding HCPs and NCCPs).

The geographic pattern of habitat protection and restoration in the Plan Area will result in a system of core habitat patches linked by ribbons of habitat along channels, sloughs, and floodplains. This approach can be thought of as a "node and network" approach. In core species habitat areas, patches or "nodes" of protected and restored habitat will be established to address site-specific species needs. The Plan provides for large-scale preservation and restoration of habitat along the channels, floodplains, and sloughs of the Delta and Suisun Marsh that will provide a "network" of habitat connections among the nodes of protected and restored core habitats. Steps to establish a connectivity network for covered species within the Plan Area will be informed and guided by the California Essential Habitat Connectivity project (Spencer et al. 2010).

Many of the natural communities addressed by the BDCP share common characteristics that are related to spatial proximity on the landscape, shared ecosystem process (exchanges of nutrients through daily tidal cycles or seasonal flooding regimes), similarity of habitat structural characteristics (herbaceous versus woody vegetation), and some are dominated by human land use practices (managed wetlands or agricultural lands). For example, tidal freshwater emergent wetland, tidal mudflat, and tidal perennial aquatic communities are typically spatially contiguous along a tidal elevation gradient and are linked through ecosystem processes such as energy and nutrient flows. Another example is the spatial distribution of grassland, alkali seasonal wetland complex, and vernal pool complex communities that, within the Plan Area, are typically intermingled with each other to the extent that these communities form a complex mosaic on the landscape that defines the mapping of each community as discrete land cover units. While grassland in the Plan Area can occur in discrete patches that can be mapped, it often occurs intermixed with the alkali seasonal wetland complex and vernal pool complex natural communities. On fine spatial scales, the seasonal wetland communities are embedded as "islands" within a larger matrix of the grassland community, and for the BDCP development those areas were mapped as complexes of communities.

3.2.4.1 Conservation Targets

Conservation targets have been established for the natural communities and the covered wildlife and plant species habitats they support. Conservation targets represent the extent and distribution of habitat to be protected, enhanced, and restored/created to achieve the biological goals and objectives. Under the monitoring program, the effectiveness of habitat enhancement, restoration, and management actions will be assessed and potential adjustments to conservation actions can be identified to maintain or improve habitat functions over time (see Section 3.6, *Monitoring and Research Program*). The habitat conservation targets have been developed to satisfy mitigation requirements associated with the impacts of covered activities on covered species and provide for the conservation of those species.

The conservation targets for natural communities and the covered wildlife and plant species are presented in Table 3-4 and Table 3-5, respectively. The process used to develop conservation targets is presented in Figure 3-9. The information used to develop the conservation targets included the:

- Distribution and extent of each natural community within the Plan Area (Figure3-3 through Figure 3-8);
- Distribution and extent of each covered species' modeled habitat that is located within the Plan Area (Figure 3-14 through Figure 3-51 in Section 3.3.2.4, *Covered Wildlife and Plant Species Goals and Objectives*);
- Primary threats and stressors for each of the covered species (Appendix A, *Covered Species Accounts*);
- Location of habitat areas known to be occupied by each of the covered species (Appendix A, *Covered Species Accounts*);
- The distribution and extent of existing protected patches of each natural community and covered species habitat (Figures 3-3 through 3-8 and 3-14 through 4-51); and
- Potential for increasing connectivity with conserved habitat areas adjacent to the Plan Area (from documents of HCP/NCCPs approved or under development for lands that are adjacent to the Plan Area).

To establish the conservation targets, this information was evaluated for each of the following variables.

- The patch size and connectivity of each natural community with other protected and unprotected natural community patches and connectivity with existing protected natural communities was evaluated. The conservation targets were formulated to include large patches of connected natural communities and not small fragmented patches;
- The extent of modeled habitat for covered species that is supported by each natural community within each of the Conservation Zones was evaluated. The conservation targets were formulated to include natural communities in locations that support modeled habitat for multiple species and exclude areas that support modeled habitat for no or a relatively small number of species, except where patches are important for conserving a particular species;
- The habitat value of patches of natural communities for associated covered species and ability to maintain habitats into the future was evaluated. The conservation targets minimize protecting low value habitats (e.g., patches of grassland on levee slopes) and habitat areas at risk for future loss to natural events (e.g., habitats on subsided lands that may be lost to future levee failures associated with flood and seismic events);

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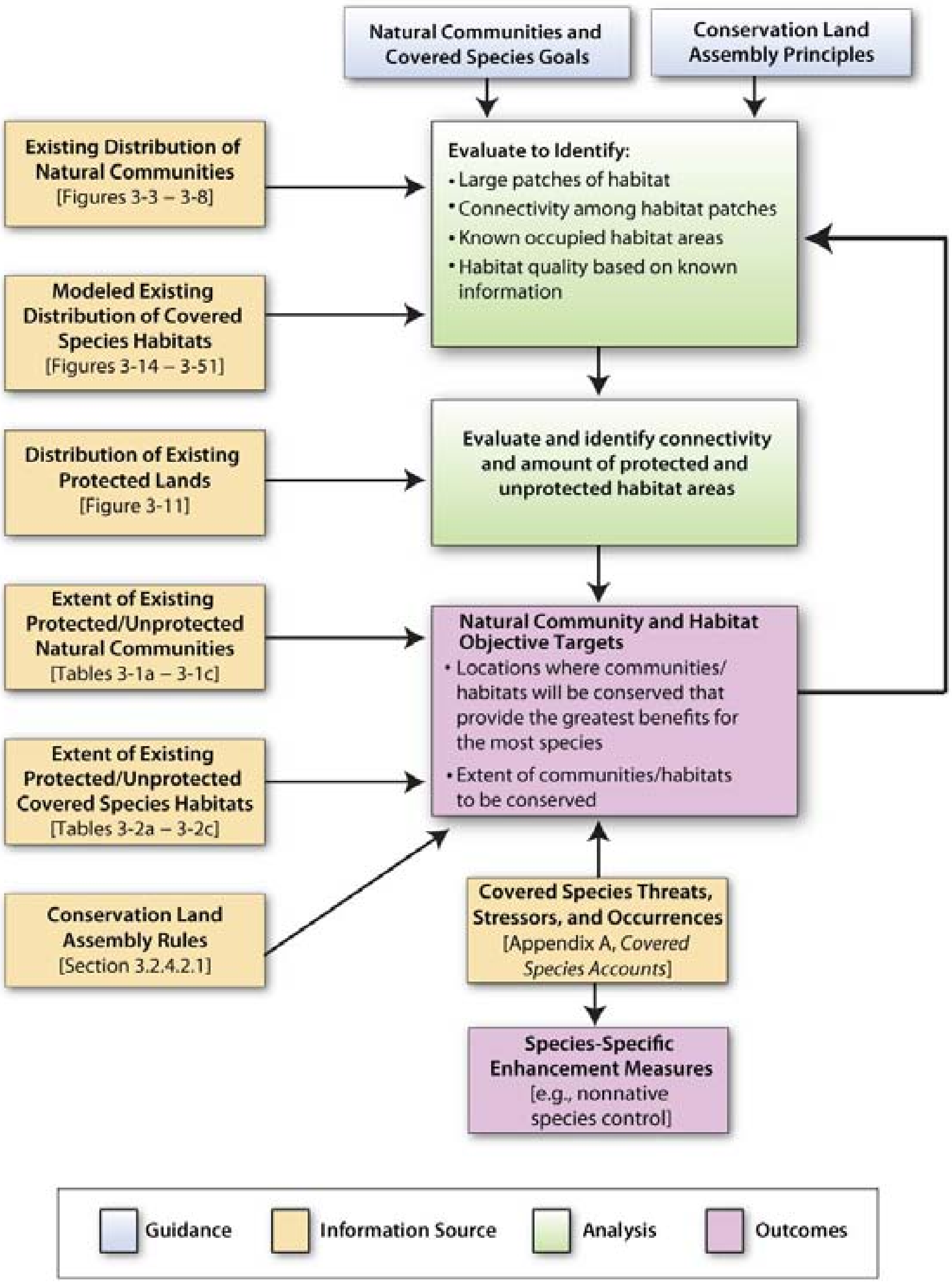

Figure 3-9. Process for Establishing Natural Community and Covered Species Habitat Targets and Species-Specific Measures

- The patch size and connectivity of each covered species' modeled habitat to other patches of modeled protected and unprotected species habitat within the Plan Area and habitat adjacent to the Plan Area was evaluated. The conservation targets were formulated to include large patches of connected modeled habitat for each of the covered species rather than small fragmented patches;
- Location of important known covered wildlife species population centers and covered plant species occurrences was evaluated. The conservation targets were formulated to protect a proportion of these habitat areas such that these populations and occurrences will be conserved;
- Proximity of modeled covered species habitats to known occupied habitats was evaluated. The conservation targets were formulated to protect occupied habitats and unoccupied habitat areas that are connected to known occupied habitat areas such that, with implementation of enhancement measures, unoccupied habitats can be occupied in the future; and
- Based on the evaluation of these variables for each natural community and covered wildlife and plant species, the conservation targets were established such that, once they are achieved, the largest and highest quality patches of natural communities and associated covered species habitats remaining in the Plan Area will be protected. The rationale for how the natural community conservation targets presented in Table 3-4 address the conservation needs for each of the covered species is presented in Section 3.3.2.4, *Covered Wildlife and Plant Species Goals and Objectives*.

Actions that provide for the conservation of the covered species and their habitats include habitat protection, enhancement, restoration, and management. Conservation actions also include targeted species-specific actions, some of which reflect approaches identified in approved recovery plans and approved conservation plans overlap with the Plan Area.

Table 3-4. Natural Community Conservation Targets by Conservation Zone

Natural Community	*Conservation Target (acres)*		*Total Conserved Land Base (acres)*	*Applicable Conservation Zones*	*Covered Species Habitats Supported by Conserved Natural Communities*
	Restored	**Protected/ Enhanced**			
Tidal	65,000	0	65,000	1, 2, 4, 5, 6, 7, and 11	Chinook salmon (all runs), steelhead, delta smelt, longfin smelt, splittail, salt marsh harvest mouse, Townsend's western big-eared bat, Suisun shrew, tricolored blackbird, Suisun song sparrow, California black rail, California clapper rail, giant garter snake, western pond turtle, Suisun thistle, soft bird's-beak, delta tule pea, Mason's lilaeopsis, delta mudwort, and Suisun marsh aster.
Valley/foothill riparian	5,000	0	5,000	1-9 and/or 11	Chinook salmon (all runs), steelhead, splittail, riparian woodrat, riparian brush rabbit, Townsend's big-eared bat, yellow-breasted chat, white-tailed kite, Swainson's hawk, western pond turtle, and valley elderberry longhorn beetle.
Grassland	2,000	8,000	10,000	1, 8, and 11	San Joaquin kit fox, Townsend's big-eared bat, tricolored blackbird, western burrowing owl, white-tailed kite, Swainson's hawk, giant garter snake, western pond turtle, western spadefoot toad, California red-legged frog, and California tiger salamander.
Nontidal freshwater perennial emergent wetland and nontidal perennial aquatic	400	0	400	2 and 4	Townsend's big-eared bat, tricolored blackbird, giant garter snake, and western pond turtle
Alkali seasonal wetland complex	0	400	400	1, 8, and 11	San Joaquin kit fox, Townsend's big-eared bat, tricolored blackbird, western burrowing owl, white-tailed kite, Swainson's hawk, giant garter snake, western pond turtle, western spadefoot toad, California red-legged frog, and California tiger salamander.
Vernal pool complex	200	300	500	1, 8, and 11	San Joaquin kit fox, Townsend's big-eared bat, tricolored blackbird, western burrowing owl, white-tailed kite, Swainson's hawk, giant garter snake, western pond turtle, western spadefoot toad, and California red-legged frog.
Other natural seasonal wetlands	0	0	0	Not applicable.	None
Inland dune scrub	To be determined.	To be determined.	To be determined.	To be determined.	To be determined.
Agricultural habitats	0	16,620-32,640	16,620-32,640	1-9	San Joaquin kit fox, Townsend's western big-eared bat, Swainson's hawk, tricolored blackbird, greater sandhill crane, western burrowing owl, white-tailed kite, giant garter snake, and western pond turtle.
Total	**Up to 72,600**	**Up to 25,320-41,340**	**Up to 97,920-113,940**		

Table 3-5. Covered Species Habitat Conservation Targets

Covered species	*Conservation Provided by Conservation Zone (CZ)*	
	Preservation/ Enhancement (acres[2])	**Restoration (acres[2])**
San Joaquin kit fox		
Breeding habitat	1,000 CZ: 8	0
Riparian woodrat	0	300 CZ: 7
Salt marsh harvest mouse		
Wetland habitat	0	3,600-4,800 CZ: 11
Upland habitat	350-700 CZ: 11	350-700 CZ: 11
Riparian brush rabbit	0	300 CZ: 7, 8
Townsend's western big-eared bat		
Roosting and primary foraging habitat	0	5,000 CZ: 1, 2, 4-7, and/or 11
Suisun shrew	0	3,600-4,800 CZ: 11
Tricolored blackbird		
Nesting habitat	0	17,900-26,800 CZ 1, 2, 4- 7, and/or 11
Foraging habitat: non-agriculture	8,700 CZ1,2, or 4	0
Foraging habitat: agriculture	16,620-32,640 CZ 1-9	0
Suisun song sparrow	0	3,600-4,800 CZ:11
Yellow-breasted chat		
Primary nesting and migratory habitat[3]	0	≥2,000 CZ: 1, 2, 4- 7, and/or 11
Secondary nesting and migratory habitat	0	≤3,000 CZ: 1, 2, 4- 7, and/or 11
Least Bell's vireo	0	≥2,000 CZ: 1, 2, 4- 7, and 11
Western burrowing owl		
High-value habitat	8,000 CZ: 1, 8, and 11	2,000 CZ: 1, 8, and 11
Moderate- value habitat	>3,000 CZ: Any CZ	0
Western yellow-billed cuckoo	0	>1,000 CZ: 1, 2, 4-7
California least tern *Foraging habitat*	0	10,000-20,000 CZ: 1, 2, 4-7, and 11
Greater sandhill crane		
Roosting/Foraging Habitat	0	320 CZ: 3, 4, 5, 6
Foraging Habitat	>4,800 CZ: 3, 4, 5, 6	0
California black rail	0	17,500-26,400 CZ: 1, 2, 4- 7, and/or 11
California clapper rail	0	3,600-4,800 CZ: 11

Table 3-5. Covered Species Habitat Conservation Targets (continued)

Covered species	*Conservation Provided by Conservation Zone (CZ)*	
	Preservation/ Enhancement (acres[2])	**Restoration (acres[2])**
Swainson's hawk		
Foraging habitat	20,020 to 36,040 CZ 1-8, and/or 11	0
Nesting habitat	0	4,000 CZ: 1, 2, 4- 7, and/or 11
White-tailed kite		
Nesting habitat	0	4,000 CZ: 1, 2, 4- 7, and/or 11
Foraging habitat	24,620-46,040 CZ: Any CZ	0
Giant garter snake		
Primary Zone: Aquatic breeding, foraging and movement	≥6,900 CZ: 1, 2, 4, and/or 5	400 CZ: 2 and 4
Primary Zone; Upland aestivation and movement	7,100 CZ 1, 2, 4, and/or 5	0
Primary and Secondary Zone: Aquatic breeding, foraging	Not applicable.	13,290-21,640 CZ: 1, 2, 4,-7, and/or 11
Western pond turtle		
Aquatic habitat	0	27,900-46,800 CZ: 1, 2, 4-7, and/or 11
Dispersal habitat	4,000	0
Upland nesting and overwintering	≥5,230 CZ: Any CZ	5,000 CZ: 1, 2, 4-7, and/or 11
California red-legged frog		
Aquatic habitat	3 CZ: 8	0
Upland cover and dispersal habitat	1,000 (including encompassed stream aquatic habitat) CZ: 8	0
Western spadefoot toad		
Aquatic breeding habitat	300 CZ: 1, 8, and/or 11	200 CZ: 1, 8, and/or 11
Terrestrial cover and aestivation habitat	8,400 CZ: 1, 8, and/or 11	500 CZ: 1, 8, and/or 11
California tiger salamander		
Aquatic breeding habitat	300 CZ: 1, 8, and/or 11	200 CZ: 1, 8, and/or 11
Terrestrial cover and aestivation habitat	8,400 CZ: 1, 8, and/or 11	500 CZ: 1, 8, and/or 11
Valley elderberry longhorn beetle		
Riparian vegetation	0	5,000 CZ: 1, 2, 4- 7, and/or 11
Lange's metalmark butterfly	0	0
Vernal pool shrimp species (*vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid valley fairy shrimp, and California linderiella*)	300 CZ: 1, 8, and 11	200 CZ: 1, 8, and/or 11

Table 3-5. Covered Species Habitat Conservation Targets (continued)

Covered species	*Conservation Provided by Conservation Zone (CZ)*	
	Preservation/ Enhancement (acres[2])	**Restoration (acres[2])**
Vernal pool plant species (*Alkali milk-vetch, San Joaquin spearscale, Boggs Lake hedge-hyssop, Heckard's peppergrass, dwarf downingia, and legenere*)	300 CZ: 1, 8, and 11 Protect at least 3 alkali milkvetch and 2 Heckard's peppergrass unprotected occurrences CZ: 1, 8, and 11	200 CZ: 1, 8, and/or 11
Heartscale and brittlescale	150 CZ: 1, 8, and/or 11 Protect at least 3 heartscale and brittlescale unprotected occurrences CZ: 1, 8, and 11	0
Slough thistle	0	≥1,000 CZ: 7
Suisun thistle and soft bird's-beak	Protect at least 3 Suisun thistle and soft bird's-beak unprotected occurrences CZ: 11	3,600-4,800 CZ: 11
Delta button celery	≥100 CZ: 8	≥1,000 CZ: 7
Contra Costa wallflower	0	0
Carquinez goldenbush	300 CZ: 1 and/or 11 Protect at least 3 Carquinez goldenbush unprotected occurrences CZ: 1 and/or 11	0
Delta tule pea and Suisun Marsh aster	0	16,970-26,470 CZ: 1, 2, 5, 7, and 11
Mason's lilaeopsis and delta mudwort	0	16,980-26,560 CZ: 1, 2, 5, 7, and 11)
Antioch Dunes evening primrose	0	0
Side-flowering skullcap	0	0
Caper-fruited tropidocarpum	≥100 CZ: 8 Protect occurrences of caper-fruited tropidocarpum that reestablish on BDCP conservation areas CZ: 8	0

[1]Initial estimate prior to the full BDCP effects analysis.

[2]Values above 10 are rounded to the nearest 10 acres.

[3]Suisun Marsh/Upper Yolo Bypass Nest and Migratory Habitat acreage totals have been assumed to be equivalent to Primary Habitat and have been combined with the Primary Habitat acreage totals. For further definition of the Suisun Marsh/Upper Yolo Bypass Nest and Migratory Habitat, refer to Yellow-breasted Chat species account documented within Appendix A, *Covered Species Accounts*.

3.2.4.2 Assembly of Conservation Lands

Conservation lands include all areas of land and water included within BDCP protected, restored, and created natural communities in the Plan Area at full BDCP implementation. Upon full assembly of conservation lands over the term of BDCP implementation coupled with the continued operations of water facilities and management of habitats and other stressors conservation actions, all natural community and species goals and objectives are expected to be achieved. This section provides a discussion of the considerations associated with the assembly of conservation lands and guidance for selecting lands for conservation during implementation of the BDCP. Included are discussions of: (1) conservation land assembly principles; (2) existing protected lands and their relationship to conservation land assembly; (3) conservation actions that may occur outside the Plan Area; and (4) the relationship between other regional conservation planning programs and the BDCP Conservation Strategy.

3.2.4.2.1 Conservation Land Assembly Principles

The following conservation land assembly principles describe considerations used to distribute the conservation of natural communities and covered species habitats among the Conservation Zones to ensure the greatest biological benefits. These assembly principles provide guidance to the BDCP Implementation Office for selecting conservation lands.

1. Protect, enhance, and restore the full ecological diversity of natural communities and covered species habitats at the periphery of the Plan Area on lands most likely to accommodate future sea level rise and less likely to be flooded as a result of levee failures (i.e., terrestrial habitat conservation areas should be located where there is a low risk of future flooding).
2. Maintain a range of contiguous ecological gradients and provide connectivity between estuarine/wetland and upland communities inside and outside the Plan Area.
3. Design reserves to appropriately scale the ecological gradient and emphasize compatibility between restored native communities and working landscapes (e.g., agricultural lands).
4. Design reserves of sufficient size to ensure the intended conservation benefits for the target covered species.
5. Design reserves of sufficient size and configuration to ensure that they can be effectively managed given site constraints.
6. Maximize connections between preserve lands within and outside of the Plan Area.
7. Protect the highest quality natural communities and covered species' habitats available consistent with the BDCP implementation schedule.

The following are important implementation concepts that will be used by the BDCP Implementation Office to guide the design and timing of restoration actions and selection of sites for habitat protection and restoration.

1. During the BDCP near-term implementation period, focus restoration and enhancement of covered fish species habitats in north Delta locations to generate improvements in productivity consistent with continued operations of the south Delta SWP and CVP pumping facilities.
2. Identify restoration areas and design actions to accommodate and to integrate with BDCP water operations (see CM1 Water Facilities and Operation) to optimize primary and secondary productivity, spawning and rearing, and other aquatic functions that support covered species.
3. During the BDCP long-term implementation period, expand the restoration and enhancement of covered fish species habitats to include the Mokelumne and San Joaquin River deltas to provide benefits to covered fish species found in each of those areas.
4. Implement conservation measures for terrestrial and nontidal wetland communities and covered wildlife and plants in a manner that complements, as appropriate, the conservation strategies of approved and developing conservation plans for areas adjacent to and overlapping the Plan Area.
5. Restore habitat in large patches to increase the likelihood of providing the desired levels of ecological function and to support large numbers of covered species.
6. Distribute restored and enhanced habitats throughout the Delta to minimize the risk of loss of habitat benefits to catastrophic events in one part of the Delta.
7. Distribute and design restored habitats to withstand potential changes in Delta conditions associated with future sea level rise and changes in stream hydrographs.
8. Design tidal habitats to withstand effects that could be associated with Delta levee failures.
9. Restore habitat in patch sizes that are equal to or greater than the patch sizes required by the covered species that use the habitat.
10. Juxtapose restored habitats with existing habitats to improve and maintain habitat corridors and connectivity among covered species habitats.
11. Locate and design restored habitats to provide beneficial hydrodynamic effects on adjacent channel systems (e.g., increased tidal flows that may result in decreased bidirectional flow in upstream channels or provide greater mixing in adjacent channels).
12. Locate and design restored habitats to create natural gradients in the Delta that historically transitioned from shallow subtidal aquatic habitats, to riverine floodplain habitats, and to transitional upland habitats (seasonal wetland, riparian, grassland).

13. Design tidal marsh and seasonally inundated floodplain habitats to provide access and egress for covered fish species in a manner that avoids stranding or trapping of fish.
14. Locate and design restored habitats to minimize potential effects of other stressors that could degrade intended covered species benefits (e.g., effects of nearby diversions, discharges of low quality water).

3.2.4.2.2 Existing Protected Lands

An important consideration in the assembly of BDCP conservation lands is the extent and distribution of existing protected lands that conserve natural communities and covered species habitats. The BDCP Protected Lands GIS dataset identifies existing protected lands within the Plan Area. The dataset was compiled from various public sources. Ownership information was collected and organized into attributes which included: County, County Assessor's Parcel Number (APN), Management Level, Management Agency, Alias (if known), Type (type of ownership), and Data Source. Although the boundaries depicted within the data do not represent legal boundaries, they represent the best available information and were considered to be sufficient to guide development of the conservation measures for the system of conservation lands at a landscape level.

The public dataset sources used to generate the BDCP Protected Lands GIS data layer included:

- DFG Lands GIS data layer 2010;
- California Protected Areas Database March 2009;
- Central Valley Farmland Trust 2009;
- Yolo County Assessors Data 2009;
- Yolo County Natural Heritage Program 2009;
- Delta Parcels data created by DWR for SAIC 2008;
- Delta Wetlands Program website 2008;
- DWR ownership layer created for SAIC 2008;
- Sacramento Bee, 2008;
- Wildlife Conservation Board, 2008;
- GreenInfo 2007;
- Solano County Water Agency 2007;
- CaSIL Conservation Lands data layer 2005;
- USGS Oil & Gas Assessment Program 2003; and
- CA Public, Conservation and Trust Lands, v5.2.

The data layer was created by overlaying source data on top of county parcel boundary data. Parcels identified as protected lands via source datasets were then attributed with the appropriate information.

Based on the ownership information derived from the above sources, the data was evaluated and grouped into three primary categories defined as follows.

- **Category 1 protected lands:** Lands that are subject to irrevocable protection against a change in primary land use through local, state, or federal authority and with a primary management goal related to ecological protection.
- **Category 2 protected lands:** Lands that are subject to irrevocable protection against a change in primary land use through local, state, or federal authority with a primary land management goal assessed to be that of open space for mixed use in a manner that maintains ecological value.
- **Category 3 protected lands:** Lands that are subject to irrevocable protection against a change in primary land use through local, state, or federal authority. However, these lands are not managed primarily for ecological protection nor are they managed as open space for mixed use in a way that maintains ecological value.

Properties excluded from consideration included those owned by the Department of Defense and city parks. Figure 3-10 illustrates a decision matrix that was applied to assign protection categories.

The distribution of existing protected lands by Conservation Zone is presented in Figure 3-11. The extent of each natural community and covered species habitat in each of the Conservation Zones is presented in Table 3-1a-c and Table 3-2-c, respectively.

3.2.4.2.3 Conservation Actions that May Occur Outside the Plan Area

Initially, the Plan Area will encompass the Sacramento-San Joaquin Delta, Suisun Marsh, and the upper Yolo Bypass. However, additional areas may be incorporated into the Plan Area during plan implementation to accommodate conservation actions that advance the biological goals and objectives of the BDCP. Such conservation actions are limited to the preservation and/or restoration of habitat for terrestrial species located within any of the six Delta counties.[10] In particular, BDCP conservation actions will likely be directed to areas that would support both the BDCP Conservation Strategy and regional conservation planning efforts underway in the Delta counties.

[10] The Delta counties are: Sacramento, San Joaquin, Yolo, Solano, Contra Costa, and Alameda.

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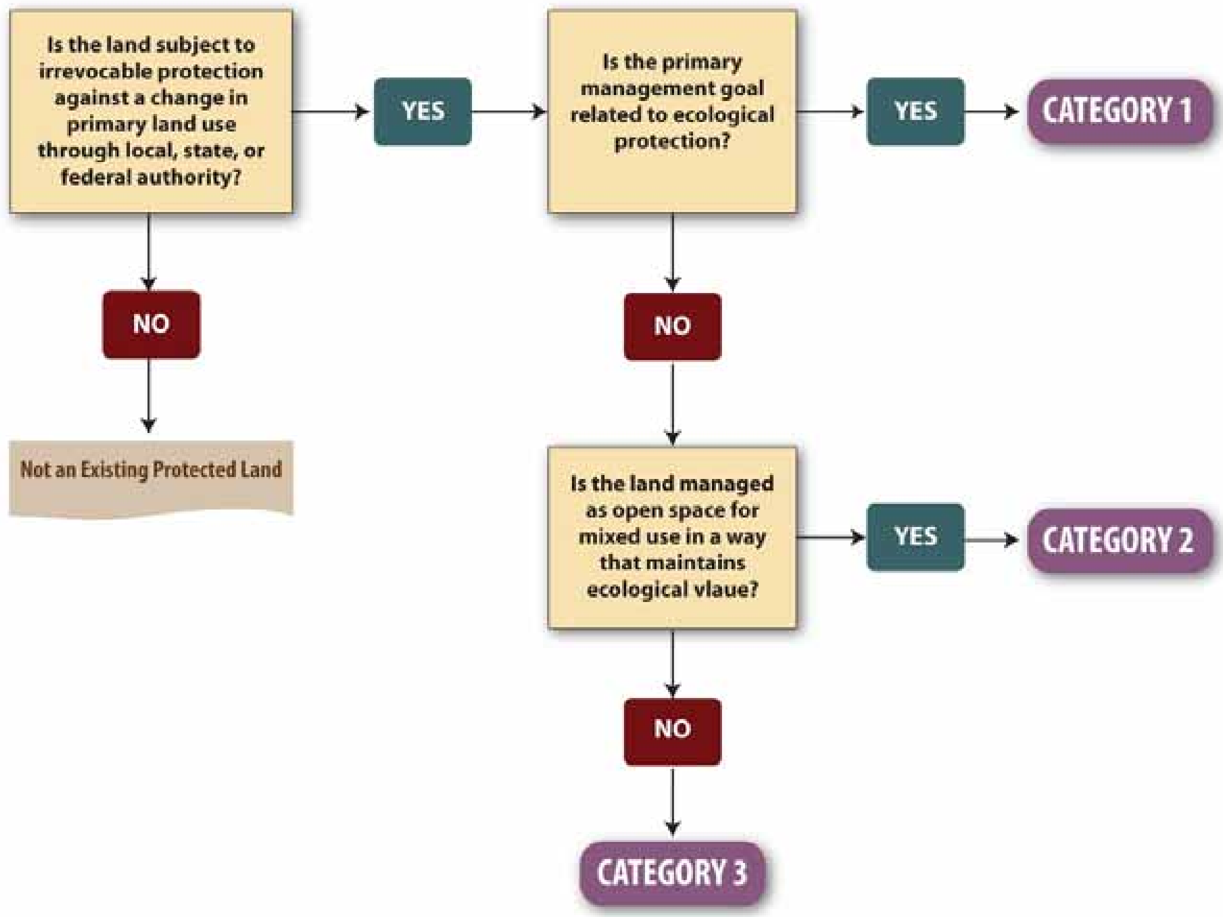

PROTECTED LANDS	
CATEGORY 1	Land use is protected with a primary management goal related to ecological protection.
CATEGORY 2	Land use is protected with a primary management goal related to maintaining open space for mixed use in a manner that maintains ecological value.
CATEGORY 3	Land use is protected, but not managed as open space for mixed use in a way that maintains ecological value.

Figure 3-10. Decision Matrix for Assigning Protection Status Categories for Compiled Protected Lands Database

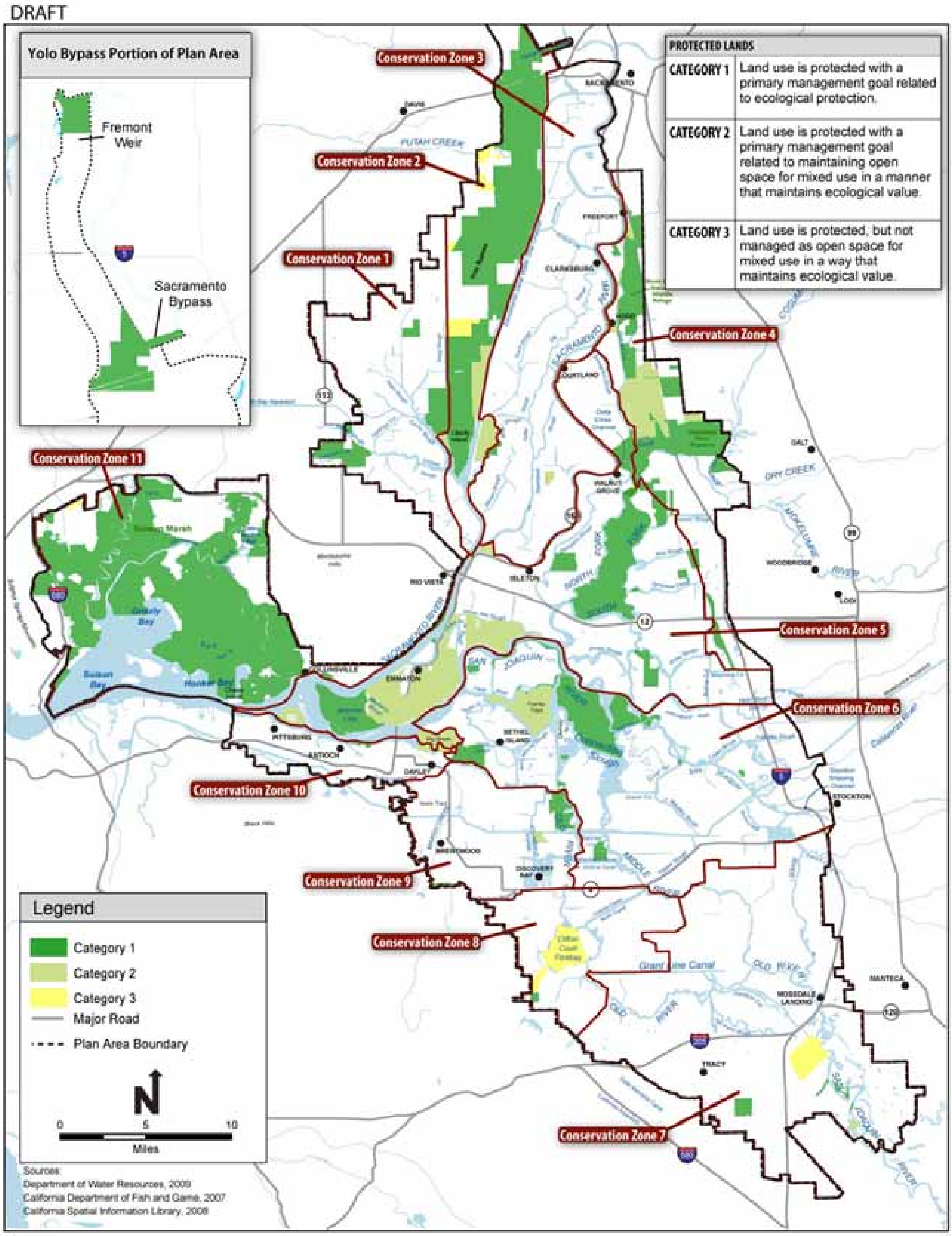

Figure 3-11. Distribution of Protected Lands and Conservation Zones 1-11

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Most of the habitat for covered wildlife and plant species is found at the margins of the Plan Area or in distinct portions of the Plan Area. For some species, the Plan Area includes only low functioning habitat. The approach to conservation for these species varies reflecting the fragmented distribution of their habitats within the Plan Area, the extent and connectivity of those habitats within and adjacent to the Plan Area, and the distribution and abundance of each of the species. Conservation measures to address species such as giant garter snake, San Joaquin kit fox, and vernal pool invertebrates may more effectively be implemented on lands just outside of the Plan Area in the Delta counties.

3.2.4.2.4 Relationship between other Regional Conservation Planning Programs and the BDCP Conservation Strategy

Several regional conservation plans have been approved in the vicinity of the Delta and others are in the process of being developed. These plans are generally sponsored by local governments and special districts to address the mitigation and conservation needs of terrestrial and wetland wildlife and plant species. The regional conservation plans that overlap with BDCP, listed in rank order of amount of physical overlap, are:

- San Joaquin County HCP (approved);
- East Contra Costa County HCP/NCCP (approved);
- Solano County HCP (in development);
- Yolo County HCP/NCCP (in development);
- Suisun Marsh Habitat Restoration and Management Plan (in development);
- South Sacramento County HCP (in development); and
- East Alameda County Conservation Strategy (in development).

The San Joaquin County HCP has the largest amount of overlap with the BDCP Plan Area with more than 300,000 acres of land in common. The East Alameda County Conservation Strategy has the least amount of overlap with the BDCP Plan Area with less than 5,000 acres of land in common. An additional plan, the approved Natomas Basin HCP in Sacramento County, is adjacent to the Upper Yolo Bypass area that is included in the BDCP Conservation Strategy. Most of the BDCP wildlife and plant covered species are also covered or proposed for coverage by at least one of these other plans (Table 3-6). There are BDCP covered species that occur in surrounding plan areas that are not covered by those plans and species covered in these other plans that are not covered under the BDCP. The geographic and species overlap with surrounding plans provides an opportunity for collaboration and partnership in the implementation of conservation actions common to these plans and the BDCP.

Table 3-6. BDCP Covered Species that are Covered or Proposed for Coverage under Overlapping and Adjacent HCPs and NCCPs

BDCP Covered Species	*Species Covered or Currently Proposed for Coverage in Adjacent and Overlapping HCPs and NCCPs*					
	San Joaquin County HCP	**East Contra Costa HCP/NCCP**	**Natomas Basin HCP**	**Solano County HCP[11]**	**South Sacramento HCP[12]**	**Yolo County HCP/NCCP**
Mammals						
San Joaquin kit fox *Vulpes macrotis mutica*	X	X				
Riparian woodrat *Neotoma fuscipes riparia*	X					
Salt marsh harvest mouse *Reithrodontomys ravivenstris*				X		
Riparian brush rabbit *Sylvilagus bachmani riparius*	X					
Townsend's western big-eared bat *Corynorhinus townsendii*		X				X
Suisun shrew *Sorex ornatus sinuosus*				X		
Birds						
Tricolored blackbird *Agelaius tricolor*	X	X	X	X	X	X
Suisun song sparrow *Melospiza melodia maxillaries*				X		
Yellow breasted chat *Icteria viriens*				X	X	X
Least Bell's vireo *Vireo bellii pusillus*						X
Western burrowing owl *Athene cunicularia*	X	X	X	X	X	X
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	X					X

[11] Per version of covered species on website, last updated February 2007.

[12] Per version of covered species on, last updated June 23, 2008.

Table 3-6. BDCP Covered Species that are Covered or Proposed for Coverage under Overlapping and Adjacent HCPs and NCCPs (continued)

BDCP Covered Species	***Species Covered or Currently Proposed for Coverage in Adjacent and Overlapping HCPs and NCCPs***					
	San Joaquin County HCP	**East Contra Costa HCP/NCCP**	**Natomas Basin HCP**	**Solano County HCP[13]**	**South Sacramento HCP[14]**	**Yolo County HCP/NCCP**
Birds						
California least tern *Sternula antillarum browni*						
Greater sandhill crane *Grus canadensis tabida*	X				X	
California black rail *Laterallus jamaicensis coturniculus*				X		
California clapper rail *Rallus longirostris obsoletus*				X		
Swainson's hawk *Buteo swainsoni*	X	X	X	X	X	X
White-tailed kite *Elanus leucurus*					X	X
Reptiles						
Giant garter snake *Thamnophis gigas*	X	X	X	X	X	X
Western pond turtle *Emys marmorata*	X	X	X	X	X	X
Amphibians						
California red-legged frog *Rana aurora draytonii*	X	X		X		X
Western spadefoot toad *Spea hammondii*	X		X		X	X
California tiger salamander *Ambystoma californiense*	X	X	X	X	X	X

[13] Per version of covered species on website, last updated February 2007.

[14] Per version of covered species on, last updated June 23, 2008.

Table 3-6. BDCP Covered Species that are Covered or Proposed for Coverage under Overlapping and Adjacent HCPs and NCCPs (continued)

BDCP Covered Species	*Species Covered or Currently Proposed for Coverage in Adjacent and Overlapping HCPs and NCCPs*					
	San Joaquin County HCP	**East Contra Costa HCP/NCCP**	**Natomas Basin HCP**	**Solano County HCP[13]**	**South Sacramento HCP[14]**	**Yolo County HCP/NCCP**
Fish						
Central Valley steelhead *Oncorhynchus mykiss*				X		
Sacramento River winter-run Chinook salmon *Oncorhynchus tshawytscha*				X		
Central Valley spring-run Chinook salmon *Oncorhynchus tshawytscha*				X		
Central Valley fall- and late fall-run Chinook salmon *Oncorhynchus tshawytscha*				X		
Longfin smelt *Spirinchus thaleichthys*						
Delta smelt *Hypomesus transpacificus*	X			X		
Sacramento splittail *Pogonichthys macrolepidotus*	X			X		
White sturgeon *Acipenser transmontanus*						
North American green sturgeon *Acipenser medirostris*						
Pacific lamprey *Lampetra tridentata*						
River lamprey *Lampetra ayresii*						
Invertebrates						
Lange's metalmark butterfly *Apodemia mormo langei*						
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	X		X	X	X	X

Table 3-6. BDCP Covered Species that are Covered or Proposed for Coverage under Overlapping and Adjacent HCPs and NCCPs (continued)

BDCP Covered Species	*Species Covered or Currently Proposed for Coverage in Adjacent and Overlapping HCPs and NCCPs*					
	San Joaquin County HCP	**East Contra Costa HCP/NCCP**	**Natomas Basin HCP**	**Solano County HCP**[13]	**South Sacramento HCP**[14]	**Yolo County HCP/NCCP**
Invertebrates						
Vernal pool tadpole shrimp *Lepidurus packardi*	X	X	X	X	X	X
Conservancy fairy shrimp *Branchinecta conservation*	X			X		X
Longhorn fairy shrimp *Branchinecta longiantenna*	X	X				
Vernal pool fairy shrimp *Branchinecta lynchi*	X	X	X	X	X	X
Midvalley fairy shrimp *Branchinecta mesovalleyensis*		X	X	X	X	X
California linderiella *Linderiella occidentalis*				X		X
Plants						
Alkali milk-vetch *Astragalus tener* var. *tener*				X		X
Heartscale *Atriplex cordulata*				X		
Brittlescale *Atriplex depressa*		X		X		X
San Joaquin spearscale *Atriplex joaquiniana*		X		X		X
Slough thistle *Cirsium crassicaule*	X					
Suisun thistle *Cirsium hydrophilum* var. *hydrophilum*				X		
Soft bird's-beak *Cordylanthus mollis* ssp. *mollis*				X		

Table 3-6. BDCP Covered Species that are Covered or Proposed for Coverage under Overlapping and Adjacent HCPs and NCCPs (continued)

BDCP Covered Species	***Species Covered or Currently Proposed for Coverage in Adjacent and Overlapping HCPs and NCCPs***					
	San Joaquin County HCP	**East Contra Costa HCP/NCCP**	**Natomas Basin HCP**	**Solano County HCP**[13]	**South Sacramento HCP**[14]	**Yolo County HCP/NCCP**
Plants						
Dwarf downingia *Downingia pusilla*				X	X	
Delta button-celery *Eryngium racemosum*	X					
Contra Costa wallflower *Erysimum capitatum* var. *angustatum*						
Boggs Lake hedge-hyssop *Gratiola heterosepala*	X		X	X	X	
Carquinez goldenbush *Isocoma arguta*				X		
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	X		X	X		X
Legenere *Legenere limosa*	X		X	X	X	
Heckard's peppergrass *Lepidium latipes* var. *heckardii*				X		X
Mason's lilaeopsis *Lilaeopsis masonii*	X			X		X
Delta mudwort *Limosella subulata*	X			X		
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii*						
Side-flowering skullcap *Scutellaria lateriflora*	X					
Suisun Marsh aster *Symphyotrichum lentum* (formerly *Aster lentus*)	X			X		
Caper-fruited tropidocarpum *Tropidocarpum capparideum*						

Opportunities exist for joint implementation of conservation actions for covered species and natural communities both inside and outside of the BDCP Plan Area. The BDCP Implementation Office may partner with willing regional conservation planning sponsors to jointly implement conservation actions that complement each plan and provide economies of scale and efficiencies. These partnerships would be guided by the following criteria.

- BDCP is responsible for the mitigation of its impacts; and the mitigation actions and the mitigation requirements of the BDCP must be additive to the mitigation obligations of other plans (i.e., BDCP mitigation cannot supplant the mitigation obligations of other plans); and

Conservation actions implemented by another conservation program within the BDCP Plan Area on behalf of the BDCP could be funded by the BDCP to cover the costs of initial implementation, long-term management, long-term monitoring, and remedial actions.

3.3 Biological Goals and Objectives

This section describes the biological goals and objectives of the BDCP. Biological goals are defined as broad guiding principles for development of the Conservation Strategy that can be parsed into more manageable subsets of biological objectives. These objectives, in turn, provide measurable metrics by which to measure progress in meeting plan goals and help inform the adaptive management process. The BDCP biological goals and objectives are consistent with the guidance provided in the federal Five-Point Policy for Habitat Conservation Plans[15] and with the BDCP Planning Agreement conservation goals and objectives. BDCP biological goals are intended to be broad principles designed to guide the conservation strategy to meet the statutory criteria of the NCCPA and Sections 7 and 10 of the ESA. BDCP objectives may be either habitat or species based, and they are described as specific, measurable objectives.[16] Specific biological goals and objectives set parameters and benchmarks for the development and implementation of BDCP conservation measures and help frame the monitoring and adaptive management programs.

The biological goals and objectives are purposefully framed to reflect and respond to the significant ecological complexity of the Delta and associated scientific uncertainties. They are designed to serve several important functions in the Conservation Strategy. The first is to describe the desired biological outcomes of the Conservation Strategy, and how those outcomes will contribute to the long-term conservation of covered species and their habitats. The second is to serve as important yardsticks by which to measure progress in achieving those outcomes across multiple temporal and spatial scales. A third, closely related function, is to provide the context and framework for the monitoring program and monitoring metrics by which to evaluate the effectiveness of the conservation measures themselves, and to inform the adaptive

[15] See 65 FR No. 106 at 35242 (June 1, 2000)

[16] According to the federal Five Point HCP Policy, "the Services and the applicants must determine the appropriate unit of measure such as numbers of individuals at a particular life stage, all life stages, or quantity or quality of habitat." 65 Fed. Reg. 35242, 35244 (June 1, 2000).

management program through which adjustments to the Conservation Strategy may occur over the course of its implementation.

As is standard practice in conservation planning, these biological goals and objectives are themselves not intended to constitute permit conditions or otherwise serve as required regulatory targets for the permittees/authorized entities. Rather, the purpose of biological goals and objectives is to guide the development and implementation of the conservation strategy. As long as permittees/authorized entities properly implement the Conservation Strategy elements, they will be fulfilling their plan obligations in compliance with their Section 10 and Section 2835 permits.[17]

The ecological complexity of the Delta and the extent of scientific uncertainty associated with this complexity require a conservation strategy that is flexible, testable, and scientifically grounded. A rationale that identifies the general underlying problems is provided with each of the biological goals and objectives statements. The BDCP Conservation Strategy is built on a set of core hypotheses about how to restore the ecological processes and functions necessary to achieve biological goals and objectives over time. Core hypotheses are articulated as problem statements that are associated with each of the conservation measures and are intended to provide an orderly, scientifically-disciplined approach to managing complexity and uncertainty. These core hypotheses will be tested and evaluated, verified or adjusted during BDCP implementation through an adaptive management process. The biological goals and objectives are part of this overall approach. They are designed in a conceptual hierarchy, the components of which are measurable, transparent and verifiable. They are intended to be consistent with the goals and objectives of existing recovery plans and other regional species plans goals that have been established for the covered species, so that implementation of the BDCP contributes to the long-term conservation of covered species and their habitats.

The biological goals and objectives are organized hierarchically on the basis of the following ecological scale:

- **Ecosystem Goals and Objectives.** Ecosystem goals and objectives are focused on the extent, distribution, and connectivity among habitats and improvements to the overall condition of hydrological, physical, chemical, and biological processes in the Plan Area in support of achieving goals and objectives for natural communities and covered species.
- **Natural Community Goals and Objectives.** Natural community goals and objectives are focused on maintaining or enhancing ecological functions and values of natural communities. Achieving natural community goals and objectives also serve to conserve habitat of associated covered species and other native species.
- **Species-Specific Goals and Objectives.** Species-specific goals and objectives address species-specific stressors and habitat needs that are not addressed under the higher order

[17] As the federal fish and wildlife agencies have stated, "[w]hether the HCP is based on prescriptions, results, or both, the permittee's obligation for meeting the biological goals and objectives is proper implementation of the operating conservation program. In other words, under the No Surprises assurances, a permittee is required only to implement the HCP, IA, if any, and terms and conditions of the permit." 65 Fed. Reg. at 35251.

ecosystem and natural community goals and objectives. For covered fish species, goals and objectives may be life stage specific.

These goals and objectives are intended to encompass the ecological functions within the Plan Area that are important for covered species. They thus relate directly to the functions of habitats within the Plan Area that have been designated as "critical habitats" for covered species by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Table 3-7 correlates these goals and objectives to the elements of critical habitats within the Plan Area deemed important by both agencies for species proposed to be covered by the BDCP.

Table 3-7. Goals and Objectives that Address Primary Constituent Elements of Critical Habitat Designated for Covered Species

Primary Constituent Element of Critical Habitat	*Goals and Objectives that Address Primary Constituent Elements*	
	Goals	**Objectives**
California tiger salamander critical habitat[7]		
Standing bodies of fresh water (including natural and manmade (e.g., stock)) ponds, vernal pools, and other ephemeral or permanent water bodies which typically support inundation during winter rains and hold water for a minimum of 12 weeks in a year of average rainfall.	VPNC1; VPNC2; ONSW1	VPNC1.1; VPNC2.1; ONSW1.1
Upland habitats adjacent and accessible to and from breeding ponds that contain small mammal burrows or other underground habitat that California tiger salamander depend upon for food, shelter, and protection from the elements and predation.	GRNC1; GRNC2; ONSW1	GRNC1.1; GRNC1.2; GRNC2.2; GRNC2.3; GRNC2.4; ONSW1.1
Accessible upland dispersal habitat between occupied locations that allow for movement between such sites.	GRNC1; GRNC2	GRNC1.1; GRNC1.2; GRNC2.1; GRNC2.2; GRNC2.3; GRNC2.4
Vernal pool tadpole shrimp, Conservancy fairy shrimp, and vernal pool fairy shrimp critical habitat[8]		
Topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools described in PCE (ii), providing for dispersal and promoting hydroperiods of adequate length in the pools.	VPNC1; VPNC2; GRNC1	VPNC1.1; VPNC2.1; GRNC1.1; GRNC1.2
Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum of 41 days (vernal pool tadpole shrimp), 19 days (Conservancy fairy shrimp, and 18 days for vernal pool fairy shrimp (Helm 1998), in all but the driest years; thereby providing adequate water for incubation, maturation, and reproduction. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.	VPNC1; VPNC2; GRNC1	VPNC1.1; VPNC2.1; GRNC1.1; GRNC1.2
Sources of food, expected to be detritus occurring in the pools, contributed by overland flow from the pools' watershed, or the results of biological processes within the pools themselves, such as single-celled bacteria, algae, and dead organic matter, to provide for feeding.	VPNC1; VPNC2; GRNC1	VPNC1.1; VPNC2.1; VPNC2.2; GRNC1.1; GRNC1.2

Table 3-7. Goals and Objectives that Address Primary Constituent Elements of Critical Habitat Designated for Covered Species (continued)

Primary Constituent Element of Critical Habitat	*Goals and Objectives that Address Primary Constituent Elements*	
	Goals	**Objectives**
Structure within the pools described in PCE (ii), consisting of organic and inorganic materials, such as living and dead plants from plant species adapted to seasonally inundated environments, rocks, and other inorganic debris that may be washed, blown, or otherwise transported into the pools, that provide shelter.	VPNC1; VPNC2; GRNC1	VPNC1.1; VPNC2.1; VPNC2.2; GRNC1.1; GRNC1.2
Suisun thistle[9]		
Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels).	BMNC1	BMNC1.1
Open channels that periodically contain moving water with ocean-derived salts in excess of 0.5 percent.	BMNC1	BMNC1.1
Gaps in surrounding vegetation to allow for seed germination and growth.	BMNC1; BMNC2; SUTH1	BMNC1.1; BMNC2.1; SUTH1.2
Soft bird's-beak[9]		
Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels).	BMNC1	BMNC1.1
Rarity or absence of plants that naturally die in late spring (winter annuals)	BMNC1; BMNC2	BMNC1.1; BMNC2.1
Partially open spring canopy cover (approximately 790 nMol/m2/s) at ground level, with many small openings to facilitate seedling germination.	BMNC1; BMNC2; SOBB1	BMNC1.1; BMNC2.1; SOBB1.2

[7]From Final Rule, Federal Register, Vol. 70, No. 154, August 11, 2005. pp. 46923-46999.
[8]From Final Rule, Federal Register, Vol. 72, No. 70, April 12, 2007. pp. 18517-18553.
[9]From Final Rule, Federal Register, Vol. 72, No. 70, April 12, 2007. pp. 18518-18553.

Monitoring metrics and metric values or targets that may be associated with these monitoring metrics accompany objectives and are described in Section 3.6, *Monitoring and Research Program*. The purpose of the metrics and targets is to describe how progress will be measured towards or away from these goals and objectives over the course of BDCP implementation. They are intended to enable the BDCP Implementation Office and other interested parties to track how the implementation of the conservation measures may be effectuating improvements in the system as a whole at the larger scale of these objectives. In some cases, these metrics may be identical to those used to track the effectiveness of individual conservation measures; in other cases, the metrics may be broader than those established for conservation measures.

The metrics for these biological objectives are described in Section 3.6, *Monitoring and Research Program*. These metrics will likely change over the term of the BDCP as new capabilities emerge to track performance in achieving the objectives and as the scientific understanding of the ecological and biological functions of the Bay Delta evolve. They are intended to serve as an essential component of the monitoring and adaptive management program for the Plan, and may be changed through the BDCP adaptive management decision making process (Section 3.7, *Adaptive Management Program*).

3.3.1 Framework for the Goals and Objectives

To address the many uncertainties associated with conserving covered fish species, the aquatic biological goals and objectives were shaped within the framework of the "logic chain" architecture as described in Section 3.2.3.1, *Aquatic Resources Conservation Strategy Development Process*. The logic chain captures the underlying rationale and assumptions for the conservation measures and establishes benchmarks against which progress can be measured. This clear articulation of hypotheses and expected outcomes of implementing the conservation measures facilitates the effective assessment of progress towards achieving the goals and objectives and the effectiveness of the conservation measures during Plan implementation.

Figure 3-12 and Figure 3-13 illustrate these hierarchical relationships between broad, general goals at the species and ecosystem levels, BDCP biological goals and objectives, conservation measures that are designed to achieve the biological goals and objectives (see Section 3.4, *Conservation Measures*), and the monitoring and adaptive management components of the Conservation Strategy (Section 3.6, *Monitoring and Research Program*, and Section 3.7, *Adaptive Management Program*). Figure 3-12 depicts the relationship among the different tiers of the BDCP goals and objectives themselves, and how these tiers tie back into the viability attributes. Figure 3-13 depicts the relationship between overall general species conservation and recovery goals – at the top of the pyramid – and the key substantive components of the BDCP plan itself: the biological goals and objectives for the BDCP, the conservation measures of the BDCP, and the monitoring and adaptive management actions for the BDCP. It also describes the key attributes of long-term species viability in terms of abundance, diversity, spatial distribution and growth rates so as to demonstrate graphically how the BDCP goals and objectives and its conservation measures are intended to contribute to the achieving of these attributes. Together, these two figures are intended to illustrate the tiered conceptual hierarchy both within the BDCP itself and how it will contribute to the larger conservation goals for those species covered by the plan.

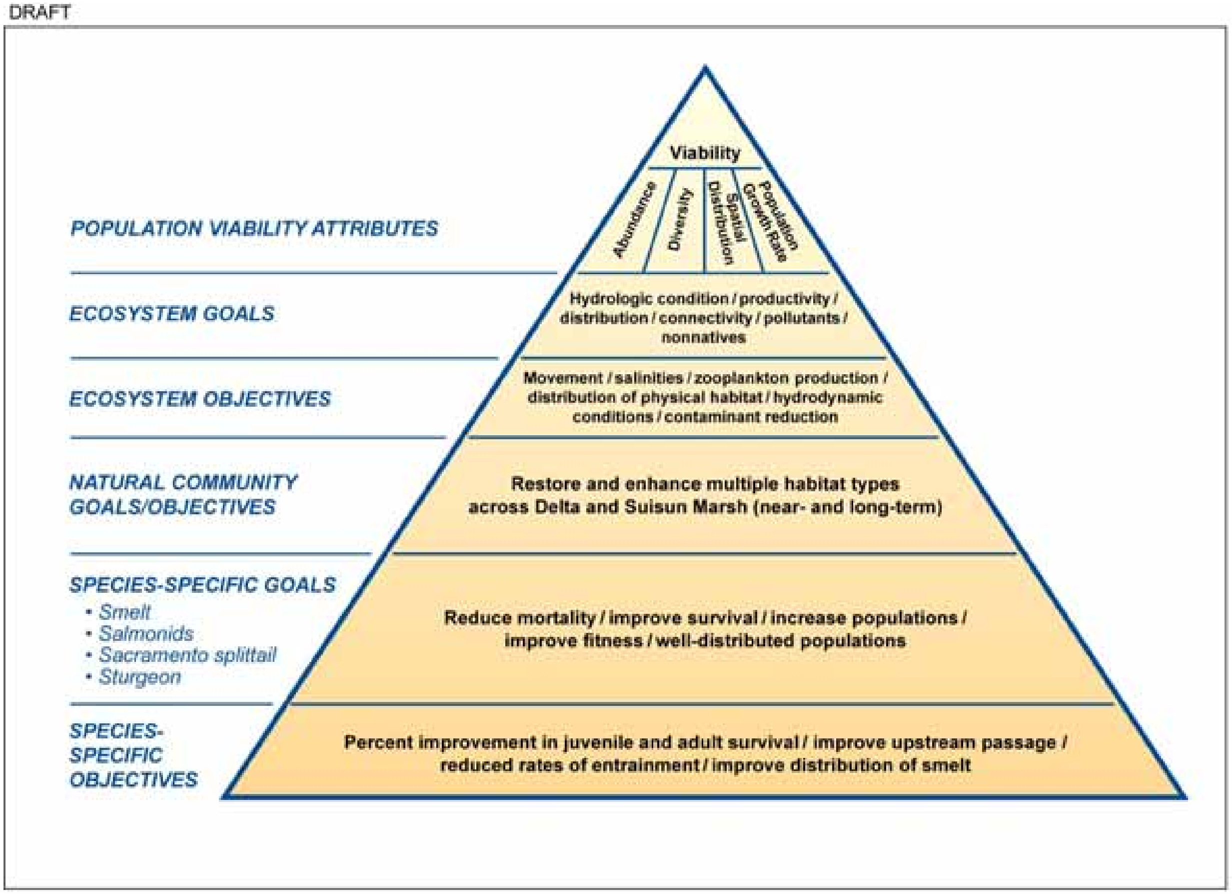

Figure 3-12. Relationships Among Goals and Objectives Tiers

DRAFT

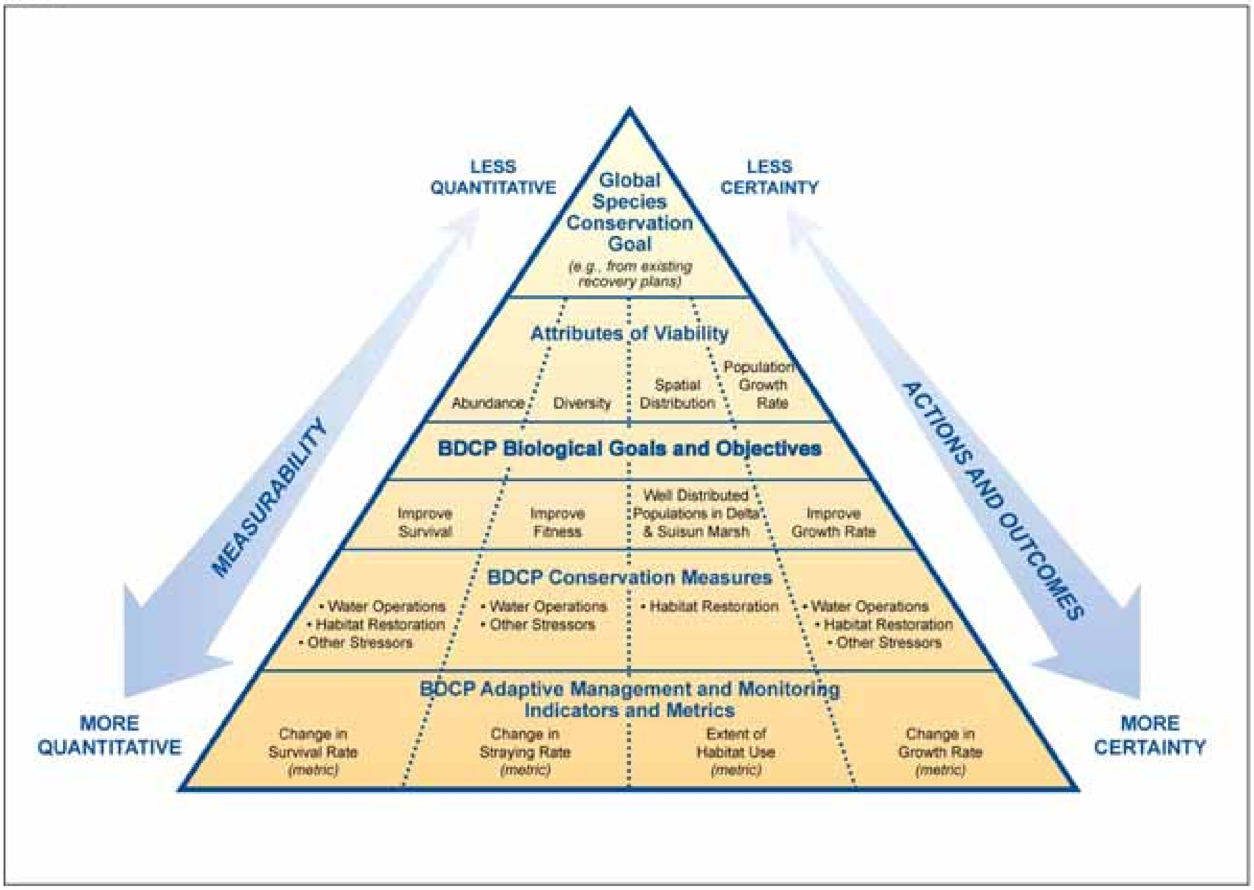

Figure 3-13. Biological Goals and Objectives: Relationships with Broader Goals, Conservation Measures, Adaptive Management, and Monitoring

There is generally greater certainty associated with conservation approaches to covered wildlife and plant species than for covered fish species. The development of goals and objectives for natural communities and covered wildlife and plant species followed a well established approach based on the frameworks used in other HCP/NCCPs and USFWS recovery plans that address the same species and communities. HCP and NCCP programs with plan areas that overlap with the BDCP Plan Area were used as sources of information in developing goals and objectives for the BDCP natural communities and covered wildlife and plants. Based on guidance from and in collaboration with the USFWS and DFG, the biological goals and objectives were developed. The goals and objectives are intended to guide the conservation strategy and meet the statutory criteria for the NCCPA and Sections 7 and 10 of the ESA. Through a collaborative and iterative process, goals and objectives for each covered natural community and covered species were formulated on the basis of specific biological rationale based on the ecological setting, species biology, threats to communities and species, and the potential effects of covered activities. Conservation measures and avoidance and minimization measures were designed to achieve the broad-based goals and the more specific or measureable objectives. The monitoring, research, and adaptive management programs will provide new information and program flexibility to improve the conservation actions to meet goals and objectives during Plan implementation.

3.3.2 Goal and Objective Statements

This section presents the ecosystem, natural community, and species-specific biological goals and objectives. Each goal and objective is assigned a unique alpha-numeric code that is used throughout the BDCP document and that will assist with monitoring of implementation of the BDCP Conservation Strategy. A rationale is associated with each of the biological goals and objectives statements. These rationales identify the general underlying problems that the conservation measures (that are designed to achieve each of the biological objectives) are intended to address.

3.3.2.1 Ecosystem Goals and Objectives

Ecosystem goals and objectives were developed to follow the principles of conservation biology and the requirements of NCCPA. For the covered fish species, the ecosystem goals and objectives are designed to address major stressors of ecosystem processes and functions that support the covered species. These goals and objectives address the hydrodynamic and water quality functions of habitat, movement, and food production for each of the life stages of the covered fish species using the Plan Area, as well as the effects of nonnative predator and competitor species. For the covered wildlife and plant species, these goals and objectives address the desired extent, distribution, connectivity, and ecological function of ecosystems supporting their habitats and life requirements within the BDCP landscape.

3.3.2.1.1 Landscapes and Ecological Gradients

Goal ECSY1: Protect and restore large landscapes representing a range of physical and biological attributes (e.g., hydrology, soil, and plant associations) necessary to sustain viable populations of covered species and to preserve native species biodiversity.

> **Objective ECSY1.1:** Protect 25,000-41,000 acres of existing natural communities that support covered species.

> **Objective ECSY1.2:** Protect a range of environmental gradients (e.g., hydrology, elevation, and soils) across a diversity of natural communities.

> **Objective ECSY1.3:** Restore or create up to 65,000 acres of tidally influenced habitat consisting of subtidal, mudflat, tidal marsh, and transitional upland habitat for sea level rise accommodation that supports a gradient of natural communities and habitat for covered species.

> **Objective ECSY1.4:** Restore or create up to 10,000 acres of seasonally inundated floodplain and 20 miles of channel margin habitat.

> **Objective ECSY1.5:** Manage protected and restored or created habitats to enhance habitat functions for associated covered and other native species over the term of the BDCP.

Goal ECSY2: Provide hydrodynamic conditions within Delta waterways that are more reflective of natural patterns of flow within the BDCP Plan Area and Suisun Marsh.

> **Objective ECSY2.1:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.

> **Objective ECSY2.2:** Support the movement of adult life stages of native fish species to natal spawning habitats.

> **Objective ECSY 2.3:** Promote water quality conditions within the Delta that help restore native fish habitat.

> **Objective ECSY2.4:** Maintain or increase life history diversity of native fishes and a diversity of rearing conditions for native fishes over time.

> **Objective ECSY 2.5:** Promote greater connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic species.

<u>*Rationale*</u>

Habitat loss, fragmentation, and degradation within and outside of the Plan Area have disrupted the ecosystem function and large-scale habitat connectivity that are necessary for sustaining covered and other native species and maintaining biodiversity. Protecting and restoring large swaths of connected habitat will enhance ecosystem processes and connectivity and help increase the abundance, distribution, and diversity of covered and other native species.

3.3.2.1.2 Connectivity

Goal ECSY3: Provide for connectivity among protected lands to provide for the movement of native organisms among habitat areas and to facilitate genetic exchange among populations.

> **Objective ECSY3.1:** Protect corridors of habitat that provide linkages among protected habitat areas within and adjacent to the Plan Area.

> **Objective ECSY3.2:** Improve habitat corridors that allow covered and other native species to move into protected habitats from adjacent areas and to move among habitat areas within protected lands.

<u>*Rationale*</u>

The destruction of habitat for native species has both reduced the extent of habitat and fragmented more extensive areas of habitat into isolated patches of habitat. These impacts to habitat have disrupted the historical movement and dispersal patterns of individuals and their genetics and threaten the health and existence of the species. Maintaining habitat connectivity also makes it more likely that individuals can disperse into and colonize new habitat or territories as those areas become available. Achievement of this goal will benefit all covered and other native species within the Plan Area.

3.3.2.1.3 Ecosystem Processes

Goal ECSY4: Promote ecosystem processes that support natural communities, covered species, other native species, and the habitats of those species.

> **Objective ECSY4.1**: Maintain and improve disturbance regimes and other processes that support functioning natural communities.

Goal ECSY5: Increase aquatic primary and secondary production in the Delta, Yolo Bypass and Suisun Marsh to increase the abundance and availability of food for native aquatic organisms.

> **Objective ECSY5.1:** Over the term of the BDCP, increase the abundance and productivity of zooplankton that provide food and support food production for covered fish species in Delta waterways.

Objective ECSY5.2: Over the term of the BDCP, increase the abundance and productivity of aquatic invertebrate species that provide food and support food production for covered fish species in Delta waterways.

Goal ECSY6: Reduce the adverse predation effects of nonnative species on covered fish species.

Objective ECSY6.1: Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fishes.

Objective ECSY6.2: Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta.

Rationale

The variability and range of ecosystem characteristics such as disturbance regimes and dynamic ecosystem physical and chemical processes such as tidal and nontidal inundation dynamics, seasonal fluvial flooding and low flow dynamics, and nutrient flows have been drastically altered or eliminated in the Plan Area due to the modification of ecosystem hydrology, the conversion of natural habitat to agricultural systems, residential and commercial development, and other anthropogenic effects. These ecosystem physical and chemical processes drive many biological processes and contribute towards sustaining viable populations of covered and other native species. Maintaining and restoring these ecosystem processes will sustain and increase the extent of natural communities which support the abundance, distribution, and diversity of covered and other native species, which are expected to increase or maintain as described in this Plan. .

3.3.2.1.4 Climate Change

Goal ECSY7: Protect lands with a sufficient range of habitat conditions to accommodate anticipated shifts in the distributions of covered species and natural communities in response to climate change.

Objective ECSY7.1: Protect sufficient upland transitional habitat area adjacent to restored brackish and freshwater tidal emergent wetland to permit the future upslope natural establishment of tidal emergent wetland communities with sea level rise.

Rationale

The effects of climate change on the Plan Area are expected to have far-reaching and potentially dramatic impacts on native species and natural communities. Sea level rise will inundate some subsided and low-lying terrestrial areas, while other effects of climate change are expected to be more complex. For example, changes in temperature range and precipitation patterns may cause some areas of suitable habitat to become unsuitable for some species; while other areas of currently unsuitable habitats may become suitable for other species. Many habitats and species are expected to be affected and their temporal dynamics and spatial distributions will change in unpredictable ways. Faced with such large, uncertain, and dynamic responses, it is important that a broad range of elevation, connectivity, and other habitat characteristics be protected to ensure that while some current habitat may be lost to species due to global climate change, sufficient suitable habitat will remain available to sustain both covered and non-covered species. Achievement of this goal will benefit all covered and other native species within the Plan Area.

3.3.2.2 Natural Community Goals and Objectives

Natural community goals and objectives were developed following the principles of conservation biology and the requirements of the NCCPA. Natural community goals and objectives were developed to address:

- Protecting each natural community in quantities and locations that contribute to the conservation of associated covered and other native species;
- Maintaining and enhancing the habitat functions supported by preserved habitats to provide for sustaining and increasing the abundance and distribution of associated covered and other native species; and
- Restoring or creating natural communities to increase the extent and availability of covered and other native species habitats to accommodate increases in abundance and distribution.

Information used to develop the natural community goals and objectives included:

- Current spatial distribution and extent of each natural community within the Conservation Zones (Figure 3-3 through Figure 3-8);
- Preliminary estimates of the extent of each natural community that could be affected by the implementation of BDCP covered activities and conservation measures;
- Condition of habitat functions supported by existing patches of natural communities;
- Function of existing patches of natural communities as habitat corridors supporting the movement of covered and other native species among habitat areas inside and outside of the Conservation Zones;
- Spatial distribution of patches of natural communities relative to existing preserved areas;
- The spatial distribution of covered species habitats within Conservation Zones and the distribution of known occurrences of covered species; and
- The habitat-related conservation needs of covered and other native species within and adjacent to the Conservation Zones.

Each natural community supports habitat for multiple covered species and multiple natural communities may provide habitat functions for a particular covered species. Table 3-8 describes the habitat functions that are provided by each of the natural communities that primarily support each species in the Plan Area. Table 3-9 identifies all of the natural communities that support habitat for each of the covered species as described in each species' habitat model (see Appendix A, *Covered Species Accounts*). For example, grassland supports foraging habitat for the Swainson's hawk and breeding and foraging habitat for the western burrowing owl. Agricultural lands also support foraging habitat for both of these species. Consequently, conservation of foraging habitat for these species can be accomplished by preserving, enhancing, and/or restoring a specified quantity of either grassland or agricultural land or a combination of both. The strategy for the conservation of natural communities is based on the need to provide a distributed and heterogeneous spatial arrangement of habitat for each covered species.

Natural community goals and objectives are outlined below. The approach and rationale used to establish each objective follows for each natural community. Conservation measures designed to meet all objectives are found in Section 3.4. Table 3-10 presents the expected extent of each natural community that will be protected and restored in the Plan Area with full BDCP implementation.

3.3.2.2.1 Tidal Perennial Aquatic

Tidal perennial aquatic natural community includes both deep and shallow aquatic environments (deep is greater than 10 ft [approximately 3 m] depth from mean lower low tide [lowest of the low tide in a day]; shallow is from mean lower low tide to 10 ft [3 m] depth) (CALFED 2000). Under current water operation conditions in the Plan Area, the tidal perennial aquatic natural community is predominantly fresh water with brackish conditions occurring in Suisun Bay at times of high tides and low river flows.

The tidal perennial aquatic natural community is an important link between upstream and downstream ecosystems. Much of the productivity, organic matter, and inorganic sediment from upstream waterways and marshes eventually moves into the tidal perennial aquatic community and subsequently moves downstream to the Pacific Ocean. In the Plan Area, saline oceanic water mixes with freshwater from rivers in the western region of the tidal perennial aquatic natural community. This mixing establishes a salinity gradient, which varies by area and location with seasonal variations in freshwater outflow and tidal action and which drives the location of species that require specific salinity ranges. Historically, in most seasons, the salinity gradient was generally farther downstream than it now occurs under similar precipitation and unimpaired flow conditions (Contra Costa Water District 2010). See Section 2.3.4.1, *Tidal Perennial Aquatic* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of the tidal perennial aquatic natural community.

The historical functions of the tidal perennial aquatic natural community in the Delta have been substantially reduced through the destruction of tidal communities and the loss and fragmentation of aquatic habitats, and the alteration of natural tidal regimes.

Table 3-8. Habitat Function of BDCP Natural Communities that Support Primary Habitats for Covered Wildlife and Plant Species[18]

Covered Species	***Natural Community***													
	Tidal perennial aquatic	**Tidal mudflat**	**Tidal brackish emergent wetland**	**Tidal freshwater emergent wetland**	**Valley/ foothill riparian**	**Grassland**	**Inland dune scrub**	**Alkali seasonal wetland complex**	**Vernal pool complex**	**Other natural seasonal wetland**	**Nontidal freshwater perennial emergent wetland**	**Nontidal perennial aquatic**	**Managed wetland**	**Agricultural habitats**
Mammals														
San Joaquin kit fox						All life history require-ments								Foraging and movement
Riparian woodrat					All life history require-ments									
Salt marsh harvest mouse			All life history require-ments			Upland refugia during high tides								
Riparian brush rabbit					All life history require-ments									
Townsend's big-eared bat	Foraging	Foraging	Foraging	Foraging	Roosting and Foraging	Foraging		Foraging	Foraging	Foraging	Foraging	Foraging	Foraging	Foraging
Suisun shrew			All life history require-ments			Upland refugia during high tides							All life history require-ments	
Birds														
Tricolored blackbird				Breeding	Breeding	Foraging		Foraging	Foraging	Foraging	Breeding		Breeding and Foraging	Foraging
Suisun song sparrow			All life history require-ments	All life history require-ments									All life history require-ments	
Yellow-breasted chat					All life history require-ments									
Least Bell's vireo					All life history require-ments.									
Western burrowing owl						Breeding and foraging		Foraging	Foraging	Foraging			Foraging	Breeding and foraging
Western yellow-billed cuckoo					All life history require-ements									
California least tern	Foraging													

[18] This table represents primary habitats for covered species and species groups, not all the natural communities that may support some habitat functions included in each species' habitat models presented in Appendix A, Covered Species Accounts.

Table 3-8. Habitat Function of BDCP Natural Communities that Support Primary Habitats for Covered Wildlife and Plant Species[19] (continued)

Covered Species	*Natural Community*													
	Tidal perennial aquatic	**Tidal mudflat**	**Tidal brackish emergent wetland**	**Tidal freshwater emergent wetland**	**Valley/ foothill riparian**	**Grassland**	**Inland dune scrub**	**Alkali seasonal wetland complex**	**Vernal pool complex**	**Other natural seasonal wetland**	**Nontidal freshwater perennial emergent wetland**	**Nontidal perennial aquatic**	**Managed wetland**	**Agricultural habitats**
Birds														
Greater sandhill crane						Foraging		Foraging	Foraging	Foraging			Foraging and roosting	Roosting and foraging
California black rail			All life history requirements	All life history require-ments							All life history requirements			
California clapper rail			All life history requirements											
Swainson's hawk					Breeding	Foraging		Foraging	Foraging	Foraging			Foraging	Foraging
White-tailed kite					Breeding	Foraging		Foraging	Foraging	Foraging			Foraging	Foraging
Reptiles														
Giant Garter Snake	Breeding, foraging, and movement			Breeding, foraging, and movement		Aestiva-tion and movement		Aestiva-tion and movement	Aestiva-tion and movement	Breeding, foraging, and move-ment	Breeding, foraging, and movement	Breeding, foraging, and movement	Aestivation and movement	Breeding (rice), foraging, aestivation, and movement
Western pond turtle	Foraging and movement		Foraging and movement	Foraging and movement	Breeding, foraging, aestivation, and movement	Breeding, foraging, aestivation, and movement		Foraging and movement	Foraging and movement	Foraging and move-ment	Foraging and movement	Foraging and movement	Foraging and movement	Foraging, and movement
Amphibians														
California red-legged frog				Breeding, foraging and movement	Foraging, aestivation, and movement	Foraging, aestivation, and movement			Foraging, aestivation, and movement		Breeding, foraging and movement	Breeding, foraging	Foraging and movement	Foraging and movement
Western spadefoot toad						Foraging, aestivation, and movement		Foraging, aestivation, and movement	Breeding and foraging	Foraging, and breeding		Breeding		
California tiger salamander						Foraging, cover, and movement		Foraging and movement	Breeding and foraging					

[19] This table represents primary habitats for covered species and species groups, not all the natural communities that may support some habitat functions included in each species' habitat models presented in Appendix A, Covered Species Accounts.

Table 3-8. Habitat Function of BDCP Natural Communities that Support Primary Habitats for Covered Wildlife and Plant Species[19] (continued)

Covered Species	*Natural Community*														
	Tidal perennial aquatic	**Tidal mudflat**	**Tidal brackish emergent wetland**	**Tidal freshwater emergent wetland**	**Valley/ foothill riparian**	**Grassland**	**Inland dune scrub**	**Alkali seasonal wetland complex**	**Vernal pool complex**	**Other natural seasonal wetland**	**Nontidal freshwater perennial emergent wetland**	**Nontidal perennial aquatic**	**Managed wetland**	**Agricultural habitats**
Invertebrates															
Lange's metalmark butterfly							All life history require-ments								
Valley elderberry longhorn beetle					All life history require-ments										
Vernal pool tadpole shrimp									All life history require-ments						
Conservancy fairy shrimp									All life history require-ments						
Longhorn fairy shrimp									All life history require-ments						
Vernal pool fairy shrimp									All life history require-ments						
Mid Valley fairy shrimp									All life history require-ments						
California linderiella									All life history require-ments						

Table 3-8. Habitat Function of BDCP Natural Communities that Support Primary Habitats for Covered Wildlife and Plant Species[19] (continued)

Covered Species	*Natural Community*													
	Tidal perennial aquatic	**Tidal mudflat**	**Tidal brackish emergent wetland**	**Tidal freshwater emergent wetland**	**Valley/ foothill riparian**	**Grassland**	**Inland dune scrub**	**Alkali seasonal wetland complex**	**Vernal pool complex**	**Other natural seasonal wetland**	**Nontidal freshwater perennial emergent wetland**	**Nontidal perennial aquatic**	**Managed wetland**	**Agricultural habitats**
Plants														
Alkali milk-vetch[2]									All life history require-ments					
Heartscale[3]						All life history require-ments		All life history require-ments	All life history require-ments					
Brittlescale[3]						All life history require-ments		All life history require-ments	All life history require-ments					
San Joaquin spearscale[4]						All life history require-ments		All life history require-ments	All life history require-ments					
Slough thistle[6]					All life history require-ments									
Suisun thistle[7]			All life history require-ments											
Soft bird's-beak[8]			All life history require-ments											
Dwarf downingia									All life history require-ments					
Delta button celery[9]					All life history require-ments	All life history require-ments		All life history require-ments	All life history require-ments					
Contra Costa wallflower							All life history require-ments							

Table 3-8. Habitat Function of BDCP Natural Communities that Support Primary Habitats for Covered Wildlife and Plant Species[19] (continued)

Covered Species	*Natural Community*														
	Tidal perennial aquatic	**Tidal mudflat**	**Tidal brackish emergent wetland**	**Tidal freshwater emergent wetland**	**Valley/ foothill riparian**	**Grassland**	**Inland dune scrub**	**Alkali seasonal wetland complex**	**Vernal pool complex**	**Other natural seasonal wetland**	**Nontidal freshwater perennial emergent wetland**	**Nontidal perennial aquatic**	**Managed wetland**	**Agricultural habitats**
Plants															
Boggs Lake hedge-hyssop									All life history require-ments					
Carquinez goldenbush[10]						All life history require-ments		All life history require-ments						
Delta tule pea[11]			All life history require-ments	All life history require-ments	All life history require-ments									
Legenere									All life history require-ments					
Heckard's peppergrass[12]									All life history require-ments					
Mason's lilaeopsis[13]		All life history require-ments	All life history require-ments	All life history require-ments	All life history require-ments									
Delta mudwort[13]		All life history require-ments	All life history require-ments	All life history require-ments	All life history require-ments									
Antioch Dunes evening-primrose							All life history require-ments							
Side-flowering skullcap					All life history require-ments									
Suisun Marsh aster[14]			All life history require-ments	All life history require-ments	All life history require-ments									

Table 3-8. Habitat Function of BDCP Natural Communities that Support Primary Habitats for Covered Wildlife and Plant Species[19] (continued)

Covered Species	*Natural Community*													
	Tidal perennial aquatic	**Tidal mudflat**	**Tidal brackish emergent wetland**	**Tidal freshwater emergent wetland**	**Valley/ foothill riparian**	**Grassland**	**Inland dune scrub**	**Alkali seasonal wetland complex**	**Vernal pool complex**	**Other natural seasonal wetland**	**Nontidal freshwater perennial emergent wetland**	**Nontidal perennial aquatic**	**Managed wetland**	**Agricultural habitats**
Plants														
Caper-fruited tropidocarpum						All life history require-ments								
Other Species Groups														
Wintering Waterfowl	Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting		Foraging and resting		Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting
Resident Waterfowl	Foraging, resting, and brooding	Foraging and resting	Foraging and resting	Foraging and resting		Foraging, nesting, and resting		Foraging, nesting, and resting	Foraging, nesting, and resting	Foraging and resting	Foraging and resting	Foraging, resting, and brooding	Foraging and resting	Foraging, nesting, brooding, and resting
Migrant Shorebirds	Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting		Foraging and resting		Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting	Foraging and resting		Foraging and resting
Wading birds	Foraging	Foraging	Foraging and roosting	Foraging, breeding, and roosting	Roosting	Foraging		Foraging	Foraging	Foraging	Foraging and breeding	Foraging	Foraging	Foraging

[1] Riparian brush rabbits will also use small grassland and seasonal wetlands that occur immediately adjacent to or as openings within riparian communities.

[2] Occurs along the upper margins of vernal pools, playa pools, and in swales in the clay alluvium vernal pools and playas, Montezuma Block vernal pools and playas, and alkaline sink/meadow vernal pools in the BDCP vernal pool complex regions.

[3] Occurs along intermittent and perennial drainages and along the borders of playa pools in the clay alluvium vernal pools and playas, Montezuma Block vernal pools and playas, and alkaline sink/meadow vernal pools in the BDCP vernal pool complex regions. Also occurs in alkali seasonal wetland complex in the same areas.

[4] Occurs in more saline or disturbed areas in the clay alluvium vernal pools and playas, Montezuma Block vernal pools and playas, and alkaline sink/meadow vernal pools in the BDCP vernal pool complex regions. Also occurs in grassland and alkali seasonal wetland complex in the same areas.

[5] Not known to occur in the Plan Area or ROAs.

[6] In the southern San Joaquin Valley it occurs in the scoured and overflow areas of stream channels on alkaline soils. In the northern San Joaquin Valley the historical occurrences have been along tidal river channels or in wetland inclusions in agricultural fields.

[7] Endemic to the Suisun Marsh where it occurs adjacent to first-order channels or mosquito control ditches that link to first-order channels.

[8] In Suisun Marsh soft bird's-beak is distributed in bands at the lower margin of the brackish high marsh that are not correlated with elevation, but with soil pore water salinity during the dry season which is determined by distance to channel and varies from season to season depending on freshwater flows from creeks draining into the marsh. Where the topography is more complex, such as areas with ridges or mounds and on levee banks, soft bird's-beak can be found in a variety of patch shapes.

[9] Delta button celery occurs in two habitat types. One habitat type is seasonally scoured and inundated swales, depressions, and clay flats in the floodplain of the San Joaquin River and the other alkaline clay deltas of Coast Range tributaries that are deposited immediately above the flood basin of the San Joaquin River where plant cover is typical alkaline sink vegetation.

[10] Carquinez goldenbush occurs along seasonal drainages, adjacent to the margins of alkaline playa pools, and in association with vegetation that is transitional between the brackish marsh and the grasslands within the 3.4-4.3 meter NAVD88 elevation band along the eastern border of Suisun Marsh.

[11] Occurrences in open vegetation in freshwater areas are on the landward side of the landward boundary of Tidal Freshwater Emergent Wetland and in brackish water areas in and near Suisun Marsh, within a range of tidal elevations that are generally near drainages.

[12] Occurs in all BDCP vernal pool complex regions on alkaline clays soils in areas that are not deeply inundated.

[13] Occurs on open areas of tidal mudflats that are susceptible to scour and deposition and it colonizes new areas through water transported seed and vegetative parts.

[14] Occurrences in open vegetation in freshwater areas are on the landward side of the landward boundary of Tidal Freshwater Emergent Wetland and in brackish water areas in and near Suisun Marsh, within a range of tidal elevations that are generally near drainages. It is also found in less densely vegetated areas of valley/foothill riparian vegetation.

Table 3-9. Natural Communities Supporting Modeled Covered Species' Habitats

Covered Species	*Natural Communities Supporting Species Habitat*
San Joaquin kit fox	
Breeding, foraging, and dispersal habitat	Grassland, Vernal Pool Complex
Foraging and dispersal habitat	Agricultural Habitats
Riparian woodrat	Valley/Foothill Riparian
Salt marsh harvest mouse	
Wetland habitat	Tidal Brackish Emergent Wetland, Managed Wetland
Upland habitat	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex
Riparian brush rabbit	Valley/Foothill Riparian
Townsend's big-eared bat	
Roosting and primary foraging habitat	Valley/Foothill Riparian
Primary foraging habitat	Valley/Foothill Riparian
Secondary foraging habitat	Tidal Perennial Aquatic, Tidal Mudflat, Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex, Other Natural Seasonal Wetland, Nontidal Freshwater Perennial Emergent Wetland, Nontidal Perennial Aquatic, Managed Wetland, Agricultural Habitats
Suisun shrew	Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Alkali Seasonal Wetland Complex, Nontidal Freshwater Perennial Emergent Wetland, Managed Wetland
Tricolored blackbird	
Nesting habitat	Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Valley/Foothill Riparian, Nontidal Freshwater Perennial Emergent Wetland, Managed Wetland
Foraging habitat: non-agriculture	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex, Other Natural Seasonal Wetland, Managed Wetland
Foraging habitat: agriculture	Agricultural Habitats
Suisun song sparrow	Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Alkali Seasonal Wetland Complex, Nontidal Freshwater Perennial Emergent Wetland, Managed Wetland
Yellow-breasted Chat	
Primary nesting and migratory habitat[2]	Valley/Foothill Riparian
Secondary nesting and migratory habitat	Valley/Foothill Riparian
Least Bell's vireo	Valley/Foothill Riparian
Western burrowing owl	
High-value habitat	Grassland, Vernal Pool complex
Moderate-value habitat	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex
Low-value habitat	Alkali Seasonal Wetland Complex, Vernal Pool Complex, Other Natural Seasonal Wetland, Managed Wetland, Agricultural Habitats
Western yellow-billed cuckoo	Valley/Foothill Riparian
California least tern	Tidal Perennial Aquatic
Greater sandhill crane	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex, Managed Wetland, Agricultural Habitats

Table 3-9. Natural Communities Supporting Modeled Covered Species' Habitats (continued)

Covered Species	*Natural Communities Supporting Species Habitat*
California black rail	Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Alkali Seasonal Wetland Complex, Nontidal Freshwater Perennial Emergent Wetland, , Managed Wetland
California clapper rail	Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland,
Swainson's hawk	
Nesting habitat	Valley/Foothill Riparian
Foraging habitat	Grassland, Alkali Seasonal Wetland Complex, Other Natural Seasonal Wetland, Managed Wetland, Agricultural Habitats
White-tailed kite	
Breeding habitat	Valley/Foothill Riparian
Foraging habitat	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex, Other Natural Seasonal Wetland, Managed Wetland, Agricultural Habitats
Giant garter snake	
Primary Zone: Aquatic breeding, foraging, and movement	Tidal Perennial Aquatic, Tidal Freshwater Emergent Wetland, Other Natural Seasonal Wetland, Nontidal Freshwater Perennial Emergent Wetland, Agricultural Habitats
Primary zone: Upland aestivation and movement	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex, Other Natural Seasonal Wetland, Managed Wetland, Agricultural Habitats
Western pond turtle	
Aquatic habitat	Tidal Perennial Aquatic, Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Nontidal freshwater perennial emergent wetland, Nontidal perennial aquatic
Dispersal habitat	Valley/Foothill Riparian, Alkali Seasonal Wetland Complex, Vernal Pool Complex, Other Natural Seasonal Wetland, Managed Wetland, Agricultural Habitats
Upland nesting and overwintering	Valley/Foothill Riparian, Grassland, Vernal Pool Complex
California red-legged frog	
Aquatic habitat	Tidal Freshwater Emergent Wetland, Nontidal Freshwater Perennial Emergent Wetland, Nontidal Perennial Aquatic, Managed Wetland
Upland cover and dispersal habitat	Valley/Foothill Riparian, Grassland, Vernal Pool Complex
Dispersal habitat	Agricultural Habitats
Western spadefoot toad	
Aquatic breeding habitat	Vernal Pool Complex, Other Natural Seasonal Wetland, Nontidal Perennial Aquatic,
Terrestrial cover and aestivation habitat	Grassland, Alkali Seasonal Wetland Complex
California tiger salamander	
Aquatic breeding habitat	Vernal Pool Complex
Terrestrial cover and aestivation habitat	Grassland, Alkali Seasonal Wetland Complex
Lange's metalmark butterfly	Inland Dune Scrub
Valley elderberry longhorn beetle	
Riparian vegetation	Valley/Foothill Riparian
Non-riparian channels and grasslands	Grassland, Vernal Pool Complex

Table 3-9. Natural Communities Supporting Modeled Covered Species' Habitats (continued)

Covered Species	*Natural Communities Supporting Species Habitat*
Vernal pool shrimp species (vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, California linderiella)	Vernal Pool Complex
Vernal pool plant species (Alkali milk-vetch, San Joaquin spearscale, Boggs Lake hedge-hyssop, Heckard's peppergrass, legenere)	Vernal Pool Complex
Heartscale and brittlescale	Alkali Seasonal Wetland Complex, Vernal Pool Complex, Grassland
Slough thistle	Valley/Foothill Riparian
Suisun thistle and soft bird's-beak	Tidal Brackish Emergent Wetland
Delta button-celery	Valley/Foothill Riparian, Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex
Dwarf downingia	Venal Pool Complex
Contra Costa wallflower	Inland Dune Scrub
Carquinez goldenbush	Grassland, Alkali Seasonal Wetland Complex, Vernal Pool Complex
Delta tule pea and Suisun marsh aster	Tidal Brackish Emergent Wetland, Tidal Freshwater Emergent Wetland, Valley/Foothill Riparian
Mason's lilaeopsis and delta mudwort	Tidal Mudflat
Antioch Dunes evening-primrose	Inland Dune Scrub
Side-flowering skullcap	Valley/Foothill Riparian
Caper-fruited tropidocarpum	Grassland

Table 3-10. Expected Extent of Conserved Natural Communities in Conservation Zones 1-11 with BDCP Implementation

Natural Communities	*Total Extent (acres)*	*Total Existing Protected (acres)*	*Percent Existing Protected (acres)*	*BDCP Protected (acres)* **A**	*BDCP Restored (acres)* **B**	*BDCP Conserved (acres)* **A+B**	*Total Conserved with BDCP Implement-ation* **(Existing +BDCP)**	*Percent Conserved with BDCP Implement-ation*
Tidal perennial aquatic	86,240	18,080	21%	0	24,913-31,622[2]	24,913-31,622	42,963-49,672	39-42%
Tidal mudflat[1]	Not available.	Not available.	Not available.	0	Not available.	Not available.	Not available.	Not available.
Tidal brackish emergent wetland	8,351	5,102	61%	0	3,676-4,826[2]	3,676-4,826	8,292-9,442	72-75%
Tidal freshwater emergent wetland	8,947	4,990	56%	0	13,924-21,644[2]	13,924-21,644	18,897-26,617	83-87%
Valley foothill riparian	17,337	5,338	31%	0	5,000	5,000	9,608	45%
Grassland	62,880	14,984	24%	8,000	2,000	10,000	23,974	39%
Alkali seasonal wetland complex	3,723	2,769	74%	400	0	400	3,111	87%
Vernal pool complex	6,958	4,379	63%	300	200	500	4,849	69%
Other natural seasonal wetland	265	205	77%	0	0	0	205	77%
Nontidal freshwater perennial emergent wetland	1,134	408	36%	0	400	400	1,948	30%
Nontidal perennial aquatic	5,341	1,239	23%	0				
Managed wetlands	64,844	52,676	81%	To come.	To come.	To come.	To come.	To come.
Agricultural lands	503,779	57,168	11%	To come.	0	To come.	To come.	To come.
Alfalfa	82,283	3,665	5%	Not available.	0	Not available.	Not available	Not available.
Irrigate Pasture	49,693	12,748	26%	Not available.	0	Not available.	Not available.	Not available.
Vineyard	28,901	2,476	9%	0	0	0	2,266	8%
Orchard	18,020	343	2%	0	0	0	278	2%
Rice	12,637	2,202	17%	4,600	0	4,600	6,802	54%
Other Cultivated Crops	229,828	24,736	11%	Not available.	0	Not available.	Not available.	Not available.
Subtotal: Cropland only	421,361	46,171	11%	16,620-32,640	0	16,620-32,640	57,976-73,996	15-19%
Other Agricultural lands	82,418	10,997	13%	0	0	0	9,252	12%
Subtotal: All agricultural land	503,779	57,168	11%	16,620-32,640	0	16,620-32,640	67,227-83,248	14-18%
Total	**769,799**	**167,338**	**22%**	**25,320-41,340**	**50,113-65,692**	**75,433-107,032**	**223,104-254,703**	**29-33%**

[1]Tidal mudflats are not delineated within the BDCP land cover type GIS data base, but are subsumed in acreages shown for tidal communities.

[2]Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

Tidal Perennial Aquatic Goals and Objectives

Goal TANC1: The expected outcome is tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic food web processes.

> **Objective TANC1.1**: Restore or create 10,000 to 20,000 acres of tidal perennial aquatic in the BDCP Restoration Opportunity Areas (Conservation Zones 1, 2, 4, 5, 7, and 11) that supports aquatic food production and habitat for covered and other native species.

Goal TANC2: The expected outcome is biologically diverse tidal perennial aquatic natural community that is enhanced for native species and sustained by natural ecological processes.

> **Objective TANC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal perennial aquatic community for covered and other native species over the term of the BDCP.

Rationale for Goals and Objectives

Tidal Perennial Aquatic Natural Community Extent and Connectivity

The tidal perennial aquatic natural community influences the establishment and persistence of other natural communities. As sediment accumulates in this community, the elevation of the surface of the bottom eventually increases to the point that it is shallow enough to be colonized by emergent vegetation, and the colonized areas may become tidal emergent wetland or valley/foothill riparian natural communities.

Native Biodiversity and Tidal Perennial Aquatic Function

Biologically Diverse Tidal Perennial Aquatic. The tidal perennial aquatic natural community is largely unvegetated; however, where vegetation exists, it is either rooted and frequently submerged or unrooted and floating. Submerged aquatic plant species include native water primrose and eel grass. Dense eel grass beds provide habitat for young fish and other aquatic organisms and are an important food source for waterfowl, although their occurrence in the Plan Area is very limited. Invasive submerged nonnative plant species include Brazilian waterweed and Eurasian watermilfoil. Brazilian waterweed grows in dense stands along the margins of channels and across shallow bays and significantly restricts the access of juvenile fish to shallow water habitat. It also provides excellent habitat for nonnative ambush predators, such as bass and sunfish, by reducing water velocity, resulting in lower levels of suspended matter in the water column which increases water clarity and produces better hunting conditions for nonnative ambush predators (Brown and Michniuk 2007).

Native floating aquatic plant species include duckweed and floating water fern, and generally occur as free-floating beds of plants at the surface or suspended in the water column. Because floating aquatic plants are not rooted, wind and water movement determine distribution and density. In contrast to the smaller native species, water hyacinth, an invasive species, grows in dense mats that can greatly reduce primary productivity within the water column (NMFS 2004) and provide habitat for nonnative ambush predators, such as bass and sunfish.

The flow of primary productivity through food webs has been greatly affected by the introduction of nonnative species. The native copepod, *Eurytemora*, is an important food source for delta smelt and larval longfin smelt. For example, after the introduction of the highly efficient filter-feeding overbite clam into the Delta (Kimmerer and Orsi 1996), this native copepod declined in abundance. This has allowed for increased colonization of the Delta by nonnative copepods, *Pseudodiaptomus* and *Limnoithona* which have lower fish foraging efficiency. Introduced clams in the tidal perennial aquatic natural community, the Asian clam and overbite clam, are highly efficient filter feeders that significantly reduce phytoplankton and zooplankton concentrations in the water column, resulting in reduced food availability for native fishes, such as delta smelt and young Chinook salmon (Kimmerer and Orsi 1996, NMFS 2004, Center for Biological Diversity 2007).

The tidal perennial aquatic natural community supports over 50 species of fish, approximately one-half of which are native. It is used as habitat by fish for foraging, spawning, egg incubation and larval development, juvenile nursery areas, and migratory corridors. Most species spend their entire lives in the tidal perennial aquatic natural community while others may spend certain seasons or parts of their lives in habitats outside of the tidal perennial aquatic natural community, depending on the state of physical factors such as salinity, turbidity, dissolved oxygen, flow rates, and water temperature. The tidal perennial aquatic community also supports many wildlife species including some covered species. For example, where this community borders tidal freshwater emergent wetland community and contains structural elements such as woody debris as basking sites, giant garter snake and western pond turtle may occur.

Nonnative fish species that have been introduced into the tidal perennial aquatic natural community include striped bass, largemouth bass, smallmouth bass, bluegill sunfish, threadfin shad, golden shiner, fathead minnow, common carp, brown bullhead, white catfish, yellowfin goby, shimofuri goby, and shokihaze goby. No introduction of a nonnative fish species has clearly caused the extinction of a native fish species in the Bay-Delta (Cohen and Carlton 1995); however, nonnative introductions may have significantly contributed to the decline of some native species due to predation and competition for shared resources. For example, smallmouth bass has been associated with the decline of hardhead, a native minnow found in the Delta; and introductions of several centrarchid species (sunfish and black basses) have been associated with the extirpation of the native Sacramento perch from the Delta.

Species Protection. Resident and migratory fish use the tidal perennial aquatic natural community for purposes of spawning, rearing, foraging, and escape cover (CALFED 2000). Young steelhead and Chinook salmon forage in the tidal perennial aquatic natural community as fry and juveniles to put on critical weight before entering the ocean.

In addition to its value as habitat for fish, the tidal perennial aquatic natural community provides reproduction, feeding, and resting habitat for many species of mammals and birds. The tidal perennial aquatic natural community is used by shorebirds, wading birds, and waterfowl for foraging, resting, and escape cover, including BDCP covered California least tern that feeds on fish in the tidal perennial aquatic natural community.

Restoring 2,100 acres of tidal freshwater emergent wetland, with inclusions of the tidal perennial aquatic natural community, in Conservation Zone 4 will provide habitat for giant garter snake and provide the potential for future expansion and colonization from nearby giant garter snake populations (Badger Creek and Coldani Marsh/White Slough subpopulations) into the Delta. It will also provide additional protected tidal perennial aquatic habitat to facilitate the north-south movement of giant garter snakes between the Coldani Marsh/White Slough subpopulation and Stone Lakes National Wildlife Refuge. Restoring 5,000 acres of tidal freshwater emergent wetland in Conservation Zone 7 will provide additional giant garter snake habitat and facilitate the expansion of existing populations into the South Delta.

Tidal Perennial Aquatic and Climate Change

Warmer water temperatures from future climate change would be detrimental to temperature-dependent native fish species in the tidal perennial aquatic natural community due to alterations of the timing of optimal temperature regimes required for fish spawning, rearing, and migration (Bennett 2005, Lindley et al. 2007). High water temperatures can also cause lethal and sublethal effects on some species of fish and other organisms in the community during specific life stages. Warmer water temperatures may also promote the success of nonnative species, such as centrarchids (e.g., black basses, sunfish) and cyprinids (e.g., carp), that spawn during periods with warmer water temperatures (Moyle 2002).

Climate change is predicted to cause more precipitation to fall as rain instead of snow and cause earlier melting of the snowpack. These changes would lead to greater peak flows during the rainy season and lower flows during the dry season. Knowles and Cayan (2004) predict that inflows will increase by 20 percent from October through February and decrease by 20 percent from March through September. Such changes could affect species in the tidal perennial aquatic natural community by altering environmental cues, such as changes in flows and temperature that trigger the timing of biological events such as migration and spawning. Changes in these cues could lead to confusion in the timing of migration and spawning which could ultimately affect the growth, fecundity, and survival of individuals.

A combination of reduced outflow from the Plan Area during the dry season and a rising sea level would increase the extent of saltwater intrusion into the Plan Area (Knowles and Cayan 2002, 2004) and could shift the low salinity zone farther upstream, which would influence the amount of rearing habitat available to native estuarine species (USFWS 2004). Reduced flow into the Plan Area during summer and fall could also lead to increased residence time, which could exacerbate the high water temperature and low dissolved oxygen problems that already occur in some portions of the Plan Area. Concentrations of toxic substances may also increase during the summer and fall as flow-driven flushing and dilution decrease.

Sea level rise could negatively affect fish species that rely on shallow water habitat by deepening preferred shallow water areas of the Plan Area and changing them to deep water zones. Conversely, sea level rise may create more shallow water and floodplain areas that inundate more readily, thus providing a benefit to species that use floodplains as rearing habitat.

Conservation Measures for Tidal Perennial Aquatic

- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.2 Tidal Mudflat

Tidal mudflat is an ephemeral, mostly unvegetated habitat that usually occurs as patches in areas of disturbance or sediment deposition associated with various intertidal elevations of tidal brackish and tidal freshwater emergent wetlands, and with the upper elevations of the tidal perennial aquatic natural community. It also occupies sediment depositional areas along natural and artificial levees that are ephemeral microhabitats within the valley/foothill riparian natural community, as well as in specific habitats such as seasonal floodplain and channel margin habitats.

The extent of tidal mudflat within the Plan Area has been substantially reduced with the construction of levees and dikes, the channelization of waterways, and the conversion of tidal marshes to agricultural and other land uses. This reduction in the extent of tidal mudflat has reduced the availability of foraging habitat that supports shorebird migrations along the Pacific Flyway and has reduced the extent of silt substrates at the interface of tidal perennial aquatic and tidal emergent wetland that supports habitat for covered species. See Section 2.3.4.2, *Tidal Mudflat* in Chapter 2, *Existing Ecological Conditions,* for more detail on the current state of this natural community.

An increase in extent of tidal mudflat habitat is expected to occur through the restoration of tidal brackish and freshwater emergent wetland community, valley/foothill riparian community, and channel margin enhancement in areas that respond to the dynamic processes that lead to disturbance or deposition events that produce tidal mudflat. This restoration of tidal mudflat habitat will provide foraging habitat for shorebirds and wading birds and will create patches of suitable habitat for several BDCP covered plant species.

Tidal Mudflat Goals and Objectives

Goal MFNC1: The expected outcome is areas of tidal mudflat that provide foraging habitat for shorebirds and wading birds, and substrates suitable for the natural establishment of BDCP covered plant species.

Objective MFNC1.1: Restore or create 20 linear miles of edge areas within other natural communities that serve as tidal mudflat substrate and which will support habitat for tidal mudflat-associated species as a component of BDCP restored tidal brackish emergent wetland and tidal freshwater emergent wetland natural communities and channel margin enhancement.

Objective MFNC1.2: Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal mudflat as a component of BDCP restored brackish and freshwater tidal habitat and channel margin enhancement for covered and other native species over the term of the BDCP.

Rationale for Goals and Objectives

Tidal Mudflat Natural Community Extent and Connectivity

The tidal mudflat natural community generally occupies a narrow transition zone in the intertidal zone of various natural communities in the Plan Area. Tidal mudflat is ephemeral and is sustained through disturbances to other nearby communities or through the deposition of mineral soil within the intertidal zone. Tidal mudflats are typically located in a transition area near brackish and freshwater tidal emergent wetland. These wetlands experience disturbances to their vegetation via the restoration of natural tidal and salinity regimes in brackish areas and through flow and sediment related disturbances in freshwater areas.

Under the tidal mudflat goals and objectives, 20 linear miles of edge areas within brackish and freshwater tidal emergent wetland that could support tidal mudflat will be restored, and tidal mudflat will be allowed to develop under natural processes. Restoration of the tidal mudflat natural community is expected to occur through the BDCP efforts to restore brackish and freshwater tidal emergent wetland communities and other natural communities. The restoration of larger extents of brackish and freshwater tidal emergent wetland, valley/foothill riparian communities and the restoration of seasonal floodplain and channel margin habitats will provide more extensive and frequent disturbances than currently occur and will support a greater extent of tidal mudflat community. Tidal mudflat is expected to develop along the narrow transition zone between the tidal perennial aquatic natural community and the brackish and freshwater tidal emergent wetland natural communities and in sediment depositional areas along artificial and natural levees within the valley/foothill riparian natural community. For the implementation schedule of tidal habitat restoration, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Tidal Mudflat Function

Biologically Diverse Tidal Mudflat. When exposed at low tide, lower elevation tidal mudflats serve as foraging habitat for waterfowl and shorebirds which consume crustaceans, bivalves, gastropods, aquatic insects, and polychaetes that live in tidal mudflats. When covered at high tide, these same areas serve as shallow open water habitat for several BDCP covered pelagic fish species, including splittail, salmonids, and sturgeon. These species use the area as a shallow water refuge from predators and also forage on benthic invertebrates.

Tidal mudflat is expected to develop naturally from the effective management of brackish and freshwater tidal emergent wetland and will not be specifically enhanced or managed. Most of the physical processes that will be designed into the restoration of tidal emergent wetland are expected to evolve naturally and will produce ephemeral patches of tidal mudflat. Some biological processes in tidal marsh habitats may require active management, such as the control of invasive species; however, there is little current knowledge about the effects of invasive species on tidal mudflat habitats. This uncertainty is expected to be resolved through baseline surveys, effectiveness monitoring, and targeted research.

Species Protection. Two BDCP covered plant species, Mason's lilaeopsis and Delta mudwort, can be found on higher elevation tidal mudflat. Mason's lilaeopsis is more abundant in brackish areas, while Delta mudwort is more abundant in freshwater (Golden and Fiedler 1991, Fiedler and Zebell 1993, Zebell and Fiedler 1996, Meisler 2002, Fiedler et al. 2007). The rate of plant colonization and succession on tidal mudflat depends on the supply of propagules and the distance to clonal plants. Restoration of tidal mudflat will also create patches of suitable habitat for BDCP covered plant species Delta tule pea and Suisun Marsh aster.

Tidal Mudflat and Climate Change

It is expected that sea level rise will shift tidal mudflats to higher elevations in areas with a gradual topographic incline. Where steep levee sides occur, the areal extent of tidal mudflats could be diminished as a result of sea level rise. Additionally, tidal mudflat extent is affected by rates of sedimentation and erosion. If sediment deposition does not match sediment export, the extent of tidal mudflats could change; and it is not clear how climate change will affect sediment deposition and export rates. However, implementation of BDCP tidal mudflat goals and objectives can improve the extent, and thus potential resilience, of this natural community in the face of climatic changes.

Conservation Measures for Tidal Mudflat

- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.3 Tidal Brackish Emergent Wetland

The tidal brackish emergent wetland natural community is a transitional community between the tidal perennial aquatic natural community and terrestrial upland natural communities; it can also exist as isolated patches on islands (e.g., islands within Suisun Bay). In the Plan Area, tidal brackish emergent wetland natural community currently persists at the following locations: Suisun Marsh, the south side of Suisun Bay, and along the shore and on islands in the saltwater/freshwater mixing zone that extends from near Collinsville westward to the Carquinez

Strait. However, despite its large potential extent, most tidal brackish emergent wetland is present in undiked areas of Suisun Marsh, such as Rush Ranch and Hill Slough. Smaller patches also occur along undiked shorelines on the south shore of Suisun Bay, and on undiked in-channel islands such as Brown's Island. See Section 2.3.4.3, *Tidal Brackish Emergent Wetland* in Chapter 2, *Existing Ecological Conditions,* for more detail on the current state of this natural community.

Substantial reductions in the extent, distribution, and condition of the historical tidal brackish emergent wetland natural community in Suisun Marsh have reduced the extent and diversity of tidal brackish emergent wetland for associated covered and other native species. Prior to extensive anthropogenic modifications of Suisun Marsh that included dike building and drainage, the tidal brackish emergent wetland natural community comprised an estimated 69,000 acres of what was the largest tidal brackish water marsh complex in the western United States (Boul and Keeler-Wolf 2008). Today, only 8,351 acres (12 percent) remain; 5102 acres (61 percent) of which is currently under protected status.

Conservation of the tidal brackish emergent wetland natural community will be achieved by increasing the extent and connectivity of the community, by establishing connectivity with other natural communities along an environmental gradient from aquatic to upland areas, by reestablishing ecological conditions and processes that sustain the community, and by enhancing native biodiversity. Tidal brackish emergent wetland restoration will be implemented in Suisun Marsh through the breaching of dikes around unsubsided areas of the marsh and through site-specific contouring to speed the establishment of natural tidal channels. Restoring tidal brackish marsh habitats along an environmental gradient extending from the tidal perennial aquatic natural community to upland natural communities is expected to increase the abundance and distribution of associated native species, improve connectivity among habitat areas within Suisun Marsh and Suisun Bay, provide nutrients and food to adjacent subtidal aquatic habitat, and to contribute to the long-term conservation of tidal brackish marsh-associated covered species.

Tidal Brackish Emergent Wetland Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Rationale for Goals and Objectives

Tidal Brackish Emergent Wetland Natural Community Extent and Connectivity

The conservation of tidal brackish emergent wetland focuses on restoration and management rather than on protection because of the very limited extent of this community compared to historical conditions, and because most of the existing natural community has been protected or is unlikely to be developed. Two of the largest patches of tidal brackish emergent wetland in Conservation Zone 11, Rush Ranch and Hill Slough, are owned by the Department of Fish and Game and are actively managed for their natural resource values. Much of the remaining area of tidal brackish emergent wetland natural community in Conservation Zone 11 is protected from future development under the Suisun Marsh Protection Plan. Areas of this natural community in Conservation Zone 5, although not under formal protection, occur on mid-channel islands that are subject to strong tidal forces, wave action, and are isolated from roadways. These factors render tidal emergent wetlands in Conservation Zone 5 largely unsuitable for development and therefore, protection is not a priority.

Under the tidal habitat restoration goals and objectives, 65,000 acres of tidal habitat will be restored; of which at least 7,000 acres will be in brackish areas of Suisun Marsh. A portion of the restored area (3,600 to 4,800 acres) will be restored tidal brackish emergent wetland natural community. The extent of acres targeted for Suisun Marsh is in part a function of the potential for wetland restoration based on historical and current conditions. Restoration sites will be chosen based on appropriate marsh plain elevations, hydrodynamic conditions, and environmental gradients. Priority for restoration will be given to sites that were former tidal brackish emergent wetland, that fall within intertidal tidal elevations, and that are suitable for creating a gradient from subtidal habitats to upland habitats through the breaching of dikes. Consideration will also be given to sites that will increase connectivity among preserve lands or that will accommodate sea-level rise. Restoration of tidal brackish emergent wetland natural community in Suisun Marsh will increase the extent and connectivity of an already established network of habitat and will improve foraging and/or dispersal dynamics for a variety of wildlife species. The implementation schedule of tidal habitat restoration is described in the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Tidal Brackish Emergent Wetland Function

Biologically Diverse Tidal Brackish Emergent Wetland. Implementation of tidal brackish emergent wetland natural community restoration actions will aid in the recovery of natural tidal fluctuation that is essential to improve the function of the natural community. Restoration of tidal influence affects water accessibility, soil oxygen status, and soil salinity, all of which are critical factors for the wetland vegetation. Endemic plant species located within and near the intertidal area in this community, such as BDCP covered species Suisun thistle, Suisun Marsh aster, and soft bird's-beak, will benefit from the restoration of tidal influence.

The target restoration goal for the tidal brackish emergent wetland natural community includes the relatively brackish channel margin habitat with tall bulrushes, tules, and cattails; the more brackish transition zone with species-rich vegetation containing a diversity of structural habitats; and the marsh plain that is dominated by low stature salt-tolerant species such as pickleweed and saltgrass and may include bare patches of very saline soil.

Directing the restoration of tidal brackish emergent wetland natural community to the Suisun Marsh is expected to provide the greatest possible benefit for BDCP covered aquatic and terrestrial species and for the tidal brackish emergent wetland natural community which the species depend upon for habitat and food web support. Vegetated marsh plains are also expected to filter non-point source pollution from surface runoff or subsurface infiltration that otherwise would flow into Suisun Bay. The potential restoration areas in Suisun Marsh are extensive and interconnected and will allow for the foraging and dispersal dynamics of a wide range of BDCP covered and other native species.

Enhancing and managing the natural community to maintain variation in inundation, composition, and structure will be critical for maintaining the value of tidal brackish emergent wetland as habitat. Natural physical processes will be restored through the design of the restoration sites and natural site evolution will be allowed. In contrast, some biological processes will require active management. For example, both the transition zone and marsh plain are frequently invaded by nonnative species such as perennial pepperweed and fennel in the intertidal zone and annual grasses immediately above the MHHW line. Tall nonnative plant species form dense patches, excluding native species; and some small nonnative annuals, such as barbgrass (*Hainardia cylindrical*) and rabbitsfoot grass (*Polypogon monspeliensis*), impact BDCP covered soft bird's-beak (a hemiparasite) by functioning as ineffective host plants (Grewell 2005). These invasive species significantly degrade the habitat value of this community and will require active management methods to reduce and prevent increases of their cover at levels that will minimize their negative effects on the community. While methods have been developed to reduce the cover of these species in the short term, there are no long term control solutions; and effective management of invasive species will require focused studies to develop those methods.

The tidal brackish emergent wetland community is frequently invaded by nonnative animals such as feral pigs. Pigs can have significant adverse effects on marsh vegetation, especially BDCP covered Suisun thistle (Fiedler et al. 2007, USFWS 2009a). Other nonnative animals that have been shown to significantly reduce populations of BDCP covered salt marsh harvest mouse, California black rail, and California clapper rail (Suisun Ecological Workgroup 2001) include red fox, feral cats, and rats (Brown 2004, Takekawa et al. 2006). Management methods to reduce or eliminate populations of invasive animals will be developed and implemented.

The range of potential restoration sites vary by past disturbance regime and location in Suisun Marsh. Therefore, this community will be enhanced using techniques that are tailored to each specific restoration site. The combination of unknown past effects and variable current condition means that there will be a broad range of uncertainty in implementing the enhancement techniques, frequencies, and intensities of application that will be informed by baseline surveys, effectiveness monitoring, and targeted research studies.

Species Protection. When fully restored, this community will provide habitat for covered terrestrial species, and will provide structure as well as nutrient and energy flows to the aquatic food web that supports covered fish species that rear and spawn in the channels of the marsh. BDCP covered species expected to benefit from tidal brackish emergent wetland restoration include delta smelt, longfin smelt, all runs of Chinook salmon, Central Valley steelhead, salt marsh harvest mouse, Suisun shrew, Suisun song sparrow, California black rail, California clapper rail, white-tailed kite (foraging), western pond turtle, Suisun thistle, soft bird's-beak, Delta tule pea, Suisun Marsh aster, Delta mudwort, and Mason's lilaeopsis. Restoration of tidal brackish emergent wetland will also provide breeding and wintering habitat for a variety of waterfowl, shorebirds, and other waterbirds in an ecologically functioning landscape within the Suisun Marsh complex.

Tidal Brackish Emergent Wetland and Climate Change

The tidal brackish emergent wetland natural community is directly linked to salinity gradients and sea level. Delta wetlands are particularly sensitive to long-term sea level rise associated with global climate change and changes in Delta sediment discharge. In order to be maintained, the tidal brackish emergent wetland natural community must have the ability to accrete sediments at rates high enough to keep its surfaces intertidal (Watson and Byrne 2009). That accretion rate will in turn depend on how changing salinity and inundation duration affect the species composition of the wetland (Culberson et al. 2004, Watson and Byrne 2009).

The potential restoration sites in Suisun Marsh are generally located on unsubsided mineral soils and are adjacent to upland communities so that restoration actions will be efficient and relatively resilient to the effects of global sea level rise. Additionally, a 900-acre area of similar unsubsided mineral soils will be restored just beyond the eastern limit of the brackish water area in Conservation Zone 5, which could function as refugia for species adapted to brackish conditions from the effects of global climate change.

Conservation Measures for Tidal Brackish Emergent Wetland

- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.4 Tidal Freshwater Emergent Wetland

The tidal freshwater emergent wetland natural community is typically a transitional community between the tidal perennial aquatic natural community and valley/foothill riparian or terrestrial upland communities, such as grasslands and agricultural lands. In the Plan Area, the tidal freshwater emergent wetland natural community occurs across a range of hydrologic and soil conditions, often occurring at the shallow, slow-moving or stagnant edges of freshwater waterways in the intertidal zone. It frequently experiences long duration flooding.

Prior to the 1860s, the tidal freshwater emergent wetland natural community covered an estimated 87 percent of the Delta, with extensive marshes forming dense stands of vegetation bisected by meandering channels (The Bay Institute 1998). Today, the distribution of the tidal freshwater emergent wetland natural community in the Plan Area is limited to narrow fragmented bands or small patches along island levees, in-channel islands, shorelines, sloughs, and shoals. A total of 8,947 acres of this natural community remain within the Plan Area, 4,990 acres (56 percent) of which is currently under protected status.

Channelization, levee-building, agricultural conversion, urban development, removal of vegetation to stabilize levees, and upstream flood control have reduced the extent of the tidal freshwater emergent wetland natural community and altered its ecological function through changes to flooding frequency, inundation, depth, and duration, and the quantity of sediment deposition. These substantial reductions in the extent, distribution, and condition of tidal freshwater marshes that historically covered most of the Delta have reduced the extent and diversity of tidal freshwater habitats for associated covered and other native plant and wildlife species. See Section 2.3.4.4, *Tidal Freshwater Emergent Wetland* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

When fully restored, tidal freshwater emergent wetland will support a complex habitat structure composed of bulrushes, tules, cattails, and other emergent marsh species that will provide habitat for covered terrestrial species and provide nutrient and energy flows to the aquatic food web that supports covered fish species that rear in the channels of the marsh.

Tidal Freshwater Emergent Wetland Goals and Objectives

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Rationale for Goals and Objectives

Tidal Freshwater Emergent Wetland Natural Community Extent and Connectivity

A total of 65,000 acres of tidal habitats will be restored by the BDCP, of which 13,900 to 21,600 acres will be tidal freshwater emergent wetland. Remnant patches of tidal freshwater emergent wetlands can currently be found near the confluence of the Sacramento and San Joaquin rivers, along Cache and Lindsey sloughs and the Yolo Bypass, along the mainstem and several channels of the San Joaquin, Old, and Middle rivers, Dutch Slough, Lost Slough, and near the confluence of the Cosumnes and Mokelumne rivers.

Tidal freshwater emergent wetland restoration will be implemented across a wide geography in the Delta with most of the restored acreage occurring in the Cache Slough area and in the south Delta. Sites will be selected for restoration based on their spatial distribution, extent, location, and configuration of restored tidal habitat, the ability to minimize impacts to existing habitats or infrastructure, the ability to restore appropriate tidal range to a site, the potential for a site to produce and export productivity to sustain aquatic food webs in the river channels, and the potential to accommodate sea-level rise. Priority will be given to sites that will increase connectivity among preserve lands.

The modification of natural Delta hydrology through levees, drainage, and water exports has reduced the extent and diversity of tidal freshwater habitats for associated covered and other native plant and wildlife species. Tidal brackish emergent wetland restoration will be implemented through the breaching of levees around unsubsided areas of the marsh, combined with site specific contouring to speed the establishment of natural tidal channel morphology and sinuosity. Restoring tidal freshwater marsh habitats along an environmental gradient extending from the subtidal perennial aquatic natural community to upland natural communities is expected to increase the abundance and distribution of associated native wildlife and plant species, improve connectivity among habitat areas within the Plan Area, provide nutrients and food to adjacent subtidal perennial aquatic habitat, and contribute to the long-term conservation of tidal freshwater marsh-associated covered species.

Because the tidal freshwater emergent wetland restoration areas are distributed throughout the Delta, there will be extensive site to site variation in physical and biological characteristics. Given this variability, enhancement actions will use techniques that are tailored to each specific restoration site. The inherent variability among potential restoration sites also means that there will likely be a broad range of uncertainty in implementing the restoration and enhancement techniques. Therefore, restoration and enhancement techniques and effective application frequencies and intensities will be informed by baseline surveys, effectiveness monitoring, and targeted research. For the implementation schedule of tidal habitat restoration, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Tidal Freshwater Emergent Wetland Function

Biologically Diverse Tidal Freshwater Emergent Wetland. There are 17 plant community alliances (i.e., unique species assemblages) mapped in the Plan Area that fall within the tidal freshwater emergent wetland natural community (Table 2-8) (Sawyer and Keeler-Wolf 1995, Hickson and Keeler-Wolf 2007). In tidal freshwater emergent wetlands, tules, cattails, and willows (*Salix* spp.) dominate the vegetation along the Sacramento River; while throughout the San Joaquin River area of the Delta, bulrushes, tules, common reed (*Phragmites australis*), and willows are more often the dominant species (Atwater 1980, Watson 2006, EDAW 2007, Hickson and Keeler-Wolf 2007, Watson and Byrne 2009). In some areas of the Delta, generally freshwater areas may become brackish during periods of low flows. These potential salinity changes are driven by the incursion of higher salinity oceanic water from Suisun Bay up the Sacramento and San Joaquin rivers and from salinity transported by the San Joaquin River into the Delta. There may also be local sources of salinity in the vicinity of Lindsey and Cache sloughs that might become less diluted by Sacramento River water under periods of low flows, causing a shift to more salt-adapted species.

The vegetation and associated waterways of the tidal freshwater emergent wetland natural community in the Plan Area provide food and cover for numerous species of birds (e.g., waterfowl, shorebirds, wading birds), mammals, reptiles, emergent aquatic insects, and amphibians. Many tidal freshwater emergent wetlands remaining in the Plan Area are highly altered. This has substantially reduced its value as habitat for many plant and wildlife species. However, the remaining tidal freshwater emergent wetlands are essential wintering grounds for migratory birds.

Some species, such as waterfowl and egrets, have adapted to foraging on certain types of Delta cropland that were converted from historical wetland areas (DFG 2005). These and other species are expected to benefit from restoration of ecologically functioning tidal freshwater emergent wetlands. Many fish in the tidal perennial aquatic natural community will also use tidal freshwater emergent wetland habitat when it is inundated. Younger stages (e.g., larvae, fry) of some fish species rear in shallower waters that support the emergent vegetation of the tidal freshwater emergent wetland natural community; and some fish species use the emergent vegetation as refuge from predation and high flows (The Bay Institute 1998).

In tidal freshwater emergent wetlands, emergent vegetation releases organic debris (“drift”) into the waterways, providing nutrients and cover, and forms the base of the aquatic food chain supporting primary consumers such as microorganisms, macroinvertebrates, and insects.. The tidal freshwater emergent wetland natural community also processes influxes of nutrients that find their way into the aquatic system (“nutrient transformation”), thereby contributing further to the aquatic food web.

Enhancing and managing tidal freshwater marsh to maintain variation in tidal inundation, species composition, and vegetation structure will be critical for supporting the value of tidal freshwater marsh as habitat. Natural physical processes will be restored through the careful design and implementation of habitat restoration. As part of the restoration, natural geomorphology will be allowed to develop.

However, some biological process will require active management. For example, the area immediately above MHHW is often invaded by species such as perennial pepperweed and giant reed (*Arundo donax*), and both species grow as dense monocultures which eliminate native plant species in both riparian and tidal wetland habitats. Invasive species significantly degrade the habitat value of this community and only management actions to reduce and limit their cover to low levels will minimize their adverse effects on the community. For example, the giant reed eliminates native plants, resulting in the reduction of food and habitat for a number of native birds, insects, and other wildlife. While methods have been developed to reduce the cover of invasive species in the short-term, there are no long-term control solutions and effective management of invasive species will require an uninterrupted long-term commitment.

The tidal freshwater emergent wetland community has also been invaded by nonnative animals such as cowbirds and feral cats that can have significant negative effects native wildlife. Management methods to reduce or eliminate populations of nonnative animals will be developed and implemented.

Species Protection. When fully restored, this community will provide habitat for covered terrestrial species, as well as structure and nutrient and energy flows to the aquatic food web that supports covered fish species that rear and spawn in the channels of the marsh. The augmented productivity and structural diversity of the restored tidal freshwater emergent wetland will create a diversity of nesting and foraging habitat for California black rail, greater sandhill crane, tricolored blackbird, giant garter snake, western pond turtle, and several species of waterfowl and shorebirds. It will also provide patches of suitable habitat for covered plant species, such as Delta tule pea, Suisun Marsh aster, Delta mudwort, and Mason's lilaeopsis.

Restoring 2,100 acres of tidal freshwater emergent wetland in Conservation Zone 4 will provide habitat for giant garter snake and provide the potential for future expansion and colonization from nearby giant garter snake populations (Badger Creek and Coldani Marsh/White Slough subpopulations). It will also provide additional protected tidal freshwater emergent wetlands to facilitate the north-south movement of giant garter snakes between the Condani Marsh/White Slough subpopulation and Stone Lakes National Wildlife Refuge. Restoring 5,000 acres of tidal freshwater marsh complex in Conservation Zone 7 will provide additional giant garter snake habitat and facilitate expansion of existing populations into the south Delta.

Greater sandhill crane is also expected to benefit from the restoration of 2,100 acres of tidal freshwater marsh complex in Conservation Zone 4 by providing additional roosting, resting, and foraging habitat within the species' primary use area where the tidal range is sufficiently narrow. Restoration of 5,000 acres of tidal freshwater emergent wetland in Conservation Zone 7 will provide suitable roosting and foraging habitat south of the current primary use area and facilitate expansion of the wintering range.

Tidal Freshwater Emergent Wetland and Climate Change

Since it is intertidal, the tidal freshwater emergent wetland natural community is directly affected by sea level and will be particularly sensitive to the predicted long-term sea level rise associated with global climate change (Nicholls et al. 1999). To persist in the face of rising sea levels the tidal freshwater emergent wetland natural community will have to maintain a maximum MLLW inundation depth of -35 cm by shifting its distribution upslope where it can or by accumulating mineral and organic sediment at a rate that will match that of sea level rise. The upslope shift will also shift tidal freshwater emergent wetland vegetation farther upstream as the tidal area migrates upstream.

Much of the area occupied by tidal freshwater emergent wetland is along armored levees; therefore, the relocation of the intertidal zone would be primarily vertical to the extent that the levees remain above sea level. In areas where sedimentation rates do not match sea level rise or where levees in subsided areas are breached or overtopped, there will be a reduction in the extent of tidal freshwater emergent wetland as it is replaced by the tidal perennial aquatic community. The implementation of BDCP tidal freshwater emergent wetland goals and objectives will increase the extent of this natural community and help ensure its persistence through climatic changes.

Conservation Measures for Tidal Freshwater Emergent Wetland

- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management
- CM13 Nonnative Aquatic Vegetation Control

3.3.2.2.5 Nontidal Freshwater Perennial Emergent Wetland

The nontidal freshwater perennial emergent wetland natural community is composed of permanently saturated wetlands, including meadows, dominated by emergent plant species that cannot tolerate permanent saline or brackish conditions. It generally occurs with and forms the boundary around the nontidal perennial aquatic natural community, and both are embedded in other natural communities (e.g., agricultural, grassland). Conservation of nontidal freshwater perennial emergent wetland will occur primarily in conjunction with the creation and protection of nontidal perennial aquatic natural community (see below under *Nontidal Perennial Aquatic*).

Historically, nontidal emergent wetland occurred primarily in the Yolo, American, and Cosumnes basins and in depressions along the margins of the Plan Area that ponded water long enough to support emergent aquatic vegetation such as tules, bulrushes, cattails, and other native vegetation. This community was among the most ecologically productive in the Delta, providing important nesting, feeding, and cover habitat for many native species, including BDCP covered species.

The extent of nontidal freshwater perennial emergent wetlands in California, including the Delta, has declined dramatically over the past century due to reclamation and conversion of the natural community to other uses, primarily agriculture (Gilmer et al. 1982, The Bay Institute 1998). Substantial reductions in the extent, distribution, and condition of historical nontidal freshwater perennial emergent wetland that resulted from agricultural conversion and the deterioration of natural hydrology has reduced the extent and diversity of freshwater marsh communities for associated covered and other native plant and wildlife species.

Today, nontidal freshwater perennial emergent wetland in the Plan Area is largely an artifact of agricultural practices or sites managed to maintain waterfowl habitat. Additionally, because of habitat loss and substitution, many native species that historically used tidal marsh habitats in the Delta are now dependent on remnant or created patches of nontidal emergent wetlands. See Section 2.3.4.7, *Nontidal Freshwater Perennial Emergent Wetland* in Chapter 2, *Existing Ecological Conditions,* for more detail on the current state of this natural community.

There are currently only 1,134 acres of nontidal freshwater perennial emergent wetland in the Plan Area, and most of it occurs as small fragmented patches along the edges of channels in the nontidal perennial aquatic and valley/foothill riparian natural communities. Approximately 36 percent of this area (408 acres) is already under a protected status. Creating additional freshwater marsh in association with nontidal perennial aquatic habitat in strategic areas; protecting aquatic habitat migration corridors such as canals and drains; and protecting associated upland habitat are expected to maintain or increase the abundance of native associated wildlife and plant species, improve connectivity among habitat areas within and adjacent to the Plan Area, and contribute to the long-term conservation of freshwater marsh-associated covered species.

Nontidal Freshwater Perennial Emergent Wetland Goals and Objectives

Goal NWNC1: The expected outcome is nontidal freshwater perennial emergent wetland natural community that supports habitat for covered and other native species.

> **Objective NWNC1.1**: Create 400 acres of nontidal freshwater marsh (including components of nontidal perennial aquatic and perennial emergent wetland communities) that functions as habitat for the giant garter snake, tricolored blackbird, and western pond turtle within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4 and the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.

Goal NWNC2: The expected outcome is biologically diverse nontidal freshwater perennial emergent wetland communities that are enhanced for native species and sustained by ecological processes.

> **Objective NWNC2.1**: Maintain and enhance the habitat functions of protected and created nontidal freshwater perennial emergent wetlands for covered and other native species over the term of the BDCP.

Rationale for Goals and Objectives

Nontidal Freshwater Perennial Emergent Wetland Natural Community Extent and Connectivity

Conservation of nontidal freshwater perennial emergent wetland will occur through the protection and management of agricultural and grassland landscapes throughout the Plan Area that include remnant patches of nontidal emergent wetland, associated canals and streams, and associated upland habitat. Focused conservation will include the creation of 400 additional acres of nontidal freshwater perennial emergent wetland and associated nontidal perennial aquatic habitat within a larger protected landscape. This approach will focus on the protection and expansion of two existing giant garter snake subpopulation centers.

While nontidal freshwater emergent wetland natural community will be protected throughout much of the Plan Area in coordination with the protection of other natural communities (e.g., agricultural lands, grasslands), the conservation strategy for nontidal freshwater perennial emergent wetland and nontidal perennial aquatic natural communities is focused on restoring these communities in areas where the greatest benefit to covered species can be achieved. The strategy involves protecting, enhancing, and restoring these communities primarily for the benefit of two giant garter snake subpopulation centers: the Caldoni Marsh/White Slough subpopulation in Conservation Zone 4 and the Yolo/Willow Slough subpopulation in Conservation Zone 2.

Emergent marsh and associated open water habitat will be created in association with existing occupied habitats to protect and allow for expansion of these subpopulations. Surrounding agricultural lands will be targeted for acquisition in order to build larger contiguous preserves in these areas that support a network of irrigation canals and other aquatic features in addition to the restored wetland habitats within the agricultural matrix of these two areas. In this way, the protected landscape and restored wetland habitats will provide additional aquatic habitat and protect associated movement corridors and upland habitats for these subpopulations.

As these conservation areas are designed, agricultural parcels will be selected based on their proximity and connectivity to occupied sites and opportunities for restoration and enhancement. Restored habitats will be created with appropriate patch sizes and within the existing agricultural matrix to maximize connectivity and the potential for expansion and dispersal. This approach is designed to protect the existing subpopulation centers and create opportunities for the expansion of these subpopulations.

With targeted conservation of 400 acres of nontidal freshwater perennial emergent wetland and perennial aquatic natural communities under the BDCP, approximately 1,948 acres of the combined communities would be protected, an 18 percent increase in the extent of protected habitat of these types. Additional protection will occur in conjunction with the conservation of other natural communities and through enhancement and management of those natural communities. For the implementation schedule of nontidal marsh restoration, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Nontidal Freshwater Perennial Emergent Wetland Function

Biologically Diverse Nontidal Freshwater Perennial Emergent Wetland. All patches of nontidal freshwater perennial emergent wetland natural community mapped in the Plan Area are dominated by broad-leaf cattail (Hickson and Keeler-Wolf 2007). Other plant species frequently found in Plan Area nontidal freshwater perennial emergent wetlands include tules, bulrushes, sedges, rushes, and other emergent plant species.

The nontidal freshwater perennial emergent wetland natural community is among the most productive wildlife habitat in California (DFG 2005) providing primary productivity through its aquatic food web; aquatic habitat for native fish, amphibians, and reptiles; food, cover, and water for mammals, reptiles, amphibians, and birds; and vegetation structure for predator avoidance and nesting of wildlife. Some species, such as BDCP covered giant garter snake, rely on freshwater emergent wetlands for their entire life cycle. The BDCP covered California red-legged frog uses this natural community as breeding habitat; and migrating waterfowl use it as foraging and loafing habitat.

These ecological functions provided by nontidal freshwater perennial emergent wetlands in the Plan Area are limited by habitat fragmentation and small patch sizes. Protection and creation of this natural community will focus on reestablishing these functions within the two giant garter snake preserves and elsewhere on preserved BDCP lands.

Created and protected nontidal freshwater perennial emergent wetland areas will be actively managed to promote high value wetland habitat. These areas will require regular monitoring and periodic manipulation of herbaceous emergent vegetation and possibly floating aquatic vegetation to maintain the appropriate balance of open water and vegetation components that will benefit BDCP covered species. Because the sites occur within agricultural areas, they will require careful management and monitoring of some agricultural practices, such as aerial application of pesticides and fertilizers, water control, and maintenance of buffers. Nonnative centrarchid fish (bass and sunfish) and bullfrog are known predators of giant garter snake and western pond turtle, and their populations may need to be periodically controlled. Additionally, the nontidal freshwater perennial emergent wetland community may be invaded by nonnative animals such as cowbirds and feral cats, as well as nonnative plants, such as ludwigia, that can have adverse effects on native wildlife. Management methods to reduce or eliminate populations of nonnative animals and plants will be developed and implemented.

Species Protection. Agricultural lands surrounding two existing giant garter snake subpopulation centers will be targeted for acquisition in an effort to establish two 1,000-acre preserves to provide for the conservation of giant garter snake and other nontidal freshwater perennial emergent wetland and agriculture-associated covered species. Freshwater marsh creation will occur within the preserves in selected areas, and the marsh will be designed to build off of existing occupied giant garter snake sites to improve connectivity among habitat areas within and adjacent to the Plan Area. Creation and protection of the preserves is also expected to increase the abundance of other covered species, such as western pond turtle and tricolored blackbird and contribute to the long-term conservation of nontidal freshwater perennial emergent wetland-associated covered species.

Nontidal Freshwater Perennial Emergent Wetland and Climate Change

Sea level rise will affect the location, extent, and composition of the nontidal freshwater perennial emergent wetland natural community, in places where the natural community exists at or below current sea level, as a result of increased water elevation, increased saltwater intrusion, and a tidal hydrological regime. Nontidal freshwater perennial emergent wetland locations existing at water's edge will become more deeply immersed or, in the case of overtopped levees, deeply flooded. Flooded depressions in upland areas presumably already support this natural community, and it is not likely that natural processes in these upland areas would replace the area that will be lost closer to sea level. Implementation of BDCP nontidal freshwater perennial emergent wetland goals and objectives will increase the extent of this natural community and associated habitat services, despite potential losses of this natural community resulting from climate change.

Conservation Measures for Nontidal Freshwater Perennial Emergent Wetland

- CM3 Natural Communities Protection
- CM10 Nontidal Marsh Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.6 Nontidal Perennial Aquatic

The nontidal perennial aquatic natural community can be found in association with any terrestrial community and can occur as isolated ponds or as the open water component of nontidal freshwater perennial emergent wetland and valley/foothill riparian communities. Conservation of nontidal perennial aquatic natural community will occur primarily in conjunction with the creation and protection of nontidal freshwater perennial emergent wetland (See above under *Nontidal Freshwater Perennial Emergent Wetland*).

Historically, the nontidal perennial aquatic natural community occurred primarily in the Yolo, American, and Cosumnes basins and in depressions along the margins of the Plan Area that ponded water for sufficient duration and depth to support areas of open water among emergent aquatic vegetation such as tules, bulrushes, cattails, and other native vegetation. This community provided important open water habitat for waterfowl, other water birds, and many other native species.

The distribution and historical functions of the Delta nontidal perennial aquatic community have been substantially reduced from historical conditions through the effects of agricultural conversion and land management practices resulting in the loss of natural hydrology. Today, the nontidal perennial aquatic community in the Plan Area is largely an artifact of agricultural practices or sites managed to maintain waterfowl habitat. Additionally, because of habitat loss and conversion, many native species that historically used tidal marsh habitats in the Delta are now dependent on remnant or created patches of nontidal perennial aquatic habitat. See Section 2.3.4.6, *Nontidal Perennial Aquatic* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

There are currently 5,341 acres of the nontidal perennial aquatic natural community in the Plan Area, most of which occurs as small fragmented patches along the edges of channels. Approximately 23 percent of this area (1,239 acres) is already under a protected status. Creating additional nontidal perennial aquatic habitat in association with nontidal freshwater perennial emergent wetland in strategic areas, protecting aquatic habitat migration corridors such as canals and drains, and protecting associated upland habitat are expected to maintain or increase the abundance of native associated wildlife and plant species, improve connectivity among habitat areas within and adjacent to the Plan Area, and contribute to the long-term conservation of nontidal perennial aquatic-associated covered species.

Conservation of nontidal perennial aquatic will occur through the protection and management of agricultural and grassland landscapes throughout the Plan Area that include remnant patches of nontidal emergent wetland, associated canals and streams, and associated upland habitat. Focused conservation will include the creation of 400 additional acres of nontidal freshwater perennial emergent wetland (See Objective NWCN1.1) that includes the emergent wetland and associated nontidal perennial aquatic habitat components within a larger protected landscape. This approach will focus on the protection and expansion of two existing giant garter snake subpopulation centers. Agricultural lands surrounding these subpopulation centers will be targeted for acquisition in an effort to establish two 1,000-acre preserves to provide for the conservation of giant garter snake and other freshwater emergent wetland and agriculture-associated covered species. Nontidal freshwater perennial emergent wetland creation will occur within the preserves in selected areas designed to build off of existing occupied giant garter snake sites and improve connectivity among habitat areas within and adjacent to the Plan Area. Creation and protection of the preserves is also expected to increase the abundance of other covered species, such as western pond turtle and tricolored blackbird and contribute to the long-term conservation of nontidal perennial aquatic-associated covered species.

Nontidal Perennial Aquatic Goals and Objectives

Goal NANC1: The expected outcome is nontidal perennial aquatic communities that support habitat for covered and other native species.

Objective NANC1.1. Restore 400 acres of nontidal marsh as per Objective NWNC1.1

Goal NANC2: The expected outcome is biologically diverse nontidal perennial aquatic communities that are enhanced for native species and sustained by ecological processes.

> **Objective NANC2.1**: Maintain and enhance the habitat functions of protected and created nontidal open water habitats for covered and other native species over the term of the BDCP.

Rationale for Goals and Objectives

Nontidal Perennial Aquatic Natural Community Extent and Connectivity

While the nontidal perennial aquatic natural community will be protected throughout much of the Plan Area in coordination with the protection of other natural communities (e.g., agricultural habitats, grasslands), the conservation strategy for nontidal perennial aquatic and nontidal freshwater perennial emergent wetland natural communities is focused on restoring these communities in areas where the greatest benefit to covered species can be achieved. The strategy involves protecting, enhancing, and restoring these communities primarily for the benefit of two giant garter snake subpopulation centers: the Caldoni Marsh/White Slough subpopulation in Conservation Zone 4 and the Yolo/Willow Slough subpopulation in Conservation Zone 2.

Nontidal freshwater perennial emergent wetland and associated open water habitat will be created in association with existing occupied habitats to protect and allow for expansion of these subpopulations. Surrounding agricultural lands will be targeted for acquisition in order to build larger contiguous preserves in these areas that support a network of irrigation canals and other aquatic features in addition to the restored wetland habitats within the agricultural matrix of these two areas. In this way, the protected landscape and restored wetland habitats will provide additional aquatic habitat and protect associated movement corridors and upland habitats for these subpopulations.

As these conservation areas are designed, agricultural parcels will be selected based on their proximity and connectivity to occupied sites and opportunities for restoration and enhancement. Restored habitats will be created with appropriate patch sizes and within the existing agricultural matrix to maximize connectivity and the potential for expansion and dispersal. This approach is designed to protect existing subpopulation centers and create opportunities for the expansion of these subpopulations.

With the additional conservation of 400 acres of nontidal freshwater perennial emergent wetland and perennial aquatic natural communities under the BDCP, approximately 1,948 acres of the combined communities would be protected, an 18 percent increase in the extent of protected habitat of these types. Protection of giant garter snake upland refuge habitat will be expanded in appropriate areas adjacent to the habitat creation sites. For the implementation schedule of nontidal marsh restoration, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation*.

Native Biodiversity and Nontidal Perennial Aquatic Function

Biologically Diverse Nontidal Perennial Aquatic. A significant ecosystem function of the nontidal perennial aquatic natural community is primary productivity through its aquatic food web. The nontidal perennial aquatic natural community provides habitat for a variety of species, from single-celled organisms to semi-aquatic mammals. There are non-plant primary producers such as diatoms, desmids, and filamentous green algae that often form the base of the nontidal perennial aquatic food web. Zooplankton (e.g., rotifers, copepods, and cladocerans) also live suspended in the water column, grazing on phytoplankton.

Plant species vary with inundation depth and distance from shore. There are submerged aquatics (e.g., native pondweed and invasive nonnative Brazilian waterweed) and floating aquatics (e.g., native duckweed and invasive nonnative water hyacinth). The submerged portions of these plants provide a substrate for smaller algae and cover for smaller aquatic animals, including fish; however, the invasive Brazilian waterweed, Eurasian watermilfoil, and water hyacinth form thick mats that exclude native vegetation and associated wildlife (SFEI 2003).

A variety of aquatic insects use the nontidal perennial aquatic natural community for their larval stage. Wildlife species that use the nontidal perennial aquatic natural community for resting and foraging include waterfowl, shorebirds, semi-aquatic mammals (e.g., beaver, muskrat, and river otter), piscivorous birds (e.g., bald eagles and osprey), and insectivorous birds and bats that prey on insects that gather over open water. Small ponds of the nontidal perennial aquatic natural community can also serve as brooding habitat for ducks nesting in nearby upland habitats. Some water-dependent species, such as BDCP covered western pond turtle, require adjacent upland, riparian woodlands, or emergent wetlands for cover or nesting habitat.

Species Protection. Created and protected nontidal perennial aquatic habitat will be actively managed to promote high habitat function for giant garter snake and western pond turtle. These areas will require regular monitoring and periodic manipulation of herbaceous emergent vegetation and possibly floating aquatic vegetation to maintain the appropriate balance of open water and vegetative components. Because the sites occur within agricultural areas they will require the careful management and monitoring of some agricultural practices, such as aerial application of pesticides and fertilizers, water control, and maintenance of buffers. Nonnative centracharid fish (bass and sunfish) and bullfrog are known predators of giant garter snake and western pond turtle and their populations may need to be periodically controlled. Additionally, the nontidal perennial aquatic habitat may be invaded by nonnative plants, such as ludwigia, that can have adverse negative effects on native wildlife. Management methods to reduce or eliminate populations of the nonnative animals and plants will be developed and implemented.

While designed specifically to meet the ecological requirements of giant garter snake, restored freshwater marshes will also provide habitat for other aquatic and marsh-associated covered species, such as the western pond turtle and tricolored blackbird.

Nontidal Perennial Aquatic and Climate Change

Sea level rise will affect the location, extent, and composition of the nontidal perennial aquatic natural community, in places where the natural community exists at or below current sea level, as a result of increased water elevation, increased saltwater intrusion, and a tidal hydrological regime. Flooded depressions in upland areas presumably already support this natural community, and it is not likely that natural processes in these upland areas would replace the area that will be lost closer to sea level. Implementation of BDCP nontidal perennial aquatic goals and objectives will increase the extent of the natural community and associated habitat services, despite potential losses of this natural community resulting from climate change.

Conservation Measures

- CM3 Natural Communities Protection
- CM10 Nontidal Marsh Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.7 Valley/Foothill Riparian

Valley/foothill riparian natural community historically occurred above the tidal zone along the margins of the Delta, except in the Cache Slough area and eastern Contra Costa County, on the eastern margin of the Yolo Basin, and along channels and sloughs of the Sacramento and San Joaquin rivers. Since reclamation and levee construction began under the Swamp and Overflow Land Act of 1850, substantial reductions in the extent, distribution, and condition of valley/foothill riparian communities from agricultural conversion, stream channelization, and urbanization have reduced the extent and diversity of valley/foothill riparian natural community for associated covered and other native plant and wildlife species.

Currently, the valley/foothill riparian natural community represents less than 4 percent of the total acreage in the Plan Area. In general, riparian communities do not occur in large patches as do other vegetation types. Instead, they tend to be distributed across the landscape as narrow corridors along watercourses or as isolated remnant patches near watercourses. The majority of the valley/foothill riparian natural community occurs as blackberry scrub, or willow/blackberry scrub with occasional patches of cottonwood, willow and oak trees. The largest patches are associated with levee blowouts on Delta Islands that lead to the establishment of isolated patches of willow scrub.

The main riparian corridors in the Plan Area are found along the San Joaquin, Sacramento, Old, Middle, and Mokelumne rivers, with the Sacramento River currently supporting the smallest extent of valley/foothill riparian natural community due to extensive engineered levees. Some smaller drainages, such as Putah Creek and Elk Slough, retain relatively continuous but narrow corridors of riparian woodland. These remnant riparian communities, while highly degraded relative to their historical occurrence, continue to provide habitat for several BDCP covered species, including riparian brush rabbit, Swainson's hawk, white-tailed kite, yellow-breasted chat, yellow-billed cuckoo, and valley elderberry longhorn beetle.

Valley/foothill riparian natural community currently covers a total of 17,338 acres in the Plan Area. Most of this acreage is distributed among Conservation Zones 2 through 7, with smaller amounts in the other 5 conservation zones. In Conservation Zones 2 and 4, most of the acreage of existing valley/foothill riparian natural community is already protected. In Conservation Zone 3, however, less than 1 percent of the total 2,080 acres of valley/foothill riparian natural community is currently protected. Of the total 17,338 acres of valley/foothill riparian natural community existing in the Plan Area, 5,339 acres (30.8 percent) are under protected status. See Section 2.3.4.5, *Valley/Foothill Riparian* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

Conservation of valley/foothill riparian natural community will be achieved through the restoration of 5,000 acres of riparian forest and scrub in Conservation Zones 1, 2, 4, 5, 7, and/or 11. Riparian habitat will be restored in conjunction with tidal habitat, floodplain habitat, and channel margin restoration activities and through directed planting to restore habitat specifically for riparian brush rabbit.

Riparian Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.2**: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Rationale for Goals and Objectives

Riparian Natural Community Extent and Connectivity

Restoration of valley/foothill riparian natural community will occur in restored floodplains and along main channels. This is expected to establish a more natural ecological gradient extending from shallow subtidal aquatic to upland transitional habitats. Along with BDCP conservation of other natural communities, valley/foothill riparian restoration will increase the abundance and distribution of associated native wildlife and plant species; improve connectivity among habitat areas within and adjacent to the Plan Area; improve genetic interchange among native riparian-associated species' populations; provide nutrients and food to adjacent aquatic habitats; and contribute to the long-term conservation of riparian-associated BDCP covered species.

Priority for restoration will be given to sites that provide a range of environmental gradients; increase connectivity between preserve lands; and provide additional habitat for species with currently very limited distributions. Under the goals and objectives for valley/foothill riparian natural communities, 5,000 acres will be restored with the aim of providing a full range of seral stages. Riparian restoration will be conducted in association with the restoration of tidal and nontidal wetlands, seasonally inundated floodplains, and channel margin enhancement, reestablishing a greater degree of hydrological connectivity with riparian areas, naturally promoting the regeneration and establishment of native plants, including willow-dominated scrub.

Most of the riparian restoration in the Plan Area will be in restored seasonally inundated floodplain habitat and associated with tidal restoration in Conservation Zone 7, where currently only 4.5 percent is under protected status. Restoration will also be implemented in Conservation Zones 1-6 associated with tidal habitat restoration and channel margin enhancement. On restored floodplains, restoration will be in large patches (typically over 100 acres) while restoration associated with tidal habitat and channel margins will be mostly long and narrow patches. Following restoration and other BDCP actions, the amount of valley/foothill riparian natural community in the Plan Area under protected status will be increased by 80 percent. For the implementation schedule of valley/foothill restoration, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Valley/Foothill Riparian Function

Biologically Diverse Riparian Communities. Under a regime of natural disturbances, primarily flooding, riparian natural communities tend to vary widely in terms of both vegetation composition and structure. For example, willow thickets and mature riparian gallery forests represent riparian communities at different seral stages. Obligate and facultative riparian species may use all or only a subset of riparian communities. For example, least Bell's vireo is more likely to occur in willow-dominated riparian; yellow-breasted chat is more likely to occur in dense riparian scrub with a relatively sparse overstory; and yellow-billed cuckoo is more likely to occur in a relatively dense cottonwood/willow forest. To meet the ecological requirements of riparian-associated covered species, habitat management activities will focus on maintaining the full range of riparian communities and processes that support those communities. Existing riparian natural communities protected in BDCP conservation lands are expected to be somewhat degraded due to past or current land use practices and the spread of nonnative plants. Riparian communities will be enhanced using techniques tailored to vegetation type and site. Enhancement techniques and frequencies and intensities of application will be informed by baseline surveys, effectiveness monitoring, and targeted studies. Techniques that could be used to enhance riparian communities include but are not limited to cattle exclusion, selective application of herbicides, mowing, mechanical removal, and supplemental seeding of natives. Enhancing riparian communities within the BDCP conservation lands will likely require applying a number of these management techniques simultaneously at different sites.

Riparian passerine birds including least Bell's vireo have been adversely affected by habitat loss and cowbird parasitism. Management of riparian natural communities will address the impact of cowbird parasitism, based on site-specific conservation objectives, the documented extent of parasitism, and its impacts on the locally-occurring native species. Management of cowbird parasitism may involve cowbird trapping as appropriate.

Species Protection. Riparian restoration will create additional habitat and potential for local range expansion of several species including riparian woodrat, riparian brush rabbit, Townsend's big-eared bat (roosting and foraging), yellow-breasted chat, least Bell's vireo, western yellow-billed cuckoo, Swainson's hawk (nesting), white-tailed kite (nesting), western pond turtle, valley elderberry longhorn beetle, slough thistle, Delta button-celery, Suisun Marsh aster, and side-flowering skullcap, delta smelt, all runs of Chinook salmon, and Central Valley steelhead.

Several of the covered terrestrial wildlife species are riparian obligate birds and mammals. This is true of the riparian woodrat and the riparian brush rabbit among mammals, and the yellow-breasted chat, yellow-billed cuckoo, and least Bell's vireo among birds. Other terrestrial wildlife species use riparian natural communities extensively. Swainson's hawk and white-tailed kite forage in open country, but nest in tall trees, often in patches of riparian forest.

For all of the BDCP covered species listed above, as well as numerous other native riparian species, population declines and/or range contractions have been linked mainly or exclusively to loss of riparian habitat. The restoration of 5,000 acres of riparian natural communities in the Plan Area represents an important, positive development toward the conservation of all those species. Crucial to the conservation of the riparian woodrat and the riparian brush rabbit in particular is habitat restoration and management in Conservation Zone 7, where most of the riparian restoration will be implemented with most of it in large patches.

Restoration and protection of riparian natural communities with connectivity between them will provide an opportunity for some species to recolonize some of their historical distribution. These riparian corridors will also provide important connectivity for wildlife movement among various other natural communities within and adjacent to the Plan Area.

Riparian and Climate Change

Future climate change can affect the valley/foothill riparian natural community in a number of ways. Increased variability in precipitation will change the timing, duration, and magnitude of Delta inflows, resulting in more intense winter flooding and greater erosion of riparian habitats (Field et al. 1999, Hayhoe et al. 2004). Increased variability in precipitation can also produce prolonged droughts, making riparian vegetation more prone to fires.

A rise in sea level can affect the valley/foothill riparian natural community through increased water elevation and increased salt water intrusion. As water levels rise, riparian vegetation at the water's edge will become more frequently flooded, causing species intolerant of longer inundation periods to migrate upslope if suitable habitat is present. Changes in channel water salinity may also cause species shifts. Implementation of BDCP valley/foothill riparian goals and objectives can improve the extent, and thus potential resilience, of this natural community in the face of climate change.

Conservation Measures for Valley-Foothill Riparian

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM5 Seasonally Inundated Floodplain Restoration
- CM6 Channel Margin Habitat Enhancement
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.8 Grassland

Although California native grassland originally covered one-quarter of the land mass of the state (Barbour et al. 2007, Stromberg 2010), it has recently been identified as one of the twenty most endangered ecosystems in the United States (Noss et al. 1995). Once occurring in the Central Valley as widespread, species-rich prairies (Keeler-Wolf et al. 2007) with a high density of perennial grasses, valley grasslands today are highly-fragmented and dominated by nonnative annual grasses and other species. In the Plan Area, valley grassland comprises one of the two most common natural or seminatural vegetation communities, occupying approximately one-fourth of non-cultivated lands.

Direct and indirect anthropogenic influences on this landscape have resulted in the reduction, conversion, and fragmentation of valley grassland. These changes in turn have led to diminished ecological conditions necessary to sustain a well-functioning grassland natural community. Degradation of grassland quality and quantity has contributed to almost complete conversion of the vegetation community from perennial to annual grasses in less than two centuries.

Many native grassland species have been reduced in abundance or distribution through these processes. However, native plant species remain rich in number, persisting and coexisting with nonnative plants in traditional locations within remaining grasslands. Some animal species have also adjusted well to the new type of grassland. Thus, the current grassland community still offers highly valuable habitats to many grassland dependent species. See Section 2.3.4.12, *Grassland* in Chapter 2*, Existing Ecological Conditions,* for more detail on the current state of this natural community.

Conservation of grassland has three general intentions: increase grassland extent and connectivity to improve habitat quantity; recover native biodiversity at every level; and restore ecological functions necessary to sustain this natural community.

Grassland Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

> **Objective GRNC2.3**: Increase opportunities for wildlife movement through grassland habitat.

> **Objective GRNC2.4**: Increase burrow availability for burrow-dependent species.

> **Objective GRNC2.5**: Increase prey, especially small mammals and insects, for grassland-foraging species.

Rationale for Goals and Objectives

Grassland Natural Community Extent and Connectivity

In determining the aerial extent and spatial configuration of grasslands to be conserved, the following criteria were considered: habitat value of the grasslands that currently exist within the Plan Area; ecological and evolutionary processes that sustain grasslands; spatial and functional needs of covered grassland species, including genetic exchange; and projected impacts on grasslands resulting from implementation of the BDCP.

Large contiguous grasslands within the Plan Area are present in Conservation Zones 1, 2, 4, 6, 8, and 11. Zones 3, 5 and 7 contain few large patches of grassland and Zones 9 and 10 have many small fragments of grassland distributed throughout a matrix of urban and agricultural land cover. Of those zones with areas of large existing grasslands, grassland in Zones 2 and 4 have largely been protected. 76 percent of the grassland in Zone 2 (Yolo Bypass Wildlife Area) and 67 percent of the grassland in Zone 4 (Stone Lakes NWR and Cosumnes River Preserve) are currently protected.

Zone 6 contains large areas of unprotected grasslands, but the zone is in the deeply subsided portion of the Delta and is intersected by large channels that make connection to adjacent islands impossible. The fact that the grasslands occur on deeply subsided areas also makes them susceptible to future levee failures and does not allow for the establishment of natural environmental gradients of uplands to marsh and aquatic habitats. Grasslands in this zone do not support many covered species.

Most critical for grassland conservation are Zones 1, 8, and 11. These zones are situated at the periphery of the Delta where elevations are suitable for upland habitats adjacent to restored tidal habitats. Protection and enhancement of grasslands adjacent to restored tidal marsh habitats would reestablish one of the most important historical environmental gradients (along the water-land interface) that has been largely lost due to construction of levees and reclamation of wetlands. These areas will also be more able to adapt to changes in sea level because they are at higher elevations. Grasslands in these zones also often co-occur with vernal pool complex or alkali seasonal wetland natural communities. Some protected grasslands in Zones 1 and 11 can be conserved to build upon existing and planned preserves between these two zones in Solano County. Protection of additional grasslands in this area will protect an important connection between Suisun Marsh and the Cache Slough area. Zone 8 has little protected grassland but is located near important areas for conservation that were identified in the East Contra Costa County HCP/NCCP. Habitats in these three zones support a variety of BDCP covered species and are especially important areas in the Plan Area for vernal pool plant and animal species, California tiger salamander, western burrowing owl, and rare grassland plant species. In addition to providing habitat for these species, Zone 8 supports and is adjacent to the best habitats in the Plan Area for California red-legged frog and San Joaquin kit fox.

Currently approximately 17 percent of grassland in Zones 1, 8, and 11 is protected. With the additional conservation of 8,000 acres of grassland that is proposed under the BDCP, approximately 74 percent would be protected. This would put habitat conservation in these areas on par with Zones 2 and 4 (76 percent and 67 percent, respectively).

Priority for restoration will be given to sites that provide a range of environmental gradients and increase connectivity between preserve lands. Under the BDCP, 65,000 acres of tidal habitats will be restored which include subtidal, intertidal, and transitional upland habitats. Lands acquired for restoration of these tidal habitats will include regions of higher elevation lands that would accommodate sea level rise and would also contribute to the goals and objectives for the grassland natural community. These lands would be considered high priority for grassland restoration. For the implementation schedule of grassland restoration and protection, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Grassland Function

Biologically Diverse Grasslands. Valley grassland is species-rich, with 50 plant species commonly found in 30 x 30 m plots (Heady et al. 1991). Grassland plant species exist in patches of plant communities called (vegetation) alliances, which are unevenly spread throughout the grassland and sometimes extend into other nearby natural communities as well. Valley grassland is an extremely productive natural community, but is still not well understood.

Before the introduction of livestock grazing and modern agriculture practices, alliances characterized by perennial grasses were common in the Central Valley. Barry (1972) estimated that 99 percent of the pre-contact purple needlegrass (*Nassella pulchra*) alliance has disappeared in the valley grassland community. While its historical extent and abundance are still under debate (and classification of sub-communities (associations) under this alliance remains incomplete), it is assumed that various patches of perennial grasses, many in bunch form, and associated forbs, were widely distributed in the Central Valley (D'Antonio et al. 2007) before changes in land use affected this natural community. Native grassland vegetation alliances are likely to be found within the BDCP conservation lands, but these grasslands are expected to be degraded (i.e., low relative cover of native species) due to past and current land uses practices (e.g., deep soil disturbance and heavy grazing) and the competitive spread of nonnative plants.

Many grasslands to be conserved in the Plan Area will require intensive management that mimics natural pressures on the system; however, where possible, natural ecological processes will be allowed to influence grassland structure, succession, and heterogeneity. Historically, herbivory and fire determined native grass vigor and distribution. Wind exacerbates arid conditions characteristic of valley grasslands, and wind spreads fire, which likely maintained historical grassland extent and distribution, and contributed to the mosaic of vegetation alliances and structure, in turn determining patch dynamics of animal habitats. Natural ecological processes should be allowed to drive structure and dynamics in BDCP grasslands as much as possible.

Species Protection. In the Plan Area, there is now a limited distribution of purple needlegrass, along with several other alliances of perennial grass. Another bunchgrass, alkali sacaton (*Sporobolus airoides*), is often found on alkali or sodic stratum. In contrast, stolonous (non-bunching) creeping rye-grass (*Leymus triticoides*) covers wetter areas at the margins of riparian and emergent wetland communities. Valley grasslands, in this sense, exist as transitional zones which reflect underlying environmental gradients and create ecotones in the Bay Delta region.

Recent studies show that purple needlegrass influences soil chemistry and soil structure and contributes to underground soil heterogeneity (Parker and Schimel 2010), which is already enriched by critical microorganisms (fungi, bacteria, nematodes) and bioturbation by burrowing rodents. In native grasslands, these subterranean processes in turn contribute to diversity of flora composition above ground. On the other hand, local homogenization of soil properties caused by annual nonnative grasses are thought to create a feedback loop that encourages their invasion.

Grassland communities in the Plan Area exhibit complexity and diversity at all spatial scales, and perennial grasses and related ecological processes play a pivotal role in dynamically sustaining that complexity. Successful restoration of grassland alliances, especially those comprised of native perennial grasses will likely benefit not only the characteristic species, but valley grasslands as integrated communities (as well as nearby natural communities) by promoting essential ecological functions.

The grassland flora of the Central Valley and Bay Delta evolved under the influence of prehistoric herbivores, for example large herds of deer, elk, pronghorn, and other grazing animals. Although dense concentrations of most of these large mammals and their predators are no longer present, deer and medium-sized carnivores (e.g., gray fox, coyote) still inhabit the Plan Area. Herbivores and carnivores with a propensity to move widely will especially benefit from increases in the extent and connectedness of grasslands. This goal is underscored by the California Essential Wildlife Connectivity Project (Spencer et al. 2010), an interagency, multi-stakeholder effort steered by DFG and Caltrans to identify, map, and implement wildlife movement corridors and habitat linkages throughout the State. Twenty-four of the 192 “Essential Connectivity Areas” identified by this project occur in the Central Coast Ecoregion of the state with six of these in or adjacent to the Plan Area. In the Central Coast Ecoregion, the landcover in the identified Essential Connectivity Areas is 25 percent grassland or herbaceous, second only to the Great Central Valley in the representation of this landcover type within important wildlife movement corridors.

A large proportion of animal species that inhabit grasslands are either fossorial or burrow-dependent, attributes which provide access to constant underground habitats, presumably for temperature regulation and for protection from fire and predators. Some fossorial grassland mammals can be considered keystone species because the burrows they dig are critical to the survival of many other species and essential for a well-functioning grassland community. For example, California ground squirrels excavate burrows that provide substantial benefits to native covered species, including San Joaquin kit fox (den sites), western burrowing owl (nesting and roosting habitat), and California red-legged frog, California tiger salamander, and western spadefoot toad (upland aestivation sites). Unfortunately, ground squirrels have been the target of widespread poisoning campaigns in California where they threaten levees or are perceived as pests. Loss and fragmentation of grasslands have also reduced ground squirrel distribution and abundance. By increasing the extent of grassland, and the abundance and distribution of host burrowers, many native species will benefit.

Grasslands in the Plan Area provide foraging habitat for predators by supporting populations of small animals (mice, voles, rabbits, insects, amphibians, reptiles) on which they prey. Sufficient prey populations are critical to the health and persistence of predator populations. Enhancing the extent and abundance of rodent, lagomorph, and insect (e.g., grasshopper) populations will increase the prey base for San Joaquin kit fox and other carnivores, and raptor species, including Swainson's hawk, western burrowing owl, and white-tailed kite. Grassland conservation and restoration will also help to offset impacts to agricultural lands that produce prey for covered species.

Other ecological factors, in addition to the size and density of rodent populations, may limit populations of covered species in the Plan Area. For example, the population of San Joaquin kit fox may be limited by mortality from road kill, poisoning, coyote predation, or competition from nonnative red foxes (U.S. Fish and Wildlife Service 1998). However, there is evidence in other parts of the kit fox range that abundance of prey affects reproductive success (Egoscue 1975; White and Ralls 1993). Although research to date suggests that prey abundance is important, a lack of studies in the northern portion of the kit fox range contributes to uncertainty about the efficacy of this conservation measure in BDCP grasslands.

Because of this uncertainty, adaptive management and targeted studies are required to understand factors controlling kit fox and other predator populations and to improve management techniques. Pilot studies of management methods that enhance the rodent prey base will be conducted through the Adaptive Management Program, and effective management measures will be incorporated into grassland management actions.

Grasslands and Climate Change

The most decisive factor determining grassland presence or absence is soil water accessibility (Bartoleme et al. 2007). In the Plan Area, precipitation greatly influences soil water level and accessibility at any given location. Seasonal and annual variations in rainfall amount and pattern are vast in this region, and valley grasslands respond significantly to such stochastic fluctuations. For example, an area dominated by lush grasses in a rainy year may exhibit a vivid display of wildflowers the following spring. Therefore, it is expected that valley grasslands will be influenced, perhaps in unexpected ways, by near-future and long-term climate change. Implementation of all BDCP goals and objectives for grassland, especially promotion of underground processes, is expected to substantially improve the flexibility and resilience of this natural community and contribute to its persistence.

Conservation Measures for Grasslands

- CM3 Natural Communities Protection;
- CM8 Grassland Communities Restoration; and
- CM11 Natural Communities Enhancement and Management.

3.3.2.2.9 Alkali Seasonal Wetland Complex

The alkali seasonal wetland complex natural community is distributed within or adjacent to grasslands and adjacent to tidal marshes and oak savanna. It is associated with seasonally saturated alkali soils along the northwestern and southwestern margins of the Delta and around the perimeter of Suisun Marsh. Alkali seasonal wetland complex was once very common in the Central Valley and portions of the Plan Area; however, conversion of land to agriculture, waterfowl habitat, and commercial and urban land use has eliminated or degraded the habitat functions of the alkali seasonal wetland complex natural community through direct removal of vegetation, removal of watershed topography by leveling of the land, and the establishment of nonnative plants. For example, in east Contra Costa County the historical extent of this community has been reduced from 8,800 acres to 2,720 acres, 30 percent of its historical extent (SFEI 2010). These reductions in the extent, distribution, and condition of alkali seasonal wetland complex have reduced the diversity of native plant species uniquely associated with alkali soils and habitat for associated covered and other native wildlife species.

There are approximately 3,723 acres of alkali seasonal wetland complex natural community in the Plan Area that generally exist as two contrasting DFG vegetation types. One type, which is by far the most extensive, is dominated by perennial saltgrass (*Distichlis spicata*); while the other type is rare, covers approximately 260 acres, and is dominated by woody iodine bush shrubs. Saltgrass grasslands are typically characterized by having low productivity and are grazed by both native wildlife and domestic livestock. Because saltgrass is a prostrate grass it creates a visually open habitat that provides foraging habitat for raptors. Iodine bush habitat provides a structurally diverse habitat with open areas of salt scalds and very low herbaceous vegetation for foraging by wildlife as well as closed canopy shrub-dominated areas for cover. See Section 2.3.4.8, *Alkali Seasonal Wetland Complex* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

Currently 2,769 acres (74 percent) of alkali seasonal wetland complex natural community in the Plan Area are in a protected status. Protecting and enhancing additional alkali seasonal wetland complex natural community in conjunction with adjoining natural communities is expected to maintain or increase the abundance of native wildlife and plant species, improve connectivity among habitat areas within and adjacent to the Plan Area, and contribute to the long-term conservation of alkali seasonal wetland complex and grassland natural communities associated covered species.

Alkali Seasonal Wetland Goals and Objectives

Goal AWNC1: The expected outcome is protected alkali seasonal wetland complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective AWNC1.1**: Protect 400 acres of alkali seasonal wetland complex natural community in Conservation Zones 1, 8, and/or 11.

Goal AWNC2: The expected outcome is biologically diverse alkali seasonal wetland complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective AWNC2.1**: Maintain and, where habitat functions for covered species can be increased, increase the diversity and relative cover of native grasses and forbs.

Rationale for Goals and Objectives

Alkali Seasonal Wetland Natural Community Extent and Connectivity

In determining the extent and spatial configuration of alkali seasonal wetland complex natural community to be conserved, the following criteria were considered: the habitat value of alkali seasonal wetland complex that currently exists within the Plan Area; the spatial and functional needs of covered species that use alkali seasonal wetland complex; and the projected impacts on alkali seasonal wetland complex resulting from the implementation of the BDCP. Under the alkali seasonal wetland complex natural community goals and objectives, 400 acres of the community will be protected in Conservation Zones 1, 8, and/or 11, which correspond to the same areas where impacts will occur.

Additionally, alkali seasonal wetland complex natural community in Conservation Zones 1, 8, and 11 is situated at elevations that are suitable for serving as upland habitats adjacent to restored tidal habitats; and in Conservation Zones 1 and 11 can be protected to enhance the spatial extent and connectivity of existing and planned preserves in Solano County that span tidal and upland habitats. Further, the protection of additional alkali seasonal wetland complex natural community in this area will protect the habitat connectivity between Suisun Marsh and Cache Slough and maintain its function as a movement corridor for wildlife.

Protection of 400 acres of alkali seasonal wetland complex natural community under the BDCP will prevent the removal or degradation of these alkali seasonal wetlands from future changes in land use. Even though 74 percent of the current extent of this natural community is protected, it is a rare community that warrants further protection. Its current extent is only a small fraction of its historical extent before it was converted to other land uses; therefore, preserving as much remaining area as possible is important for preserving the biota and preserving the hydrological function of the alkali seasonal wetland complex natural community which requires a more extensive watershed than the vernal pool complex natural community. Following full implementation of the BDCP, the extent of protected alkali seasonal wetland complex natural community in the Plan Area will be increased from 2,769 acres to 3,112 acres, a 12 percent net increase accounting for the loss of 57 acres of protected alkali seasonal wetland complex. For the implementation schedule of alkali seasonal wetland complex protection, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Alkali Seasonal Wetland Complex Natural Community Function

Biologically Diverse Alkali Seasonal Wetland Complex. While alkali seasonal wetland complex natural community may be perennial grassland that is dominated by saltgrass or woody scrub dominated by iodine bush, it typically has a diverse forb component that consists of spring vernal pool-like vegetation in areas of heavy clay or salt scalds followed by summer flowering tarweeds, tarplants (*Hemizonia* and *Holocarpha* spp.), *Atriplex* (*Atriplex* spp.) and perennial gumplant (*Grindelia* spp.). They also support diverse assemblages of native ground-nesting bees and other important pollinators for both native and agricultural plant species. Saltgrass is found in most areas of alkali seasonal wetland complex natural community, while the iodine bush shrub is found within the Plan Area only near the Clifton Court Forebay. The saltgrass-dominated areas generally provide a lower, non-woody physical structure with relatively fast nutrient and carbon cycling. The iodine bush-dominated areas tend to have a patchy distribution of shrubs, providing greater structural variation and relatively slower carbon cycling

Enhancement and management of protected alkali seasonal wetland complex natural community is expected to improve native biodiversity and enhance the function of this natural community for covered and other species. Careful planning will be required to resolve uncertainties regarding appropriate management regimes for this community type in the context of a larger diverse and managed landscape. Alkali seasonal wetland complex natural community in the Plan Area is generally interspersed with or adjacent to grassland and vernal pool complex, and all three communities are generally managed together within large pastures. There is very little information available regarding the appropriate management of alkali seasonal wetland complex per se, but there is one long-term grazing study available for mixed exotic annual and saltgrass perennial grassland for the Jepson Prairie area (Swiecki and Bernhardt 2008). To resolve this general lack of information, enhancement techniques and effective application frequencies and intensities will be informed by baseline surveys, effectiveness monitoring, and targeted research. Techniques that could be used to enhance alkali seasonal wetland complex within the context of the other communities include but are not limited to: appropriate grazing regimes including grazing exclusion, prescribed burning, and the appropriate use of herbicides to control invasive nonnative plant species. Enhancing the alkali seasonal wetland complex natural community will likely require applying multiple management techniques simultaneously and the spatial separation of some of the techniques.

Species Protection. Brittlescale and heartscale habitat consists of ephemeral drainages within the alkali seasonal wetland complex natural community, while Delta button-celery occupies clay flats that periodically flood. Specific habitat acreage requirements for brittlescale, heartscale, and Delta button-celery are necessary to ensure that the specific habitat conditions required by these species are included within the alkali seasonal wetland complex natural community that will be protected (see Species Goals and Objectives). Other BDCP covered species expected to benefit from alkali seasonal wetland complex natural community protection and enhancement include San Joaquin kit fox, Townsend's big-eared bat, tricolored blackbird, Suisun song sparrow, western burrowing owl, Swainson's hawk, white-tailed kite, giant garter snake, western pond turtle, California red-legged frog, California tiger salamander, western spadefoot toad, and Carquinez goldenbush. For the implementation schedule of alkali seasonal wetland complex natural community protection and enhancement, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Alkali Seasonal Wetland Complex and Climate Change

Alkali seasonal wetland complex natural community is generally located at elevations that will not be directly inundated by rising sea level, but could be subjected to vegetation changes through altered hydrology in adjacent tidal areas. Another potential impact of climate change would be driven by increased variability in precipitation. The species present in this community are adapted to variable precipitation; and increased variability could lead to changes of the vegetation within the community. Implementation of BDCP alkali seasonal wetland complex natural community goals and objectives can improve the extent, and thus potential resilience, of this community in the face of climatic changes.

Conservation Measures for Alkali Seasonal Wetland Complex

- CM3 Natural Communities Protection
- CM11 Natural Communities Enhancement and Management

3.3.2.2.10 Vernal Pool Complex

The vernal pool complex natural community is characterized by both isolated and interconnected groups of vernal pool wetlands and seasonal swales within the matrix of grassland or alkali seasonal wetland natural communities. Vernal pools in California provide habitat for a number of endemic and rare species (Jain 1979, Jones and Stokes Associates 1990, Skinner and Pavlik 1994, Solomeshch et al. 2007). A single vernal pool may support over 100 species of native plants and animals (USFWS 2005).

Within the Plan Area, there are 6,954 acres of vernal pool complex, of which 68 percent is found in the grassland natural community, 31 percent is found in the alkali seasonal wetland complex, and 1 percent is found in other natural community types. The vernal pool complex is uncommon in the Plan Area, found only in a few locations along the very margin of the Plan Area. Vernal pools are found west of the Sacramento River from Putah Creek south to the gently sloped terraces immediately to the north and east of the Montezuma Hills; on the north and eastern margins of Suisun Marsh; east of the Sacramento River in the Stone Lakes area; and west of the San Joaquin River from Byron to Discovery Bay (Witham 2003, ESA 2005, Leigh Fisher

Associates 2005, Williamson et al. 2005, Witham 2006, Baraona et al. 2007, Kleinschmidt Associates 2008, Rains et al. 2008). See Section 2.3.4.9, *Vernal Pool Complex* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

Conversion of land for agricultural and urban uses has eliminated or degraded the habitat functions and value of vernal pool complex natural community through direct the removal of vegetation, the elimination of vernal pool watershed topography with land leveling, and disruption of natural seasonally hydrology by flood irrigation. The reduction in the extent, distribution, and condition of vernal pools has reduced the diversity of native vernal pool plant species such as BDCP covered alkali milk-vetch, Heckard's peppergrass, and legenere. It has also eliminated habitat for associated covered and other native wildlife species such as BDCP covered vernal pool shrimp species.

Of the 6,958 acres of vernal pool complex in the Plan Area, 4,379 acres (63 percent) is currently under protected status. Preserving, restoring, and enhancing additional remaining vernal pool complex in conjunction with surrounding grassland habitats is expected to further maintain or increase the abundance of native wildlife and plant species, improve connectivity among habitat areas within and adjacent to the Plan Area, and contribute to the long-term conservation of vernal pool- and grassland-associated covered species, including western spadefoot toad, California tiger salamander, vernal pool shrimp species, and various vernal pool plant species.

Vernal Pool Complex Goals and Objectives

Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective VPNC1.1**: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.

Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective VPNC2.1**: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.

> **Objective VPNC2.2**: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.

Rationale for Goals and Objectives

Vernal Pool Complex Natural Community Extent and Connectivity

In determining the extent and spatial configuration of vernal pool complex natural community to be conserved, the following criteria were considered: the habitat value of the community that currently exists within the Plan Area; the extent and distribution of the community that is currently under protected status; the spatial and functional needs of covered species that use the community as habitat; and the projected impacts on the community resulting from implementation of the BDCP. Under the vernal pool complex natural community goals and objectives, 300 acres of vernal pool complex will be protected and 200 acres of vernal pool complex will be restored in Conservation Zones 1, 8, or 11.

Vernal pool complex natural community is distributed within or adjacent to a variety of natural communities on relatively impermeable soils in shallow basins and drainages on level terrain along the margins of the Plan Area. In the Plan Area, the vernal pool complex natural community consists of four fairly uniform types: annual grassland vernal pools in the Stone Lakes area; clay alluvium vernal pools and playa pools running from Putah Creek south to Cache Slough; Montezuma Block vernal pools and playa pools in the Jepson Prairie/Montezuma Hills area; and alkaline sink/meadow vernal pools in the Byron/Clifton Court Forebay area.

These areas are generally at the margins of the species distributions where the vernal pool complex natural community transitions into other natural communities such as tidal brackish or tidal freshwater emergent wetland. The community can also grade into the agricultural habitat natural community where its unique characteristics are blurred to varying degrees by human driven impacts such as land leveling and ripping, altering the supply of water through flood irrigation.

BDCP actions will increase the amount of extant vernal pool complex natural community in protected status in the Plan Area by 300 acres from a current 4,379 acres, or 63 percent, to 4,679 acres, or 67 percent of the total 6,959 acres of vernal pool complex. The BDCP will also restore and additional 200 acres of vernal pool complex natural community in the Plan Area. The net increase in area of both restored and protected vernal pool complex, accounting for a small loss of lower quality vernal pool complex, will result in a total of 4,849 acres vernal pool complex in protected status.

All of the vernal pool complex natural community in the Plan Area is found within Conservation Zones 1, 4, 8, 9, and 11. Most of the community present in Conservation Zone 4 is already protected; while in Conservation Zone 9, it consists of small patches that are isolated among developed areas and agricultural land. Vernal pool complex natural community in Conservation Zones 1, 8, and 11 is situated at elevations that are suitable for serving as upland habitats adjacent to restored tidal habitats and additionally, in Conservation Zones 1 and 11, can be protected to build upon existing and planned preserves in Solano County between these conservation zones. Protection of additional vernal pool complex natural community in this area will protect an important connection between Suisun Marsh and the Cache Slough area. Vernal pool complex natural community in Conservation Zone 8 consists of relatively rare alkaline sink/meadow vernal pools that warrant protection. For the implementation schedule of vernal pool complex natural community protection and restoration, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Vernal Pool Complex Function

Biologically Diverse Vernal Pool Complex. The restoration of 200 acres of vernal pool complex natural community will enhance native biodiversity and habitat heterogeneity within the Plan Area. Priority for restoration will be given to sites that display clear vernal pool signatures on aerial imagery, possesses relatively natural hydrology, provide a range of environmental gradients, and that will increase connectivity between protected lands. Under the vernal pool complex natural community goals and objectives, 200 acres of vernal pool complex will be restored in Conservation Zones 1, 8, or 11; and 300 acres will be protected in those conservation zones.

Vernal pool complex natural community in the Plan Area is generally interspersed with the grassland and alkali seasonal wetland complex natural communities; and all three communities are generally managed together, although there is very little experience in managing and alkaline sink/meadow vernal pools.

There is very little information available regarding the appropriate management of the types of vernal pool complex found in the Plan Area but there is one long-term grazing study available for mixed exotic annual and saltgrass perennial grassland for the Jepson Prairie area. To resolve this general lack of information, restoration and enhancement techniques and effective application frequencies and intensities will be informed by baseline surveys, effectiveness monitoring, and targeted research. Techniques that could be used to enhance vernal pool complex within the context of the other communities include but are not limited to: appropriate grazing regimes including grazing exclusion; prescribed burning; and the appropriate use of herbicides to control invasive nonnative plant species. Enhancing vernal pool complex will likely require applying multiple management techniques simultaneously and the spatial separation of some of the techniques.

The vernal pool complex is essentially an amphibious ecosystem with differing functions dependent upon whether it is in a flooded or dry stage. When flooded, it contains ephemeral aquatic invertebrates, the immature stages of amphibians, and hosts waterfowl. As the water recedes, the ecosystem services first change from those of a fully aquatic system to a wetland, and then to a terrestrial ecosystem (Williams 2006). Through this process the food web linkages break down as the community becomes more integrated with the terrestrial landscape around it. When dry, it is integrated with the surrounding terrestrial ecosystems and provides foraging habitat for native wildlife, and is typically managed as rangeland and grazed by sheep or cattle.

Vernal pools are defined in large part by their hydrology, which has three components: 1) the source of water; 2) the duration of inundation and waterlogged soil phases; and 3) the seasonal timing of these phases. Rainfall is the primary source of water to vernal pools as it falls directly into the vernal pool or is transported a short distance across the watershed of the vernal pool; however, there can be groundwater transport to a vernal pool through a shallow perched aquifer or a combination of rainfall and creek flooding (ESA 2005, Williamson et al. 2005, Rains et al. 2008). The duration and timing of the inundation and waterlogged soil phases also vary; with hard-pan vernal pools having shorter phases centered during the middle of the wet season, while clay-pan and clay vernal pools have longer phases extending earlier and later into the wet season (ESA 2005, Williamson et al. 2005, Rains et al. 2008).

Vernal pool plant species are generally adapted to survive standing water throughout winter and spring and dry soils in summer (CALFED 2000, Solomeshch et al. 2007). Duration of inundation correlates with two clear functional plant groups (Zedler 1987, 1990, Barbour et al. 2003, Barbour et al. 2005, Barbour et al. 2007). Plants found at the edge of pools are adapted to the fluctuating hydrology of shallow vernal pools or to the edges of deep vernal pools. These species are prone to elimination by competition with upland exotic grass species or through thatch accumulation (Barry 1995, Griggs 2000, Marty 2005). The second functional plant group is adapted to the longer inundation periods of the pool basins.

Vernal pool plant species also vary among the four types of vernal pool complex in the Plan Area. The annual grassland type found in the Stone Lakes area is dominated by Eurasian annual grasses with a varying mixture of native grasses and herbs depending on the farming history of the site. The clay alluvium vernal pools and playa pools type from Putah Creek south to Cache Slough is dominated in the spring by either Eurasian annual grasses or a variable mixture of saltgrass and native herbs and dominated in the summer by native tarweeds, or the exotic yellow starthistle. The Montezuma Block vernal pools and playa pools type in the Jepson Prairie/Montezuma Hills area is similar to the clay alluvium vernal pools and playa pools type, but extensive areas are also in agriculture production as dry-farmed wheat. The alkaline sink/meadow vernal pools type in the Byron/Clifton Court Forebay area has surrounding vegetation that is typically dominated by native grasses such as saltgrass and alkali ryegrass or by woody shrubs like iodine bush and subshrubs such as bush seepweed and alkali heath.

In the Plan Area, nonnative species invade and degrade the vernal pool complex at various points along the moisture gradient. The margins of vernal pools are often dominated by the nonnative Italian ryegrass, while the deeper portions of hardpan pools are invaded by low mannagrass (Gerlach et al. 2009). Other parts of vernal pool complexes are often invaded by perennial pepperweed (Swiecki and Bernhardt 2002, Witham 2003, ESA 2005, Witham 2006, ESA 2007, Gerlach et al. 2009).

Species Protection. The vernal pool complex natural community is utilized as habitat by a number of wildlife species. Some use the community only for a specific part of their life history. For example, amphibians such as California tiger salamander and western spadefoot toad use vernal pools and playa pools for breeding, but are otherwise essentially terrestrial animals. Some waterfowl forage in vernal pools and playa pools during the wet season, consuming invertebrates (ducks and shorebirds) and vegetation (geese) (Medeiros 1976, Reiner and Swenson 2000). Some species spend their entire lives in vernal pools and playa pools, for example the five crustacean species covered under the BDCP (mid-valley fairy shrimp, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, and California linderiella).

Vernal pool complex natural community protection and restoration will provide habitat for BDCP covered western spadefoot toad, California tiger salamander, mid-valley fairy shrimp, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, California linderiella, alkali milk-vetch, heartscale, brittlescale, San Joaquin spearscale, dwarf downingia, Delta button-celery, Boggs Lake hedge-hyssop, legenere, and Heckard's peppergrass. Most of the BDCP covered vernal pool plant species are generally confined to small scattered populations growing in vernal pools and swales on alkaline clay soils. When they occur on unprotected land they are especially vulnerable to agriculture intensification or development. BDCP tidal restoration activities could also potentially affect some occurrences. In such cases, surveying for and protecting individual occurrences of these species is an effective conservation strategy that can yield population level benefits.

Vernal Pool Complex and Climate Change

Climate change is expected to alter the vernal pool complex natural community. Because this natural community is generally located at elevations that will not be directly impacted by rising sea level, the primary impact of climate change is predicted to be driven by changes in the hydrological regime due to increased variability in precipitation. The species present in this community are adapted to existing hydrological conditions, such that increased variability of precipitation would likely lead to a shorter and more variable wet season or similar changes in the inundation period. It is not known how increased variability in pool hydrology would affect the plants and animals inhabiting them, but because these species are adapted to current conditions, the impacts will likely be negative. In addition, rising average temperatures could result in increased evapotranspiration rates and therefore shorter wetted periods for vernal pools, the impacts of which are expected to be adverse to native plants and wildlife. The implementation of BDCP vernal pool complex natural community goals and objectives will increase the extent of this natural community and help ensure its persistence through climatic changes.

Conservation Measures for Vernal Pool Complex

- CM3 Natural Communities Protection
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

3.3.2.2.11 Inland Dune Scrub

Inland Dune Scrub occurs in only one location in the Plan Area. It is found along the south shore of the San Joaquin River immediately east of the city of Antioch within the Antioch Dunes National Wildlife Refuge (ADNWR) and on two adjacent (PG&E) properties. These areas of inland dune scrub are fully protected by ownership or conservation Memoranda of Understanding (MOUs). These protected lands are completely isolated from other terrestrial habitats by development to the west, south, and east, and by the San Joaquin River to the north.

Historically, the 190-acre dune paralleled the San Joaquin River shore for 2 miles and was 0.15 mile wide and 120 feet tall (Howard and Arnold 1980, SFEI (San Francisco Estuary Institute) 2010). Mining of the sand in the late 19th and early 20th century for the manufacture of pottery, bricks, asphalt and concrete reduced the extent of the dunes. After WWII, commercial development occurred in the area where the dune had been mined, and the sand mining moved eastward. The USFWS negotiated a purchase to establish the 55-acre Antioch Dunes National Wildlife Refuge (ADNWR) with the sand dunes that remained in 1980. See Section 2.3.4.13, *Inland Dune Scrub* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

To increase the level of conservation benefits provided to inland dune scrub species, the BDCP inland dune scrub conservation will be implemented through the funding of appropriate management actions and studies.

Inland Dune Scrub Goals and Objectives

Goal IDSC1: The expected outcome is support for funding of the USFWS management and enhancement of the inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge.

> **Objective IDSC1.1:** The BDCP will support the funding of the USFWS program for management, enhancement, and monitoring of inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge at an annual amount of $XX.XX for X years.

Rationale for Goals and Objectives

Inland Dune Scrub Natural Community Extent and Connectivity

Currently, the degraded remnants of the inland dune scrub natural community are being managed exclusively for the three endangered species which the ADNWR was established to protect. The inland dune scrub natural community transitions into tidal brackish emergent wetland along its border with the San Joaquin River (USFWS (United States Fish & Wildlife Service 1984, 2001); and its other three sides are bordered by commercial developments. Management actions to increase the dune-like characteristics of ADNWR have included creating small dunes with dredged sand material (USFWS 1984a, 2001). Additionally there are captive breeding and propagation reintroduction program for Lange's metalmark, Contra Costa wallflower, and Antioch Dunes evening primrose (Johnson et al. 2007, USFWS 2008).

Native Biodiversity and Inland Dune Scrub Function

Biologically Diverse Inland Dune Scrub. Inland dune scrub is more similar to the vegetation of sandy soils in the San Joaquin Valley and Mojave Desert than to coastal scrub communities (Howard and Arnold 1980). The pre-disturbance species composition of the vegetation was not well described; however, based on early charts and a postcard dating from the early 1900s, the vegetation contained widely scattered large valley oaks, live oaks, various shrub species, and numerous herbaceous species (Howard and Arnold 1980, SFEI (San Francisco Estuary Institute) 2010).

The BDCP inland dune scrub natural community is defined by the presence of two vegetation types. One vegetation type consists of a broadleaf shrubland that was classified as the *Lupinus albifrons* (silver bush lupine) Antioch Dunes alliance (5 acres), and the other is a dwarf shrub vegetation type classified as the *Lotus scoparius* (deerweed) Antioch Dunes alliance (15 acres).

The primary problematic nonnative plant species in this community are annual grasses such as ripgut brome, vetches, and yellow starthistle (*Centaurea solstitialis*) (USFWS 2001a) which form dense patches that crowd out native plant species and reduce habitat quality for wildlife and invertebrates. The current management plan for the Antioch Dunes NWR invasive nonnative plant species control efforts includes hand pulling of individual invasive plants through the efforts of volunteers, targeted herbicide application, controlled burns, the restoration of some dune-like topography, and planting of nursery-grown nakedstem buckwheat (USFWS 2001a, 2008).

The Antioch Dune has also been known as an entomological hotspot since the 1930s when research entomologists began collecting in what is now the Sardis Unit of the ADNWR (Howard and Arnold 1980, Arnold 1983). A total of 27 taxa were described from Antioch Dunes during that decade. Eight of those taxa are endemic to the Antioch Dune. Four are now extinct, three are of uncertain status, and the eighth is the federally and state endangered Lange's metalmark butterfly (*Apodemia mormo langei*).

Species Protection. The BDCP conservation actions for the inland dune scrub natural community are consistent with and help to achieve the recovery objectives for Lange's metalmark butterfly identified in the 5-year Review (USFWS 2008). The Lange's metalmark butterfly captive breeding and release program will include the nursery propagation and out-planting of the white-flowered, sand-associated, ecotype of nakedstem buckwheat and the management of the nakedstem buckwheat to create dense patches of older plants with an extensive layer of leaf litter. The required sizes of self-sustainable Lange's metalmark butterfly populations have not yet been determined, but may be revealed as the controlled propagation studies proceed.

Lange's metalmark butterfly is endemic to areas of Oakley sand soil in east Contra Costa County that support nakedstem buckwheat which is its larval host plant and its adult nectar plant (Arnold 1983). Contra Costa wallflower and Antioch Dunes evening primrose are microendemics that only occur on the Antioch Dune itself. Lange's metalmark butterfly is entirely dependent on a particular white-flowered, sand-associated, ecotype of nakedstem buckwheat (*Eriogonum nudum* ssp. *auriculatum*) that has a later and longer blooming season than ecotypes growing on rocky areas nearby on Mt. Diablo. Additionally, its dependence on the plant extends to the leaf litter that accumulates near the base of large plants growing in large clumps (Arnold 1983).

Historically, nakedstem buckwheat occurred on the 190-acre Antioch Dune; in an area 1.5 miles southeast of the Antioch Dune as a 3-mile long by 1.5-mile wide 3,000-acre oblong patch on the Oakley sand soil southwest of Oakley; and in an unknown location near Brannan Island (Howard and Arnold 1980, Arnold 1983, 2005, SFEI (San Francisco Estuary Institute) 2010). The dune habitat has been reduced to 20 acres by sand mining, and the rest of the habitat was lost through development and agriculture. The remaining 20 acres of habitat has been further degraded by nonnative invasive plants such as vetches and annual grasses, and older dense stands of nakedstem buckwheat have been lost to wildfires (United States Fish & Wildlife Service 2001, 2008).

Inland Dune Scrub and Climate Change

The primary impact of climate change on the inland dune scrub natural community is predicted to be driven by changes in the hydrological regime due to increased variability in precipitation. The species present in this community are adapted to variable precipitation, and it is uncertain how they will be affected by increased variability. The inland dune scrub natural community is generally located at elevations that will not be directly impacted by rising sea level. Implementation of BDCP inland dune scrub goals and objectives will help ensure propagation of sensitive inland dune scrub species.

Conservation Measures for Inland Dune Scrub

- CM11 Natural Communities Enhancement and Management

3.3.2.2.12 Agricultural Habitats

The majority of lands in the Delta are currently used for agriculture. Agricultural habitats in the Plan Area formerly consisted of extensive brackish and freshwater wetlands, open grasslands, broad riparian systems, and oak woodlands. By the mid-1800s, reclamation of wetlands began to transform the Delta into an agricultural region with a complex system of channelized waterways and Delta "islands." The conversion of natural vegetation to agriculture eliminated large areas of native habitats. Nevertheless, some agricultural systems continue to support abundant wildlife and provide essential breeding, foraging, and roosting habitat for many resident and migrant wildlife species; although they generally support a less diverse community of wildlife compared with most native habitats (Fleskes et al. 2005, EDAW 2007, USFWS 2007a, Kleinschmidt 2008).

The agricultural landscape within the Plan Area is a dynamic matrix of a variety of land cover types, including perennial, semi-perennial, and seasonally or annually rotational crops. The large extent of the rotational crops results in a cover type matrix that is subject to change annually based primarily on agricultural economic conditions. This dynamic land management regularly changes habitat values at the field level for agriculture-associated BDCP covered species, while the overall landscape habitat values may change more slowly. See Section 2.3.4.14, *Agricultural Habitats* in Chapter 2, *Existing Ecological Conditions,* for more detail on the current state of this natural community.

Some BDCP covered species utilize agricultural habitats and in some cases have come to rely on the habitat value of certain agricultural landscapes, practices, and crop types. A reduction in agricultural acreage in the Plan Area will occur largely as a result of restoring tidal and nontidal wetland habitats. These restored habitats will incorporate a range of ecological gradients and will thus include associated grassland, open water, riparian, and other habitats. The removal of agricultural habitats through restoration of wetlands and associated communities will reduce the extent of upland agricultural habitats. However, the reduction in cropland acreage will be largely offset by 1) the value of restored wetlands and associated communities that will provide higher value habitat to some agriculture-associated species such as giant garter snake, greater sandhill crane, white-tailed kite, and tricolored blackbird; and 2) the stabilization of higher value agricultural cover types on BDCP protected lands.

Agricultural Habitat Goals and Objectives

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

> **Objective ALNC1.1**: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.

> **Objective ALNC1.2**: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson’s hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson’s hawk nesting habitat.

> **Objective ALNC1.3**: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain at least 3,000 acres of pasture that supports western burrowing owl foraging habitat. This objective may be partially or fully achieved through preservation of other land cover types that provide moderate-value or greater habitat function for the western burrowing owl.

Objective ALNC1.4: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain at least 4,800 acres that supports greater sandhill crane foraging habitat within its Winter Use Area and within 2 miles of known roosting sites in Conservation Zones 3, 4, 5 and/or 6.

Objective ALNC1.5: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands and 4,600 acres of rice lands, maintain and protect 1,000 acres within or adjacent to habitat occupied by the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.

Objective ALNC1.6: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain and protect 1,000 acres within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4.

Objective ALNC1.7: Target agricultural land conservation to provide connectivity between other protected lands.

Objective ALNC1.8: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.

Rationale for Goals and Objectives

Agricultural Habitats Extent and Connectivity

Delta crop types include small grains such as wheat and barley, field crops such as corn, sorghum, and safflower, truck crops such as tomatoes and sugar beets, forage crops such as hay and alfalfa, pastures, orchards, and vineyards (CALFED 2000, DWR 2007). The distribution of crop types in production in the Plan Area varies, depending on crop-rotation patterns and market forces. For example, over the past few decades there has been a two-fold increase in acreage used to produce corn, making it the number one crop in acreage grown; and an 18-fold increase in vineyards (DWR 2007).

Changes in crop production can have substantial effects on the habitat value of agricultural habitats for wildlife, particularly birds. Hay, grain, row crops, and irrigated pastures support abundant rodent populations, providing foraging habitat for bird species such as Swainson's hawk, white-tailed kite, and burrowing owl. Conversion of pastures, row crops, and similar agricultural habitats to orchards and vineyards has been noted as a factor affecting raptors such as Swainson's hawk (Estep 2008).

Irrigated pastures, alfalfa, and annually cultivated irrigated cropland provide foraging habitat for BDCP covered Swainson's hawk, white-tailed kite, western burrowing owl, greater sandhill crane, and tricolored blackbird. Grain, corn, and rice fields provide foraging habitats for sandhill cranes, waterfowl, wading birds, and shorebirds. Upland and seasonally flooded agricultural habitats and wetlands of the Delta support an estimated 10 percent of the waterfowl population that annually winter in California (CALFED 1998). Rice fields provide foraging habitat for many bird species as well as important aquatic habitat for giant garter snakes and western pond turtle. Orchards and vineyards, conversely, provide limited wildlife value, particularly to BDCP covered species. Orchards and vineyards develop a dense overstory canopy that generally precludes access by foraging Swainson's hawks, white-tailed kites, western burrowing owls, and other agricultural land-associated covered species.

While the agricultural landscape of the Delta is important to BDCP covered and other native species, only a portion of the landscape is utilized in any give year due to conversions and crop rotations that result in long-term (i.e., orchards, vineyards) or short-term reductions in habitat value. The use of conservation easements and fee title to protect the wildlife habitat functions for BDCP covered species will maximize habitat functions and eliminate the dynamic fluctuations in habitat functions of 4,600 acres of rice land and 12,020 to 28,040 acres of non-rice agricultural lands under BDCP conservation protection. Agricultural land placed under conservation protection under the BDCP will increase from the current 11 percent to a range of between 14 to 18 percent.

While some agriculture-associated covered species, such as Swainson's hawk are highly mobile and do not necessarily require connectivity of large preserved habitat patches, other species, such as giant garter snake and western pond turtle, will benefit from acquiring contiguous agricultural parcels that facilitate expansion of existing populations and dispersal and other movements between occupied areas and connectivity to suitable unoccupied areas. For example, connectivity of protected agricultural habitats (and restored tidal marsh and nontidal marsh) in Conservation Zone 4 will provide additional connectivity to Stone Lakes National Wildlife Refuge and facilitate northward expansion of the Coldani Marsh/White Slough giant garter snake subpopulation.

The reduction in agricultural acreage in the Plan Area will occur largely as a result of restoring tidal habitats. These restored habitats will incorporate the range of ecological gradients and will thus include associated grassland, open water, riparian, and other habitats. Most of the covered species associated with agricultural habitats including giant garter snake, Townsend's big-eared bat, white-tailed kite, tricolored blackbird, and greater sandhill crane, will use the restored habitats and benefit from the restoration activities. The distribution and abundance of these species is unlikely to be affected, and may benefit, as a result of the conversion of agricultural acreage to restored tidal marsh communities. For the implementation schedule of agricultural habitat preservation, see the BDCP implementation schedule presented in Chapter 6, *Plan Implementation.*

Native Biodiversity and Agricultural Habitats Function

Biologically Diverse Agricultural Habitats. Although cropland vegetation is grown as a monoculture using tillage or herbicides to eliminate unwanted vegetation, interspersed within the agricultural landscape are small patches or linear corridors of natural vegetation and other natural features, such as riparian woodland and scrub, wetlands, ponds, hedgerows, tree rows, and small patches of isolated native or nonnative trees that provide habitat for songbirds, raptors, reptiles, amphibians, and small mammals. Maintenance of these small but important wildlife habitats can benefit BDCP covered wildlife species. Agricultural habitats in the Plan Area are not known to support any BDCP covered plant species.

Covered wildlife species that use agricultural habitats use other habitats to meet life requirements. For example, agricultural lands are used primarily for foraging by several species that nest in riparian areas, roadside trees, or isolated trees and groves. Wetlands, streams, ponds, hedge rows, groves, and other remnant natural or created habitats are key to providing the full range of habitat elements necessary to support BDCP covered species in agricultural habitats. These native and sometimes nonnative (e.g., eucalyptus groves) are important elements within the agricultural matrix that provide essential habitat for these agricultural-associated covered species. Management of protected lands will therefore focus on the protection and enhancement of these key elements.

*Species Protection***.** Several covered species and many other native species (e.g., shorebirds, waterfowl) are associated with agricultural lands, which are used as surrogate landscapes for native communities that they replaced. Some of these species, such as Swainson's hawk and white-tailed kite, use agricultural lands as foraging habitat while they find nesting habitat in remnant patches or riparian habitat or other native and nonnative trees occurring within the agricultural matrix. Agricultural lands meet other life requirements for other covered species, such as giant garter snake and western pond turtle.

There are two primary components of giant garter snake conservation under BDCP: 1) the establishment of agricultural land preserves that will include nontidal freshwater perennial emergent wetland restoration associated with two existing subpopulations; and 2) protection of existing rice land values in the Yolo Bypass to minimize the effects of increased inundation duration and extent. Protection of other agricultural lands and restoration of tidal wetlands in Conservation Zones 4 and 7 will also benefit giant garter snake.

Although dependent on the aquatic environment, the giant garter snake occurs within the agricultural landscape where it uses interconnected watercourses (primarily irrigation canals) and associated freshwater emergent wetland habitat and rice lands during the active season and adjacent uplands during the inactive season. Maintaining an agricultural matrix that includes suitable interconnected canals with reliable water and associated emergent vegetation and adjacent upland habitats is essential for conservation of this species. Protection and management of agricultural lands within and adjacent to existing subpopulations will provide security for these occupied habitats and allow for additional expansion into adjacent protected areas. A 1,000 acre preserve is considered sufficient to protect and allow for expansion of these subpopulations. Agricultural lands within the preserves are also expected to be compatible with other BDCP covered species, including Swainson's hawk, white-tailed kite, greater sandhill crane, tricolored blackbird, and Townsend's big-eared bat.

In addition, the protection of 4,600 acres (the existing extent of rice land acres potentially affected by BDCP actions in the Yolo Bypass) of rice land or lands with equivalent value will help to sustain or increase giant garter snake use of the Yolo Bypass.

Swainson's hawk and white-tailed kite find the highest value foraging habitat on agricultural lands within the Plan Area. However, as noted above, only a portion of the landscape is suitable in any given year due to crop rotations and conversions to unsuitable cover types. The protection and management of between 12,020 and 28,040 acres of non-rice agricultural land distributed throughout the agricultural landscape within the Plan Area will ensure long-term stability of high value foraging habitat for these wider-ranging species.

Greater sandhill crane is also closely associated with agricultural lands in the Delta and will benefit from the protection of at least 4,000 acres of agricultural land within its primary use area (refer to species model in Appendix A, *Covered Species Accounts*). Agricultural lands managed as crane foraging habitat will include high value crops such as corn, wheat, alfalfa, and irrigated pasture. Close proximity to known roosts increases the opportunity for foraging use.

While not providing optimal habitat conditions, the burrowing owl also uses some agricultural habitats including hay crops and irrigated pastures. These are considered moderate value cover types for burrowing owl (refer to species model in Appendix A, *Covered Species Accounts*). Agricultural land conservation will also include the protection of at least 3,000 acres of pastureland suitable for western burrowing owl. This cover type is compatible with Swainson's hawk, white-tailed kite, and greater sandhill crane use.

Also, as noted above, many of the BDCP covered species associated with agricultural habitats, including giant garter snake, Townsend's big-eared bat, white-tailed kite, tricolored blackbird, and greater sandhill crane, will use the BDCP restored habitats and benefit from the restoration activities. The distribution and abundance of these species is unlikely to be affected, and may benefit, as a result of the conversion of agricultural acreage to restored tidal marsh communities.

Agricultural Habitats and Climate Change

Agricultural habitats may be particularly sensitive to precipitation changes and long-term sea level rise associated with global climate change. Increased variability in precipitation is likely to reduce the reliability of water supply available for irrigating crops at critical times of the year; and crop types cultivated may change with elevated ambient temperatures. With sea level rise exacerbating current conditions, a powerful earthquake in the region could collapse levees, leading to major saltwater intrusion and flooding throughout the Delta if flows were sufficiently low, altering the tidal prism and causing substantial changes to the agricultural areas (Mount and Twiss 2005). Areas within levees that are currently farmed could be impaired. Climate change impacts on agricultural habitats and its potential effect on covered species is addressed primarily by restricting the extent of conservation that occurs within areas that are currently below sea level in the Central Delta.

Conservation Measures for Agricultural Habitats

- CM3 Natural Communities Protection
- CM11 Natural Communities Enhancement and Management

3.3.2.2.13 Managed Wetland

The managed wetland natural community consists of areas that are intentionally flooded and managed (including associated ditches and drains) during specific seasonal periods to enhance habitat values for specific wildlife species. Typically, managed wetlands are flooded during the winter in anticipation of the arrival of migratory birds. This is followed by a slow draw down of the water to manage plant seed production and control mosquito populations. Some summer irrigation may also be conducted. Salinity of managed wetlands is determined by their proximity to the more brackish waters of the western Delta.

Currently, distribution of the managed wetland natural community in the Plan Area is largely in the northern, central, and western portions of the Delta, as well as in Suisun Marsh. Substantial acreage of this natural community can be found in the Yolo Bypass, the Stone Lakes National Wildlife Refuge, the Cosumnes River Preserve, and in Suisun Marsh. Delta islands that support areas of managed wetland include Mandeville, Medford, Bradford, Van Sickle and Chipps islands, and Holland Tract.

As a surrogate for natural marshes, managed wetlands provide productive seasonal wetlands interspersed with permanent wetlands in an effort to support large populations of waterfowl and shorebirds with the production of seeds and invertebrates. Managed wetlands are also maintained to provide nesting and resting or loafing areas. Some of the nutrients and primary productivity of managed wetlands can be transferred to adjacent natural wetlands through water management activities and movements of waterfowl and shorebirds. See Section 2.3.4.10, *Managed Wetland* in Chapter 2, *Existing Ecological Conditions,* for more detail on the current state of managed wetlands.

BDCP restoration of tidal wetlands will replace some existing managed wetlands that currently provide habitat for wintering and breeding waterfowl and migrant shorebirds. While tidal restoration is expected to replace most of the habitat functions removed through this conversion, it could potentially affect the distribution and abundance of some species.

Managed Wetland Goals and Objectives

Goal MWNC1: The expected outcome is maintenance of the current level of habitat functions provided by existing managed wetlands in the Plan Area through enhancement and restoration of natural communities on BDCP conservation lands, such that those wildlife functions do not preclude achievement of the Central Valley Joint Venture (CVJV) Implementation Plan's waterfowl and shorebird conservation targets for the Delta and Yolo Basin.

Objective MWNC1.1: Maintain the level of wintering and breeding waterfowl habitat functions currently supported by habitats in the Plan Area through protection, restoration, and management of habitat of equivalent function on BDCP conservation lands.

Objective MWNC1.2: Maintain the current level of migrant shorebird habitat functions currently supported by habitats in the Plan Area through protection, restoration, and management of habitat of equivalent function on BDCP conservation lands.

Goal MWNC2: The expected outcome is biologically diverse managed wetlands that are enhanced for native species.

Objective MWNC2.1: Maintain and enhance the habitat functions of BDCP managed wetlands present on BDCP preserved lands over the term of the BDCP.

Rationale for Goals and Objectives

Managed Wetland Extent

The Central Valley Joint Venture (CVJV) has developed wetland acreage goals for nine basins within the Central Valley. The acreage goals for the Suisun basin have been surpassed while the restoration goal for wetlands in the Delta basin is 19,000 acres. The intent of BDCP is to maintain or increase the habitat functions for wintering and breeding waterfowl and migrant and breeding shorebirds supported by the Plan Area habitats to ensure that BDCP actions will not impede attainment of the goals established by the CVJV Implementation Plan for the Delta and Yolo Basin.

Biodiversity and Managed Wetland Function

Biologically Diverse Managed Wetlands. Managed wetlands are managed primarily to promote use by birds. A wide variety of waterfowl and other birds migrating along the Pacific Flyway use the managed wetland natural community when inundated. In the Plan Area, BDCP covered greater sandhill cranes forage and roost in managed wetlands; many ducks, geese, wading birds, and shorebirds forage and loaf in managed wetlands. Abundant and diverse plant and invertebrate populations in managed wetlands provide important food resources for migrating waterfowl, bats, and many other wildlife species that forage in and over these wetlands.

Managed wetland vegetation typically consists of robust, perennial emergent vegetation and annual-dominated moist-soil grasses and forbs in freshwater areas and pickleweed and brass buttons in brackish water areas. The managed wetland natural community is subjected to the same invasive nonnative plant species as the tidal brackish emergent wetland and tidal freshwater emergent wetland natural communities. However, because management operations include discing and the manipulation of flooding duration, there are more opportunities to control invasive species. One managed wetland invasive, perennial pepperweed (*Lepidium latifolium*), is a serious threat that may be spread through discing; adding complexity to land management. Other problematic invasive plant species include pampas grass (*Cortaderia selloana*), giant reed (*Arundo donax*), and the nonnative genotype of common reed (*Phragmites australis*).

Because they are often confined behind levees, environmental gradients in managed wetlands are generally controlled through active management actions such as discing and soil contouring to provide a variety of ponding depths and widths. Variations in flooding timing, duration, and water quality are used to control species composition, primary productivity, water temperature, salinity, and the timing of exports of primary productivity.

Species Protection. Managed to appropriate depths and interspersed with berms and other upland edges, managed wetlands can provide high value roosting habitat for greater sandhill cranes. Creation of additional crane roosting habitat within the crane's traditional use area will provide additional roosting opportunities, allow for greater dispersal within the use area, and facilitate use of foraging habitats that may currently be underused due to the lack of roosting habitat. Crane roosting habitat may also provide additional managed wetland habitat for waterfowl and shorebirds.

Managed Wetland and Climate Change

Seasonal changes in precipitation and sea level rise are the aspects of climate change that will most affect managed wetlands. Potential reductions of and changes in timing of flows through the Central Valley will likely reduce the amount of water available for managed wetlands management actions, such as flooding at precise times of the season to provide habitat and food for waterfowl. Additionally, the managed wetland natural community may be impacted by sea level rise as much of it is near or below sea level and protected from flooding by levees. Higher sea level, increased winter river flooding, and more intense winter storms will significantly increase the hydraulic forces acting on the levees, threatening managed wetlands.

<u>Conservation Measures for Managed Wetland</u>

- CM3 Natural Communities Protection
- CM11 Natural Communities Enhancement and Management

3.3.2.2.14 Other Natural Seasonal Wetland

The other natural seasonal wetlands natural community encompasses all remaining natural (i.e., not managed) seasonal wetland communities other than the vernal pool complex and alkali seasonal wetland complex natural communities. The other natural seasonal wetlands natural community includes seasonally ponded, flooded, or saturated soils dominated by grasses, sedges (*Carex* spp.), or rushes (*Juncus* spp.) including degraded vernal pools that were not included in the vernal pool complex natural community.

In the Plan Area, this natural community generally occurs on degraded sites consisting primarily of seasonally ponding areas in agricultural fields. It also occurs as a temporarily flooded perennial forb vegetation type that is exclusively found in a field near the Cosumnes River. While small, isolated, and degraded, these sites may still provide some habitat value to covered species (e.g., vernal pool fairy shrimp) and other native species. In some cases, other natural seasonal wetlands provide opportunities for restoration and in other cases retention of these sites within the agricultural matrix can provide important refugia for a variety of BDCP covered and other native species. See Section 2.3.4.11, *Other Natural Seasonal Wetlands* in Chapter 2, *Existing Ecological Conditions*, for more detail on the current state of this natural community.

Other Natural Seasonal Wetlands Goals and Objectives

Goal ONSW1: The expected outcome is increased habitat functions that support BDCP covered species in other natural seasonal wetland natural community within maintained and protected agricultural habitat areas.

> **Objective ONSW1.1**: Integrate management of other natural seasonal wetland natural community with management of BDCP maintained and protected agricultural lands to increase habitat functions for covered species.

Rationale for Goals and Objectives

Other Natural Seasonal Wetlands Biodiversity and Function

The ecological gradient observable between seasonal wetlands and surrounding terrestrial natural communities is marked by transitions in plant and wildlife species; this is most pronounced during the wetted phase. When flooded, the other natural seasonal wetlands natural community supports an aquatic food web that may be functionally similar to that found in undisturbed vernal pools and natural seasonal wetlands (Alexander 1976, Barclay and Knight 1981, Scheffer 2004, Williams 2006). As the water recedes, its ecosystem characteristics change from those of a fully aquatic system to those of a terrestrial ecosystem (Williams 2006), and its food web linkages break down as the community becomes more integrated with the terrestrial landscape in which it is embedded.

Plant species found in the other natural seasonal wetlands natural community consist of a mixture of exotic and native perennial forbs, grasses, sedges, and rushes that are tolerant of temporary flooding, ponding, or soil saturation during winter and spring months. Problematic invasive plant species in this natural community include low mannagrass, Italian ryegrass, and perennial pepperweed. Invertebrates of the other natural seasonal wetlands natural community are the main source of food for waterfowl and shorebirds (Silveira 1998) which also use the wetlands in their dry state for resting and seed foraging areas (USFWS 2007a, Kleinschmidt Associates 2008).

In some cases other natural seasonal wetlands may provide, or have the potential for providing value to some covered and other native species. Agricultural lands managed under BDCP for agriculture-associated species may contain small patches of other natural seasonal wetland. These sites may provide current habitat value as refugia for species that otherwise occur within the agricultural matrix, or they may provide opportunities for restoration (e.g., vernal pools).

Other Natural Seasonal Wetlands and Climate Change

Climate change is expected to impact the other natural seasonal wetlands natural community primarily through changes in the hydrological regime brought about by increased variability in precipitation. The species present in this natural community are adapted to existing hydrological conditions. Increased variability in precipitation could lead to a shorter more variable wet season, bringing changes to the inundation period. It is unknown how increased variability in seasonal wetland hydrology would affect the plants and animals inhabiting them, but because these species are adapted to current conditions, the impacts will likely be negative. In addition, rising average temperatures could result in increased evapotranspiration rates, and therefore shorter wetted periods for seasonal wetlands; the impacts of which are expected to be adverse to native plants and wildlife.

Conservation Measures for Other Natural Seasonal Wetland

- CM11 Natural Communities Enhancement and Management

3.3.2.3 Covered Fish Species Goals and Objectives

[Note to Reviewers: *The BDCP consultants most recently provided preliminary covered fish species goals and objectives in July 2009. Those objectives are being developed, refined, and revised using the logic chain process, which has been informed by independent science review. The logic chain process is intended to inform plan development and implementation. It is not intended to identify regulatory requirements, nor will every objective developed using the logic chain be incorporated into the BDCP conservation strategy. The objectives below reflect the current work in progress from the consultants. The level of detail for longfin smelt, for example, represents the level of detail the logic chain process will ultimately develop for other species. The objectives below do not represent a consensus position of the Steering Committee regarding the objectives of the BDCP.*

Ecosystem- and natural community-level goals and objectives, which were not addressed by the Logic Chain Group, are provided in Sections 3.3.2.1 and 3.3.2.2 and were derived from the July 2009 draft Conservation Strategy and the November 2010 Terrestrial Conservation Strategy.

Next Steps for Completing Goals and Objectives

The following outlines recommended steps for continuing and completing the development of objectives and metrics in accordance with the Logic Chain process as revised per input from the August 2010 Logic Chain independent review panel. These next steps are intended to build on *the discussions and subsequent work products from the logic chain workshop held on October 26-27, 2010.*

1. ***Complete Logic Chain Objective Worksheets** – convene additional technical workshops to complete specific species worksheets.*

   a. *Convene subteam for focused meetings to discuss and finalize the worksheets.*

   b. *Where existing information is insufficient to establish numeric targets, the subteams will identify specific study needs to develop such information, including a timeframe for conducting such.*

   c. *Where there is disagreement regarding an objective, or metric, the details of the disagreement will be documented for resolution at a policy level.*

   ***Timeframe:** The goal is to be done by end of January 2011.*

2. ***Revise Community Goals** –review and revise ecosystem and natural community goals as necessary to be consistent with the species objectives.*

   ***Timeframe:** The goal is to be done by end of January 2011.*

3. ***Review Proposed Conservation Measures in Light of Consensus Objectives** – once objectives have been agreed to, review existing conservation measures to identify gaps and make changes as needed.*

   ***Timeframe:** The goal is to be done by end of February 2011.*

4. ***Refine Proposed Metrics** – based on #1,#2, #3 above, refine or revise the draft metrics proposed in Section 3.6.*

   ***Timeframe:** To the extent possible, refinements should be complete by the end of February in order to allow inclusion in the complete draft plan. It has not been determined at this time the level of detail necessary prior to BDCP authorization/permitting and the additional refinements that could be developed after the plan has been authorized/permitted.*

5. ***Develop Recommendations for the Monitoring and Adaptive Management Program** – based on all of the above.*

   ***Timeframe**: Some changes may be recommended after February for inclusion in the draft plan in 2011, but it is also likely that additional refinements in both programs would be made after BDCP authorization/permitting.]*

3.3.2.3.1 Delta Smelt

[***Note to Reviewers:*** *Draft goals and objectives for delta smelt have not been discussed by the logic chain team and therefore are not included herein. Goals and objectives for delta smelt will be developed in accordance with the next steps noted above]*

3.3.2.3.2 Longfin Smelt

Stressor: Physical Spawning Habitat Loss and Modification.

BDCP Objective: Increase extent and availability of quality longfin smelt physical spawning habitat.

Relation to Global Objectives: Increasing the extent/availability and quality of spawning habitat for longfin smelt may have positive effects on productivity and abundance.

Indicator: Spatial extent of quality habitats available for longfin smelt spawning. Attributes of "quality spawning habitat (i.e. what makes a habitat "quality spawning habitat") remain to be defined as they are largely unknown at this time. The position and extent of spawning habitat is believed to track the position of the low salinity zone.

Locations: Suisun Bay, Suisun Marsh, West Delta, lower Sacramento River, lower San Joaquin (historical spawning area)

Timing (e.g. seasonality) of stressor reduction: Spawning season roughly ~December - April

Attribute: Spatial Extent: Acreage of accessible habitat

Quality: Undefined as micro-habitat requirements are unknown. Further research in this ecosystem needed.

Quantity or State: Maintain/improve existing, and increase the areal extent of longfin smelt spawning habitat that meets certain quality specifications (may be divided into "high", "medium" and "low" quality or accessibility) by ________% or by ___ acres

Confidence that "Quantity or State" are sufficient to attain objective Unknown as the hypothesis that longfin smelt are limited by physical spawning habitat substrate is undocumented and attributes of spawning micro-habitat are undefined.

Time Frame (defined herein as the time from implementation of CM's or suites of CM's until Objective may reasonably be attained). Use of newly created or improved spawning habitat substrate by spawning adults and larvae could be assessed within a few years. Attainment of Objective would be assessed after implementation of habitat restoration and following several years (~5) years in which conditions would have been expected to limit spawning habitat prior to restoration.

Stressor: Degraded pelagic habitat for larval and early life stage longfin smelt.

BDCP Objective: Increase the extent (overlap of acceptable parameters of key habitat variables) and improve quality of the physical/chemical attributes of longfin smelt pelagic habitat.

Relation to Global Objectives: Increasing the extent and improving the quality of the physical/chemical attributes of longfin smelt pelagic habitat (including transport/retention dynamics) will increase longfin smelt abundance and productivity.

Indicator(s):

1) Volume of longfin smelt's preferred pelagic habitat conditions (e.g. temperature, depth, turbidity, salinity) during critical winter and spring periods;
2) Magnitude and duration of flows that promote transport and retention of longfin smelt (e.g. gravitational circulation) in the LSZ.

These are well-indexed by the variable "X2" (the 2ppt bottom isohaline) – the frequency distribution of X2 values in different months indicates the state of longfin smelt pelagic habitat over time.

Locations: Low Salinity Zone (i.e. location changes depending on hydrology of a given year).

Timing (e.g. seasonality) of stressor reduction: Winter-Spring (December-June)

Attribute: TBD

Quantity or State: TBD

Confidence that "Quantity or State" are sufficient to attain Objective: TBD

Time Frame: TBD

Stressor: Increased food Limitation due to food web suppression.

BDCP Objective: Increased density of longfin smelt preferred prey.

Relation to Global Objectives: Abundance and productivity are expected to increase with an increasing longfin smelt food supply

Indicator: 1) longfin smelt preferred prey items (mysids, Eurytemora, amphipods, *Psuedodiaptomous*, etc)(additional system-wide indicators include: 1) individual growth rates or condition index to understand extent of food limitation and 2) diet studies -- to determine if the longfin smelt diet has been affected by restoration-related impacts to food supplies).

Locations: the low salinity zone (0-6psu)

Timing (e.g. seasonality) of stressor reduction: TBD

Attribute: Density of prey and at least one of the following

1) individual growth rates or proportion of maximum ration attatined (Pmax)
2) condition index and
3) diet studies -- to determine if the increase in food translates to decrease in food limitation

Quantity or State: A 10x increase in prey density would be required, at a minimum, on the basis of rough approximations of trophic transfer relationships found in many food webs. [Importantly, the committee did not determine what level of increase in the longfin smelt population would be required].

Alternative basis for quantity/state of this objective might be to identify prey density during historical period of desired longfin smelt abundance (e.g. 1967-1984) and establish this as the objective.

Time Frame: Expectation of time required to attain objective varies with type of conservation measure employed.

Confidence that "Quantity or State" are sufficient to attain Objective:

Differs depending on the conservation measures employed

Potential covariate in unmanaged stressors: unimpaired hydrology (food abundance sensitive to outflow). In other words, effectiveness of non-flow related measures is evaluated against expectation of food web productivity given the relationship between prey density and hydrology in a given year (modifications to actual hydrology as well as other physical habitats are both expected to play a role in food web productivity).

Stressor #: Increased toxin concentrations (pyrethroids, Organophosphates, surfactants).

BDCP Objective: Reduce toxic compound concentrations to below identified thresholds that impede productivity of the longfin smelt food supply (ie, that produce detectable effects on those things that longfin smelt eat).

<u>Indicator</u>: Concentrations of identified toxins and zooplankton bioassays

<u>Locations</u>: Will vary by toxin. They should be measured where they would potentially effect longfin smelt. Pyrethroids would be measured in sediment, organophosphates in the water column, etc. Some (but not all) potential toxins might be measured as concentration in fish tissues; in this case it would be necessary to correlate body-burden with fish condition, performance, and fertility.

<u>Timing (e.g. seasonality) of stressor reduction</u>: Step 1: determine when/where food limitation is occurring. Step 2: evaluate water toxicity indicators at those times/places relative to other areas

<u>Attribute</u>: Intentionally left blank [unknown]

<u>Quantity or State</u>: Intentionally left blank [unknown]

<u>Time Frame:</u> Intentionally left blank [unknown]

<u>Confidence that "Quantity or State" are sufficient to attain Objective:</u> The current effect of toxins on the populations of organisms that longfin smelt eat is unknown.

<u>Stressor #</u>: Increased nutrient concentrations (ammonium) and/or altered N:P ratios.

<u>BDCP Objective</u>: Reduce nutrient concentrations to below identified thresholds that impede productivity of the longfin smelt food supply (ie, that produce detectable effects on those things that longfin smelt eat) and/or that support levels of toxic organisms (e.g. microsystis) that inhibit attainment of longfin smelt distribution objectives.

<u>Relation to Global Objectives</u>: Limitation of the food supply potentially constrains longfin smelt abundance and productivity. If the limitation is regionally specific, foodweb limitations may constrain longfin smelt distribution as well.

Nutrient levels that encourage growth of toxic organisms like *microcystis* may be limited longfin smelt distribution.

<u>Indicator</u>: Concentrations of identified nutrients; intensity of Microcystis bloom? Restoration of spring-summer diatom blooms…

<u>Locations</u>: Suisun Bay in the late spring-fall.

<u>Timing (e.g. seasonality) of stressor reduction</u>: May-October

<u>Attribute</u>: Diatom blooms, zooplankton population responses

<u>Quantity or State</u>: Intentionally left blank [unknown]

Time Frame: May-Octoberish [unknown]

Confidence that "Quantity or State" are sufficient to attain Objective: The current effect of nutrients on the populations of organisms that longfin smelt eat is unknown. Some research has indicated levels of ammonium that may inhibit production at the base of the food web (phytoplankton), though if/how improving phytoplankton growth in certain years will transfer to longfin smelt is unknown. The ammonium threshold (~4 umolar?) is fairly certain; concentrations below this are not expected to inhibit primary production.

Stressor #: Entrainment

BDCP Entrainment Objective (A): For winter protection of reproductive adults: combined SWP and CVP December through February salvage of juvenile and adult longfin smelt shall not exceed ___ times the value of the Fall Midwater Trawl longfin smelt index (all ages) from the previous September through December.

For winter spring protection of larvae and early juveniles: Larvae entrainment modeled by surface oriented particles (DSM2 particle tracking model) shall not exceed ___ of surface oriented particles from the sampling stations ___, while longfin smelt larvae are being detected at ___ of ___ sampling locations in the San Joaquin River and south Delta .

Relation to Global Objectives: Reducing entrainment of reproductive, larval, and early juvenile longfin smelt will increase productivity (survival and total egg production)

Indicator: See above

Locations: Salvage measured at Project Diversions and impingement (or relevant measure) at Mirant Power Plant. Stock of spawning aged fish measured by FMWT and/or other survey at existing survey stations.

Timing (e.g. seasonality) of stressor reduction: Dec-June. longfin smelt entrainment is a greater concern during low outflow periods when X2 is nearer the south Delta export facilities.

Attribute: X2 OMR and other flow variables

Quantity or State: See above.

Time Frame: Measure efficacy should be detectable in first few years after implementation in which low outflow conditions would make longfin smelt susceptible to entrainment. Attainment of objective would be evaluated after several years of "susceptible conditions".

Confidence that "Quantity or State" are sufficient to attain Objective: Needs further documentation – see K. Newman Life Cycle model? In particular, pre-screen mortality estimates for longfin smelt should be studied.

BDCP Entrainment Objective (B): Spawning and larval migration spatial extent will not be limited by entrainment mortality or diversion-related impacts to habitat

Relation to Global Objectives: Reducing entrainment of spawning, larval, and early juvenile longfin smelt in the lower San Joaquin River will allow for increased spatial distribution of spawning

Indicator: X2 and OMR flows

Locations: Old and Middle River flow gauges on either side of Bacon Island and QWEST – the flow estimate for the San Joaquin River at Jersey Point in the DAYFLOW database (where flow is currently measured)

Timing (e.g. seasonality) of stressor reduction: Dec-June. longfin smelt entrainment is a greater concern in years when outflow conditions place X2 close to the south Delta export facilities.

Attribute: Net average flow in Old and Middle River and at Jersey Point

Quantity or State: OMR Flows not to be more negative than ___ cfs December – June (spawning-larval period)

Time Frame: Measure efficacy could be modeled prior to plan implementation. Ground-truthing this estimate in the field requires some substantial new sampling/monitoring. Effect would be expected to materialize in concert with restoration efforts in the south Delta including improved flows and reduction in *Egeria*.

Confidence that "Quantity or State" are sufficient to attain Objective: Conceptual model for longfin smelt indicates that continued entrainment-related mortality in the South Delta could be a factor in declining detection for spawning activity in that region. Research needs re: longfin smelt reproductive site fidelity.

3.3.2.3.3 Chinook Salmon

Stressors Addressed: Habitat loss; flow alterations; predation;; impingement and entrainment; passage impediments; and illegal harvest

Stressors Not Addressed: Contaminants; ocean conditions; and access to historical spawning habitat.

Goal CHSA1: Contribute to conditions that will support increased abundance, increased spatial extent of key lifestages, restore genetic diversity and increase productivity of all runs of Chinook salmon.

Objective CHSA1.1: Increase habitat extent, availability, and quality for juvenile Chinook salmon of all runs, including presence of suitable food resources.

Stressor: Habitat loss, food limitation, and passage impediments.

Objective CHSA1.2: Increase growth rates of juvenile Chinook salmon of all runs while rearing in the Plan Area.

Stressor: See CHSA1.1

Objective CHSA1.3: Help to maintain adequate dissolved oxygen levels in the Stockton Deep Water Ship Channel to avoid blocking migration of adult fall-run Chinook salmon and spring-run Chinook salmon once a viable run is established in the San Joaquin River.

Stressor: Low dissolved oxygen concentrations on the San Joaquin River near Stockton

Objective CHSA1.5: Increase immigration success by __% and reduce migratory delays by __%

Stressor: Altered flow conditions, poor water quality, exposure to unscreened water diversions, entrainment

Objective CHSA1.6: The total percentage of juvenile Chinook salmon entrained at the CVP and SWP pumps shall not exceed __% of the Juvenile Production Estimate (JPE) (methods for determining JPE and target entrainment percentages to be determined for each run including an analysis of data by water year type to scale the targets accordingly)

***Stressor*:** Entrainment of juvenile salmon at unscreened water diversions and CVP and SWP pumping plants.

Objective CHSA1.7: Reduce illegal harvest of adult Chinook salmon (all runs).

Stressor: Illegal take of covered species.

Objective CHSA1.8: Reduce susceptibility to, and impact of predation by nonnative predatory fish on juvenile outmigrants by _%.

Stressor: High densities of nonnative fish that prey on outmigrating salmon (NMFS 2009).

Objective CHSA1.9: Manage salmonid hatchery operations to minimize genetic affects on all naturally producing Chinook salmon run.

Stressor: Threats of hatchery programs in the Central Valley to spring-run Chinook salmon stock genetic integrity.

3.3.2.3.4 Central Valley Steelhead

Stressors Addressed: Habitat loss; flow alterations; predation;; impingement and entrainment; passage impediments; and illegal harvest.

Stressors Not Addressed: Contaminants; access to historical spawning habitat.

Goal STEE1: Contribute to conditions that will support increased abundance, increased spatial extent of key lifestages, restore genetic diversity and increase productivity of Central Valley steelhead.

Objective STEE1.1: Increase extent, availability, and quality of migration habitat for juvenile steelhead.

Stressor: Flow alterations, predation, poor water quality, habitat loss

Objective STEE1.2: Increase growth rates of juvenile steelhead while rearing in the Plan Area.

Stressor: See STEE1.1

Objective STEE1.3: Improve upstream and downstream passage for steelhead. Increase immigration success by __%.

Stressor: Passage impediments, flow alterations, low dissolved oxygen concentrations on the San Joaquin River near Stockton

Objective STEE1.4: Increase survival of outmigrating smolts by __%

Stressor: Flow alterations

Objective STEE1.5: The total percentage of juvenile steelhead entrained at the CVP and SWP pumps shall not exceed __% (methods for determining the percentage of entrainment and target entrainment levels to be determined with targets scaled according to water year type)

Stressor: Entrainment at unscreened water diversions and CVP and SWP pumping plants

Objective STEE1.6: Reduce illegal harvest of adult steelhead

Stressor: Illegal take of covered species.

Objective STEE1.7: Reduce susceptibility to, and impact of predation by nonnative predatory fish on juvenile outmigrants

Stressor: Predation caused by high densities of nonnative predatory fish

Objective STEE1.8: Manage salmonid hatchery operations to minimize genetic effects on all naturally producing steelhead run.

Stressor: Threats to natural steelhead posed by hatchery programs, including: (1) mortality of natural steelhead in fisheries targeting hatchery-origin steelhead; (2) competition for prey and habitat; (3) predation by hatchery-origin fish on younger natural fish; (4) genetic introgression by hatchery-origin fish that spawn naturally and interbreed with local natural populations; and (5) disease transmission (NMFS 2009).

3.3.2.3.5 Sacramento Splittail

Stressors Addressed: Habitat loss and food limitations, entrainment, predation by nonnative predators;

Stressors Not Addressed: Toxins and Contaminants

Goal SASP1: Contribute to conditions that will support the increased abundance and productivity of of Sacramento splittail in the Plan Area.

Objective SASP1.1: Increase access to, and availability of suitable spawning, rearing and foraging habitat for splittail. Increase the total surface area of inundated floodplain habitat by ___% when Delta inflow is __ cfs. [**Note to Reviewers**: *Look at the acreage to flow curve relationship. Look for opportunities to maximize the flooding for 30 days.]*

Stressor: Habitat loss, particularly loss of floodplain and channel margin habitat

Objective SASP1.2: Increase food availability for all life stages of Sacramento splittail by ___%.

Stressor: Food limitation

Objective SASP1.3: Help to maintain multiple spawning cohorts of Sacramento splittail as part of the breeding population.

Objective SASP1.4: The total percentage of splittail entrained at the CVP and SWP pumps shall not exceed __% (methods for determining the percentage of entrainment and target entrainment levels to be determined with targets scaled according to water year type)

Stressor: Entrainment

Objective SASP1.5: Reduce predation of splittail by centrachids and other predators.

Stressor: Predation by nonnative fish

3.3.2.3.6 Green Sturgeon

Stressors Addressed: Habitat loss; flow alterations; passage impediments; entrainment; dredging and illegal harvest.

Stressors Not Addressed: Contaminants, invasive species.

Goal GRST1: Contribute to conditions that will support the increased abundance, productivity, distribution and life-history and genetic diversity of green sturgeon in the Plan Area.

Objective GRST1.1: Improve rearing habitat for green sturgeon. [***Note to Reviewers:*** *Logic Chain Objective* #5)

Stressor: Habitat loss.

Objective GRST1.3: Improve upstream passage success for adult green sturgeon through the Fremont Weir and other operational gates/barriers. [***Note to Reviewers:*** *Logic Chain Objective #2]*

Stressor: Passage impediments.

Objective GRST1.4: The total percentage of green sturgeon entrained at the CVP and SWP pumps shall not exceed __% (methods for determining the percentage of entrainment and target entrainment levels to be determined with targets scaled according to water year type)

Stressor: Entrainment.

Objective GRST1.5: Determine through targeted studies the significance of poaching to the population and based upon study results, reduce poaching of adult green sturgeon in the Plan Area.

Stressor: Poaching green sturgeon

Objective GRST1.6: Avoid and minimize adverse effects of construction or maintenance dredging related to BDCP activities on green sturgeon.

Stressor: Construction or maintenance dredging related to BDCP activities.

3.3.2.3.7 White Sturgeon

Stressors Addressed: Habitat loss; flow alterations; passage impediments; entrainment; dredging and illegal harvest.

Stressors Not Addressed: Contaminants, , invasive species

Goal WHST1: Contribute to conditions that will increase the abundance, productivity and distribution of white sturgeon in the Plan Area.

> **Objective WHST1.1**: Improve rearing habitat conditions for white sturgeon.

> ***Stressor***: Habitat loss, invasive plant species *[**Note to Reviewers:** Tidal marsh allocanthous support of clams and other macro-crustaceans contribute to the prey base of sturgeon]*

> **Objective WHST1.3**: Improve upstream passage success for adult white sturgeon through the Fremont and Lisbon weirs and other operational gates.

> ***Stressor***: The Fremont Weir is a documented barrier to white sturgeon (Z. Matica, Department of Water Resources, pers. comm.).

> **Objective WHST1.4:** The total percentage of white sturgeon entrained at the CVP and SWP pumps shall not exceed __% (methods for determining the percentage of entrainment and target entrainment levels to be determined with targets scaled according to water year type) [***Note to Reviewers:*** *Entrainment is a low magnitude stressor for sturgeon, currently. This should be addressed during real-time operations*]

> ***Stressor***: White sturgeon entrainment from agricultural operations, power plants, and the state and federal water project facilities

> **Objective WHST1.5:** Reduce poaching of adult white sturgeon in the Plan Area

> ***Stressor***: Poaching of adult white sturgeon.

> **Objective WHST1.6**: Avoid and minimize adverse effects of construction or maintenance dredging related to BDCP activities on white sturgeon.

> ***Stressor***: Construction or maintenance dredging related to BDCP activities

3.3.2.3.8 River Lamprey

Stressors Addressed: Habitat loss; flow alterations; passage impediments; and illegal harvest.

Stressors Not Addressed: Contaminants, predation by nonnative species, and dredging

Goal RILA1: Contribute to conditions that will support the maintenance and restoration of river lamprey distribution and abundance to higher levels than present.

Objective RILA1.1: Restore and/or enhance river lamprey rearing habitat.

Stressor: Habitat loss.

Objective RILA1.3: Identify impediments/barriers to upstream passage of adult river lamprey and implement lamprey-specific passage and protection measures.

Stressor: Passage impediments. **Objective RILA1.4**: Help maintain flow conditions that facilitate outmigration of juvenile river lampreys.

Stressor: Flow alterations.

3.3.2.3.9 Pacific Lamprey

Stressors Addressed: Habitat loss; flow alterations; passage impediments and illegal harvest.

Stressors Not Addressed: Contaminants, predation by nonnative species and dredging

Goal PALA1: Contribute to conditions that will support the maintenance and restoration of Pacific lamprey distribution and abundance to higher levels than present.

Objective PALA1.1: Restore and/or enhance Pacific lamprey rearing habitat.

Stressor: Habitat loss.

Objective PAILA1.2: Reduce stranding of Pacific lamprey ammocoetes

Stressor: Passage impediment caused by dewatering of channels

Objective PALA1.4: Help maintain flow conditions that facilitate outmigration of juvenile Pacific lampreys.

Stressor: Flow alterations.

3.3.2.4 Covered Wildlife and Plant Species Goals and Objectives

This section presents goals and objectives that provide for the conservation of covered wildlife and plant species. Conservation for covered species is addressed primarily through ecosystem and natural community goals and objectives. For some species, additional species-specific goals and objectives were deemed necessary for conservation and are included below. This section lists the applicable natural community and species-specific goals and objectives for each covered species and presents the rationale and conservation approach that will be used to achieve them. Table 3-11 presents the expected extent of each covered wildlife and plant species' habitat that will be protected and restored in the Plan Area with full BDCP implementation.

Table 3-11. Expected Extent of Conserved Species Habitat Types in Conservation Zones 1-11 with BDCP Implementation

Covered Species	*Total Extent (acres)*	*Total Existing Preserved (acres)*	*Percent Existing Preserved (acres)*	*BDCP Preserved (acres)* **A**	*BDCP Restored (acres)* **B**	*BDCP Conserved (acres)* **A+B**	*Total Conserved with BDCP Implementation* **(Existing +BDCP)**	*Percent Conserved with BDCP Implementation*
San Joaquin kit fox								
Breeding habitat	5,217	638	12%	1,000	0	1,000	1,557	31%
Riparian woodrat	1,539	97	6%	0	300	300	394	22%
Salt marsh harvest mouse								
Wetland habitat	11,124	9,600	86%	0	3,600-4,800	3,600-4,800	10,831-12,031	89-90%
Upland habitat	2,815	2,334	83%	350-700	350-700	700-1,400	2,416-3,116	85-100%
Riparian brush rabbit	2,894	138	5%	0	300	300	435	14%
Townsend's western big-eared bat								
Roosting and primary foraging habitat	6,892	1,876	27%	0	5,000	5,000	6,720	58%
Suisun shrew	28,741	22,590	79%	0	3,600-4,800	3,600-4,800	20,518-21,718	79-80%
Tricolored blackbird								
Nesting habitat	24,036	14,372	60%	0	17,900-26,800	17,900-26,800	28,852-37,752	76-81%
Foraging habitat: non-agriculture	99,587	40,818	41%	8,700	0	8,700	45,653	49%
Foraging habitat: agriculture	275,937	33,097	12%	16,620-32,640	0	16,620-32,640	47,253-63,273	50-68%
Suisun song sparrow	26,959	21,177	79%	0	3,600-4,800	3,600-4,800	19,979-21,179	79-80%
Yellow-breasted chat								
Primary nesting and migratory habitat[20]	8,640	3,125	36%	0	≥2,000	≥2,000	≥4,722	≥47%
Secondary nesting and migratory habitat	5,530	1,896	34%	0	≤3,000	≤3,000	≤4,561	≤57%
Least Bell's vireo	14,139	5,008	35%	0	≥2,000	≥2,000	≥6,272	≥42%
Western burrowing owl								
High-value habitat	78,447	26,261	34%	8,000	2,000	10,000	34,281	46%
Moderate- value habitat	52,800	16,214	31%	>3,900	0	>3,900	>19,094	>39%
Western Yellow-Billed Cuckoo								
Breeding Habitat	6,826	2,763	41%	0	>1,000	>1,000	>3,356	>46%
California Least Tern								
Foraging habitat	86,240	18,080	21%	0	10,000-20,000	10,000-20,000	28,016-38,016	29-36%
Greater sandhill crane								
Roosting/Foraging habitat[21]	11,829	6,743	57%	0	320	320	7,063	60%
Foraging habitat	184,257	33,259	18%	>4,800	0	>4,800	>34,373	>19%
California black rail	33,563	24,593	73%	0	17,500-26,400	17,500-26,400	36,828-45,728	82-85%
California clapper rail	7,895	5,013	64%	0	3,600-4,800	3,600-4,800	8,294-9,494	74-77%

[20] Suisun Marsh/Upper Yolo Bypass Nest and Migratory Habitat acreage totals have been assumed to be equivalent to Primary Habitat and have been combined with the Primary Habitat acreage totals. For further definition of the Suisun Marsh/Upper Yolo Bypass Nest and Migratory Habitat, refer to Yellow-breasted Chat species account documented within Appendix A, *Covered Species Accounts*.

[21] Restoration is aimed at roosting habitat, which can be a component of foraging habitat depending on agricultural management practices.

Table 3-11. Expected Extent of Conserved Species Habitat Types in Conservation Zones 1-11 with BDCP Implementation (continued)

Covered Species	*Total Extent (acres)*	*Total Existing Protected (acres)*	*Percent Existing Protected (acres)*	*BDCP Protected (acres)* **A**	*BDCP Restored (acres)* **B**	*BDCP Conserved (acres)* **A+B**	*Total Conserved with BDCP Implementation* **(Existing +BDCP)**	*Percent Conserved with BDCP Implementation*
Swainson's hawk								
Foraging habitat	436,417	75,743	17%	20,020-36,040	0	20,020-36,040	88,935-104,955	23-26%
Nesting habitat	10,149	3,258	32%	0	4,000	4,000	6,789	50%
White-tailed kite								
Breeding habitat	13,714	4,518	33%	0	4,000	4,000	7,951	47%
Foraging habitat	478,251	101,068	21%	24,620-46,040	0	24,620-46,040	112,851-134,271	26-31%
Giant garter snake								
Aquatic breeding, foraging and movement[22]	19,824	5,725	29%	≥6,900	13,690-22,040	≥20,590-≥28,940	≥25,994-≥34,344	≥79-83%
Upland aestivation and movement[23]	190,805	31,954	17%	7,100	0	7,100	36,113	20%
Western pond turtle								
Aquatic habitat	78,511	30,591	39%	0	27,900-46,800	27,900-46,800	53,855-72,755	54-61%
Dispersal habitat	579,334	109,348	19%	4,000	0	4,000	98,528	19%
Upland nesting and overwintering	54,880	19,738	36%	≥5,230	5,000	≥10,230	≥27,958	≥50%
California red-legged frog								
Aquatic habitat	117	4	3%	3	0	3	7	6%
Upland cover and dispersal habitat	4,984	640	13%	1,000	0	1,000	1,560	33%
Western spadefoot toad								
Aquatic breeding habitat	6,791	4,256	63%	300	200	500	4,746	69%
Terrestrial cover and aestivation habitat	14,352	5,071	35%	8,400	500	8,900	13,821	99%
California tiger salamander								
Aquatic breeding habitat	6,772	4,255	63%	300	200	500	4,746	68%
Terrestrial cover and aestivation habitat	14,352	5,071	35%	8,400	500	8,900	13,821	99%
Valley elderberry longhorn beetle								
Riparian vegetation	17,130	5,310	31%	0	5,000	5,000	9,583	46%
Lange's metalmark butterfly	1,108	67	6%	0	0	0	67	6%
Vernal pool shrimp species (*Vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid valley fairy shrimp, and California linderiella*)	6,821	4,319	63%	300	200	500	4,810	69%

[22] Preservation and 400 acres of restoration is targeted for primary zone giant garter snake habitat in CZ's 2 and 4.

[23] Preservation is targeted for primary zone giant garter snake habitat in CZ's 1, 2, 4, and/or 5.

Table 3-11. Expected Extent of Conserved Species Habitat Types in Conservation Zones 1-11 with BDCP Implementation (continued)

Covered Species	*Total Extent (acres)*	*Total Existing Protected (acres)*	*Percent Existing Protected (acres)*	*BDCP Protected (acres)* **A**	*BDCP Restored (acres)* **B**	*BDCP Conserved (acres)* **A+B**	*Total Conserved with BDCP Implementation* **(Existing +BDCP)**	*Percent Conserved with BDCP Implementation*
Vernal pool plant species (*Alkali milk-vetch, San Joaquin spearscale, Boggs Lake hedge-hyssop, Heckard's peppergrass, dwarf downingia, and legenere*)	6,958	4,380	63%	300	200	500	4,850	69%
Heartscale and brittlescale	496	127	26%	150	0	150	274	56%
Slough thistle	1,831	188	10%	0	≥1,000	≥1,000	≥1,188	≥42%
Suisun thistle and soft bird's-beak	1,225	869	71%	0	3,600-4,800	3,600-4,800	3,890-5,090	92-94%
Delta button celery	3,345	270	8%	≥100	≥1,000	≥1,100	≥1,369	≥32%
Contra Costa Wallflower	20	17	85%	0	0	0	17	85%
Carquinez goldenbush	1,032	391	38%	300	0	300	689	70%
Delta tule pea and Suisun Marsh aster	5,948	3,699	62%	0	16,970-26,470	16,970-26,470	19,593-29,093	90-93%
Mason's lilaeopsis and delta mudwort	6,931	1,717	25%	0	16,980-26,560	16,980-26,560	18,617-28,197	78-85%
Antioch Dunes evening primrose	20	17	85%	0	0	0	17	85%
Side-flowering skullcap	2,495	701	28%	0	0	0	689	28%
Caper-fruited tropidocarpum	1,410	21	2%	≥100	0	≥100	≥121	≥9%

3.3.2.4.1 San Joaquin Kit Fox

In Northern California, the San Joaquin kit fox is a year-round resident of grassland habitats (Swick 1973, Hall 1983, Bell 1994), although it may also sometimes forage in fallow fields and irrigated row crops (Bell 1994). Its home range size is highly variable and tends to be related to prey abundance (White and Ralls 1993, White and Garrott 1999); its territories range from less than 2.6 square kilometers (sq km) (1 square mile [sq mi]) up to approximately 31 sq km (12 sq mi) (Morrell 1972, Knapp 1978, Zoellick et al. 1987b, Paveglio and Clifton 1988, Spiegel and Bradbury 1992, White and Ralls 1993). Habitat loss and fragmentation due to urbanization and agricultural expansion are the principal factors that have been implicated in the decline of the San Joaquin kit fox in the San Joaquin Valley (Laughrin 1970, Jensen 1972, Morrell 1975, Knapp 1978). By 1979, only an estimated 6.7 percent of the San Joaquin Valley floor's original native habitat south of Stanislaus County remained untilled and undeveloped (USFWS 1983). In its northern range, continued urbanization, primarily in Contra Costa and Alameda counties, water storage and conveyance projects, road construction, energy development, and other activities continue to reduce and fragment its remaining grassland habitat and contribute to kit fox declines through displacement, isolation of populations, creation of barriers to movement, direct and indirect mortality, and the reduction of prey populations (USFWS 1998a).

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

> **Objective GRNC2.3**: Increase opportunities for wildlife movement through grassland habitat.

> **Objective GRNC2.4**: Increase burrow availability for burrow-dependent species.

> **Objective GRNC2.5**: Increase prey, especially small mammals and insects, for grassland-foraging species.

Rationale and Conservation Approach

Since the primary stressor on the kit fox is the loss and fragmentation of its grassland habitat through urban and agricultural expansion, protection of grassland habitat is considered the most effective approach to the kit fox's conservation (Figure 3-14). In the recovery plan for the San Joaquin kit fox and other San Joaquin Valley upland species (USFWS 1998a), the recommended conservation strategy is centered on establishing a network of conservation areas and reserves. During the implementation of BDCP, conservation of the kit fox will similarly be provided through habitat protection, with an emphasis on protecting the largest remaining contiguous patches of habitat, and ensuring habitat connectivity with adjacent occupied areas. Because kit fox habitat within the Plan Area is located along the margin, rather than in the core, of the species' range, the possibility exists that BDCP conservation measures will be implemented outside the boundaries of the Plan Area, but this will occur only if and where conservation measures are expected to maximize the benefit for kit fox conservation. This contingency would be selected should a specific opportunity arise for conservation in a core kit fox habitat area, consistent with conservation plans for those locations as described in Section 3.2.4, *Development of the Terrestrial Resources Component of the Conservation Strategy*.

Conservation of San Joaquin kit fox in the Plan Area will focus on the preservation and enhancement of 1,000 acres of its grassland breeding, foraging, and dispersal habitat (Table 3-5).

Protection of kit fox habitat will focus in particular on acquiring the largest remaining contiguous patches of unprotected grassland breeding habitat, which are located in Conservation Zone 8 south of Highway 4 (see Appendix A, *Covered Species Accounts*). Conservation Zone 8 supports 74 percent of the modeled kit fox grassland breeding habitat in the Plan Area (Table 3-11). Following BDCP implementation, the percent of modeled kit fox breeding, foraging, and dispersal habitat protected in Conservation Zone 8 will increase from 16 percent to 42 percent.

Kit fox home ranges are large; therefore, habitat connectivity is key to the conservation of the species. Breeding habitat present in Conservation Zones 7, 9, and 10 occurs only in small fragmented patches, which by themselves are likely to be of limited value to the kit fox (see Appendix A, *Covered Species Accounts*). Even protected grassland habitat in Conservation Zone 8 is unlikely to encompass an entire home range. For this reason, protected habitat will be acquired in locations that provide connectivity to existing protected breeding habitats in Conservation Zone 8 and to other adjoining kit fox habitat within and adjacent to the Plan Area. Connectivity to occupied habitat adjacent to the Plan Area will help ensure the movement of kit fox to larger habitat patches outside of the Plan Area.

Declines in prey abundance associated with ground squirrel poisoning programs have been identified as a stressor contributing to reduced kit fox abundance (see habitat model in Appendix A, *Covered Species Accounts*). Consequently, protected grassland will be managed and enhanced to increase the abundance and distribution of kit fox mammalian prey species (e.g., discontinued use of pesticides, manipulation of topography, mowing for increasing ground squirrel densities).

In summary, the Plan Area lies along the margin of the kit fox's distribution, where conservation measures might provide only limited benefits. However, should the proposed kit fox habitat conservation actions be implemented in the Plan Area, they are still expected to maintain sufficient habitat area to sustain or increase the existing Plan Area kit fox population. The same proposed habitat conservation actions are also expected to maintain connectivity with occupied core populations that are adjacent to the Plan Area and are covered under adjacent and overlapping HCP/NCCPs. Conservation measures may be implemented outside rather than within the Plan Area. Such a conservation approach would be selected only where conservation benefits are expected to be greater than from conservation measures implemented within the Plan Area.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

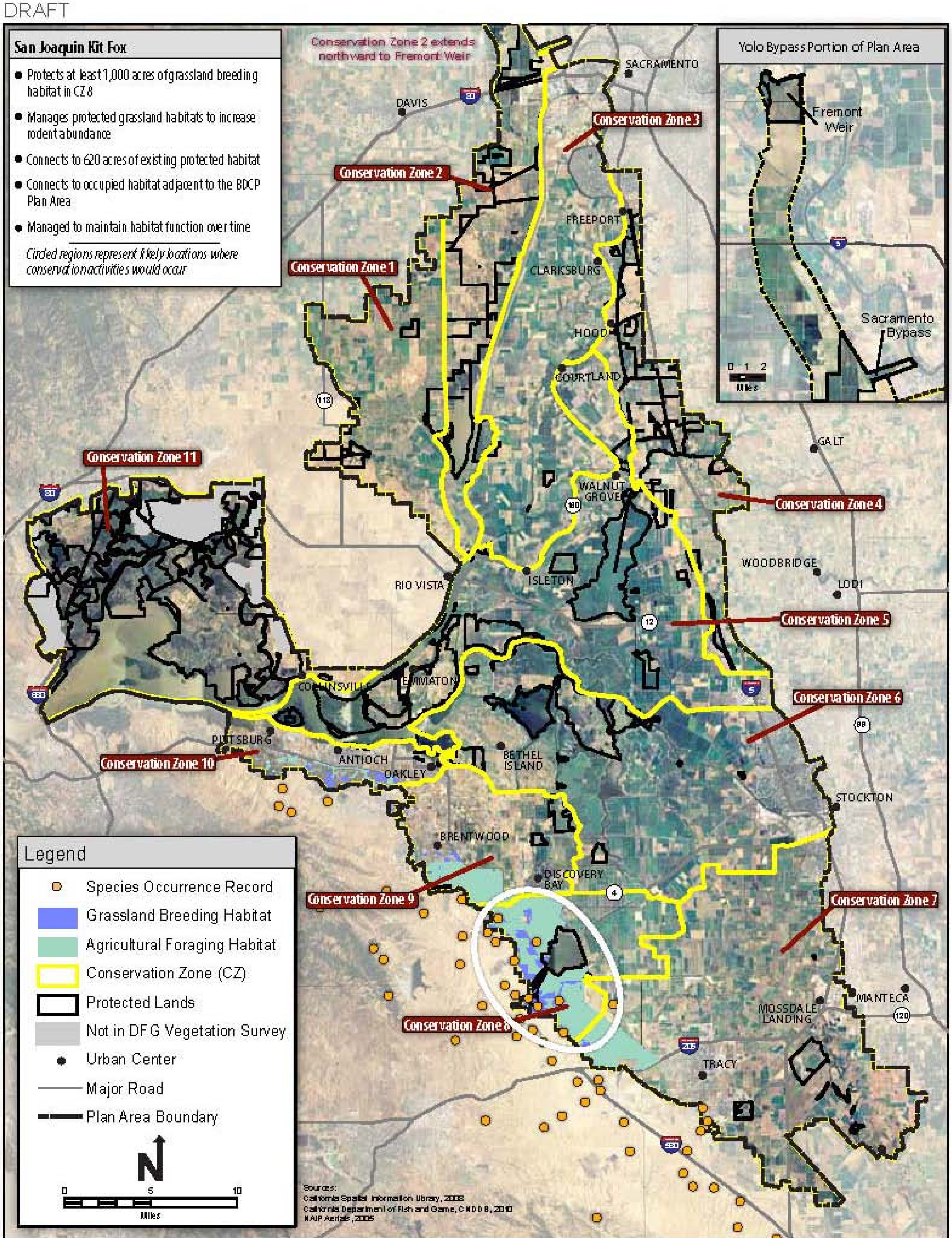

Figure 3-14. San Joaquin Kit Fox Habitat Distribution and Conservation Strategy

3.3.2.4.2 Riparian Woodrat

The riparian woodrat (*Neotoma fuscipes riparia*) is a subspecies of the dusky-footed woodrat that occurs in riparian woodland with an overstory canopy of trees and a moderate to dense shrub understory, reaching its highest densities in willow thickets growing under a canopy of valley oaks (Williams 1986, USFWS 1998a). It is not known to occur in the Plan Area, but the only verified extant population of riparian woodrat is only 2 miles east of the Plan Area in Caswell Memorial State Park along the Stanislaus River (Williams 1986, 1993). Small patches of potentially occupied valley oak riparian forest occur along the San Joaquin River from the southern tip of the Plan Area north to approximately the Interstate 5 overcrossing near Lathrop (Appendix A, *Covered Species Accounts*).

The riparian woodrat is a federally listed species and a state species of special concern (Williams 1986). Once occupying a larger range, it is now confined to the lower portions of the San Joaquin and Stanislaus rivers in northern San Joaquin County (Williams 1986, 1993, USFWS 1998a). Habitat loss and fragmentation are considered the main causes for the riparian woodrat's range contraction. There has been a nearly 90 percent reduction in the extent of riparian communities along major streams flowing onto the floor of the northern San Joaquin Valley (Katibah 1983), much of the loss is due to habitat conversion to agricultural lands and the construction of large dams and canals (Appendix A, *Covered Species Accounts*).

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Species-Specific Goals and Objectives

Goal RIWR1: The expected outcome is restored and protected habitat for the riparian woodrat.

> **Objective RIWR1.1:** Of the 5,000 acres of restored valley/foothill riparian, restore and manage 300 acres to meet the ecological requirements of the riparian woodrat in Conservation Zone 7.

Rationale and Conservation Approach

Habitat protection and, where appropriate, habitat restoration, is the central component of the conservation strategy recommended in the Recovery Plan for the riparian woodrat and other upland species of the San Joaquin Valley (USFWS 1998a). The Recovery Plan establishes an overall goal of establishing three riparian woodrat populations based on conservation actions aimed at protecting and restoring riparian habitat, together with species reintroduction (USFWS 1998a). The overall BDCP biological goal for the riparian woodrat is to restore suitable riparian woodrat habitat to provide for the species' conservation; this is congruent with the Recovery Plan (Figure 3-15) (see Appendix A, *Covered Species Accounts*). Conservation will be directed towards restoring valley/foothill riparian within the Plan Area to provide habitat that could allow for future reintroduction or expansion of the existing riparian woodrat population into the Plan Area. The 5,000 acres of valley/foothill riparian to be restored under the Plan is expected to include patches of riparian vegetation that supports riparian woodrat habitat. These patches will increase the likelihood of future colonization of Plan Area habitats by the riparian woodrat.

Additionally, of the 5,000 acres of riparian habitat to be restored under the Plan, BDCP will restore and manage 300 acres of riparian vegetation with specific riparian woodrat habitat attributes, including a willow understory and oak overstory. Riparian woodrat habitat would be restored in patches of at least 25 acres, which is believed to exceed the minimum habitat patch size requirements for the species. The extent of existing known occupied habitat is approximately 250 acres (see Appendix A, *Covered Species Accounts*). Restoration of 300 acres of additional habitat is expected to contribute to conservation of the riparian woodrat by substantially increasing the extent of available and protected habitat.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

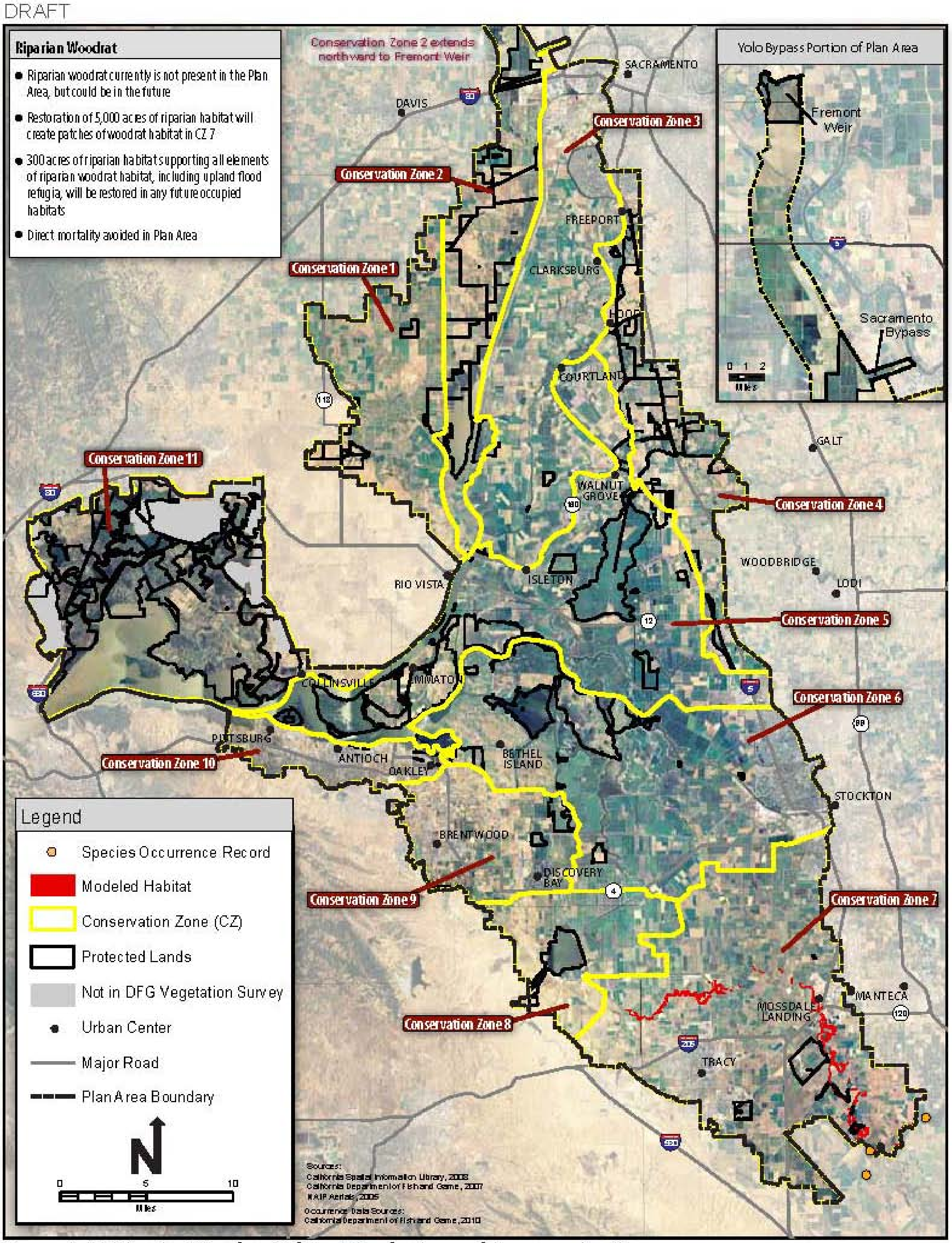

Figure 3-15. Riparian Woodrat Habitat Distribution and Conservation Strategy

3.3.2.4.3 Salt Marsh Harvest Mouse

The salt marsh harvest mouse is a small rodent endemic to the salt and brackish marshes of San Francisco, San Pablo, and Suisun Bays (USFWS 2001b). It depends on salt marshes as its optimal habitat and is primarily found in vegetation dominated by pickleweed. Upland refugia are important during high tide events so that it can escape flooded low-lying marshlands (see Appendix A, *Covered Species Accounts*). Much of the occupied habitat in Suisun Marsh consists of suitable patches of tidal brackish emergent wetland within a nontidal managed and diked wetland complex (including upland grasslands used as refugia during high tide events) that the mouse has adapted to following the reclamation of historical Suisun Bay tidal marshes. The size of salt marsh harvest mouse populations in Suisun Marsh are likely limited by habitat fragmentation.

The recovery plan for this state and federally endangered species was completed in 1984 and is currently under revision (Appendix A, *Covered Species Accounts*). The historical range of the species likely included most of the marshland in the San Francisco Bay Area. Today, the species might occupy an area representing only approximately 15 percent of the historical salt marsh habitat formerly found in the San Francisco Bay Area (Dedrick 1989). Much of this remaining habitat is isolated by dikes and landfill, is subject to backfilling, subsidence, and vegetation changes, and as a result is unlikely to support salt marsh harvest mouse (Shellhammer 1989). Thus, the remaining populations are small and separated by large areas of unsuitable habitat, and the loss and degradation of tidal marsh habitats continue to be the most significant threat to the salt marsh harvest mouse and other tidal marsh species.

Applicable Natural Community Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Rationale and Conservation Approach

Because the primary stressor on the salt marsh harvest mouse is loss of its tidal marsh habitat due to urban and agricultural expansion, the recovery plan for the salt marsh harvest mouse emphasizes habitat protection, enhancement, and restoration as essential to the conservation and recovery of the species (USFWS 1984b). BDCP-proposed restoration, enhancement, and management of tidal habitat and associated refugia in Suisun Marsh is consistent with the 1984 Recovery Plan for the salt marsh harvest mouse (Figure 3-16). It also helps to achieve the salt marsh harvest mouse objectives of the draft tidal marsh ecosystems recovery plan (USFWS 2010) and the objectives of the Suisun Marsh Restoration Plan (under development).

Restoration of tidal habitat will remove and degrade patches of tidal brackish emergent wetland that are currently occupied by salt marsh harvest mouse; therefore, restoration will be sequenced and located in a manner that minimizes any initial, temporary loss of habitat. Approaches for restoring tidal habitat to support salt marsh harvest mouse habitat are described in Conservation Measure CM4 Tidal Habitat Restoration. Restored tidal habitats will be designed to the extent practicable within site constraints to provide the full range of environmental gradients from tidal areas to uplands that existed under historical conditions in Suisun Marsh. This approach is expected to result in restoration of patches of salt marsh harvest mouse habitat within a mosaic of larger marsh plain habitat. A total of between 3,600 and 4,800 acres[24] of tidal wetland and 350 to 700 acres of associated upland habitat is expected to be restored in the Suisun Marsh (Conservation Zone 11) and provide high value habitat for the salt marsh harvest mouse. It is anticipated that following completion of all tidal habitat restoration in Suisun Marsh, tidal marsh plain habitats will be restored in patches larger than currently found (characterized by habitat fragmentation by dikes, roads, and other infrastructure, as well as unsuitable habitat). These larger unfragmented patches are expected to be of higher ecological value to the salt marsh harvest mouse and facilitate population expansion and growth in Suisun Marsh. The transitional upland component of restored tidal habitats will be designed to provide flood refugia (grassland) habitat during high tide events.

BDCP actions are expected to initially impact salt marsh harvest mouse wetland habitat in Suisun Marsh, but most marshes to be impacted will be managed wetlands. Over the full course of BDCP implementation, BDCP actions will preserve and restore a greater amount of tidal marsh than will be impacted, and thus significantly advance the conservation of the salt marsh harvest mouse.

Nonnative predators (e.g., feral cats) are believed to be an important stressor on the salt marsh harvest mouse. Therefore, the design and management of restored habitat will include control of nonnative predators (e.g., through direct removal of predators or through design of restored habitats that minimize access of predators into occupied habitats).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

[24] Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

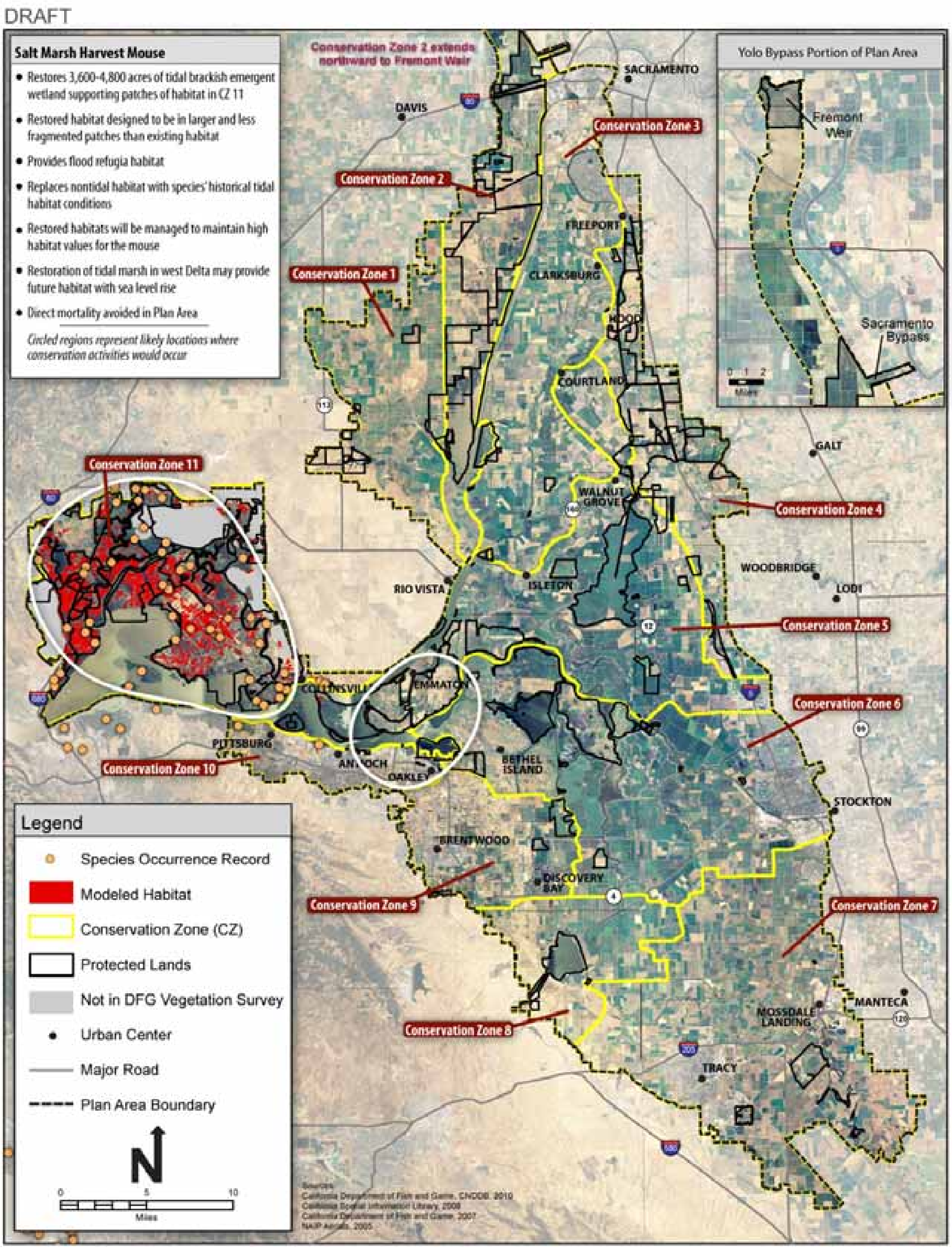

Figure 3-16. Salt Marsh Harvest Mouse Habitat Distribution and Conservation Strategy

3.3.2.4.4 Riparian Brush Rabbit

One of eight subspecies of brush rabbit in California, the riparian brush rabbit (*Sylvilagus bachmani riparius*) occupies a range that is disjunct from that of other brush rabbits, near sea level on the floor of the San Joaquin Valley (USFWS 1998a). Riparian brush rabbits inhabit valley riparian forests or forest patches, where they are closely associated with dense shrub vegetation (Williams et al. 2008). Occupied sites tend to be in riparian settings with an open overstory canopy of valley oak (*Quercus lobata*) or savannah-like settings that support extensive patches of low-growing willow (*Salix* spp.), wild rose (*Rosa californica*), wild grape (*Vitis californica*), or blackberry (*Rubus* spp.) (Williams et al. 2008). The brush rabbits move through the dense brush and thickets by creating tunnels through the vegetation. Seasonally available weedy/ruderal cover, including patches of tall grass, forbs, and pepperweed (*Lepidium latifolium*) is also used, particularly where it connects to more suitable woody cover (Williams et al. 2008). Generally, riparian forests that support a closed overstory canopy lack sufficient understory shrubs to support riparian brush rabbits (USFWS 1998a). Small herbaceous openings in close proximity to cover are also required for foraging, and higher elevation areas are required to sustain populations during floods (USFWS 1998a).

Due to drastic declines in brush rabbit numbers since the 1940s, the riparian brush rabbit (*Sylvilagus bachmani riparius*) is listed as endangered under the state and federal endangered species acts. The riparian brush rabbit's historical distribution may have extended along portions of the San Joaquin River and its tributaries on the valley floor from at least as south as Stanislaus County to the Delta (Orr 1935 in USFWS 1998a). Populations are known to have historically occurred in riparian forests along the San Joaquin and Stanislaus rivers and some tributaries to the San Joaquin River on the valley floor (USFWS 1998a). One population estimate within this historical range was about 110,000 individuals (USFWS 1998). The dramatic decline of the riparian brush rabbit began with the building of dams constructed for irrigation and flood control, on the major rivers of the Central Valley. Protection from flooding resulted in conversion of floodplains to croplands and the consequent reduction and fragmentation of remaining riparian communities. By the mid-1980s, the riparian forest within the species' former range had been reduced to a few small and widely scattered fragments totaling about 5,189 acres (USFWS 1998a).

As a result of habitat loss, remaining populations of riparian brush rabbits occur in only two areas of San Joaquin County. The first is a patch of approximately 258 acres in Caswell Memorial State Park (CMSP) on the Stanislaus River. The second population, which was only confirmed in late 1998, occupies approximately 270 acres in several small, isolated or semi-isolated patches along Paradise Cut and Tom Paine Slough and channels of the San Joaquin River in the southern Plan Area (Williams et al. 2002a, Williams et al. 2008).

In 2005, a captive-bred population of approximately two-dozen animals was introduced to the Faith Ranch along the San Joaquin River in Stanislaus County adjacent to the San Joaquin River National Wildlife Refuge. The recovery plan for the brush rabbit (and other upland species of the San Joaquin Valley) is focused on riparian restoration and protection, together with population reintroductions.

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Species-Specific Goals and Objectives

Goal RIBR1: The expected outcome is restored and protected habitat for riparian brush rabbit.

> **Objective RIBR1.1:** Of the 5,000 acres of riparian restoration, restore and manage at least 300 acres to meet the ecological requirements of the riparian brush rabbit in Conservation Zones 7 or 8.

Rationale and Conservation Approach

BDCP implementation will be congruent with and help achieve the goals of the recovery plan. Specifically, conservation within the Plan Area will be directed towards restoring riparian forest and scrub to provide habitat compatible with future reintroduction efforts or expansion of the existing riparian brush rabbit population into the Plan Area. Approaches for restoring riparian communities that support riparian brush rabbit habitat are described in the conservation approaches for conserving the Valley/foothill riparian natural community.

Conservation of riparian brush rabbit will be provided through restoration of 300 acres of riparian vegetation that supports brush rabbit habitat attributes within the species' historical range along Old River, Middle River, and/or the San Joaquin River or suitable tributaries in Conservation Zones 7 and 8 (Figure 3-17). Habitat will be restored in patches of at least 25 acres, which is believed to exceed the minimum habitat patch size requirements for the species.

Connectivity with currently occupied or potentially occupied habitat will be a primary factor in the selection of restoration sites. In addition to the species' limited distribution and abundance, flooding and predation are primary stressors on this species. The restored riparian brush rabbit habitat will be designed to incorporate flood refugia habitat (i.e., bunny mounds) and will be designed and managed to control predation. The extent of existing known occupied habitat is approximately 270 acres (Appendix A, *Covered Species Accounts*) and restoration of 300 acres of additional habitat located adjacent to occupied or potentially occupied habitat areas will result in a substantial increase in the extent of available habitat. Additionally, a portion of the remaining 4,500 acres riparian habitat to be restored and distributed amongst Conservation Zones 1, 4, 5, 7, and/or 11 is expected to also support riparian brush rabbit habitat over the term of the BDCP. Thus, the proposed restoration and management of riparian brush rabbit habitat are expected to sustain the existing population. Riparian habitat conservation efforts within Conservation Zones 7 and 8 will serve to accommodate any future expansion of the existing population or provide habitat for future introductions of the species.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

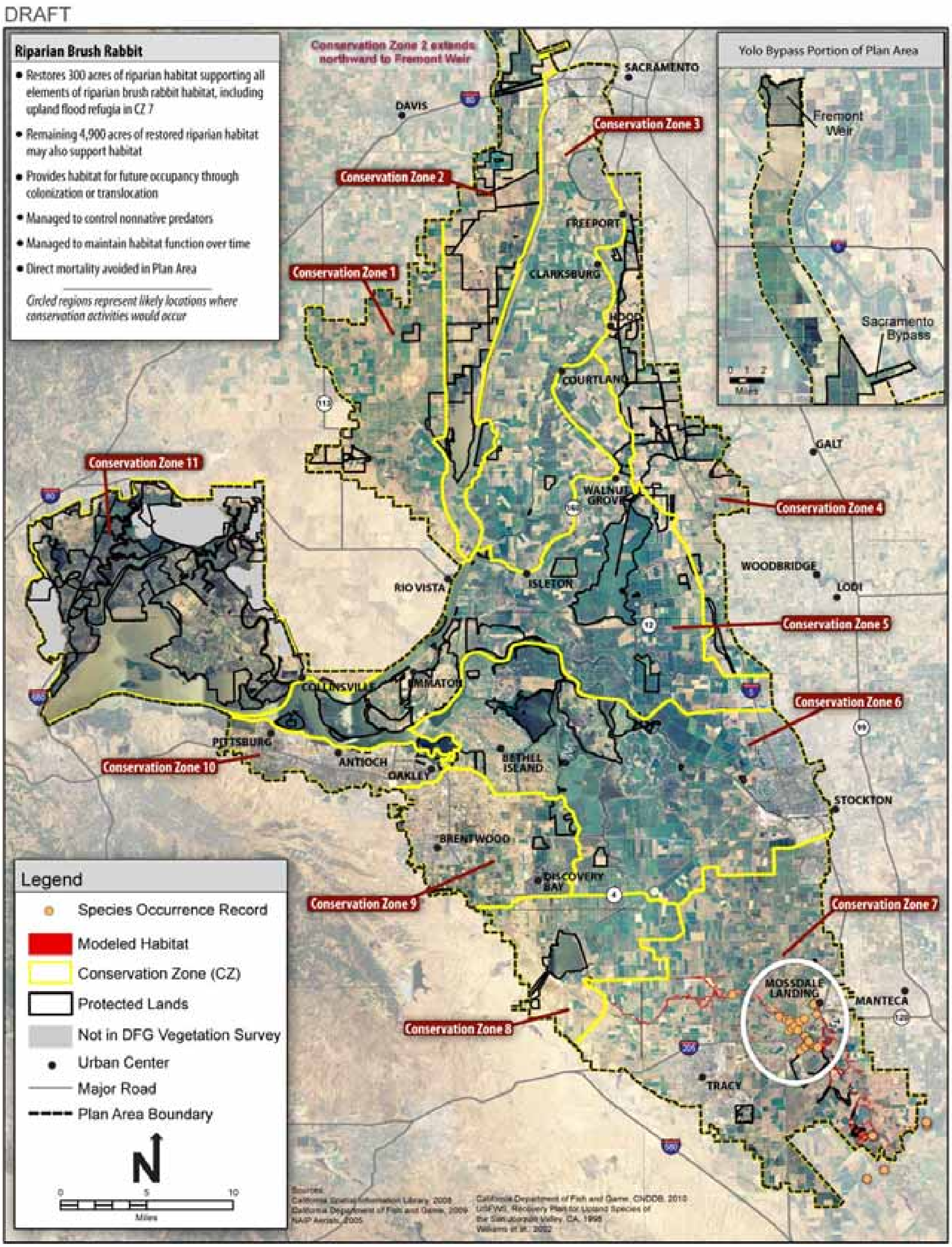

Figure 3-17. Riparian Brush Rabbit Habitat Distribution and Conservation Strategy

3.3.2.4.5 Townsend's Big-Eared Bat

Townsend's big-eared bat occurs in many habitats including active agricultural areas, riparian vegetation communities, coastal habitat types, oak woodland, conifer forest, desert scrub, and native prairies. Roosting habitat is mainly limited to caves, mines, tunnels, and other features that mimic caves, such as large tree hollows, abandoned buildings with cave-like attics, water diversion tunnels, and internal spaces in bridges. Pierson and Rainey (1998a) suggested that the species' distribution appears to be constrained primarily by the availability of suitable roosting sites and the degree of human disturbance at roosts.

According to Pierson and Rainey (1998a), there has been a 52 percent loss in the number of maternity colonies during the last 40 years, a 45 percent decline in the number of available roosts, a 54 percent decline in the total number of animals, and a 33 percent decrease in the average size of remaining colonies for the species as a whole across California. Townsend's big-eared bats have declined notably in San Francisco Bay area counties where native habitat and rural land have been converted to agriculture (i.e., wine production) or suburban/urban development. The cause of local population declines is most likely the disturbance and the destruction of roost sites. Vulnerability to human disturbance is indicated by findings that colonies have abandoned roost sites after human visitation (Humphrey and Kunz 1976). In addition to the disturbance or destruction of winter roosts, Pierson et al. (1999) also reported that Townsend's big-eared bats are threatened by the loss of clean water and the loss of roosting and foraging habitat. The impacts of pesticides and herbicides on insect prey availability may also threaten populations of this species.

No Townsend's big-eared bat has been documented in the Plan Area. However, the species is known to occur at nearby Central Valley locations and presumably could be present in the Plan Area (see Appendix A, *Covered Species Accounts*).

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

> **Objective ALNC1.1**: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.

> **Objective ALNC1.2**: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson's hawk nesting habitat.

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

Rationale and Conservation Approach

Conservation of Townsend's big-eared bat under BDCP focuses on the restoration of valley/foothill riparian as roosting and primary foraging habitat. Woody vegetation is particularly important for foraging as well as for roosting because Townsend's big-eared bats forage through both aerial hawking and substrate gleaning. Restored areas of valley/foothill riparian are anticipated to be located primarily within Conservation Zones 1, 4, 7, and/or 11 (Figure 3-18). Secondary foraging habitats are comprised of all other land cover types present in the Plan Area (e.g., cultivated lands) and will be protected through actions that provide conservation for other covered species (e.g., preservation of Swainson's hawk foraging habitat) and the restoration of tidal emergent wetland, tidal perennial aquatic, nontidal wetland, and valley/foothill riparian. The production of flying insects and, consequently the function of restored habitats as bat foraging habitat is expected to be greater in restored habitats than in cultivated land foraging habitats. Restored habitats will provide a diversity of microhabitats conducive to a greater production and availability of flying insects compared to the homogenous microhabitat conditions associated with cultivated lands that are subject to routine application of pesticides. Additionally, protected and restored habitats will be monitored to assess occupancy by the species and managed to minimize human disturbances that could affect roosting bats.

Based on model projections, the restoration of valley/foothill riparian areas will increase the extent of Townsend's big-eared bat roosting and primary foraging habitat within the Plan Area by approximately 28 percent (see detailed description of habitat requirements and habitat model assumptions in Appendix A, *Covered Species Accounts*). The substantial increase in this species' core habitat in combination with the protection and enhancement of its secondary foraging habitats is expected to sustain the existing abundance and distribution of Townsend's big-eared bat and provide for the future growth of its population.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

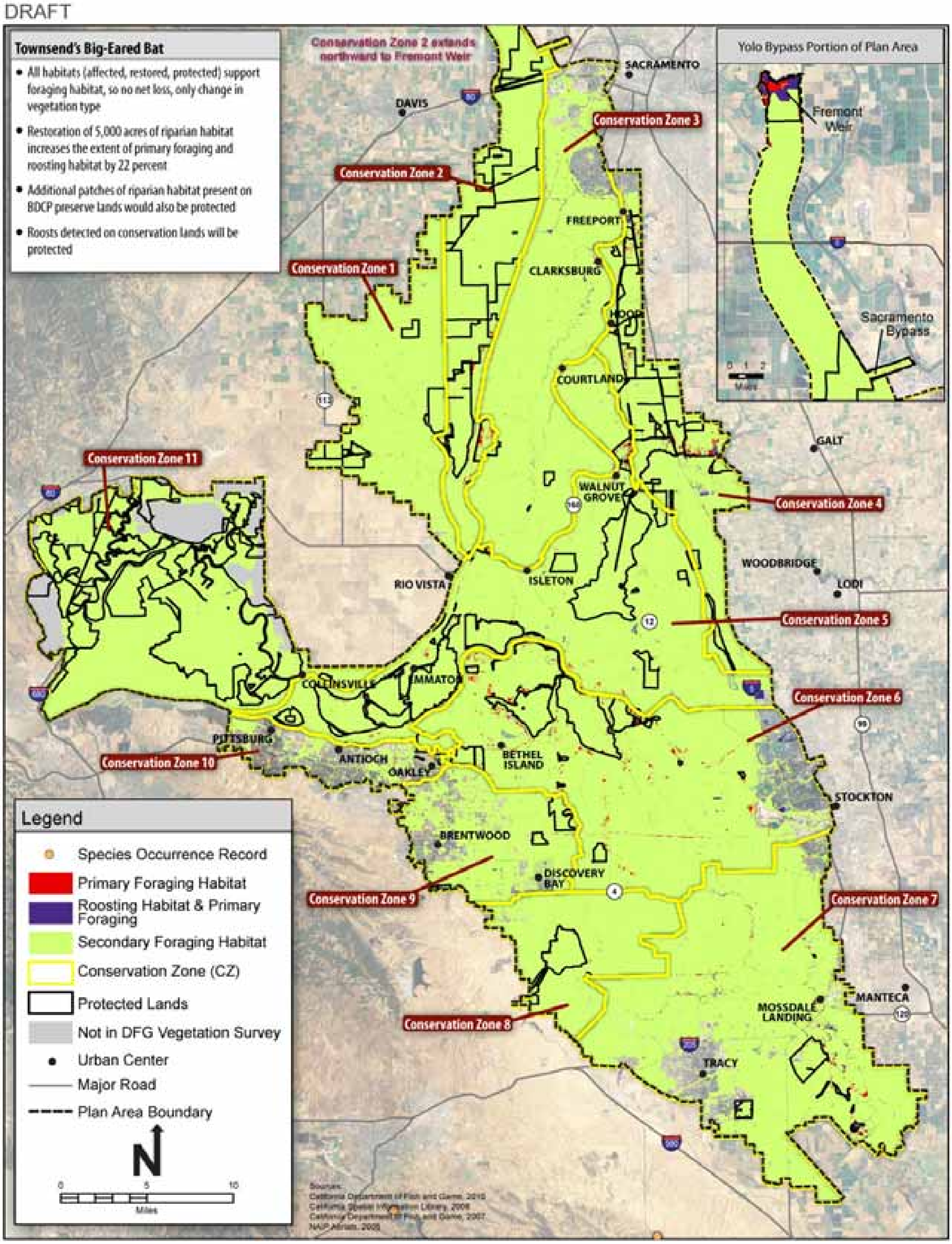

Figure 3-18. Townsend's Big-Eared Bat Habitat Distribution and Conservation Strategy

3.3.2.4.6 Suisun Shrew

The Suisun shrew is one of several subspecies of the ornate shrew and is endemic to the tidal saline and brackish salt marshes of Solano, Napa, and eastern Sonoma counties. Its current distribution is restricted to isolated remnants of natural tidal and brackish marshes along the northern borders of San Pablo and Suisun bays, including a number of locations in Suisun Marsh, Southampton Marsh, and the Napa Marshes, extending as far east as Grizzly Island and as far west as Sonoma Creek and Tubbs Island (Brown and Rudd 1981, Western Ecological Services 1986). There are no reported occurrences of Suisun shrew from within the Plan Area except in Suisun Marsh. Degradation of tidal marsh habitats continues to be the most significant threat to Suisun shrews and other tidal marsh species. Tidal marshes have been reduced by 84 percent since historical times (Dedrick 1989). The fragmentation of suitable habitats has isolated populations and reduced dispersal opportunities.

Applicable Natural Community Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Rationale and Conservation Approach

Because the primary stressor on the Suisun shrew is loss of its tidal marsh habitat, Suisun shrew conservation and recovery efforts are aimed at protecting and restoring tidal marsh habitat (e.g., CALFED Bay-Delta Program 2000). Congruent with those conservation efforts, BDCP will restore tidal marsh habitat to provide for the conservation of the Suisun shrew. Suisun shrew inhabits tidal brackish emergent wetland. Much of Suisun shrew occupied habitat is supported by suitable patches of vegetation within nontidal managed wetland complex that the mouse has adapted to following the reclamation of historical Suisun Bay tidal marshes. Conservation will be directed towards restoring tidal brackish emergent wetland, on which the species was historically dependent to produce a net increase in Suisun shrew habitat. Because restoration of tidal brackish emergent wetland will remove and degrade patches of nontidal managed wetland complex that are currently occupied by Suisun shrew, restoration will be sequenced and located in a manner that minimizes the extent of any temporary loss of habitat. Approaches for restoring tidal brackish emergent wetland to support Suisun shrew habitat are described in the conservation approach for conserving the tidal brackish emergent wetland natural community.

In the Plan Area, the Suisun shrew is only present in Suisun Marsh in Conservation Zone 11. Conservation of Suisun shrew will be provided through the restoration and management of tidal brackish emergent wetland in Suisun Marsh and associated preserved upland refugia habitats. A total of between 3,600 and 4,800 acres[25] of tidal wetland and 350 to 700 acres of associated upland habitat is expected to be restored in the Suisun Marsh (Conservation Zone 11) and provide high value habitat for the Suisun shrew (Figure 3-19). Restored marsh plain habitats will be designed to the maximum extent practicable within site constraints to provide the full range of tidal exchange that occurred under historical Suisun Bay conditions. This approach is expected to result in the establishment of patches of Suisun shrew habitat within a mosaic of larger marsh plain habitats. Restoration designs will also include the preservation and enhancement of adjacent uplands in sufficient quantity and width to function as flood refugia habitat during high tidal events. This upland habitat will be designed and managed to minimize exposure to predation during flood events. The proposed restoration of tidal brackish emergent wetland in Suisun Marsh is consistent with and helps achieve the Suisun shrew objectives of the draft tidal marsh ecosystems recovery plan (USFWS 2010) and the objectives of the Suisun Marsh Restoration Plan (under development).

Suisun shrew habitat will be restored in a sequenced manner that minimizes disturbance of existing habitat between the time that restoration actions are initiated and when restored tidal brackish emergent wetland develops as Suisun shrew habitat. Direct removal of existing tidal brackish emergent wetland will be minimized to be consistent with achieving overall BDCP wetland restoration objectives, although some existing tidal brackish emergent wetland is expected to be desiccated or inundated as a result of changes in the existing tidal range following the breaching of dikes and levees. It is anticipated that following completion of all tidal habitat restoration in Suisun Marsh, tidal brackish emergent wetland will be restored in larger patches than the existing patches of habitat that are currently fragmented by dikes, roads, unsuitable habitat areas, and other infrastructure. These larger, unfragmented patches are expected to provide higher-value habitat that will facilitate the expansion and growth of Suisun shrew populations in the Suisun Marsh.

Applicable Conservation Measures

- CM3 Natural Communities Protection;
- CM4 Tidal Habitat Restoration; and
- CM11 Natural Communities Enhancement and Management

[25] Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

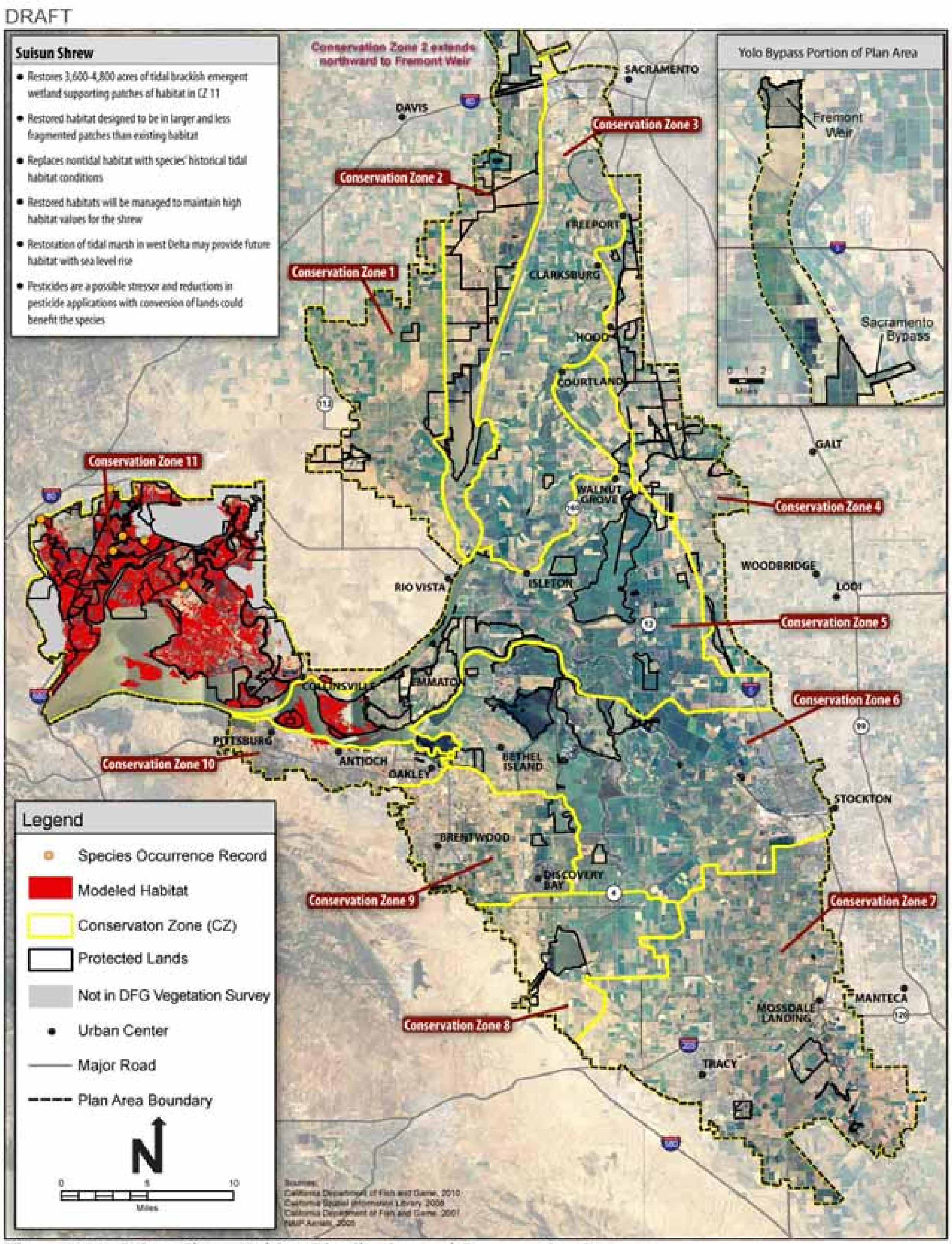

Figure 3-19. Suisun Shrew Habitat Distribution and Conservation Strategy

3.3.2.4.7 Tricolored Blackbird

Tricolored blackbirds form the largest colonies of any North American passerine bird (Beedy and Hamilton 1999) and are largely endemic to California. The state is home to more than 95 percent of the global population and more than 75 percent of the breeding population occurs in the Central Valley in any given year (Hamilton 2000). Tricolored blackbirds nest in areas with open accessible water, a protected nesting substrate (e.g., flooded, thorny, or spiny vegetation), and suitable foraging habitat (e.g., pastures, dry seasonal pools, agricultural fields such as alfalfa and rice, feedlots, and dairies) providing adequate insect prey within a few miles of the nesting colony. As many as 30,000 nests have been recorded in cattail (Typha spp.) marshes of 10 acres or less (Neff 1937, DeHaven et al. 1975). The Bay Delta is recognized as a major wintering area for tricolored blackbirds (Hamilton 2004, Beedy 2008), though there are few records of breeding colonies in the Delta (see Appendix A, *Covered Species Accounts*).

While the overall range of the species is largely unchanged since the 1930s (Neff 1937, DeHaven et al. 1975, Beedy et al. 1991, Hamilton 1998), there are now large gaps in the species' former range encompassing entire counties (e.g., Kings, San Joaquin, Riverside, San Bernardino counties). Recent surveys (Hamilton et al. 1995, Beedy and Hamilton 1997, Hamilton 2000) indicate a significant declining trend in populations in California since the 1930s and a particularly dramatic decline since 1994. Hamilton (2000) reports a 56 percent statewide decline between 1994 and 2000 (from 369,359 to 162,508 adults), and a 69 percent decline in the Sacramento Valley during that period (from 98,362 to 30,979 adults). The most significant historical and ongoing threat to the tricolored blackbird is habitat loss and alteration (e.g., (Cook 1999, DeHaven 2000, Hamilton 2004, Yolo Natural Heritage Program 2008). The initial conversion from native landscapes to agriculture removed vast wetland areas in the state and caused initial declines in populations. The more recent conversion of suitable agricultural lands to urbanization has permanently removed historical breeding and foraging habitat for this species. In urbanizing areas, habitat fragmentation and proximity to human disturbances has also led to abandonment of large historical colonies (Beedy and Hamilton 1999).

Applicable Natural Community Goals and Objectives

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal NWNC1: The expected outcome is nontidal freshwater perennial emergent wetland natural community that supports habitat for covered and other native species.

> **Objective NWNC1.1**: Create 400 acres of nontidal freshwater marsh (including components of nontidal perennial aquatic and perennial emergent wetland communities)

that functions as habitat for the giant garter snake, tricolored blackbird, and western pond turtle within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4 and the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

> **Objective ALNC1.1**: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.

> **Objective ALNC1.2**: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson's hawk nesting habitat.

Rationale and Conservation Approach

Because the primary stressor on tricolored blackbird is the loss of its wetland nesting habitat due to urban and agricultural expansion (e.g., DeHaven et al. 1975, Cook and Toft 2005), restoration of wetland nesting habitat likely represents the most effective approach to the species' long-term conservation. Conservation of tricolored blackbird within the Plan Area is directed at substantially increasing the extent of its tidal and nontidal emergent wetland nesting habitat in conjunction with protection of nearby foraging habitats (Figure 3-20). Restoration of brackish and freshwater tidal emergent wetland is expected to support large patches of emergent vegetation suitable for nesting within Conservation Zones 1, 2, 4, 5, 6, 7, and 11. Because nesting habitat will be restored in large contiguous patches in these areas, restored nesting habitat is expected to provide higher nesting habitat functions than existing patches of nesting habitat, which are generally small, fragmented, and subject to disturbance during the breeding season. The proposed restoration of up to between 17,500 to 26,400 acres of tidal emergent wetland and 400 acres of nontidal marsh habitat suitable for tricolored blackbird nesting and foraging is expected to increase the extent of available nesting habitat in the Plan Area several-fold.

Protection of foraging habitats within a few miles of nesting habitat will provide food resources necessary for successful rearing and fledging of young and all protected foraging habitats will support wintering birds. The proposed protection of agricultural habitat, grassland, and vernal pool complex foraging habitat will increase the extent of currently preserved habitat from 19 percent to up to approximately 26 percent within the Plan Area.

The protection of active nesting colonies is also essential for successful breeding. Tricolored blackbirds are sensitive to human disturbances, and establishing no-disturbance buffers around nesting colonies during the breeding season will increase the opportunities for reproductive success. No disturbance buffers will be established through implementation of Avoidance and Minimization Measures (See AMM13).

In summary, proposed BDCP restoration of nesting habitat and protection of foraging habitats are expected to be sufficient to sustain the existing breeding and wintering population(s) of tricolored blackbirds in the Plan Area. Because the Plan Area corresponds to a major wintering area yet supports only a small number of nesting colonies (largely or mainly in the Yolo Bypass; see Appendix A, *Covered Species Accounts*), restoration of wetland nesting habitat in particular has the potential to provide for future increases in of tricolored blackbird abundance and distribution.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

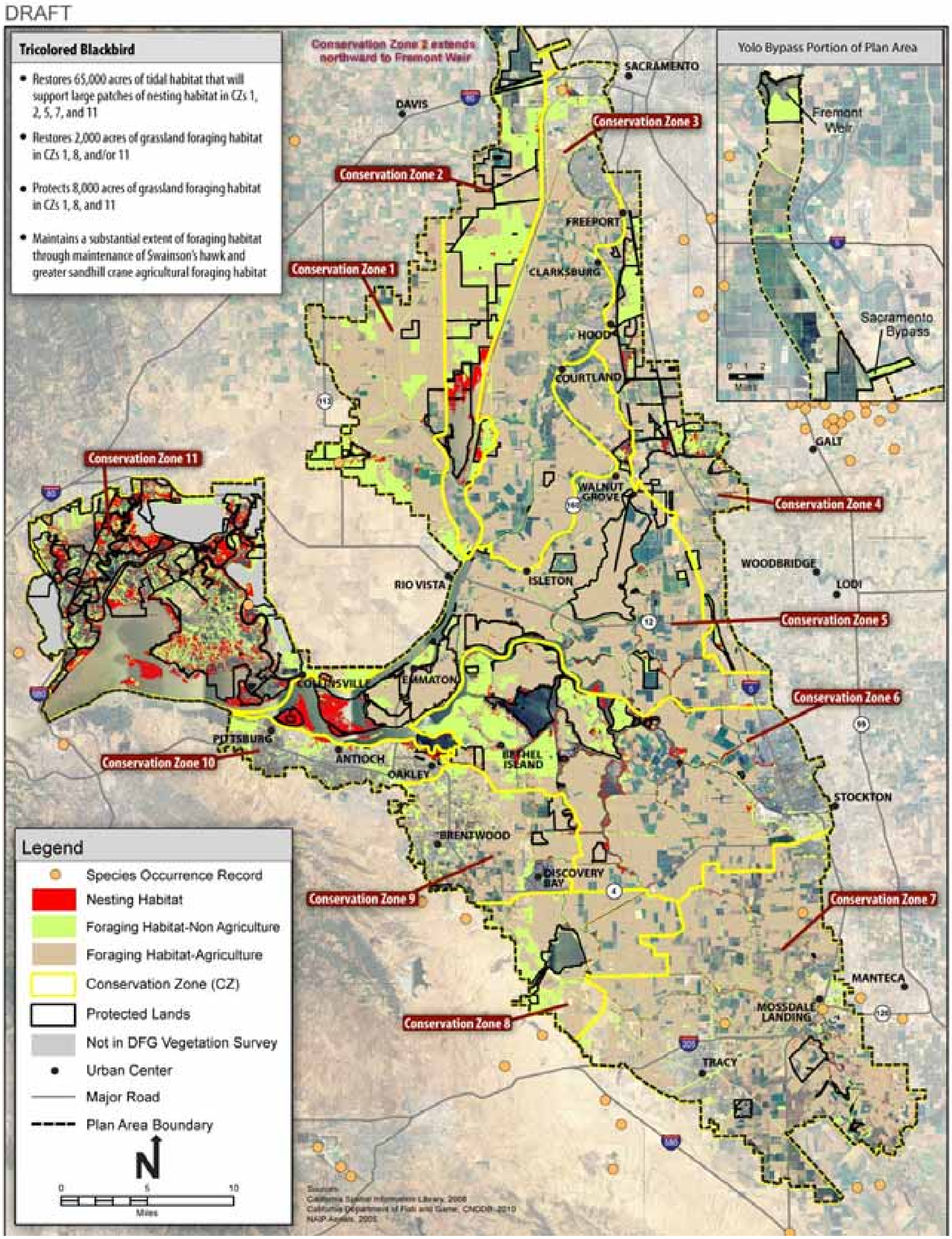

Figure 3-20. Tricolored Blackbird Habitat Distribution and Conservation Strategy

3.3.2.4.8 Suisun Song Sparrow

The Suisun song sparrow is endemic to the salt marshes of Suisun Bay and while it has been confirmed to be phenotypically distinct from neighboring subspecies (Patten 2001), genetic differentiation has not been confirmed (Chan and Arcese 2002). The Suisun song sparrow is associated with tidal marsh habitats characterized by dense vegetation with bare areas that support foraging. Its distribution extends into the Plan Area to approximately Kimbal Island; however, the majority of the range of the species is included within the Suisun Marsh. Spautz and Nur (2008), citing unpublished data from the Point Reyes Bird Observatory (PRBO), estimate the total population of Suisun song sparrows as 43,000 to 66,000 breeding pairs, approximately one-third of the estimated historical population size (Spautz and Nur 2008). Habitat loss and fragmentation, caused by diking, levee construction, channelization, invasive species, and urbanization, is considered the primary threat to the continued existence of the Suisun marsh sparrow (Larsen 1989, Spautz and Nur 2008). Throughout most of the Suisun Marsh, tidal marsh has been reduced to small fragments that are separated by dispersal barriers or only connected by very narrow strips of vegetation remaining along the banks of tidal sloughs, reducing dispersal, gene flow, and reproduction (Larsen 1989).

Applicable Natural Community Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Rationale and Conservation Approach

Because the primary stressor on the Suisun song sparrow is loss of tidal marsh habitat, the restoration of this habitat type is considered the most effective approach to the conservation of the sparrow. Under BDCP, the conservation of Suisun song sparrow will be provided through restoration and management of brackish tidal emergent wetland habitats that historically supported Suisun song sparrow habitat in Suisun Marsh (Figure 3-21). Much of the still-existing Suisun song sparrow habitat consists of patches of nontidal managed wetlands that the sparrow has adapted to following reclamation of historically Suisun Bay tidal marshes. Because restoration of tidal brackish emergent wetland will remove and degrade patches of nontidal managed wetlands that are currently occupied by Suisun song sparrow, restoration will be sequenced and located in a manner that minimizes any temporary, initial loss of habitat.

Direct removal of existing tidal brackish emergent wetland will be minimized consistent with achieving overall wetland restoration objectives, although some existing tidal brackish emergent wetland is expected to be desiccated or inundated as a result of changes in the existing tidal range following the breaching of dikes and levees. Approaches for restoring tidal brackish emergent wetland to support Suisun song sparrow habitat are described in the conservation approach for conserving the tidal brackish emergent wetland natural community.

Suisun Marsh is included in Conservation Zone 11. Restored marsh plain habitat in Conservation Zone 11 (3,600 to 4,800 acres[26]) will be designed to the maximum extent practicable within site constraints to provide the full range of tidal conditions that were associated with historical Suisun Bay tidal marsh. This approach is expected to result in restoration of patches of sparrow habitat within a mosaic of extensive brackish tidal emergent wetland.

Restored habitat will be designed to include channel habitat edges that support high functioning Suisun song sparrow nesting habitat and tidal brackish emergent wetland away from channels that is dominated by *Salicornia*, *Spartina*, and *Grindelia*.

Nonnative predators (e.g., feral cats) are believed to be an important stressor on the Suisun song sparrow. The design and management of restored habitat will include the control of nonnative predators to help maintain the species abundance (e.g., through direct removal of predators or through the design of restored habitats that minimize access of predators into occupied habitats).

The proposed restoration of tidal brackish emergent wetland in Suisun Marsh is consistent with and helps achieve the Suisun song sparrow objectives of the draft tidal marsh ecosystems recovery plan (USFWS 2010) and the objectives of the Suisun Marsh Restoration Plan (under development). It is anticipated that following completion of all tidal habitat restoration in Suisun Marsh, tidal brackish emergent wetland will be restored in larger patches than the existing patches of habitat currently fragmented by dikes, roads, infrastructure, or other unsuitable habitat. These larger unfragmented patches are expected to provide higher-value habitat and facilitate the expansion and growth of Suisun song sparrow populations in Suisun Marsh.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

[26] Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

Figure 3-21. Suisun Song Sparrow Habitat Distribution and Conservation Strategy

3.3.2.4.9 Yellow-breasted Chat

The Yellow-breasted chat is a neotropical migrant that breeds throughout much of North America and winters primarily in Mexico and Central America, with a few birds also wintering in California (Small 1994). According to Grinnell and Miller (1944), the species' breeding distribution included the entire length and breadth of California exclusive of the higher mountains and coastal islands. The yellow-breasted chat is still present in most of its historical range with the exception of most of the Central Valley (Comrack 2008). In particular, nesting populations have been extirpated from the San Joaquin and Sacramento valleys except along foothill tributaries. The yellow-breasted chat occurs in the Plan Area mainly as a spring and fall migrant. During the breeding season, however, it is sparsely distributed across the Plan Area (Appendix A, *Covered Species Accounts*).

Yellow-breasted chats nest and forage in streamside, shrubby thickets of willows, vines, and brush (Small 1994). The species has been classified as an open-canopy obligatory species (i.e., preferred open overstory and brushy understory), with population density directly related to shrub density to a height of 4.5 meters (14.8 feet) (Crawford et al. 1981). Habitat loss is implicated in yellow-breasted chat population declines throughout much of the species' range (e.g., Remsen 1978, Rosenberg et al. 1991). Shuford and Gardali's (2008) list of management recommendations includes the preservation of existing, healthy riparian habitat and the restoration of degraded riparian habitat. Also listed by Shuford and Gardali (2008) is the need to maintain and/or promote a dense shrub layer in riparian habitat and create a shrub layer in the early stages of restoration projects. Zeiner et al. (1990) report that yellow-breasted chat territory size ranges from 0.3 to 3.2 acres (0.1 – 1.3 hectare). Small territory size suggests the potential for large-scale restoration of valley/foothill riparian to promote the establishment of sizeable chat populations.

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

Objective VRNC2.2: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.

Objective VRNC2.3: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Rationale for Conservation Approach

Within the Plan Area, modeled yellow-breasted chat habitat is divided into primary and secondary habitat based on a qualitative assessment of shrub and tree densities in riparian areas. Primary habitat includes a dense shrub layer such as typically found within chat breeding territories (Figure 3-22). Secondary habitat is riparian habitat with a less developed shrub layer. BDCP yellow-breasted chat conservation is directed at increasing the extent of primary and secondary riparian nesting and migratory habitats to ensure that: (1) chat numbers in the Plan Area at a minimum remain stable; and (2) sufficient valley/foothill riparian habitat is maintained to support potential future increases in the species' abundance and distribution.

Of the 5,000 acres of BDCP riparian habitat to be restored, it is expected that a substantial amount will provide the structure, species composition, and overstory suitable as yellow-breasted chat breeding habitat. It is also anticipated that much of the restored valley/foothill riparian habitat will be restored in large patches that will minimize the potential for cowbird nest parasitism, which is believed to be a stressor on the species (see Appendix A, *Covered Species Accounts*). The proposed restoration of yellow-breasted chat riparian habitat is expected to increase the extent of available habitat in the Plan Area by approximately 35 percent and, following BDCP implementation, approximately 51 percent of the species' habitat is expected to be under protected status.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

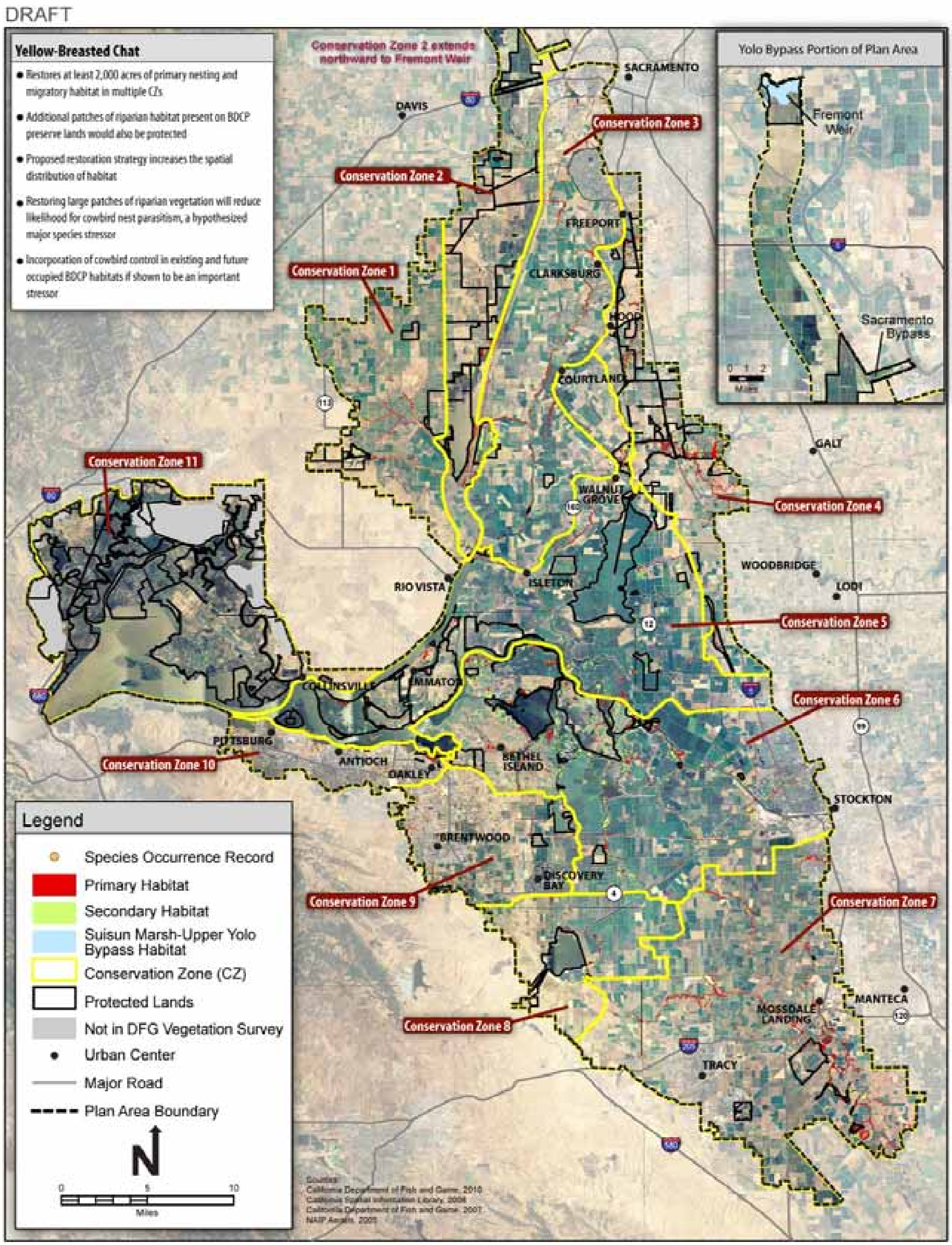

Figure 3-22. Yellow-Breasted Chat Habitat Distribution and Conservation Strategy

3.3.2.4.10 Least Bell's Vireo

A neotropical migrant, the least Bell's vireo is the only subspecies of the Bell's vireo that breeds entirely in California and northern Baja California. The least Bell's vireo's historical breeding distribution once extended from coastal southern California through the San Joaquin and Sacramento valleys as far north as Tehama County near Red Bluff. The Sacramento and San Joaquin valleys were considered the center of the species' historical breeding range supporting 60-80 percent of the historical population (51 FR 16474). Coinciding with widespread loss of riparian vegetation throughout California (Katibah 1984), Grinnell and Miller (1944) began to detect population declines in the Sacramento and San Joaquin Valley region by the 1930s. Surveys conducted in late 1970s (Goldwasser et al. 1980) detected no least Bell's vireos in the Sacramento-San Joaquin Valleys, and the species was considered extirpated from the region. By 1986, the USFWS determined that least Bell's vireo had been extirpated from most of its historical range and numbered approximately 300 pairs statewide (51 FR 16474). However, recent occurrences have suggested a northward expansion of the breeding range, including nest sites reported from the San Joaquin River National Wildlife Refuge and recent (2010) occurrences from the Yolo Bypass Wildlife Area.

The least Bell's vireo is an obligate riparian breeder that typically inhabits structurally diverse woodlands, including cottonwood-willow woodlands/forests, oak woodlands, and mule fat scrub (USFWS 1998b). Two features appear to be essential for breeding habitat: (1) the presence of dense cover within 3-6 ft. (1-2 m.) of the ground, where nests are typically placed; and (2) a dense stratified canopy for foraging (Goldwasser 1981, Gray and Greaves 1981, Salata 1981 & 1983, RECON 1989). While least Bell's vireo typically nests in willow-dominated areas, plant species composition does not seem to be as important a factor as habitat structure. Least Bell's vireo territories can range in size from 0.5-7.2 acres, but common territory sizes in Southern California range from 1.5-2.5 acres.

Critical habitat for this state and federally endangered species was designated in 1994, and a Draft Recovery Plan emphasizing the need for habitat protection and restoration was published in 1998 (USFWS 1998b). Riparian habitat creation and restoration are underway throughout California (RHJV 2004), and the least Bell's vireo is listed as a covered species in 16 Habitat Conservation Plans (HCPs), including the Coachella Valley Multi-species HCP, San Diego MSCP, Orange County NCCP/HCP, and Western Riverside MSHCP. Conservation actions under all of those habitat conservation plans and BDCP have the potential to act in synergy toward partial recovery of the vireo. The recent documentation of the species in the Yolo Bypass has heightened awareness of the species' conservation potential within the Plan Area.

<u>*Applicable Natural Community Goals and Objectives*</u>

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.2**: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Rationale and Conservation Approach

Because the primary stressor on the least bell's vireo is loss and fragmentation of its riparian habitat through urban and agricultural expansion, the protection and restoration of riparian areas is considered the most effective approach to the vireo's conservation. In the Plan Area, the conservation of least Bell's vireo will be provided through the restoration of 5,000 acres of valley/foothill riparian (of which more than 2,000 acres is expected to support least Bell's vireo) (Table 3-5) (Figure 3-23).

The least Bell's vireo is not known to presently breed in the Plan Area, but two singing males were detected in the Yolo Bypass Wildlife Area in mid-April 2010. A single breeding pair recently nested for multiple years immediately south of the Plan Area along the San Joaquin River, and because the Plan Area may support suitable riparian habitat, the species may re-establish itself within the Plan Area. Approaches for restoring valley/foothill riparian communities that support least Bell's vireo habitat are described in the conservation approaches for conserving the valley/foothill riparian natural community.

Patches of least Bell's vireo habitat are expected to be restored as a component of BDCP actions to restore 5,000 acres of valley/foothill riparian. A substantial amount of willow-dominated riparian is expected to be restored that will meet the ecological requirements of the least Bell's vireo. It is anticipated that much of the restored riparian habitat will occur in large wide patches that will minimize the potential for cowbird nest parasitism, which is a stressor on the species (see Appendix A, *Covered Species Accounts*). Given the relatively small territory size of least Bell's vireo and the large acreage of riparian habitat to be restored, BDCP riparian restoration efforts have the potential to significantly increase the likelihood of population re-establishment in the region.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

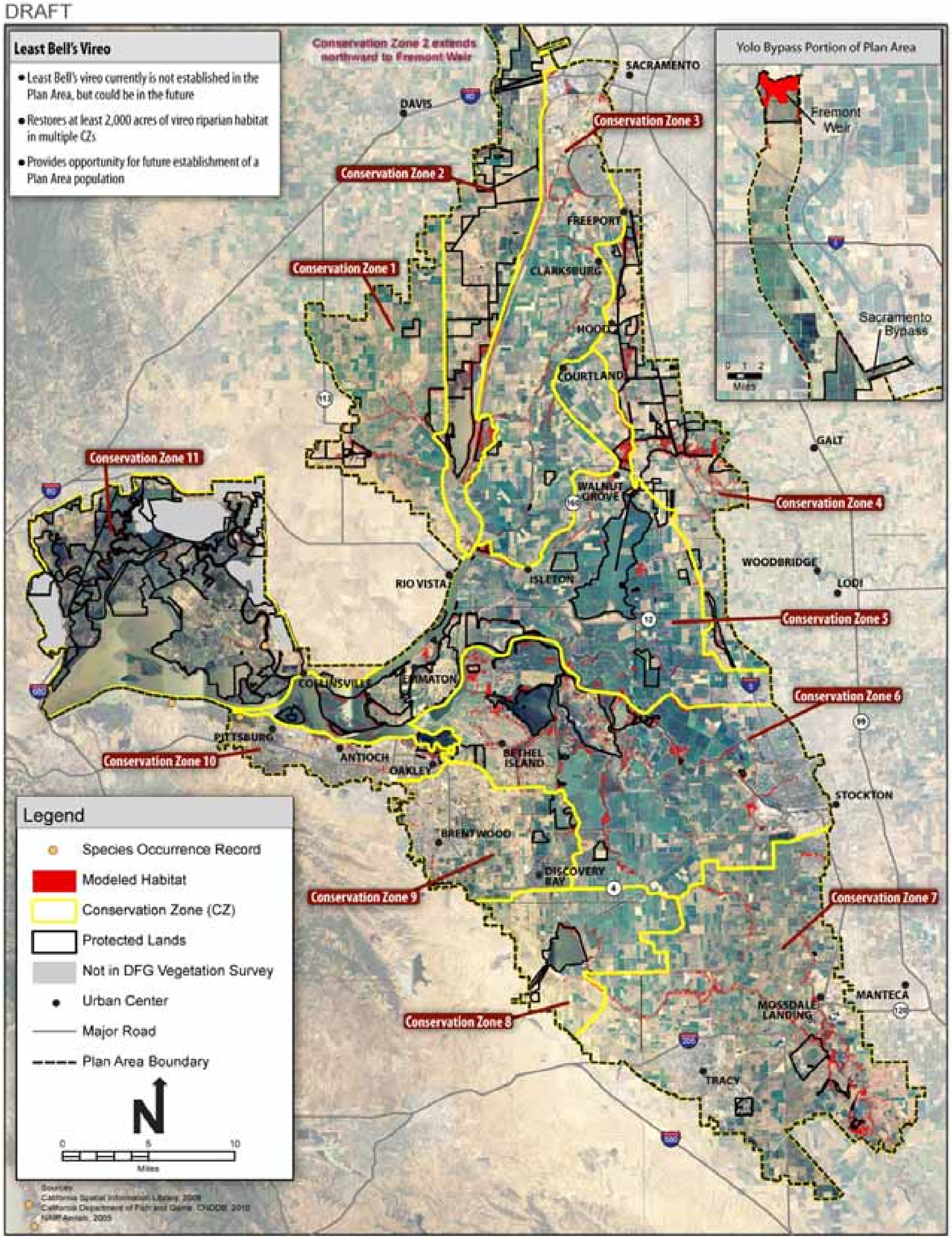

Figure 3-23. Least Bell's Vireo Habitat Distribution and Conservation Strategy

3.3.2.4.11 Western Burrowing Owl

Western burrowing owl occurrences in the Plan Area are a mix of year-round and winter residents, where habitat consists of grasslands, managed wetlands, and cultivated lands (see Appendix A, *Covered Species Accounts*). Throughout much of the species' range, and including in California, burrowing owl populations have been declining largely as a result of loss, degradation, or fragmentation of foraging and nesting habitat (Zarn 1974, Haug et al. 1993, Klute et al. 2003, DeSante et al. 2007, Desmond 2010). Causal factors are numerous, ranging from urbanization to poisoning of sciurid rodents whose burrows are used by the owls (Klute et al. 2003, DeSante et al. 2007, Desmond 2010). The majority of burrowing occurrences in the Plan Area are from the grassland/pastureland/cultivated matrix in Conservation Zones 1 and 2. However, the species is known to persist in low densities in more isolated locations where suitable burrowing habitat exists, including grassy levee slopes, remnant patches of grassland, and debris piles, roadside edges, and field edges in cultivated landscapes. The focus of BDCP on habitat for the western burrowing owl directly addresses the primary regional threat to the species (DeSante et al. 2007).

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.4**: Increase burrow availability for burrow-dependent species.

> **Objective GRNC2.5**: Increase prey, especially small mammals and insects, for grassland-foraging species.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

> **Objective ALNC1.3**: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain at least 3,000 acres of pasture that supports western burrowing owl foraging habitat. This objective may be partially or fully achieved through preservation

of other land cover types that provide moderate-value or greater habitat function for the western burrowing owl.

Objective ALNC1.8: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.

Rationale and Conservation Approach

Conservation of western burrowing owl focuses on maintaining a landscape of suitable habitat across the Plan Area and on adjacent lands through strategic acquisition and management of grassland and agricultural preserves (Figure 3-24). In terms of burrowing owl habitat, the Plan Area's grasslands, managed wetlands, and cultivated lands range in value (or quality) from high to low (see Appendix A, *Covered Species Accounts*). Specifically, BDCP implementation will result in the protection and restoration of large patches of moderate-to-high-value natural grassland foraging and breeding habitats.

Protected grassland will also be connected to burrowing owl habitats adjacent to the Plan Area to preclude further fragmentation of important habitats. The distribution of high and moderate value habitat in the Plan Area is consistent with the observed current distribution of burrowing owls. Few western burrowing owls have been documented from low-value habitat areas. Habitat will be protected in large patches that are connected to existing protected habitats and located within or near known occupied habitat. It will also be managed to increase the availability of nesting burrows and prey species through a combination of measures (e.g., discontinued use of pesticides, manipulation of topography, mowing). An estimated 33 percent of the high-value habitat, 31 percent of the moderate-value habitat, and 11 percent of the low-value habitat are currently protected, respectively. Following BDCP implementation, 46 percent of the highest value existing habitat and 39 percent of the moderate value habitat in the Plan Area will be protected. The implementation of the proposed conservation actions is expected to sustain existing burrowing owl populations within and adjacent to the Plan Area and to provide an acreage of suitable habitat large enough to allow for any future population growth.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

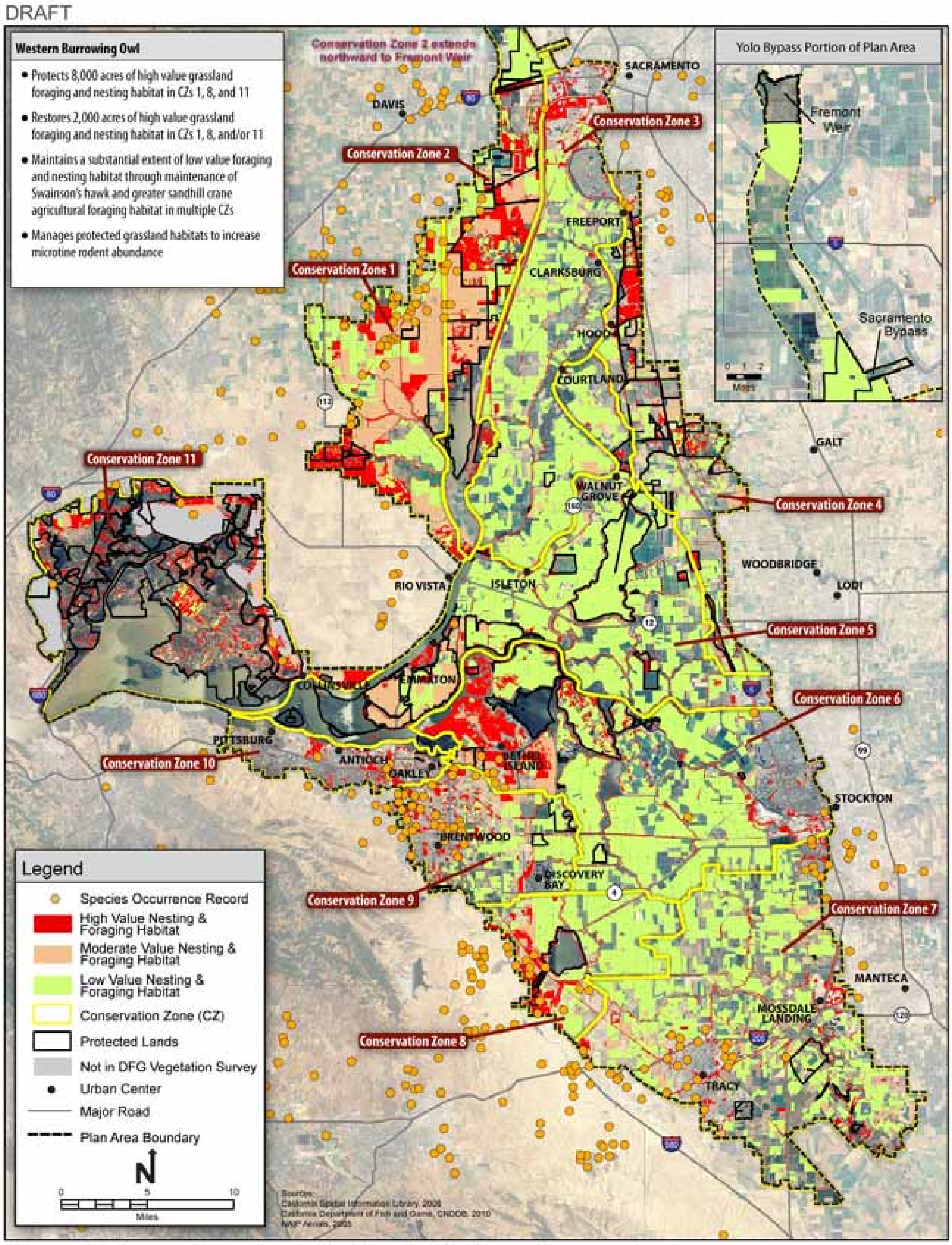

Figure 3-24. Western Burrowing Owl Habitat Distribution and Conservation Strategy

3.3.2.4.12 Western Yellow-billed Cuckoo

The yellow-billed cuckoo is a Neotropical migrant that breeds in North America and winters in South America. The range of the western yellow-billed cuckoo historically extended from southern British Columbia south to the Rio Grande in northern Mexico, and east to the Rocky Mountains (Bent 1940). Currently, the only known populations of breeding western yellow-billed cuckoo are in several disjunct locations in California, Arizona, and western New Mexico (Halterman 1991). Declines in numbers of the yellow-billed cuckoo in California are the result of the "removal widely of essential habitat conditions," as described by Grinnell and Miller (1944). Population declines in California have continued primarily in the San Joaquin Valley and along the north coast and central coast (where the populations had been extirpated by 1977) (Gaines and Laymon 1984), while the species was also nearly extirpated in the Lower Colorado River Valley by 1999. In the Sacramento Valley, only 1 percent of the species' historical habitat remains to support a small population estimated at only 50 pairs in 1987 and 19 pairs in 1989 (Laymon and Halterman 1989), most of these from Sutter, Yuba, and Butte Counties. There are no records of the species breeding in the Plan Area; however, an individual cuckoo was documented in the Central Delta during breeding season surveys conducted in 2009.

Estimates of yellow-billed cuckoo territory size on the south fork of the Kern River ranged from 8-40 hectares (20-100 acres) (Laymon and Halterman 1985), but on the Colorado River were as small as 4 hectares (10 acres) (Laymon and Halterman 1989). Patch size, type and quality of habitat, and prey abundance largely determine the size of territories (Halterman 1991). Laymon and Halterman (1989) classify a willow-cottonwood forest patch greater than 604 meters (1,980 ft) wide and greater than 81 hectares (200 acres) as optimum habitat.

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.2**: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.

Objective VRNC2.3: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Rationale and Conservation Approach

The primary stressor on the yellow-billed cuckoo is the loss and fragmentation of its riparian habitat through urban and agricultural expansion, bank stabilization, and flood control projects; therefore, the restoration of this habitat type is considered to be the most effective approach to its conservation. In the Plan Area, the conservation of western yellow-billed cuckoo will be provided through the restoration of 5,000 acres of valley/foothill riparian habitat (Table 3-5) (Figure 3-25). The western yellow-billed cuckoo has been sighted several times migrating through the Plan Area, but there have been no recently confirmed nesting records in the Plan Area or vicinity. Since most riparian corridors in the Plan Area do not support sufficiently large riparian patches for cuckoo breeding, conservation will be directed towards restoring riparian forest within the Plan Area to provide habitat that could allow for the future reintroduction or expansion of the existing yellow-billed cuckoo population into the Plan Area. Approaches for restoring valley/foothill riparian that supports western yellow-billed cuckoo habitat are described in the conservation approaches for conserving the valley/foothill riparian natural community.

Western yellow-billed cuckoo nesting habitat is located in expansive stands of riparian cottonwood-willow forests, but other species such as alder (*Alnus rhombifolia*) and box elder (*Acer negundo*) may be an important habitat element in some areas (see Appendix A, *Covered Species Accounts*). Patches of this habitat are expected to be restored as a component of BDCP actions to restore 5,000 acres of valley/foothill riparian. The large amount of valley/foothill riparian that will be restored as a result of the BDCP is expected to significantly advance conservation for the western yellow-billed cuckoo. These restoration actions could increase the likelihood for the western yellow-billed cuckoo to continue to migrate through and potentially re-initiate breeding in the Plan Area.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

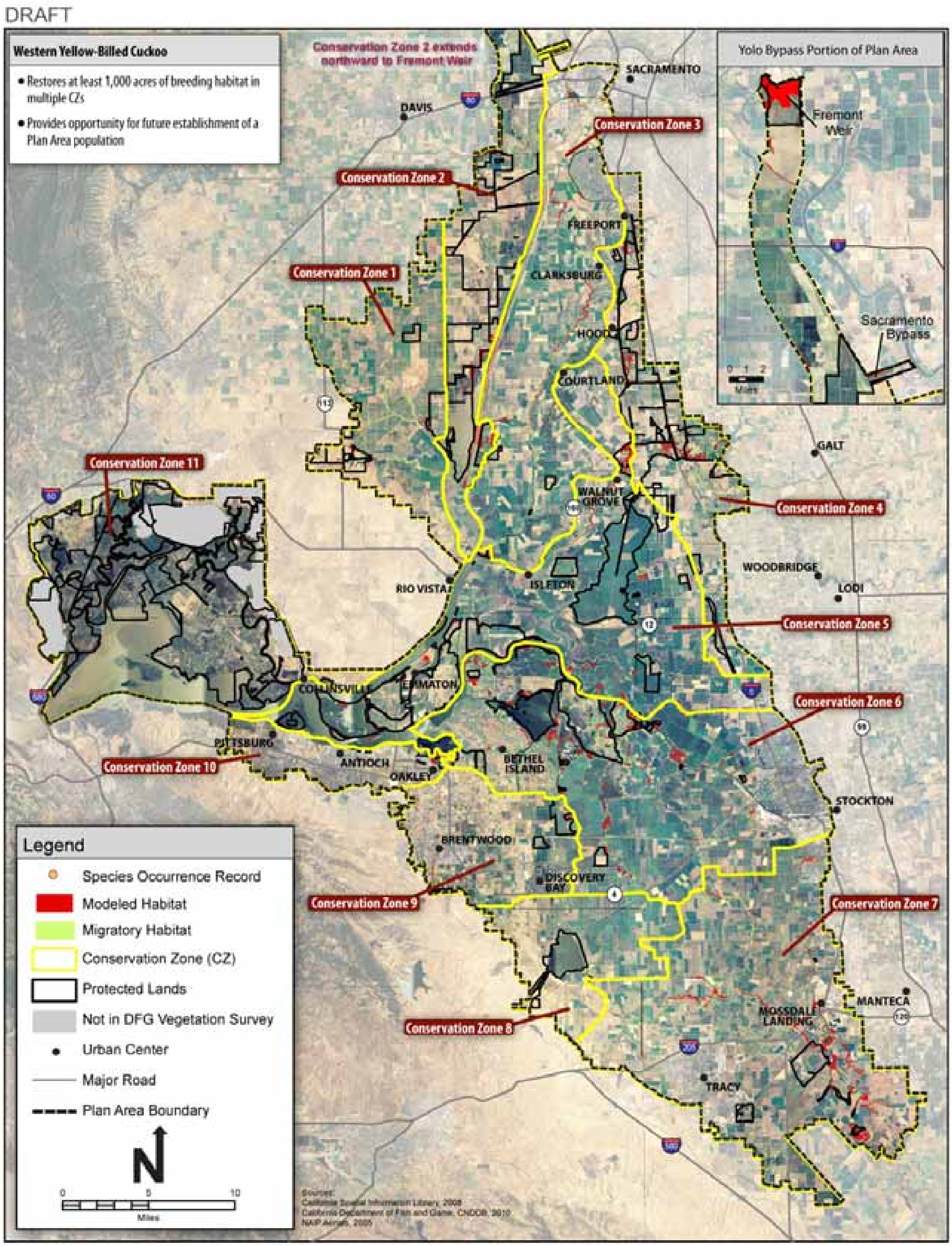

Figure 3-25. Western Yellow-Billed Cuckoo Habitat Distribution and Conservation Strategy

3.3.2.4.13 California Least Tern

California least tern is a migratory species present in California only during the breeding season; arriving in mid-April and departing in late September (Massey 1974, Cogswell 1977, Anderson and Rigney 1980, Patton 2002). Habitat loss is the primary reason for the population declines of California terns from historical levels (USFWS 2006). Since federal and state listing of the California least tern, nesting populations have increased dramatically from only a few pairs in the late 1960s to approximately 7,000 pairs at present (Marschalek 2009). However, the population size and distribution of the least California tern remains limited by the lack of natural nesting habitat (USFWS 2006). Two known breeding occurrences within the Plan Area are both on artificial substrates and virtually no natural breeding habitat exists within the Plan Area.

Applicable Natural Community Goals and Objectives

Goal TANC1: The expected outcome is tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic food web processes.

> **Objective TANC1.1**: Restore or create 10,000 to 20,000 acres of tidal perennial aquatic in the BDCP Restoration Opportunity Areas (Conservation Zones 1, 2, 4, 5, 6, 7, and 11) that supports aquatic food production and habitat for covered and other native species.

Goal TANC2: The expected outcome is biologically diverse tidal perennial aquatic natural community that is enhanced for native species and sustained by natural ecological processes.

> **Objective TANC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal perennial aquatic community for covered and other native species over the term of the BDCP.

Species-Specific Goals and Objectives

Goal CALT1: The expected outcome is an expanded California least tern population in the Plan Area.

> **Objective CALT1.1:** Create two patches of California least tern nesting habitat during restoration of tidal marsh communities.

Rationale and Conservation Approach

BDCP conservation of California least tern is directed at expanding high value foraging habitat and protecting and creating future nesting sites in the Plan Area (Figure 3-26). Currently, there are only two nesting sites associated with the Plan Area, one at the Montezuma Wetlands and one in the City of Pittsburg (see Appendix A, *Covered Species Accounts*). Neither site consists of natural nesting habitat. Overall, there is little to no natural nesting habitat available in the Plan Area. While much of the tidal perennial aquatic habitat (open water) is suitable for tern foraging, nesting habitat is a function of the availability and suitability of artificial features, such as gravel piles or unused gravel roads in the immediately vicinity of open water habitats. Because of its rarity throughout its range and particularly within the Plan Area, protection and creation of least tern nesting habitat will aid in the expansion of this species' distribution and contribute to its recovery. Tidal habitat restoration in the ROAs is projected to result in the development of 24,913 to 31,622 acres[27] of subtidal aquatic habitat based on the hypothetical restoration designs (exceeding the objective of 10,000 to 20,000 acres), much of which will be suitable as least tern foraging habitat.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM11 Natural Communities Enhancement and Management

[27] Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

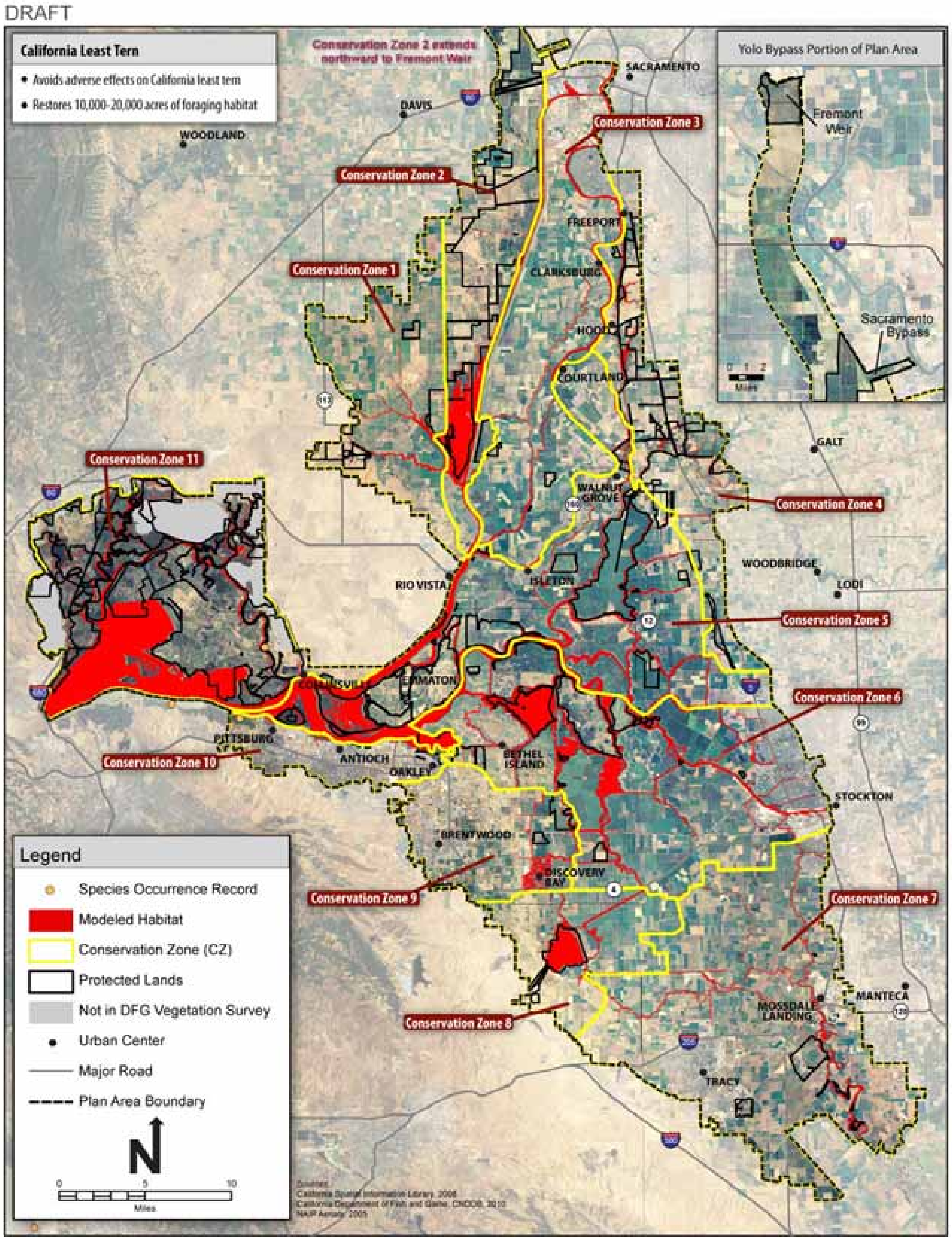

Figure 3-26. California Least Tern Habitat Distribution and Conservation Strategy

3.3.2.4.14 Greater Sandhill Crane

There are an estimated 500,000 sandhill cranes in North America, of which an estimated 62,600 are greater sandhill cranes. An estimated 8,500 of these belong to the Central Valley Population (Littlefield and Ivey 2000). Greater sandhill cranes are winter residents in the Plan Area, where they depend on certain types of agricultural fields (e.g., corn stubble fields) and on grasslands and managed wetlands for foraging; field edges, levees, rice-checks, ditches, alfalfa fields, and pastures for loafing; and inundated fields and wetlands for roosting (Appendix A, *Covered Species Accounts*).

The most significant threat to wintering greater sandhill cranes is the loss of traditional winter habitat from urbanization and agricultural conversion (Littlefield and Ivey 2000). While relatively limited urbanization has occurred to date within key crane areas, surrounding development and increased levels of human disturbances may threaten the long-term sustainability of important wintering lands. In the Delta region, the conversion of suitable agricultural foraging and roosting habitats to unsuitable cover types, particularly orchards and vineyards, has removed key habitats and altered the distribution and behavior of wintering greater sandhill cranes.

Applicable Natural Community Goals and Objectives

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

> **Objective ALNC1.2**: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson’s hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson’s hawk nesting habitat.

> **Objective ALNC1.4**: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain at least 4,800 acres that supports greater sandhill crane foraging habitat within its Winter Use Area and within 2 miles of known roosting sites in Conservation Zones 3, 4, 5, and/or 6.

Goal MWNC2: The expected outcome is biologically diverse managed wetlands that are enhanced for native species.

> **Objective MWNC2.1**: Maintain and enhance the habitat functions of BDCP managed wetlands present on BDCP preserved lands over the term of the BDCP.

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Species-Specific Goals and Objectives

Goal GSHC1: The expected outcome is expansion and protection of greater sandhill crane winter range.

> **Objective GSHC1.1**: Create 320 acres of seasonally managed greater sandhill crane roosting habitat within Conservation Zones 3, 4, 5, or 6.

Rationale and Conservation Approach

Conservation of greater sandhill crane proposed under BDCP is directed at preserving and restoring wintering habitat sufficient to sustain current wintering population numbers and provide for any future growth of the population. In particular, at least 4,800 acres of protected high functioning foraging habitat will be located within the winter use area.

Protected foraging habitat will primarily be comprised of agricultural habitats with high crane foraging value (e.g., corn, grains, irrigated pasture, alfalfa), but may include grassland and managed wetlands. Protected lands will be managed to provide high-quality foraging habitat and to minimize human disturbances during the crane's wintering period. A total of at least 4,800 acres of high value foraging habitat will be preserved and protected in Conservation Zones 3, 4, 5 and/or 6 (Figure 3-27). Preserved foraging habitat patches will be at least 160 acres in size (or less if adjacent to other protected habitat) to minimize the potential effects of human-associated visual and noise disturbances adjacent to preserved foraging habitat. The majority of foraging habitat within the winter use area is located below sea level and potentially subject to future loss with levee failures. As part of the conservation strategy, the BDCP Implementation Office will therefore consider opportunities for acquisition of lands at elevations above sea level.

In addition, the conversion from agricultural lands with uncertain or variable suitability (due to crop rotations or that are subject to conversion to unsuitable perennial crops such as orchards and vineyards) to tidal freshwater wetlands is expected to increase the habitat value of the restored lands. Restored tidal freshwater wetlands within the crane's primary use area (2,100 acres in

Conservation Zone 4) will include shallow water habitats, berms, and grassland edges and may provide suitable roosting and foraging habitat for greater sandhill cranes. Additional restored tidal freshwater wetlands south of the crane's primary use area (5,000 acres in Conservation Zone 7) is expected to provide suitable roosting, resting, and foraging habitat that may facilitate expansion of the wintering range.

Additional agricultural land preserved for other covered species including Swainson's hawk and white-tailed kite (primarily alfalfa and irrigated pasture cover types) within the crane use area will also be available to wintering greater sandhill cranes. Following implementation of BDCP actions, more than 19 percent of greater sandhill crane foraging habitat will be protected (Table 3-5). Protection and management of existing foraging habitats and restoration and management of roost sites are expected to ensure that the existing abundance of wintering cranes in the Plan Area is maintained and are expected to provide sufficient wintering habitat to accommodate potential future expansions of the crane population.

Greater sandhill crane winter roosting habitats are limited within the Plan Area and roosting cranes are intolerant of disturbances and readily will abandon roosts if disturbed. Lack of permanent roosting habitat limits the ability of cranes to use foraging habitats. To address this species' requirement, 320 acres of land will be managed specifically to meet the ecological requirements of greater sandhill crane roosting habitat will be created to ensure the future availability of sufficient winter roosting habitat. Roost sites will be at least 80 acres in size (or less if adjacent to other existing roosting habitat or otherwise meet criteria for roosting and are considered to have exceptionally high value) and will be located within the Delta winter range of the species, but with consideration of the potential for sea level rise. Roost sites will be located in areas that are not subject to disturbances and will be designed to minimize predator accessibility. Location of roost sites will also consider opportunities for expanding the range of the species by placing roosts within suitable, but underused foraging habitats due to the lack of roost sites.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM11 Natural Communities Enhancement and Management

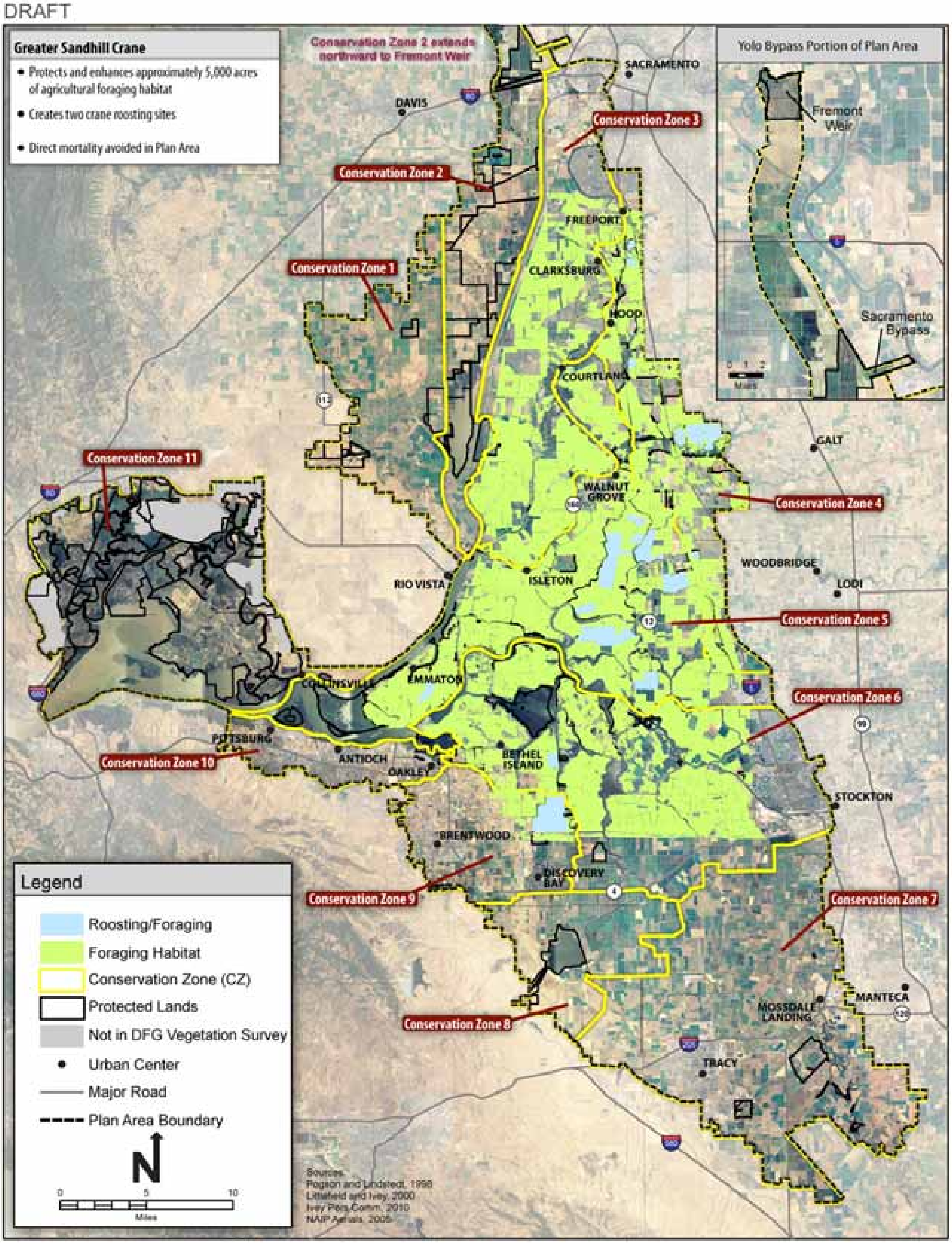

Figure 3-27. Greater Sandhill Crane Habitat Distribution and Conservation Strategy

3.3.2.4.15 California Black Rail

California black rail inhabits tidal saltwater, tidal brackish, and tidal freshwater marshes (Grinnell and Miller 1944, Manolis 1978, Spautz et al. 2005). Declines in populations of the California black rail in California and the extirpation of the rail from much of its historical coastal range are the result of tidal marsh habitat loss and degradation along with an increase in exotic predators such as black rats and red foxes (Manolis 1978, Garrett and Dunn 1981 as cited in DWR 2001, Evens et al. 1991). Currently, the species is confined to mostly pristine remnants of historical tidal marshlands, including throughout parts of Suisun Bay, which serves as one of the last large refuge areas for a viable population (Evens et al. 1991, Spautz et al. 2005). The proposed restoration of California black rail habitat in the Plan Area is consistent with and helps achieve the California black rail objectives of the draft tidal marsh ecosystems recovery plan (USFWS 2010) and objectives of the Suisun Marsh Restoration Plan (under development). Black rails also occur in lower densities in the patches of tidal freshwater marsh found along the margins of waterways in the Central Delta.

Applicable Natural Community Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Rationale and Conservation Approach

Under BDCP, the conservation of the California black rail is directed at restoring tidal marsh conditions that historically supported habitat in the Plan Area (Figure 3-28). Outside of Suisun Marsh, existing habitat is limited primarily to small and isolated remnant patches of tidal emergent wetland vegetation along Delta channels. Because opportunities for conserving species habitats along existing tidal channels are limited by levees, conservation will be provided through the restoration of large tracts of brackish and freshwater tidal emergent wetland throughout Suisun Marsh and elsewhere in the Plan Area where such restoration is practicable. A total of between 17,500 and 26,400 acres of tidal emergent wetland (freshwater and brackish) will be restored in Conservation Zones 1, 2, 4, 5, 6, 7, and 11. Restored tidal brackish emergent wetland and tidal freshwater emergent wetland will be designed to the extent practicable within site constraints to provide the full range of environmental gradients from tidal areas to uplands that existed under historical conditions in Suisun Bay and the Delta. This approach is expected to result in restoration of patches of rail habitat within a mosaic of larger marsh plain habitats. Approaches for restoring habitat to support California black rail habitat are described in the conservation approaches for conserving the tidal brackish emergent wetland and the tidal freshwater emergent wetland natural communities.

In Suisun Marsh, tidal emergent wetland will be restored in a sequenced manner that minimizes the disturbance of existing habitats between the initiation of restoration actions and the point at which restored tidal emergent wetland develops as California black rail habitat. Direct removal of existing tidal brackish emergent wetland will be minimized consistent with achieving overall wetland restoration objectives, although some tidal brackish emergent wetland is expected to be desiccated or inundated as a result of changes in the existing tidal range following the breaching of dikes and levees. It is anticipated that following completion of all tidal habitat restoration in Suisun Marsh, tidal brackish emergent wetland will be restored in larger patches than the existing patches of habitat that are currently fragmented by dikes, roads, unsuitable habitat areas, and other infrastructure. These larger unfragmented patches are expected to provide higher-value habitat and facilitate population expansion and growth of California black rail populations in Suisun Marsh.

Restoration of tidal freshwater emergent wetland in the Delta will occur primarily on existing agricultural land and is expected to expand the range of suitable California black rail habitat. Nonnative predators (e.g., feral cats) are believed to be an important stressor on the California black rail. The design and management of restored habitat will include control of nonnative predators to help maintain the species abundance (e.g., through direct removal of predators or through design of restored habitats that minimize access of predators into occupied habitats).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM10 Nontidal Marsh Restoration
- CM11 Natural Communities Enhancement and Management

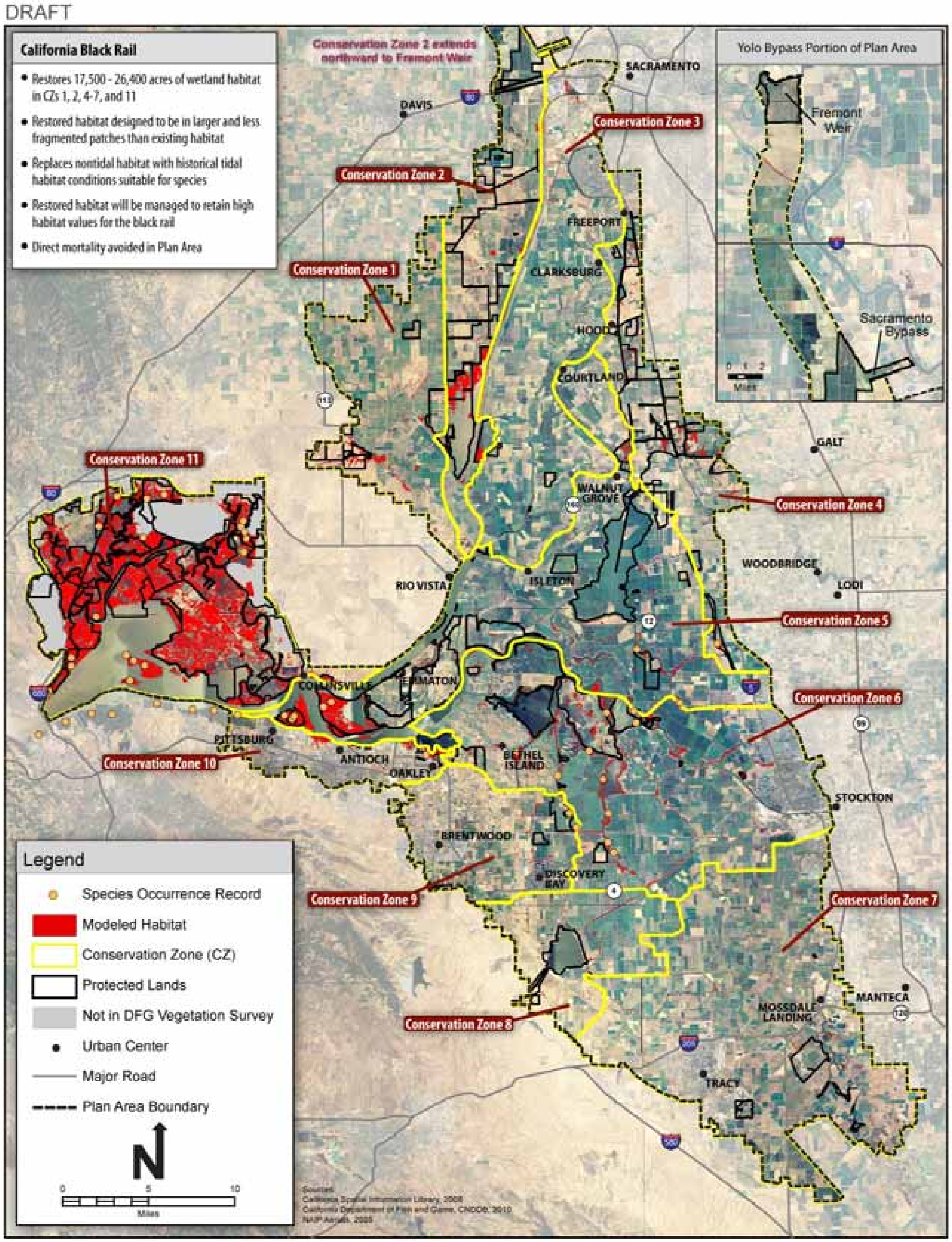

Figure 3-28. California Black Rail Habitat Distribution and Conservation Strategy

3.3.2.4.16 California Clapper Rail

The California clapper rail is a year-round resident of tidal salt and brackish marshes (Albertson 1995 as cited in LSA 2007, USFWS 1998c), occurring in higher population densities where habitat exceeds 100 ha (247 acres) in size (LSA 2007). Its current range is limited to the San Francisco Bay (extending to Suisun Bay), but the California clapper rail once ranged over much of coastal northern California (DWR 1994, USFWS 1998c, LSA 2007). The main significant threat to the California clapper rail continues to be the degradation of its tidal marsh habitat (Williams 1985, Ohlendorf and Fleming 1988, Ohlendorf et al. 1989, Harvey 1990, Lonzarich et al. 1990, Foerster and Takekawa 1991, Leipsic-Baron 1992, DFG 2000 as cited in LSA 2007). Tidal marsh habitat has been reduced by up to 84 percent in the San Francisco Bay since the mid-1800s (Dedrick 1989).

Applicable Natural Community Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Rationale and Conservation Approach

The primary focus of the Recovery Plan for the California clapper rail (USFWS 1984b) is to restore and enhance tidal marsh habitat as a means to increase population numbers and expand the distribution of the rail. BDCP implementation will tie in with existing conservation and enhancement efforts for Suisun Marsh, where more extensive patches of suitable habitat should support larger rail numbers.

The tidal brackish emergent wetland habitat of the California clapper rail is primarily in Suisun Marsh, which is encompassed by Conservation Zone 11. A small portion of the western edge of Conservation Zone 5 (western edge of Sherman Island) is also considered potential habitat for California clapper rail, although no occurrences have been documented there (Appendix A, *Covered Species Accounts*). Conservation will be directed towards restoring tidal brackish emergent wetland in Conservation Zone 11 such that of 3,600 to 4,800 acres[28] of restored tidal

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[28] Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

habitat will serve as California clapper rail habitat based on the analysis of the hypothetical restoration design (Figure 3-29). Tidal habitat restoration that will be implemented in the West Delta ROA (see Conservation Measure CM4, Tidal Habitat Restoration), may also support California clapper rail in future years with sea level rise if salinity increases in the west Delta such that freshwater tidal habitats convert to brackish tidal habitat.

Because restoration of tidal habitat will remove and degrade patches of tidal brackish emergent wetland that are currently occupied by California clapper rail, restoration will be sequenced and located in a manner that minimizes any initial, temporary loss of habitat. Approaches for restoring tidal habitat to support California clapper rail habitat are described in Conservation Measure CM4 Tidal Habitat Restoration. Restored tidal habitats will be designed to the extent practicable within site constraints to provide the full range of environmental gradients from tidal areas to uplands that existed under historical conditions in Suisun Bay. This approach is expected to result in the restoration of patches of California clapper rail habitat within a mosaic of tidal emergent wetland. It is anticipated that following completion of all tidal habitat restoration in Suisun Marsh, tidal emergent wetland will be restored in larger patches than the existing patches of habitat that are currently fragmented by dikes, roads, unsuitable habitat areas, and other infrastructure. These larger unfragmented patches are expected to provide higher ecological value that will facilitate the expansion and growth of California clapper rail populations in the Suisun Marsh. The transitional upland component of restored tidal habitats will be designed to provide flood refugia habitat during high water events.

Nonnative predators (e.g., feral cats) are believed to be an important stressor on the California clapper rail. The design and management of restored habitat will include control of nonnative predators to help maintain the species abundance (e.g., through design of restored habitats that minimize access of predators to occupied habitats and/or through direct removal of predators or). Restored habitat will also be monitored to assess the status of the species and will be adaptively managed to ensure high habitat function for the clapper rail is maintained over time. The proposed restoration of tidal habitat in Suisun Marsh is consistent with and helps achieve the California clapper rail objectives of the draft tidal marsh ecosystems recovery plan (USFWS 2010) and objectives of the Suisun Marsh Restoration Plan (under development).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM10 Nontidal Marsh Restoration
- CM11 Natural Communities Enhancement and Management

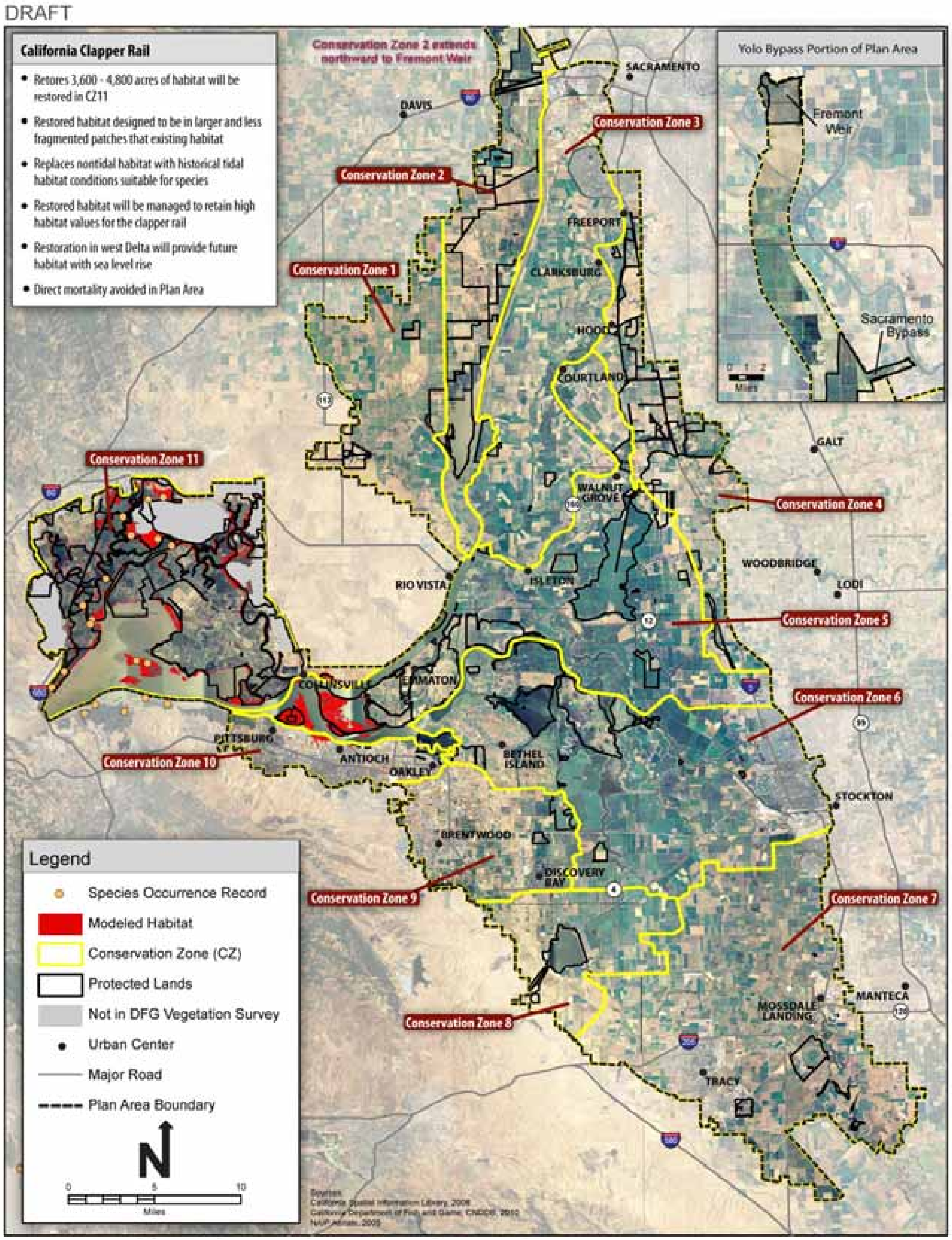

Figure 3-29. California Clapper Rail Habitat Distribution and Conservation Strategy

3.3.2.4.17 Swainson's Hawk

Nesting Swainson's hawks are widely distributed throughout the Plan Area and surrounding lands (Figure 3-30). Of the 314 nesting records since 2000, at least 220 of these are considered independent and are potentially active in any given year. They hunt primarily for rodent prey in agricultural and grassland habitats, and they nest in trees, mainly along stringers of remnant riparian forest along drainages (Estep 1984, Schlorff and Bloom 1984, England et al. 1997) as well as in isolated trees, tree rows, and other nesting habitats. Swainson's hawk population declines in California are thought to be the result of the loss of nesting and foraging habitat due to urban development and conversion to unsuitable agriculture, such as orchards and vineyards (Schlorff and Bloom 1984, England et al. 1995, 1997). Within the Bay/Delta region, high densities of nesting Swainson's hawk nesting pairs have been reported from remnant habitat patches, indicating the potential for large-scale riparian restoration to be of substantial benefit to the species (Estep 1989, 2008).

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.2**: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.5**: Increase prey, especially small mammals and insects, for grassland-foraging species.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

> **Objective ALNC1.2**: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson's hawk nesting habitat.

> **Objective ALNC1.8**: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.

Rationale and Conservation Approach

The conservation of Swainson's hawk will be provided by restoring 5,000 acres of valley/foothill riparian nesting habitat, a substantial amount of which is expected to provide suitable nesting habitat for Swainson's hawk; and by preserving 20,020 to 36,040 acres of agricultural and grassland foraging habitat (Figure 3-30). These actions are expected to sustain the current local Swainson's hawk population and provide for any future increases in Swainson's hawk numbers in the Plan Area. Breeding densities are high in some areas, particularly the north, east, and south Delta, and less so in the Central Delta and south Yolo Bypass. Nesting occurs in riparian habitats as well as roadside trees, isolated trees, and groves where trees support appropriate height and structure (see Appendix A, *Covered Species Accounts*).

The majority of the land within the Plan Area supports Swainson's hawk foraging habitat; however, habitat value varies in agricultural habitats depending on annual and seasonal crop patterns and practices, which influences prey accessibility due to the growth and structure of vegetation, and prey abundance. Because of the dynamic nature of the agricultural landscape and the variability of crop patterns and conditions seasonally and annually, only a proportion of the agricultural landscape is suitable or available for foraging in any given season or year. To account for this variability and to more accurately represent the value of Plan Area-wide foraging habitat, acres of Swainson's hawk foraging habitat were converted to habitat units by placing different crop types and other foraging habitats that traditionally occur in the Plan Area into crop value classes and assigning relative values to those classes (See Species Model in Appendix A, *Covered Species Accounts*). This approach, used to calculate foraging habitat impacts to Swainson's hawk, will also be used to ensure that similar habitat value or better is consistently maintained on BDCP protected lands during the permit period.

The majority of protected foraging habitat will be located at elevations above sea level to ensure that foraging habitat is maintained for Swainson's hawks should potential future Delta levee failures result in large-scale inundation. It is anticipated that all of the restored riparian habitat will be located within flight distance to protected foraging habitat, thus increasing the functions of both types of habitat for the species. Furthermore, patches of nesting habitat located within lands protected for other purposes will also be maintained and all protected habitats supporting active nest sites will be managed to minimize human disturbances during the breeding season.

Protected grassland and agricultural lands will be managed to provide high value Swainson's hawk foraging habitat. Conservation will occur in cooperation and in conjunction with neighboring and overlapping HCP/NCCPs to ensure that conservation actions are implemented where they most benefit the regional Swainson's hawk population and where they are compatible with conservation of other agricultural and riparian-associated species. It is also expected that ongoing agricultural land uses within and adjacent to the Plan Area will also continue to support foraging habitat for Swainson's hawks in the Plan Area.

An estimated 17 percent of Swainson's hawk foraging habitat within the Plan Area is currently protected on state and federal wildlife refuges, other state-owned lands, and mitigation banks and is expected to remain suitable Swainson's hawk foraging habitat. Following implementation of BDCP actions, between 22 and 26 percent of the total available foraging habitat will be preserved, and the extent of nesting habitat will be increased by approximately 28 percent. The proposed conservation is expected to sustain the existing population of Swainson's hawk and provide for future increases in its abundance and distribution within and adjacent to the Plan Area.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

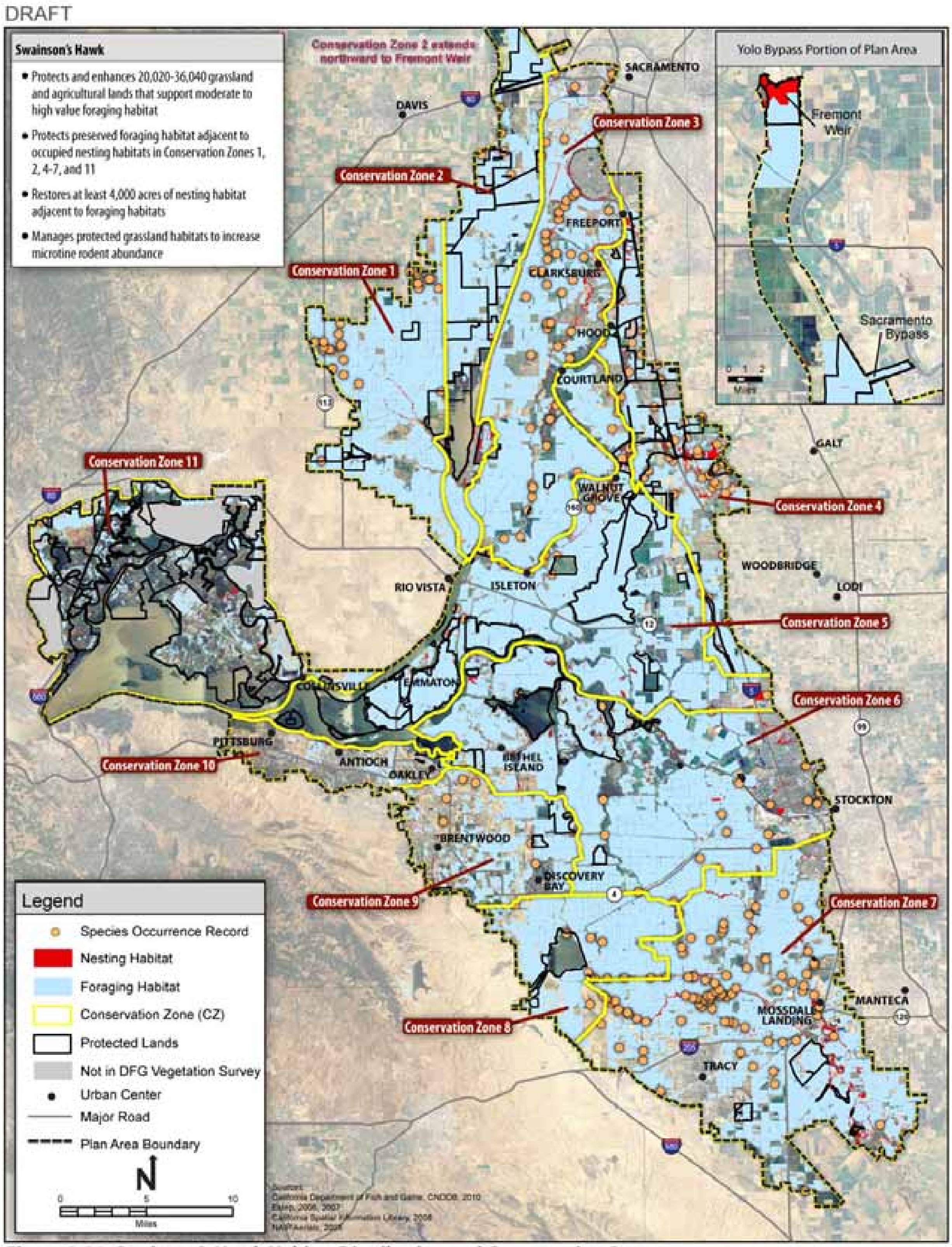

Figure 3-30. Swainson's Hawk Habitat Distribution and Conservation Strategy

3.3.2.4.18 White-Tailed Kite

The white-tailed kite inhabits or uses low elevation, open grasslands, savannah-like habitats, agricultural areas, wetlands, and oak woodlands (Dunk 1995). California is currently considered the stronghold of the white-tailed kite's breeding distribution in North America, with nearly all areas up to the western Sierra Nevada foothills and southeastern deserts occupied (Small 1994, Dunk 1995). It is an uncommon to common year-round resident in the Central Valley and other lowland valleys, and along the entire length of the coast (Dunk 1995). The white-tailed kite occurs year-round in the Plan Area, where it nests in trees, often in riparian areas, and forages in agricultural areas with accessible rodent prey populations (see Appendix A, *Covered Species Accounts*). It is designated as a state Fully Protected species pursuant to California Department of Fish and Game Code Section 3511.

Pronounced population declines and increases have been documented throughout the species' distribution in North America, in many cases the apparent result of changes in prey rodent densities caused by weather or anthropogenic habitat alteration (Ruth and Krueper 2010).

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.2**: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

Objective GRNC1.2: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

Objective GRNC2.5: Increase prey, especially small mammals and insects, for grassland-foraging species.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

Objective ALNC1.1: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.

Objective ALNC1.2: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson's hawk nesting habitat.

Objective ALNC1.8: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.

Rationale and Conservation Approach

Habitat loss and fragmentation represent threats to the species in California (see Appendix A, *Covered Species Accounts*), and BDCP conservation of white-tailed kite is directed at maintaining a landscape of suitable nesting and foraging habitat across the Plan Area and adjacent lands. This goal is to be accomplished through strategic acquisition and management of between 22,000 and 40,000 acres of grassland and agricultural preserves (as foraging habitat) and through restoration of 5,000 acres of riparian habitat (Figure 3-31). The majority of protected foraging habitat will be located at elevations above sea level to ensure that foraging habitat is maintained for white-tailed kites should potential future Delta levee failures result in extensive, permanent inundation of the lowest-lying areas. It is anticipated that all of the restored valley/foothill riparian will be located within foraging flight distance to protected foraging habitat, thus increasing the value of both types of habitat for the species. Furthermore, patches of nesting habitat located within lands protected for other purposes will also be maintained and all protected habitats supporting active nest sites will be managed to minimize human disturbance during the breeding season.

Protected grasslands and agricultural lands will be managed to provide high value white-tailed kite foraging habitat. An estimated 21 percent of white-tailed kite foraging habitat within the Plan Area is currently protected on state and federal wildlife refuges, other state-owned lands, and mitigation banks and is expected to remain suitable white-tailed kite foraging habitat. Following implementation of BDCP actions, an estimated 26 to 31 percent of the total available foraging habitat will be protected, and the extent of nesting habitat will be increased by approximately 29 percent.

White-tailed kite conservation will occur in cooperation and in conjunction with neighboring and overlapping HCP/NCCPs to ensure that conservation actions occur where they most benefit the regional white-tailed kite population and where they are compatible with conservation of other agricultural and riparian-associated species. It is also expected that ongoing agricultural land uses within and adjacent to the Plan Area will continue to support foraging habitat for white-tailed kite nesting and wintering in the Plan Area. BDCP's proposed white-tailed kite conservation strategy is expected to sustain the existing population of white-tailed kites and provide for future increases in its abundance and distribution within and adjacent to the Plan Area.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

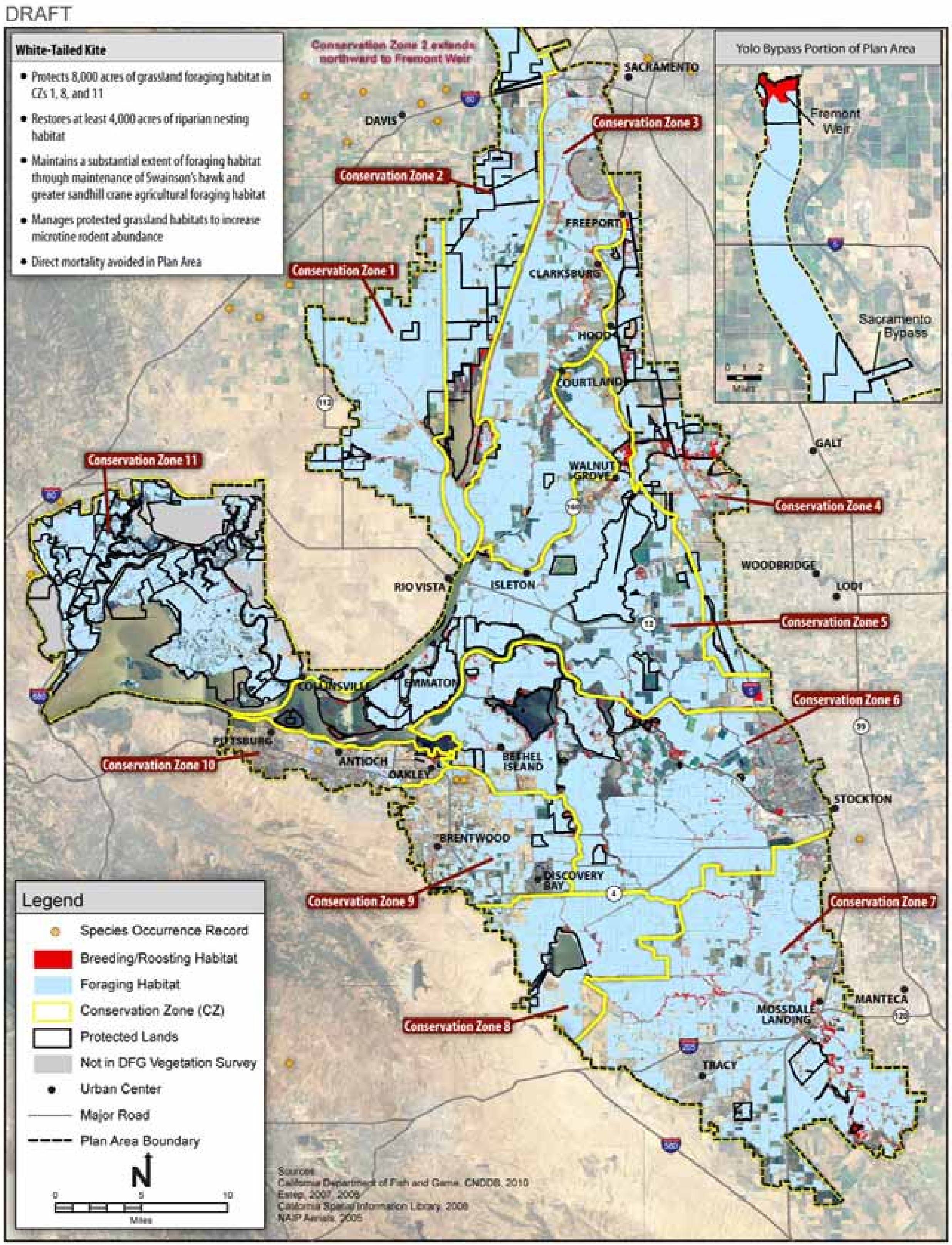

Figure 3-31. White-Tailed Kite Habitat Distribution and Conservation Strategy

3.3.2.4.19 Giant Garter Snake

The giant garter snake is endemic to wetlands in the Sacramento and San Joaquin valleys and was historically distributed throughout the San Joaquin Valley (Hansen and Brode 1980). The current distribution extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County. The Plan Area is within the Mid-Valley Recovery Unit identified in the Draft Recovery Plan, and three of the thirteen giant garter snake populations identified by the USFWS occur within the Plan Area in Yolo Basin – Willow Slough, Yolo Basin – Liberty Farms, and Coldani Marsh – White Slough (USFWS 1999a).

Giant garter snakes utilize a wide variety of aquatic habitats including marshes, ponds, sloughs, small lakes, low gradient streams, and other waterways, including agricultural wetlands such as irrigation and drainage canals, rice fields, and the adjacent uplands. Important giant garter snake habitat elements include: adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover, emergent herbaceous wetland vegetation accompanied by vegetated banks for escape cover and as foraging habitat during the active season, basking habitat of grassy banks and openings in waterside vegetation, and higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter. Home range size varies by location, with median home range estimates averaging 23 acres (range [10.3 to 203 ac], n = 8) (9 hectares, range = 4.2 to 82 ha) in a semi-native perennial marsh system and 131 acres (range [3.2 to 2,792 ac], n = 29) (53 hectares, range = 1.3 to 1130 ha) in a managed refuge (USFWS 1999a). Continued loss of wetland or other suitable habitat resulting from agricultural and urban development constitutes the greatest threat to this species' survival. Conversion of Central Valley wetlands for agriculture and urban uses has resulted in the loss of as much as 95 percent of historical habitat for the giant garter snake (Wylie et al. 1997).

Applicable Natural Community Goals and Objectives

Goal TANC1: The expected outcome is tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic food web processes.

> **Objective TANC1.1**: Restore or create 10,000 to 20,000 acres of tidal perennial aquatic in the BDCP Restoration Opportunity Areas (Conservation Zones 1, 2, 4, 5, 7, and 11) that supports aquatic food production and habitat for covered and other native species.

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

Objective FMNC2.1: Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Goal NWNC1: The expected outcome is nontidal freshwater perennial emergent wetland natural community that supports habitat for covered and other native species.

Objective NWNC1.1: Create 400 acres of nontidal freshwater marsh (including components of nontidal perennial aquatic and perennial emergent wetland communities) that functions as habitat for the giant garter snake, tricolored blackbird, and western pond turtle within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4 and the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.

Goal NWNC2: The expected outcome is biologically diverse nontidal freshwater perennial emergent wetland communities that are enhanced for native species and sustained by ecological processes.

Objective NWNC2.1: Maintain and enhance the habitat functions of protected and created nontidal freshwater perennial emergent wetlands for covered and other native species over the term of the BDCP.

Goal NANC2: The expected outcome is biologically diverse nontidal perennial aquatic communities that are enhanced for native species and sustained by ecological processes.

Objective NANC2.1: Maintain and enhance the habitat functions of protected and created nontidal open water habitats for covered and other native species over the term of the BDCP.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

Objective ALNC1.1: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.

Objective ALNC1.2: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson’s hawk, white-tailed kite, and tricolored blackbird that are located within 8 miles of occupied Swainson’s hawk nesting habitat.

Objective ALNC1.5: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands and 4,600 acres of rice lands, maintain and protect 1,000 acres within or adjacent to habitat occupied by the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.

Objective ALNC1.6: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain and protect 1,000 acres within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4.

Objective ALNC1.7: Target agricultural land conservation to provide connectivity between other protected lands.

Objective ALNC1.8: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.

Species-Specific Goals and Objectives

Goal GGSN1: The expected outcome is high quality upland and aquatic habitat containing a mosaic of features provided for extant giant garter snake populations.

Objective GGSN1.1: Create functional landscapes on giant garter snake preserves that include a mosaic of restored freshwater marsh intermixed with protected agricultural lands and interconnected water conveyance canals and natural drainages.

Goal GGSN2: The expected outcome is protected giant garter snake corridors facilitating movement and linking populations.

Objective GGSN2.1: Establish connectivity between giant garter snake preserve lands, restored tidal wetlands, and protected agricultural lands in Conservation Zone 4 to facilitate movement into unoccupied portions of the Delta and with the Badger Creek subpopulation.

Objective GGNS2.2: Establish a giant garter snake north-south corridor that includes protected agricultural lands and restored tidal and nontidal wetlands between Coldani Marsh/White Slough and the Stone Lakes National Wildlife Refuge.

Rationale and Conservation Approach

Because the primary stressor on the giant garter snake is loss and fragmentation of its aquatic and terrestrial cover habitat through urban and agricultural expansion, the focus of this conservation strategy is to protect habitat, protect and restore connectivity, and enhance habitat function, key elements of the species' Recovery Plan (USFWS 1999a).

There are four components of giant garter snake conservation under BDCP (Figure 3-32):

- The establishment of agricultural land preserves that will include nontidal freshwater marsh restoration associated with two existing subpopulations in Conservation Zones 2 and 4;
- Protection of existing rice land values in Conservation Zone 2;
- Protection, connectivity, and management of non-rice agricultural habitats in the Plan Area; and
- Restoration of freshwater tidal marshes.

Protecting and expanding existing giant garter snake subpopulations is considered the most effective approach to conservation of this species in the Plan Area. The majority of the Plan Area is considered low value habitat for this species (Appendix A, *Covered Species Accounts*); however, extant subpopulations occur along the eastern edge of the Plan Area boundary in the vicinity of White Slough (Caldoni Marsh/White Slough subpopulation) and near the northwestern edge of the Plan Area in the vicinity of Willow Slough (Yolo/Willow Slough subpopulation).

The Caldoni Marsh/White Slough and Yolo/Willow Slough subpopulations support the highest densities of giant garter snakes in the Plan Area and habitat preservation, enhancement, and restoration actions for these populations are directed at securing habitats supporting these populations from potential threats (e.g., change in land uses), expanding and enhancing these habitat areas to allow for increases in their abundance and distribution, and to help to meet USFWS recovery goals for these designated subpopulations.

The Caldoni Marsh/White Slough subpopulation is centered within the White Slough Wildlife Area and is comprised of approximately 830 acres, of which approximately 50 acres represent core giant garter snake wetland habitat. The Yolo/Willow Slough subpopulation includes unprotected habitat areas and habitat preserved within the Yolo Wildlife Area.

The conservation strategy for these subpopulations includes creation of 400 acres of nontidal marsh that will be divided between two 1,000 acre agricultural preserves in each of these subpopulation areas to help ensure their continued existence. This additional restoration of nontidal marsh (comprised of a mix of nontidal perennial aquatic and nontidal permanent emergent communities) distributed between the two subpopulation habitat areas will substantially increase connectivity among existing occupied habitat areas and provide the basis for future expansion of their distribution and abundance.

Although dependent on the aquatic environment, the giant garter snake occurs within the agricultural landscape where it uses interconnected watercourses (primarily irrigation canals) and associated freshwater emergent wetland habitat and rice lands during the active season and adjacent uplands during the inactive season. Maintaining an agricultural matrix that includes suitable interconnected canals with reliable water, associated emergent vegetation and adjacent upland habitats is essential for conservation of this species. As these conservation areas are designed, agricultural parcels will be selected based on their proximity and connectivity to occupied sites and opportunities for restoration and enhancement. Restored marsh habitats will be created in appropriate patch sizes and within the existing agricultural matrix to maximize connectivity and the potential for expansion and dispersal. This approach is designed to protect the existing subpopulation centers and create opportunities for the expansion of these subpopulations.

Protected agricultural habitats will be managed to enhance habitat conditions for giant garter snake and to minimize potential adverse effects of agricultural operations on giant garter snake in occupied habitat areas (e.g., upland buffers adjacent to aquatic habitats; timing maintenance of agricultural ditches that support aquatic and movement habitat to periods the snake is not present). Protection and management of upland and agricultural habitat areas adjacent to core wetland habitats will also be aimed at preventing potential impacts associated with adjacent land uses. If site-specific planning to design the subpopulation preserves indicates that the extent of the proposed preservation is not necessary to sustain and expand these populations, some of the proposed preservation and restoration may be directed towards securing populations adjacent to the Plan Area (e.g., the Badger Creek population) consistent with achieving objectives of adjacent conservation plans.

In addition to the creation of the giant garter snake preserves, protection of other natural communities within the Plan Area will also benefit the giant garter snake. Lands protected for Swainson's hawk and greater sandhill crane that occur within the range of the giant garter snake will provide additional protected landscape to support existing or future populations. These lands will include water conveyance systems, patches of freshwater marsh, and other aquatic habitats that will be managed to promote use by giant garter snake and other covered species. Protection of cultivated habitats in Zones 2 and 4 for Swainson's hawk and greater sandhill crane conservation are expected to provide additional opportunities for enhancing north-south movement corridors for the Yolo/Willow Slough subpopulation within the Yolo Bypass and for the Caldoni Marsh/White Slough subpopulation between Stone Lakes National Wildlife Refuge and the Caldoni Marsh/White Slough area.

The restoration of freshwater tidal marsh habitat in the Plan Area is also expected to create or enhance habitat conditions for giant garter snake and provide potential for dispersal and expansion of populations. Restoration of 13,900-21,600 acres of tidal freshwater emergent wetland and portions of 10,000-20,000 acres of adjacent tidal aquatic habitat will provide opportunities for giant garter snake expansion into areas where they are currently absent (e.g., Conservation Zone 7). Restoration of tidal habitats, particularly in potentially occupied habitat areas in Conservation Zones 2 and 4 will increase the extent of suitable giant garter snake breeding and foraging habitat in locations with narrow tidal ranges. Restoration of tidal habitats in Conservation Zone 4 will also help in providing connectivity between the Caldoni Marsh/White Slough subpopulation and the Badger Creek subpopulation. Meeting the tidal marsh restoration objectives is expected to substantially increase aquatic and associated upland habitat for giant garter snake throughout the Plan Area.

Within the Yolo Bypass, preservation of the existing extent of rice lands that could be affected by proposed Fremont Weir operations or restoration of wetlands to replace any lost habitat functions of rice lands will sustain the abundance and distribution of snakes known to inhabit cultivated portions of the Bypass. Preservation of cultivated habitats will also preserve and enhance upland aestivation habitat for giant garter snake within its Primary Habitat Area.

Consistency with USFWS Draft Recovery Plan

Guidance in the USFWS draft giant garter snake recovery plan was used in the development of the giant garter snake conservation strategy. The following links recovery action priorities for the Southern Sacramento Valley recovery unit to individual goals and objectives for giant garter snake.

Protect Existing Populations. The following objectives address protection of existing populations.

- Objectives NWNC1.1 and 2.1; NANC2.1; ALNC1.1, 1.5,1.6, and GGSN1.1 will contribute to the priority need as identified in the Draft Recovery Plan by protecting and managing habitat currently occupied by the species. These objectives will shelter the population from potential threats, increase habitat quantity, and increase habitat quality; which will lead to increased population size of the Caldoni Marsh/White Slough and Yolo/Willow Slough subpopulations.
- Objectives FMNC2.1, NWNC2.1, NANC2.1, ALNC1.8, and GGNS1.1 will contribute to the priority need as identified in the Draft Recovery Plan by increasing the quality and functionality of managed lands in or adjacent to occupied habitat. Implementing management plans and guidelines for the species on managed lands is anticipated to reduce injury and mortality associated with incompatible land uses.
- Objectives ALNC1.5 and 1.6, NWNC1.1, TANC 1.1, FMNC1.1, and GGNS1.1 and 1.2 will contribute to the priority need as identified in the Draft Recovery Plan by protecting (previously unprotected) and/or enhancing corridor habitat. Increasing the connectivity between populations and within meta-populations is expected to enhance gene flow, increase distribution, and ultimately make the populations more resilient to catastrophic events.

Restore Habitat. The following objectives address restoration of giant garter snake habitat.

- Objectives TANC1.1 and FMNC1.1 will restore 10,000-20,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 6, 7, and 11 and 13,900-21,600 acres of tidal freshwater marsh to Conservation Zones 1, 2, 5, and 7. The majority of these lands are currently non-functional or low functioning lands for giant garter snake and will be restored to enhance existing conditions. Of the total acres of tidal marsh restoration, 1,500 acres is planned for Conservation Zone 4, which will provide additional habitat, contribute to connectivity, and facilitate movement between the Caldoni/White Slough subpopulation northward toward the Cosumnes River Preserve and Stone Lakes National Wildlife Refuge.

- Objective NWNC1.1 will restore 400 acres of nontidal freshwater marsh habitat in Conservation Zones 2 and 4 to support security and expansion of the Yolo/Willow Slough and Caldoni Marsh/White Slough subpopulations.
- Objectives FMNC2.1, NWNC2.1, NANC2.1, ALNC1.8, and GGNS1.1 will protect and manage essential habitat elements within restored habitats, including upland buffers, and ensure that management actions are consistent with giant garter snake protection.

Ensure dependable water supply. The following goals address ensuring a dependable water supply for restored giant garter snake habitats.

- Goals TANC1, FMNC1, and NWNC1 seek to meet the priority need identified in the Draft Recovery Plan to provide a dependable water supply for giant garter snake populations in the Delta region. Conservation actions will include provisions for a perennial water supply with particular importance placed on the active season.

Buffer land supporting giant garter snake populations from the effects of urbanization and highway expansion. The following objectives address protecting giant garter snake populations.

- Objectives FMNC2.1, NWNC2.1, NANC2.1, ALNC1.8, and GGNS1.1 will protect, enhance, and manage essential habitat elements within restored habitats to ensure protection of giant garter snake habitat and populations. While these are general objectives that address the range of management actions for all covered species, they also include establishing and maintaining appropriate buffers between giant garter snake habitat and incompatible land uses.

Restore and maintain connectivity between populations and protected lands. The following objectives address habitat connectivity.

- Objectives TANC 1.1, FMNC 1.1, and GGSN2.1 will promote connectivity between the Caldoni Marsh/White Slough subpopulation and the Badger Creek subpopulation; and
- ALNC1.2 and GGSN2.2 will protect cultivated habitats in Zones 2 and 4 for Swainson's hawk and greater sandhill crane, which will provide opportunities for enhancing north-south movement corridors for the Yolo/Willow Slough subpopulation within the Yolo Bypass and for Caldoni Marsh/White Slough subpopulation between Stone Lakes National Wildlife Refuge and the Caldoni Marsh/White Slough area.

Development management plans and guidelines for conservation lands. Developing site-specific management plans for BDCP lands is an essential element of all goals and objectives. The following objectives specifically target the need for the development of management plans.

- Objectives FMNC2.1, NWNC2.1, NANC2.1, and ALNC1.8 will require the development of site-specific management plans for all BDCP lands, which will protect, enhance, and manage essential habitat elements for all covered species including giant garter snake.

Restore connectivity to the Northern Sacramento Valley Recovery Unit. The following objectives address connectivity throughout the Northern Sacramento Valley Recovery Unit.

- ALNC1.5 and 1.6, NWNC1.1, and GGSN1.1 and 1.2 will increase connectivity outside of the Plan Area by protecting and enhancing habitat around the Yolo/Willow Slough and Caldoni Marsh/White Slough subpopulations.;
- TANC1.1 and FMNC1.1 will create substantial additional habitat for giant garter snake and promote connectivity between the Plan Area and habitats outside the Plan Area; and
- ALNC1.2 will protect substantial cultivated habitats that will promote connectivity between the Plan Area and habitats outside the Plan Area.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM10 Nontidal Marsh Restoration
- CM11 Natural Communities Enhancement and Management

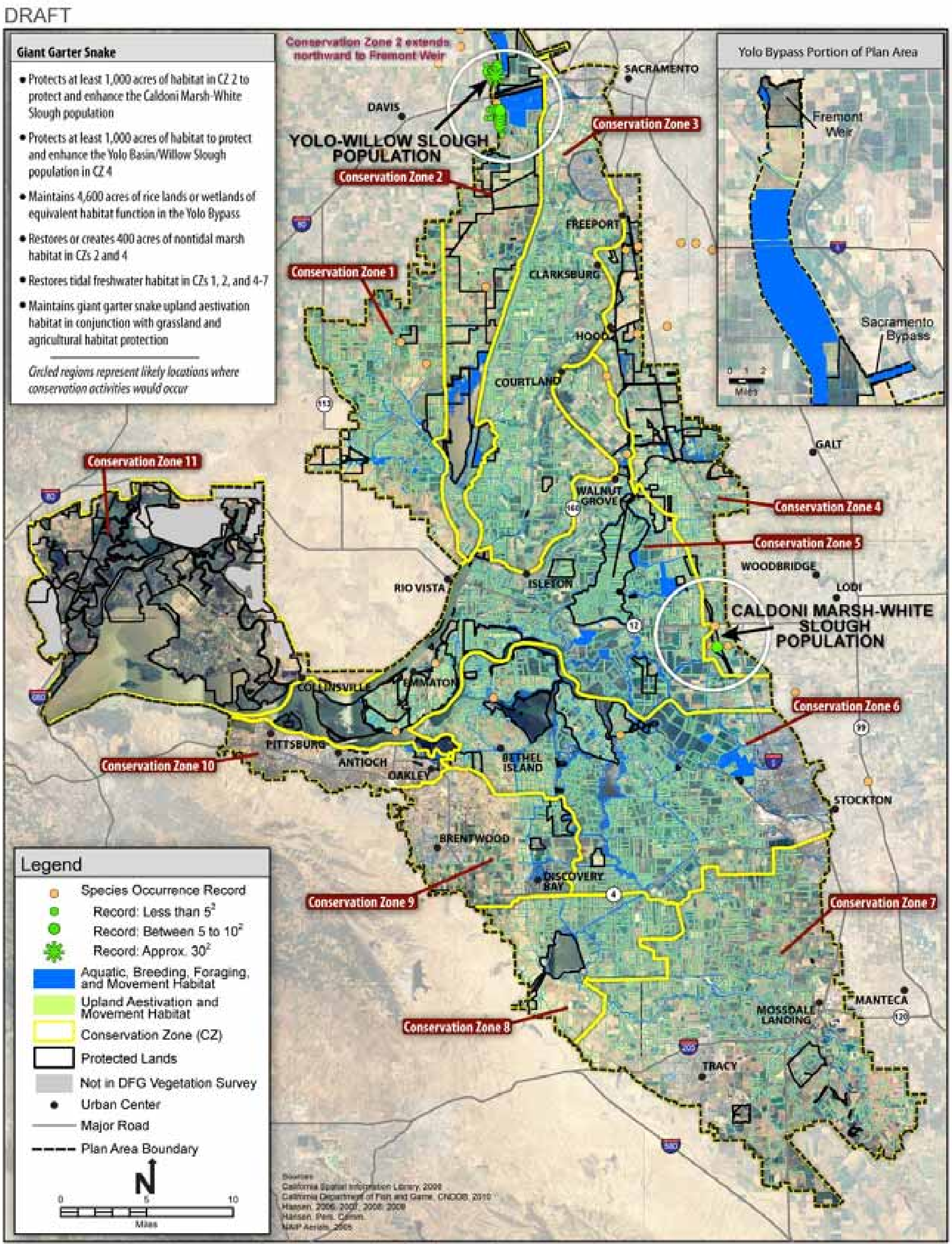

Figure 3-32. Giant Garter Snake Habitat Distribution and Conservation Strategy

3.3.2.4.20 Western Pond Turtle

The western pond turtle is a California Species of Special Concern and occurs in the Pacific states of North America from Baja California, north through Washington, and possibly into southernmost British Columbia, Canada (Bury and Germano 2008). The California Natural Diversity Database (CNDDB) reports several occurrences spread throughout the Plan Area in Sacramento, San Joaquin, and Contra Costa counties (CNDDB 2009); however, it is likely that this species is underreported and underrepresented in CNDDB. While primarily found in natural aquatic habitats, it also inhabits impoundments, irrigation ditches, and other artificial and natural water bodies (Ernst et al. 1994). The species is usually found in stagnant or slow-moving freshwater habitats, but brackish habitats are also utilized (Ernst et al. 1994). An upland habitat component is also used for movement, dispersal, and overwintering. Bury (1972) found adult males had the largest home ranges in his study (0.98 ha [2.42 ac]), followed by juveniles (0.36 ha [0.89 ac]) and adult females (0.25 ha [0.62 ac]) (Yolo Natural Heritage Program 2009). Most populations throughout the range have exhibited some declines. In California, Jennings and Hayes (1994) consider the western pond turtle as endangered from the Mokelumne River south and threatened elsewhere within the state. Loss of habitat is the most significant factor in western pond turtle declines. Over 90 percent of the historical wetlands in California have been drained, filled, or diked to support agricultural and urban development (Frayer et al. 1989).

Applicable Natural Community Goals and Objectives

Goal TANC1: The expected outcome is tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic food web processes.

> **Objective TANC1.1**: Restore or create 10,000 to 20,000 acres of tidal perennial aquatic in BDCP Restoration Opportunity Areas (Conservation Zones 1, 2, 4, 5, 7, and 11) that supports aquatic food production and habitat for covered and other native species.

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Goal NWNC1: The expected outcome is nontidal freshwater perennial emergent wetland natural community that supports habitat for covered and other native species.

> **Objective NWNC1.1**: Create 400 acres of nontidal freshwater marsh (including components of nontidal perennial aquatic and perennial emergent wetland communities) that functions as habitat for the giant garter snake, tricolored blackbird, and western pond turtle within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4 and the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.

Goal NWNC2: The expected outcome is biologically diverse nontidal freshwater perennial emergent wetland communities that are enhanced for native species and sustained by ecological processes.

> **Objective NWNC2.1**: Maintain and enhance the habitat functions of protected and created nontidal freshwater perennial emergent wetlands for covered and other native species over the term of the BDCP.

Goal NANC2: The expected outcome is biologically diverse nontidal perennial aquatic communities that are enhanced for native species and sustained by ecological processes.

> **Objective NANC2.1**: Maintain and enhance the habitat functions of protected and created nontidal open water habitats for covered and other native species over the term of the BDCP.

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.

Objective ALNC1.1: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.

Objective ALNC1.8: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.

Rationale and Conservation Approach

Because the primary stressor on the western pond turtle is loss of its aquatic and upland habitat due to urban and agricultural expansion, the preservation, enhancement, and restoration of these habitat types is considered to be the most effective approach to its conservation. Conservation of western pond turtle will be provided through the preservation and enhancement of 4,000 acres of its dispersal habitat, over 5,000 acres of its upland nesting and overwintering habitat, and restoration of 5,000 acres of overwintering and nesting habitat and between 27,900 and 46,800 acres of its aquatic habitat (Figure 3-33). The preservation and restoration of such large habitat areas is expected to significantly advance the conservation of western pond turtle in the region. Western pond turtle aquatic, dispersal, and upland nesting and overwintering occurs throughout the Plan Area.

Western pond turtle utilize a wide variety of aquatic habitats. Although primarily found in natural aquatic habitats, it also inhabits impoundments, irrigation ditches, and other artificial and natural water bodies. Western pond turtle is usually found in stagnant or slow-moving freshwater habitats, but brackish habitats are also utilized. Conservation of aquatic habitat will be provided through the restoration of tidal marsh plain and adjacent shallow subtidal habitats within Restoration Opportunity Areas (ROAs) that are expected to support extensive patches of western pond turtle habitat and _ acres of nontidal wetland that will be located in occupied giant garter snake habitat areas.

Western pond turtle upland nesting and overwintering habitat includes riparian areas and grassland. Nesting sites are typically placed about 100 m from aquatic habitat. Conservation of western pond turtle upland nesting and overwintering habitat will be provided mainly through a combination of grassland protection and riparian habitat restoration within ROAs, with grassland restoration and vernal pool complex restoration having the potential to also benefit the species. Vernal pools in particular have been shown to be used during dispersal between nesting and overwintering sites (Reese and Welsh 1997) and vernal pool complex restoration may increase the ability of western pond turtles to disperse across the BDCP landscape. A substantial amount of restored riparian habitat is expected to be adjacent to restored tidal wetland and subtidal aquatic habitat, thus ensuring proximity of nesting and overwintering habitat to aquatic habitat. Dispersal habitat consists of agricultural land and is ubiquitous within the Plan Area (see Appendix A, *Covered Species Accounts*). Protection of cultivated habitats to achieve habitat conservation targets for other covered species (e.g., protection of Swainson's hawk foraging habitat) will also preserve western pond turtle dispersal habitat.

Following BDCP implementation, restoration of pond turtle aquatic habitat is expected to increase the extent of this habitat type in the Plan Area by up to 68 percent relative to current conditions. The proposed habitat conservation actions are expected to maintain sufficient habitat area to sustain or increase the existing Plan Area population of western pond turtle and to maintain connectivity with populations adjacent to the Plan Area that are covered under adjacent and overlapping HCP/NCCPs.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM10 Nontidal Marsh Restoration
- CM11 Natural Communities Enhancement and Management

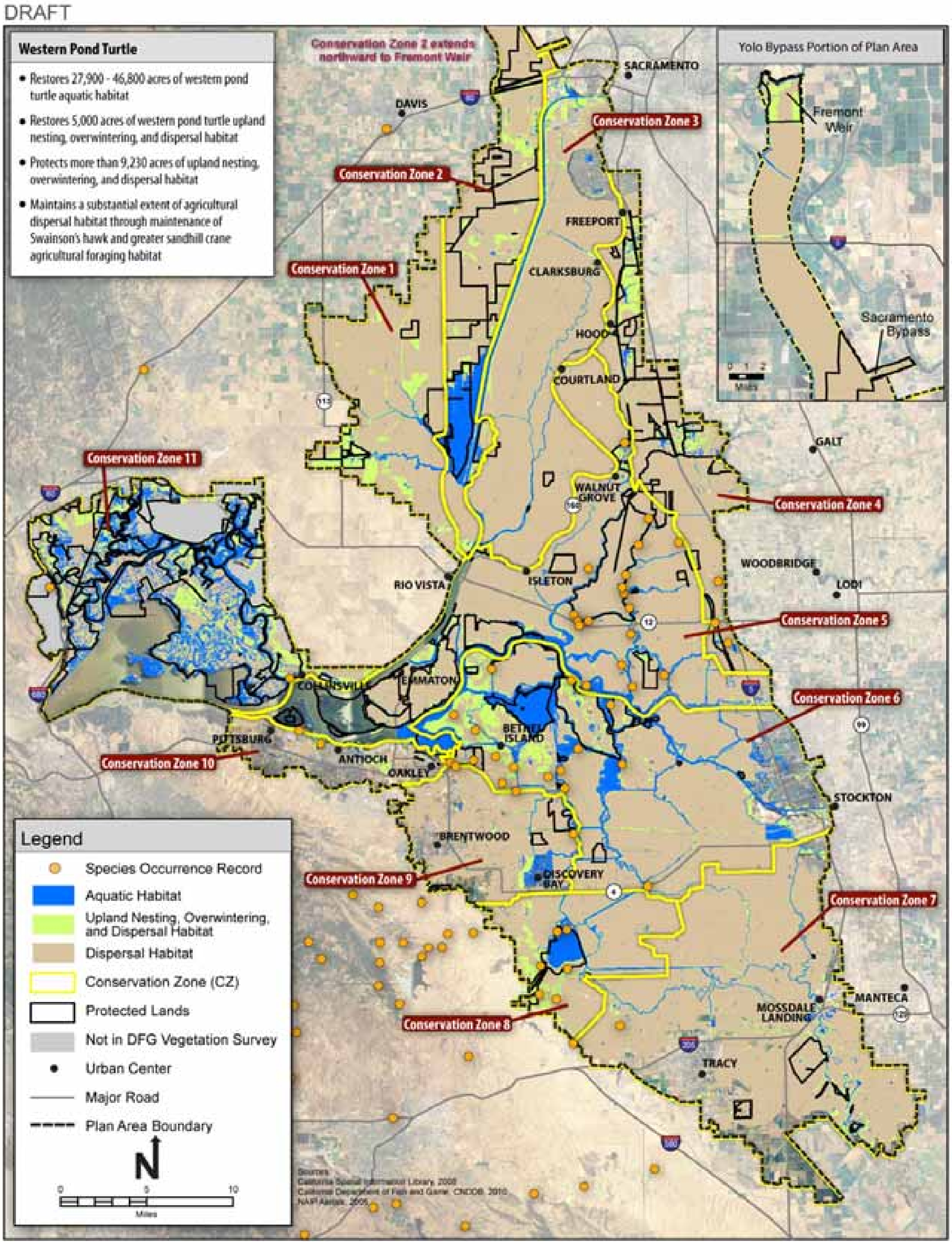

Figure 3-33. Western Pond Turtle Habitat Distribution and Conservation Strategy

3.3.2.4.21 California Red-Legged Frog

The historical range of the California red-legged frog is generally characterized as extending south along the coast from the vicinity of Point Reyes National Seashore and inland from the vicinity of Redding, southward along the interior Coast Ranges and Sierra Nevada foothills to northwestern Baja California (USFWS 2007b). Habitat typically consists of deep water ponds and pools, streams, and other aquatic habitat along with grasslands that provide movement corridors and aestivation sites. The USFWS (2002) estimates that the species has lost approximately 70 percent of its former range, with severe declines occurring primarily in the Central Valley and Southern California (Jennings and Hayes 1994). The principal factors contributing to the decline of the California red-legged frog are the loss of habitat due to urban development, the conversion of native habitats to agricultural lands, the introduction of nonnative predators, and pesticide use (Fisher and Shaffer 1996, Hobbs and Mooney 1998, Davidson et al. 2002).

Within the Plan Area, this species is restricted to the grassland natural community and associated aquatic habitats (stock ponds and small streams) in Conservation Zone 8 along the southwest periphery of the Plan Area.

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

> **Objective GRNC2.3**: Increase opportunities for wildlife movement through grassland habitat.

> **Objective GRNC2.4**: Increase burrow availability for burrow-dependent species.

Species-Specific Goals and Objectives

Goal CRLF1: The expected outcome is enhanced breeding California red-legged frog populations in the Plan Area.

> **ObjectiveCRLF1.1**: Enhance stock ponds in grassland in Conservation Zone 8 through partial livestock exclusion and predator control.

Rationale and Conservation Approach

Because a primary stressor on the California red-legged frog is the loss of its aquatic and upland habitat due to urban and agricultural expansion, the protection and enhancement of these habitat types are key elements of the U.S. Fish and Wildlife Service's Recovery Plan for the species and considered to be the most effective approach to its conservation. Conservation of California red-legged frog will be provided through the preservation of 1,000 acres of grassland natural community in Conservation Zone 8 (Figure 3-34). Habitat will be preserved and enhanced in the largest possible patch sizes adjacent to occupied habitat within and adjacent to the Plan Area and will be managed to enhance habitat functions for California red-legged frog. Conservation Zone 8 is the only location within the Plan Area where California red-legged frog is present or expected to occur. Conservation of California red-legged frog is focused on protecting its intact riparian and upland cover and dispersal habitat linking to its aquatic breeding habitat within the Plan Area and to occupied habitat areas adjacent to the Plan Area in Conservation Zone 8 south of Highway 4.

California red-legged frog upland habitat will be preserved in Conservation Zone 8. Upland habitats are comprised of grassland that supports aestivation and movement habitat to and from aquatic breeding habitats. Approximately 3,830 acres of upland cover and dispersal habitat is present in Conservation Zone 8 of which approximately 620 acres (16 percent) are currently protected. The proposed protection of grassland would be located such that it encompasses ponds and stream corridors that support breeding habitat. Protected habitat will be managed to increase the abundance of ground squirrel burrows to increase the availability of cover and aestivation sites and to increase the habitat function of any riparian habitat adjacent to preserved stream channels by providing dense stands of overhanging willows and a fringe of cattails between the willow roots and overhanging willow limbs. Stock ponds will also be enhanced by excluding livestock from a portion of the stock pond and allowing freshwater emergent vegetation to grow, facilitating red-legged frog occupancy.

California red-legged frog habitat within the Plan Area is located on the margin of its range and as such is not considered to support core habitat area for the species. Consequently, to increase the level of conservation benefits provided to California red-legged frog relative to benefits that would be provided by implementing the conservation actions within the Plan Area, the red-legged frog conservation actions may be implemented within core red-legged frog habitat areas that are located outside of the Plan Area consistent with conservation plans for those locations as described in Section 3.2.4, *Development of the Terrestrial Resources Component of the Conservation Strategy*.

Following BDCP implementation, approximately 33 percent of modeled California red-legged frog habitat in Conservation Zone 8 that links to occupied habitat outside the Plan Area would be preserved. The proposed habitat conservation actions are expected to preclude potential future fragmentation of the highest functioning frog habitat in the Plan Area and maintain sufficient habitat area to sustain or increase the existing Plan Area population of California red-legged frog and to maintain connectivity with occupied core populations adjacent to the Plan Area that are covered under adjacent and overlapping HCP/NCCPs.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM11 Natural Communities Enhancement and Management

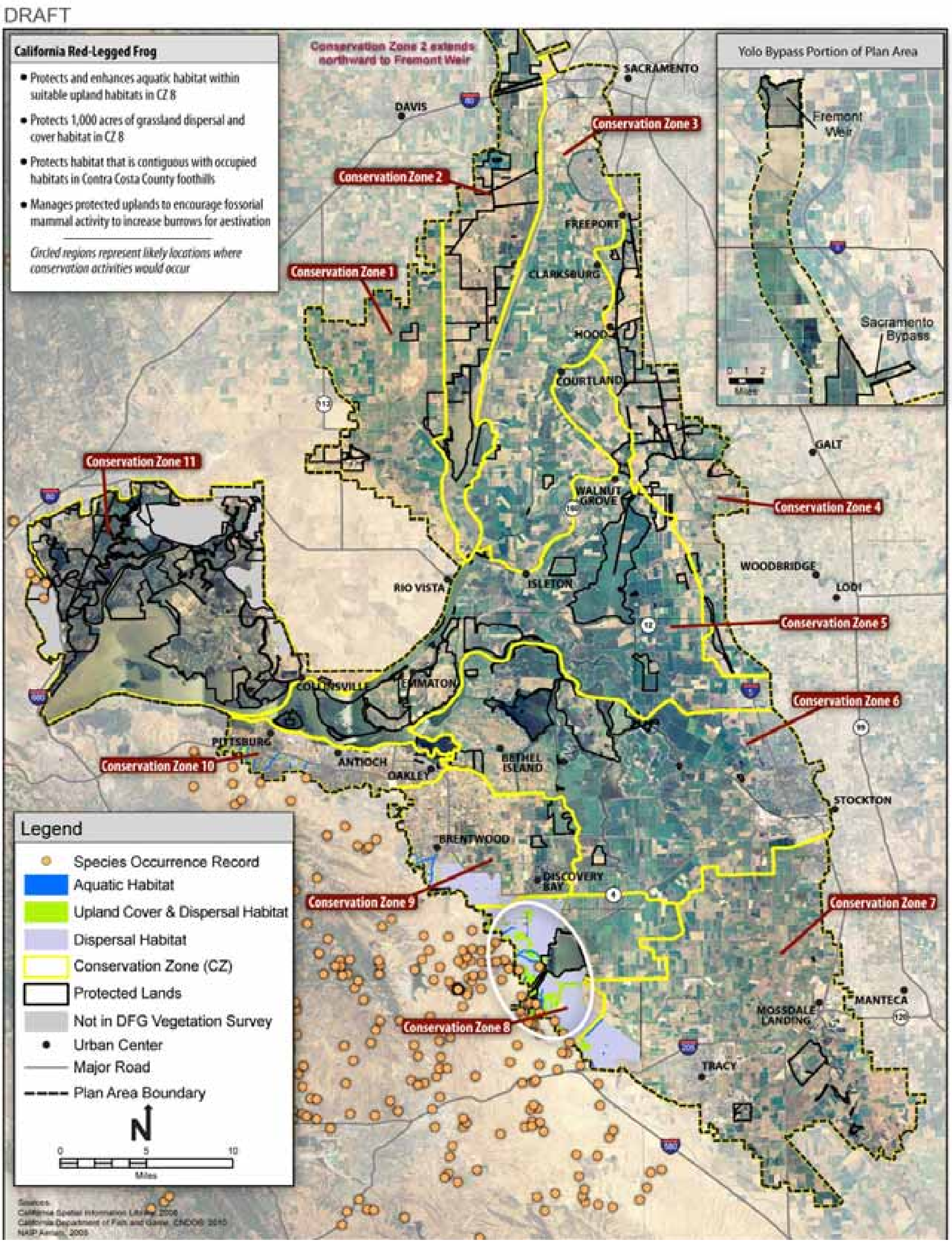

Figure 3-34. California Red-Legged Frog Habitat Distribution and Conservation Strategy

3.3.2.4.22 Western Spadefoot Toad

The western spadefoot toad is a state Species of Special Concern whose range includes portions of California, extending south to Mesa de San Carlos in Baja California, Mexico (Stebbins 1985, Jennings and Hayes 1994, California Academy of Sciences 2008, Museum of Vertebrate Zoology 2008). In California, the current range of the western spadefoot toad includes portions of the Central Valley and bordering foothills, and the Coast Ranges south of Monterey Bay (Stebbins 2003). The western spadefoot toad has been extirpated throughout most of the lowlands of southern California (Stebbins 1985) and from many historical locations within the Central Valley (Jennings and Hayes 1994, Fisher and Shaffer 1996). Fisher and Shaffer (1996) state that the western spadefoot toad populations have declined severely in the Sacramento Valley, and their density has been reduced in eastern San Joaquin Valley. Optimal habitat consists of vernal pool breeding habitat surrounded by grassland upland cover habitat. Western spadefoot toad also typically inhabits other lowland habitats such as washes, floodplains of rivers, alluvial fans, playas, and alkali flats (Stebbins 1985). Its range extends into the foothills and mountains to an elevation of 1,360 m (4,462 feet) (Jennings and Hayes 1994). The principal factors contributing to the decline of the western spadefoot are loss of habitat due to urban development, conversion of native habitats to agricultural lands, introduction of nonnative predators, and pesticide use (Fisher and Shaffer 1996, Hobbs and Mooney 1998, Davidson et al. 2002). The loss of vernal pool or other seasonal pool habitats due to land conversion is likely the greatest threat to the western spadefoot toad. More than 80 percent of occupied habitat in southern California and more than 30 percent in northern California have been lost to development or other incompatible land uses (Jennings and Hayes 1994).

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

Objective GRNC2.3: Increase opportunities for wildlife movement through grassland habitat.

Objective GRNC2.4: Increase burrow availability for burrow-dependent species.

Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

Objective VPNC1.1: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.

Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

Objective VPNC2.1: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.

Objective VPNC2.2: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.

Rationale and Conservation Approach

Because a primary stressor on the western spadefoot toad is the loss of its vernal pool breeding and upland habitat due to urban and agricultural expansion, the preservation, enhancement, and restoration of these habitat types is considered to be the most effective approach to its conservation. Conservation of western spadefoot toad will be provided mainly through the preservation and enhancement of 300 acres and restoration of 200 acres of its vernal pool complex breeding habitat and the preservation and enhancement of 8,400 acres of its grassland and associated alkali seasonal wetland cover habitat (Figure 3-35). Additionally, grassland restoration will be conducted in the Plan Area and has the potential to benefit the western spadefoot where vernal pools occur within dispersal distance. Although there are no records of western spadefoot toad occurring within the Plan Area (CNDDB 2009), potentially suitable habitat exists and the expected range extends through the Plan Area. Habitat will be preserved and restored in the largest possible patch sizes and management of preserved and restored vernal pool complex (e.g., livestock grazing) will be designed to enhance habitat functions for western spadefoot toad and other associated covered vernal pool-associated species. Western spadefoot toad breeding and upland habitat is present in Conservation Zones 1, 2, 4, 8, 9, and 11. Conservation of western spadefoot toad habitat is focused on preserving, enhancing, and restoring vernal pool complex and associated grassland habitats where opportunities for large scale conservation of western spadefoot toad habitat exist in Conservation Zones 1, 8, and 11. Breeding and associated grassland habitat in Conservation Zones 2 and 4 is almost entirely under protected status (99 percent) and vernal pool complex in Conservation Zone 9 (approximately

120 acres) is located in the vicinity of Discovery Bay and is largely fragmented by development and cultivated lands.

While western spadefoot toad lays its eggs in a variety of permanent and temporary wetlands, including rivers, creeks, pools in intermittent streams, vernal pools, temporary rain pools (CNDDB 2009) and stock ponds, optimal habitat consists of vernal pools and other temporary wetlands free of fish and other nonnative predators. Restored vernal pool complex will be designed to meet optimal habitat criteria and provide high breeding habitat function. Habitat will be restored at sites within Conservation Zones 1, 8, and 11 that historically supported fully functioning vernal pool habitats. Management of protected vernal pool complex (e.g., livestock grazing) will be designed to enhance western spadefoot toad breeding habitat functions. Habitat will preserved in conjunction with protected grassland and alkali seasonal wetlands in these same Conservation Zones.

Western spadefoot toad upland terrestrial cover and aestivation habitat will be preserved in Conservation Zones 1, 8, and 11. Upland habitat will be comprised of grassland and alkali seasonal wetland that encompasses protected aquatic breeding habitats and are within or connected to potentially occupied western spadefoot toad habitat. Connections to potentially occupied habitat will be of sufficient width to provide for the movement of western spadefoot toad to and from occupied habitat areas. Protected grassland will be managed to provide appropriate vegetative conditions to facilitate spadefoot movement and reduce predation exposure and to maintain or increase the abundance of ground squirrels and other fossorial mammal species to improve the availability of suitable aestivation sites.

Western spadefoot toad habitat within the Plan Area is located on the margin of its range and as such is not considered to support core habitat area for the species. Consequently, to maximize the level of conservation benefits provided to western spadefoot toad, conservation actions may be implemented within core western spadefoot toad habitat areas that are located outside of the Plan Area consistent with conservation plans for those locations as described in Section 3.2.4, Development of the Terrestrial Resources Component of the Conservation Strategy.

Following BDCP implementation, approximately 69 percent of modeled western spadefoot toad vernal pool complex breeding habitat and 99 percent of its modeled upland habitat will be preserved within the Plan Area. The proposed habitat conservation actions are expected to maintain sufficient habitat area to sustain or increase the potential Plan Area population of western spadefoot toad and to maintain connectivity with occupied core populations adjacent to the Plan Area and covered under adjacent and overlapping HCP/NCCPs.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

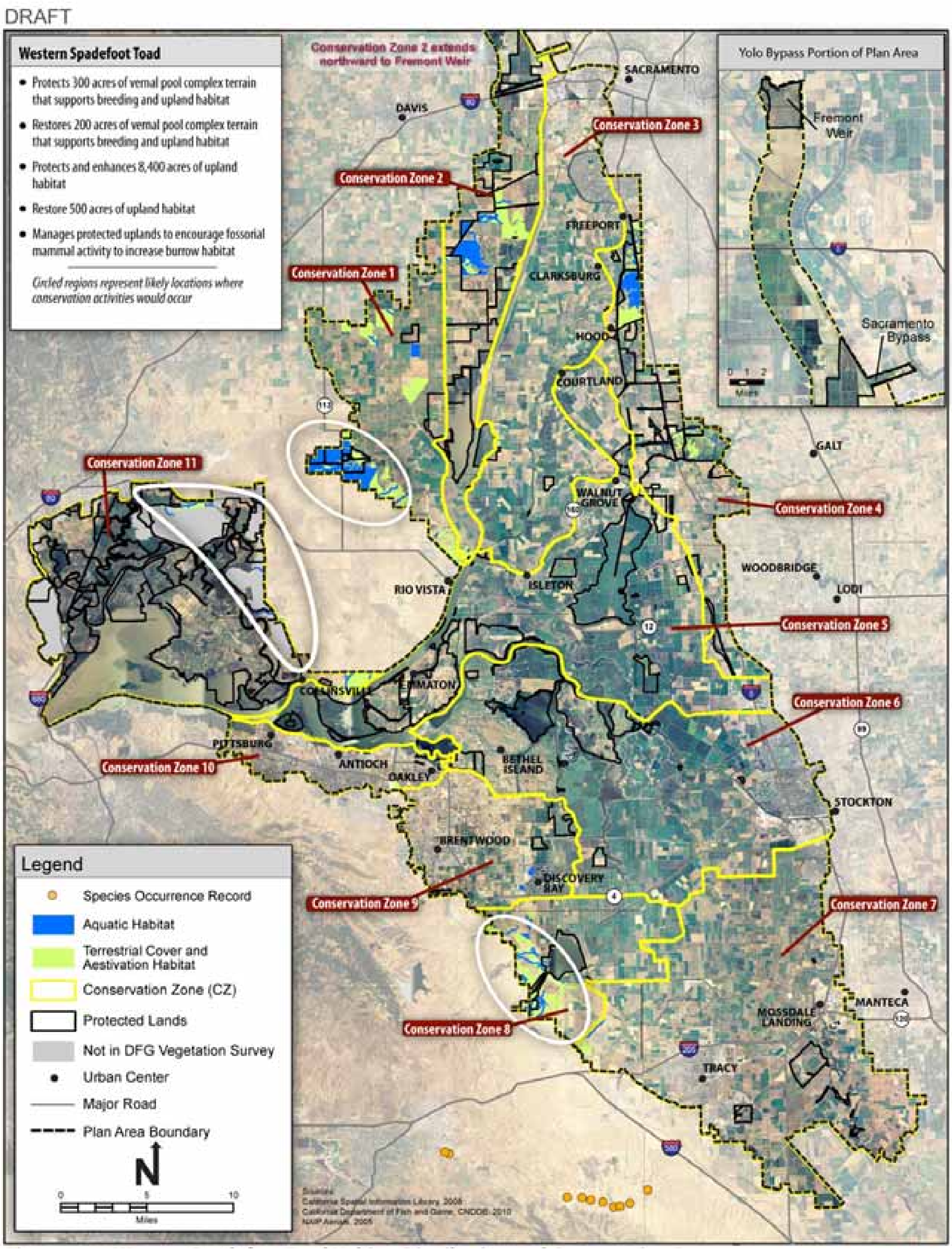

Figure 3-35. Western Spadefoot Toad Habitat Distribution and Conservation Strategy

3.3.2.4.23 California Tiger Salamander

The California tiger salamander is endemic to California, where its range is limited primarily by the availability of burrows and winter breeding habitat, primarily open grassland landscapes with vernal pools and playa pools and with burrowing squirrels and pocket gophers (Barry and Shaffer 1994). Extant populations of California tiger salamanders are believed to be declining as a result of habitat loss (Shaffer et al. 1993, Barry and Shaffer 1994, Holland 1998). In particular, an estimated 80 percent of the species' historical natural aquatic (i.e., vernal pool) habitat has been lost (Holland 1998) and the species has been eliminated from 55 to 58 percent of historical breeding sites (Barry and Shaffer 1994). There is no recovery plan for the species, but critical habitat has been designated for the species, and California tiger salamander conservation relies primarily on the preservation, enhancement, and restoration of its vernal pool complex breeding and grassland cover habitat (Appendix A, *Covered Species Accounts*). The focus on California tiger salamander habitat by BDCP not only addresses the species' primary need but also ties in with other regional conservation efforts such as the acquisition of land occupied by tiger salamander near the Bay Regional Parks District west of the Plan Area in Contra Costa and Alameda counties.

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

> **Objective GRNC2.3**: Increase opportunities for wildlife movement through grassland habitat.

> **Objective GRNC2.4**: Increase burrow availability for burrow-dependent species.

Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective VPNC1.1**: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.

Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective VPNC2.1**: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.

> **Objective VPNC2.2**: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.

Rationale and Conservation Approach

Conservation of California tiger salamander will be provided through the preservation and enhancement of 300 acres and the restoration of 200 acres of its vernal pool complex breeding habitat and the preservation, enhancement, and restoration of 8,400 acres of its grassland and associated alkali seasonal wetland cover habitat (Figure 3-36). Habitat will be protected and restored in the largest possible patch sizes and management of preserved and restored vernal pool complex (e.g., livestock grazing) will be designed to enhance habitat functions for California tiger salamander and other associated covered vernal pool-associated species. California tiger salamander breeding and upland habitat is present in Conservation Zones 1, 2, 4, 8, 9, and 11. Breeding and associated grassland habitat in Conservation Zones 2 and 4 is almost entirely under protected status (99 percent) and vernal pool complex in Conservation Zone 9 (approximately 120 acres) is located in the vicinity of Discovery Bay and is largely fragmented by development and cultivated lands. Preserved habitat will be acquired in locations that provide connectivity to existing protected and occupied habitat.

Optimal California tiger salamander breeding habitat consists of large vernal pools, playa pools, or ephemeral ponds that hold water until at least May. Pools and ponds with this long ponding duration prevent the establishment of nonnative predators, enable salamander larvae to metamorphose, and contain enough prey to allow for high breeding productivity (P. Trenham, pers. comm.). Restored vernal pool complex will be designed to meet all such California tiger salamander habitat criteria and provide high breeding habitat function. Additionally, it will be restored on sites within Conservation Zones 1, 8, and 11 that historically supported fully functioning vernal pool habitats. Management of preserved vernal pool complex (e.g., livestock grazing) will be designed to enhance tiger salamander breeding habitat functions. Habitat will be preserved in conjunction with preserved grassland and alkali seasonal wetland complex that will also be preserved in these Conservation Zones. Connections to occupied habitat will be of sufficient width to provide for the movement of salamanders to and from occupied areas.

California tiger salamander habitat within the Plan Area is located on the margin of the species' range and as such is not considered to support core habitat area for the species. Consequently, to maximize the level of conservation benefits provided to California tiger salamander, conservation actions may be implemented within core California tiger salamander habitat areas that are located outside of the Plan Area consistent with conservation plans for those locations as described in Section 3.2.4, *Development of the Terrestrial Resources Component of the Conservation Strategy*.

Following BDCP implementation, approximately 68 percent of modeled California tiger salamander vernal pool complex breeding habitat and 99 percent of its modeled upland habitat will be protected within the Plan Area. The proposed habitat conservation actions are expected to maintain sufficient habitat area to sustain or increase the existing Plan Area population of California tiger salamander and to maintain connectivity with occupied core populations adjacent to the Plan Area and covered under adjacent and overlapping HCP/NCCPs.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

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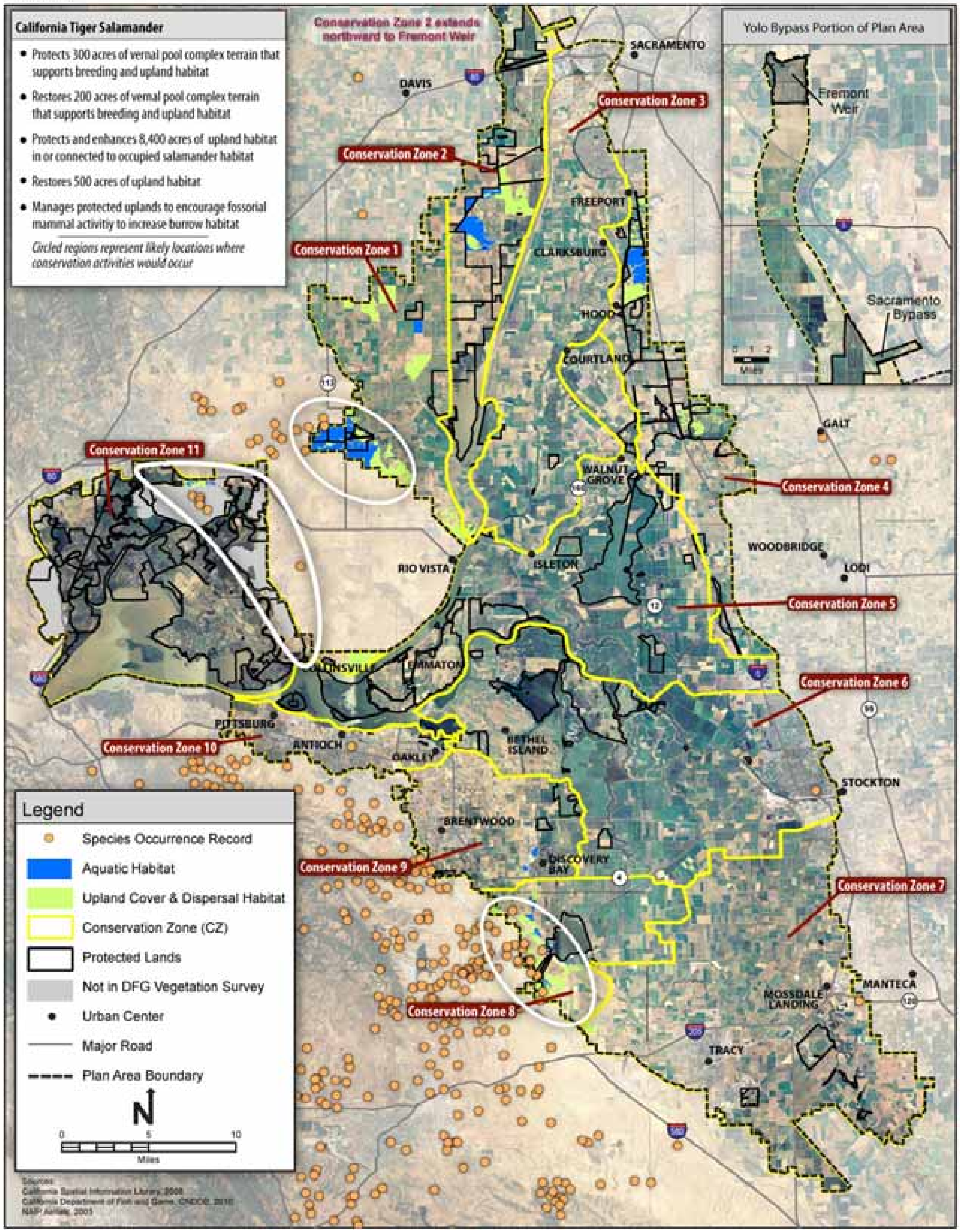

Figure 3-36. California Tiger Salamander Habitat Distribution and Conservation Strategy

3.3.2.4.24 Lange's Metalmark Butterfly

Lange's metalmark butterfly is endemic to areas of Oakley sand soil in east Contra Costa County that support nakedstem buckwheat which is its larval host plant and its adult nectar plant. It is entirely dependent on a particular white-flowered, sand-associated, ecotype of nakedstem buckwheat that grows only on the remnant of the Antioch Dune. Its dependence on the plant extends to the leaf litter that accumulates near the base of large plants growing in large clumps. The extent of the former dune has been reduced to 20 acres plus an unknown amount on two Pacific Gas & Electric (PG&E) parcels that total 12 acres. The 20-acre known extent is protected on the Antioch Dunes National Wildlife Refuge (ADNWR), while the PG&E parcels are being managed under an MOU with USFWS. All the existing habitat has been degraded by nonnative invasive plant species while some older dense stands of nakedstem buckwheat have been lost to wildfires.

The current USFWS management plan for the ADNWR provides for invasive nonnative plant species control efforts that include hand pulling of individual invasive plants through the efforts of volunteers, targeted herbicide application, the restoration of some dune-like topography, and planting of nursery-grown nakedstem buckwheat. Additionally, there is a captive breeding and reintroduction program for Lange's metalmark butterfly and a propagation and out-planting program for its host plant.

The known occurrences of Lange's metalmark butterfly within the Plan Area are located exclusively within the ADNWR and on the two adjacent PG&E properties and are fully protected by ownership and conservation MOUs. These protected lands are completely isolated from other terrestrial habitats by development to the west, south, and east, and by the San Joaquin River to the north. Consequently, to increase the level of conservation benefits provided to inland dune scrub species, inland dune scrub conservation will be implemented through funding support for appropriate management actions and studies.

Applicable Natural Community Goals and Objectives

Goal IDSC1: The expected outcome is support for funding of the USFWS management and enhancement of the inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge.

> **Objective IDSC1.1:** The BDCP will support the funding of the USFWS program for management, enhancement, and monitoring of inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge at an annual amount of $XX.XX for X years.

Species-Specific Goals and Objectives

Goal LMMB1: The expected outcome is funding support for the USFWS captive breeding and reintroduction program for Lange's metalmark butterfly.

Objective LMMB1.1: The BDCP will provide funding to support the USFWS program for the captive breeding and release of Lange's metalmark butterfly at an annual amount of $XX.XX for X years.

Rationale and Conservation Approach

Lange's metalmark butterfly is listed as endangered under the Federal Endangered Species Act but critical habitat has not been designated. The CALFED Bay-Delta Ecosystem Restoration Program Plan's Multi-Species Conservation Strategy designation for Lange's metalmark is "Recovery." After the recent 5-year review of the recovery plan by USFWS found that Lange's metalmark was declining significantly at the ADNWR and appeared to be headed towards extinction, a captive breeding and release program was begun in 2006. The current management plan is designed to meet the recovery needs for the species on the ADNWR, provides for invasive nonnative plant species control efforts, restores dune-like topography, and oversees the out-planting of nursery-grown nakedstem buckwheat.

Conservation of Lange's metalmark butterfly will be provided through the support of funding for the USFWS captive breeding program and its management of the ADNWR (Figure 3-37). The program will include the nursery propagation and out-planting of the white-flowered, sand-associated, ecotype of nakedstem buckwheat and the management of the nakedstem buckwheat to create dense patches of older plants with an extensive layer of leaf litter. The required sizes of self-sustainable Lange's metalmark butterfly populations have not yet been determined, but may be revealed as the controlled propagation studies proceed.

Applicable Conservation Measures

- CM11 Natural Communities Enhancement and Management

DRAFT

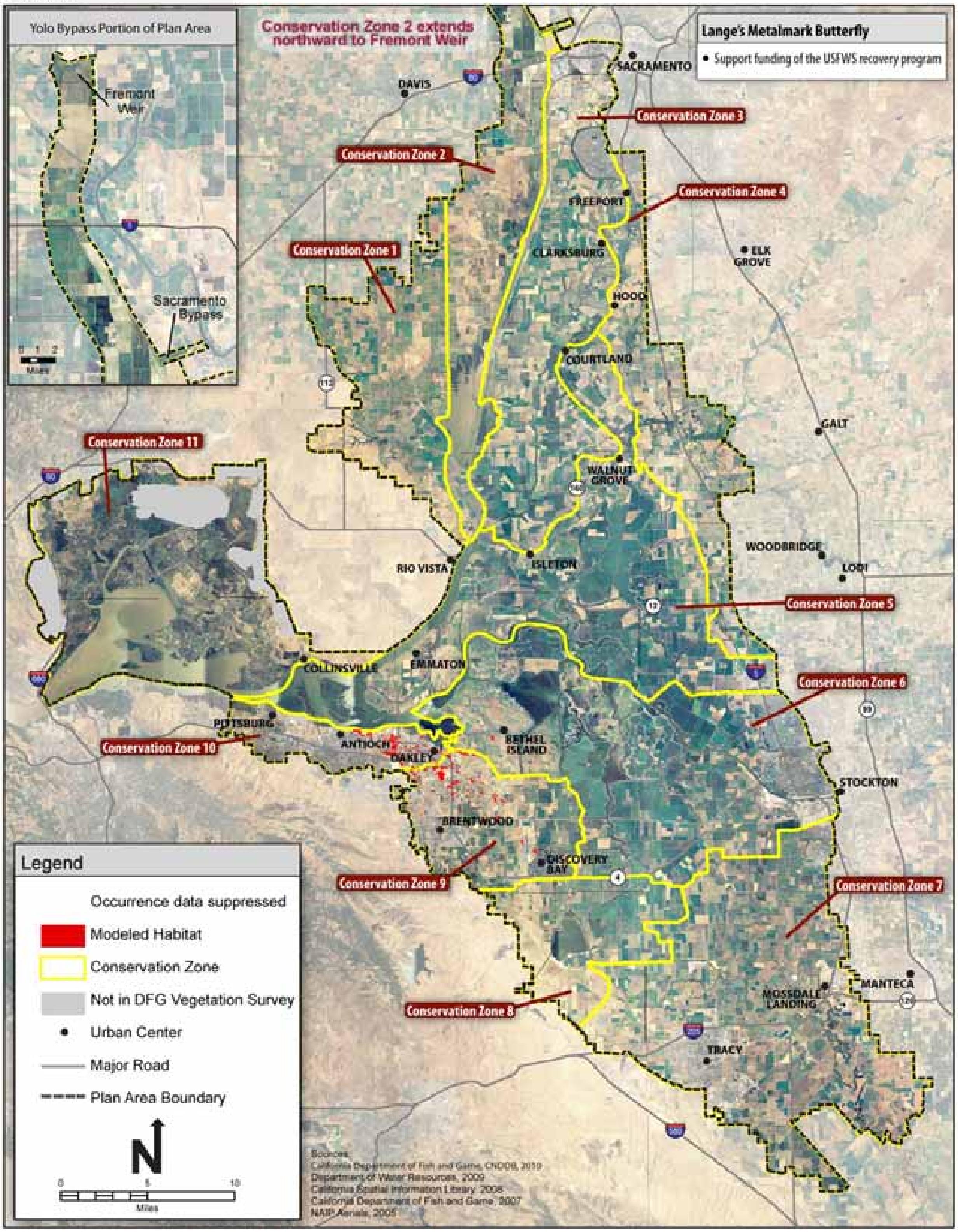

Figure 3-37. Lange's Metalmark Butterfly Habitat Distribution and Conservation Strategy

3.3.2.4.25 Valley Elderberry Longhorn Beetle

One of two subspecies of the longhorn beetle (*Desmocerus californicus*), the valley elderberry longhorn beetle is endemic to moist valley/foothill riparian corridors in the lower Sacramento and lower San Joaquin valleys (USFWS 1984c). Historically, valley elderberry longhorn beetle presumably occurred throughout the Central Valley of California. Little is known about the historical abundance of valley elderberry longhorn beetle, but the extensive destruction of its habitat suggests that the beetle’s range has been largely reduced and fragmented (USFWS 1984c). Valley elderberry longhorn beetle is closely associated with a few species of elderberry (*Sambucus* spp.) that are obligate host plants for valley elderberry longhorn beetle larvae and are necessary for the completion of the beetle’s life cycle (Linsley and Chemsak 1972, 1997, Eng 1984, Barr 1991, Collinge et al. 2001). The two main species of elderberry utilized by the valley elderberry longhorn beetle are the blue elderberry and red elderberry, two shrubs found in remnant riparian forests throughout the Central Valley.

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Rationale and Conservation Approach

The valley elderberry longhorn beetle is listed as threatened under the federal Endangered Species Act (45 FR 52803). Critical habitat has been designated, but neither of the two sites with critical habitat is located within the boundaries of the Plan Area. Conservation guidelines for the valley elderberry longhorn beetle were established by the USFWS in 1999 to mitigate development-related impacts on valley elderberry longhorn beetle habitat (USFWS 1999b). Valley elderberry longhorn beetle conservation has also been addressed in several regional conservation plans. The valley elderberry longhorn beetle is a covered species under the approved San Joaquin County Multi-species Habitat Conservation and Open Space Plan and the Natomas Basin Habitat Conservation Plan. It is proposed for coverage under the South

Sacramento Habitat Conservation Plan, the Solano County Multispecies Habitat Conservation Plan, the Yolo County Natural Heritage Program Plan, and the Butte Regional Conservation Plan. Valley elderberry longhorn beetle conservation under BDCP will therefore tie in with conservation efforts under those other habitat conservation plans.

Conservation of valley elderberry longhorn beetle will be provided through the restoration of 5,000 acres of valley/foothill riparian distributed among Conservation Zones 1, 4, 6, 7, and/or 11 (Figure 3-38). Plantings of elderberry shrubs, including shrubs translocated as mitigation, will be incorporated into the design of restored habitat. Valley/foothill riparian will be provided in large patches that will be managed to control the establishment of undesirable nonnative vegetation that can affect the health of the beetle's host plants, mainly blue elderberry and red elderberry. Based on model projections, restoration of 5,000 acres of valley/foothill riparian, including elderberry shrubs, will increase the extent of the riparian habitat that will support the valley elderberry longhorn beetle's host plant by 29 percent relative to existing conditions (see detailed description of species habitat and model assumptions in Appendix A, *Covered Species Accounts*). This projected increase is expected to be sufficient to sustain beetle populations in the Plan Area while also allowing for any future increase in the distribution and abundance of the species. Numeric targets for preservation of existing habitat are not established; however, elderberry shrubs that are present within BDCP preserved habitat areas will be preserved and maintained.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM7 Riparian Habitat Restoration

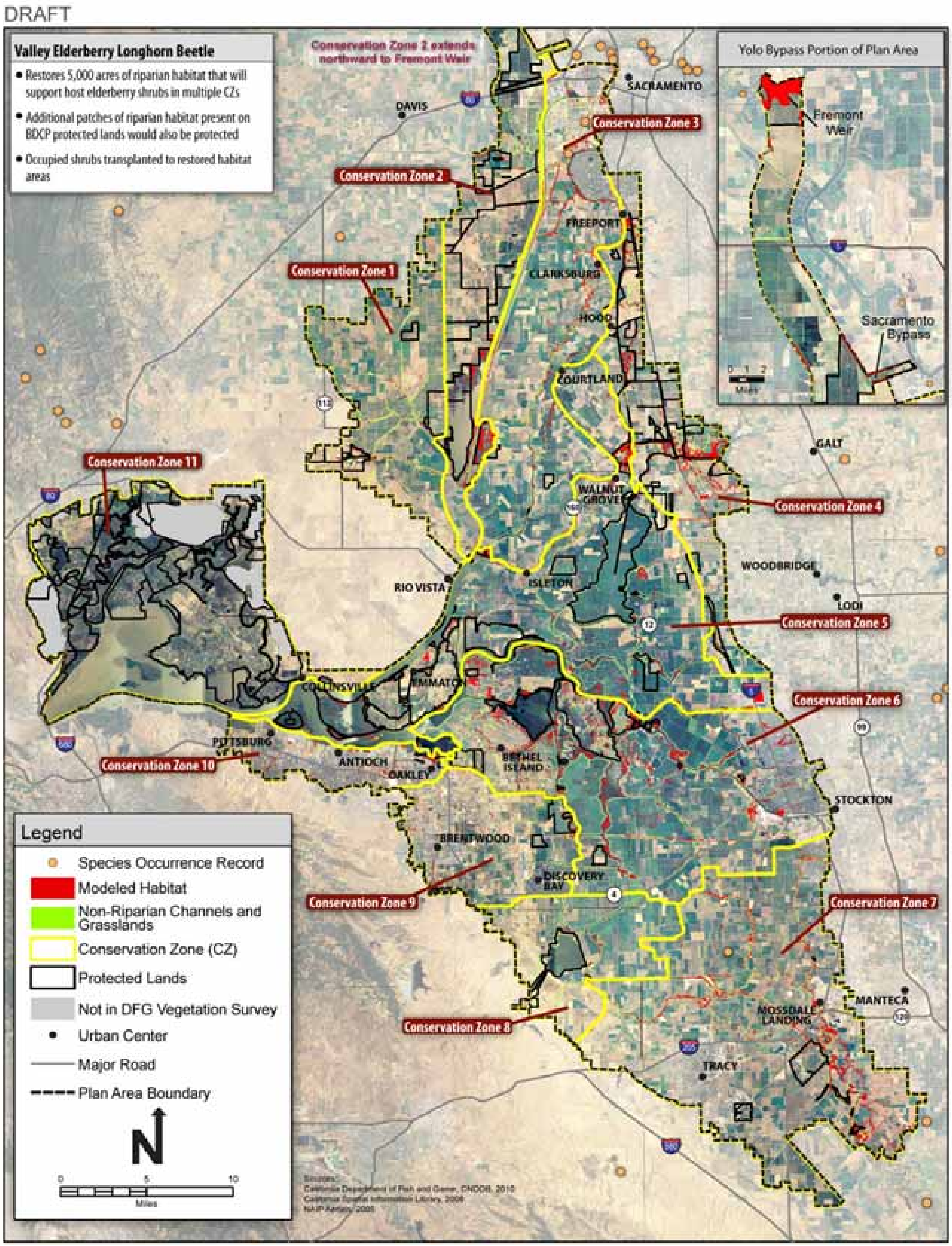

Figure 3-38. Valley Elderberry Longhorn Beetle Habitat Distribution and Conservation Strategy

3.3.2.4.26 Vernal Pool Shrimp Species (Vernal Pool Tadpole Shrimp, Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, Vernal Pool Fairy Shrimp, Midvalley Fairy Shrimp, and California Linderiella)

Several vernal pool shrimp species (vernal pool tadpole shrimp, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and California linderiella) are found in the vernal pool complex natural community in California. While specific hydrological requirements, water chemistry, and water temperature requirements may vary somewhat between the species, within the Plan Area, all are closely associated with the vernal pool complex natural community. Development, conversion of the community to agriculture, and exotic plant species are considered to be the primary stressors on these species (Showers 1996, Witham 2003, EDAW 2004, ESA 2005, Dawson et al. 2007, CNDDB 2009, CNPS 2009).

Applicable Natural Community Goals and Objectives

Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective VPNC1.1**: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.

Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective VPNC2.1**: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.

> **Objective VPNC2.2**: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.

Goal ONSW1: The expected outcome is increased habitat functions that support BDCP covered species in other natural seasonal wetland natural community within maintained and protected agricultural habitat areas.

> **Objective ONSW1.1**: Integrate management of other natural seasonal wetland natural community with management of BDCP maintained and protected agricultural lands to increase habitat functions for covered species.

Rationale and Conservation Approach

Vernal pool complex natural community supporting vernal pool shrimp habitat is present in Conservation Zones 1, 2, 4, 8, 9, and 11 along the margins of the Delta. Opportunities for large scale conservation of vernal pool shrimp species within the Plan Area, however, are located only in Conservation Zones 1, 8, and 11 (Figure 3-39). Vernal pool complex natural community in

Conservation Zones 2 and 4 is almost entirely under protected status (99 percent) and in Conservation Zone 9 (approximately 120 acres) is located in the vicinity of Discovery Bay and is largely fragmented by development and cultivated lands. Conservation of vernal pool fairy shrimp species habitat will be provided through the protection and restoration of vernal pool complex natural community that supports vernal pool shrimp species and will be protected and managed in conjunction with protected grassland and alkali seasonal wetland complex natural communities that will also be protected in these conservation zones. Habitat will be protected and restored in the largest possible patch sizes and management of protected and restored vernal pool complex natural community (e.g., invasive species control and livestock grazing) will be implemented to enhance habitat functions for vernal pool shrimp species and other associated covered vernal pool species.

It is important to conserve vernal pool complex natural community areas that encompass a range of environmental variation for the purpose of vernal pool shrimp reproduction. While Helm found no difference in the time to reproduce among fairy shrimp (Helm 1998), field data (Gallagher 1996, Alexander 2007) suggests that the average time to reproduce for California linderiella, conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp is approximately 8 weeks; while average time for midvalley fairy shrimp is approximately 2 weeks, and the minimum time to reproduce may be correlated with vernal pool hydrology. Field observations also suggest that the various shrimp species are seldom found inhabiting the same vernal pools.

The proposed protection and restoration of vernal pool complex natural community, in conjunction with existing protected natural communities and habitat, is expected to sustain vernal pool shrimp populations within the Plan Area and to increase the distribution and abundance of covered vernal pool shrimp species. Following completion of conservation actions, approximately 69 percent of vernal pool shrimp species vernal pool complex will be preserved. The conservation actions are consistent with and help to achieve the recovery objectives for Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, midvalley fairy shrimp, and vernal pool tadpole shrimp as identified in the Vernal Pool Recovery Plan (USFWS 2005).

Vernal pool shrimp habitat within the Plan Area is located on the margin of the distribution of the Central Valley vernal pool complex natural community and as such is not considered to support core habitat area for these species. Consequently, to increase the level of conservation benefits provided to vernal pool shrimp species relative to benefits that would be provided by implementing the conservation actions within the Plan Area, the vernal pool shrimp species conservation actions may be implemented within core vernal pool shrimp species habitat areas that are located outside of the Plan Area consistent with conservation plans for those locations.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

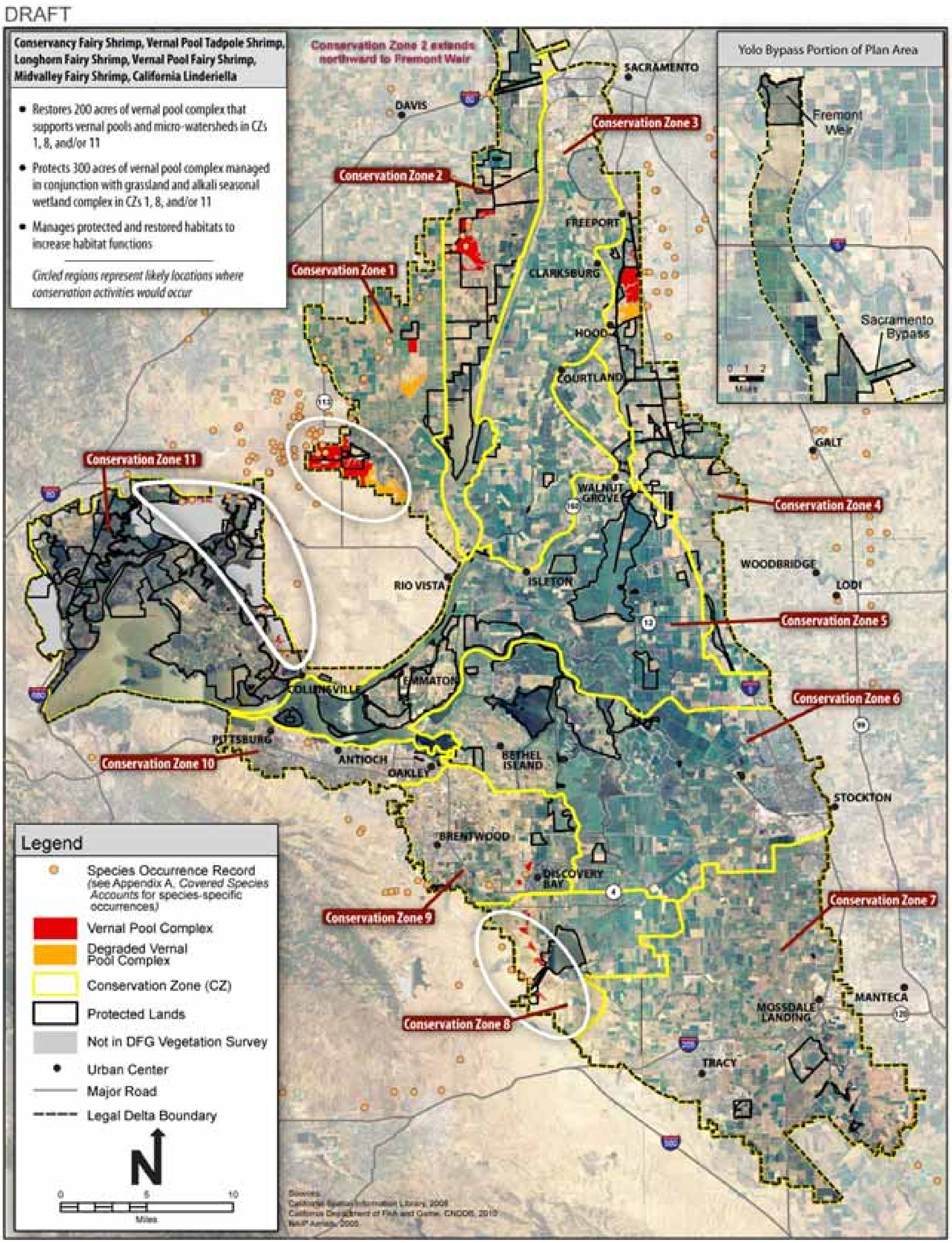

Figure 3-39. Vernal Pool Shrimp Species Habitat Distribution and Conservation Strategy

3.3.2.4.27 Vernal pool plant species (alkali milk-vetch, San Joaquin spearscale, dwarf downingia, Boggs Lake hedge-hyssop, legenere, and Heckard's peppergrass)

Several vernal pool plant species (alkali milk-vetch, San Joaquin spearscale, Boggs Lake hedge-hyssop, Heckard's peppergrass, and legenere) are endemic to California. While specific soil requirements and micro-habitat restrictions vary somewhat between species, within the Plan Area, all are closely associated with the vernal pool complex natural community. Development, agricultural conversion, and exotic plant species are considered to be the primary stressors on these species (Showers 1996, Witham 2003, EDAW 2004, ESA 2005, Dawson et al. 2007, CNDDB 2009, CNPS 2009).

Applicable Natural Community Goals and Objectives

Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective VPNC1.1**: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.

Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective VPNC2.1**: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.

> **Objective VPNC2.2**: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.

Species-Specific Goals and Objectives

Goal ALMV1: The expected outcome is protected and enhanced alkali milk-vetch populations.

> **Objective ALMV1.1**: Protect at least 3 unprotected occurrences of alkali milk-vetch in Conservation Zones 1 and/or 11.

> **Objective ALMV1.2:** Maintain and enhance the habitat functions of preserved alkali milk-vetch habitat over the term of the BDCP.

Goal HEPE1: The expected outcome is protected and enhanced Heckard's peppergrass populations.

> **Objective HEPE 1.2**: Protect at least 2 unprotected occurrences of Heckard's peppergrass in Conservation Zones 1, 8, or 11.

> **Objective HEPE1.2:** Maintain and enhance the habitat functions of preserved Heckard's peppergrass habitat over the term of the BDCP.

Rationale and Conservation Approach

Because habitat loss and exotic species are the primary stressors on vernal pool plants, protecting, enhancing, and restoring vernal pool complex natural community is expected to help maintain and potentially increase the abundance and distribution of these species. Conservation of vernal pool plant species will be directed at preserving and enhancing 300 acres and restoring 200 acres of vernal pool complex natural community (Figure 3-40) to improve habitat conditions for these species. Additionally, at least 3 unprotected occurrences of alkali milk-vetch and 2 unprotected occurrences of Heckard's peppergrass will be preserved and enhanced. Protection of vernal pool complex natural community will be achieved through the preservation and restoration of clay alluvium vernal pools and playa pools, Montezuma Block vernal pools and playa pools, and alkaline sink/meadow vernal pools (see Section 2.3.4.9, *Vernal Pool Complex*) that support vernal pool plant species in Conservation Zones 1, 8, and 11 (Figure 3-40) and will be conducted in conjunction with the preservation, enhancement, and restoration of grassland and alkali seasonal wetland complex natural communities in those conservation zones. To the extent practicable, vernal pool complex natural community will be protected and restored in the largest possible patch sizes and management of protected and restored vernal pool complex natural community (e.g., control of nonnative invasive species, restoration of natural hydrological regime, spatial linkages between patches of vernal pool complex natural community, etc.) will be designed to enhance habitat functions for vernal pool plant species and other covered vernal pool associated species.

The proposed protection and restoration of vernal pool complex natural community, in conjunction with existing protected habitat, is expected to sustain vernal pool plant species populations within the Plan Area and increase the distribution and abundance of covered vernal pool plant species. While vernal pool complex natural community supporting vernal pool plant species habitat is present in Conservation Zones 1, 2, 4, 8, 9, and 11 along the margins of the Plan Area, opportunities for the large scale conservation of vernal pool plant species within the Plan Area are located only in Conservation Zones 1, 8, and 11. Vernal pool complex natural community in Conservation Zones 2 and 4 is almost entirely under preserved status (99 percent) and vernal pool complex natural community in Conservation Zone 9 (approximately 120 acres) is located in the vicinity of Discovery Bay and is largely fragmented by development and cultivated lands.

The areas of vernal pool complex natural community within the Plan Area are located in areas that are transitional between tidal wetland communities and uplands and generally contain fragmented and degraded vernal pool complex natural community compared to areas immediately outside of the Plan Area. Because of this transitional location and due to a history of relatively intensive agricultural land uses, those areas contain little of the community that is occupied by robust populations of vernal pool plant species. Consequently, to increase the level of conservation benefits provided to vernal pool plant species relative to benefits that would be provided by implementing the conservation actions within the Plan Area, the vernal pool plant species conservation actions may be implemented within vernal pool plant species habitat core areas that are located outside of the Plan Area when consistent with conservation plans for those locations.

Following full implementation of the BDCP, 69 percent of the modeled vernal pool complex natural community in the Plan Area will be preserved (Table 3-10).

The conservation actions are consistent with and help to achieve the recovery objectives for alkali milk-vetch, Boggs Lake hedge-hyssop, and legenere identified in the Vernal Pool Recovery Plan (USFWS 2005).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

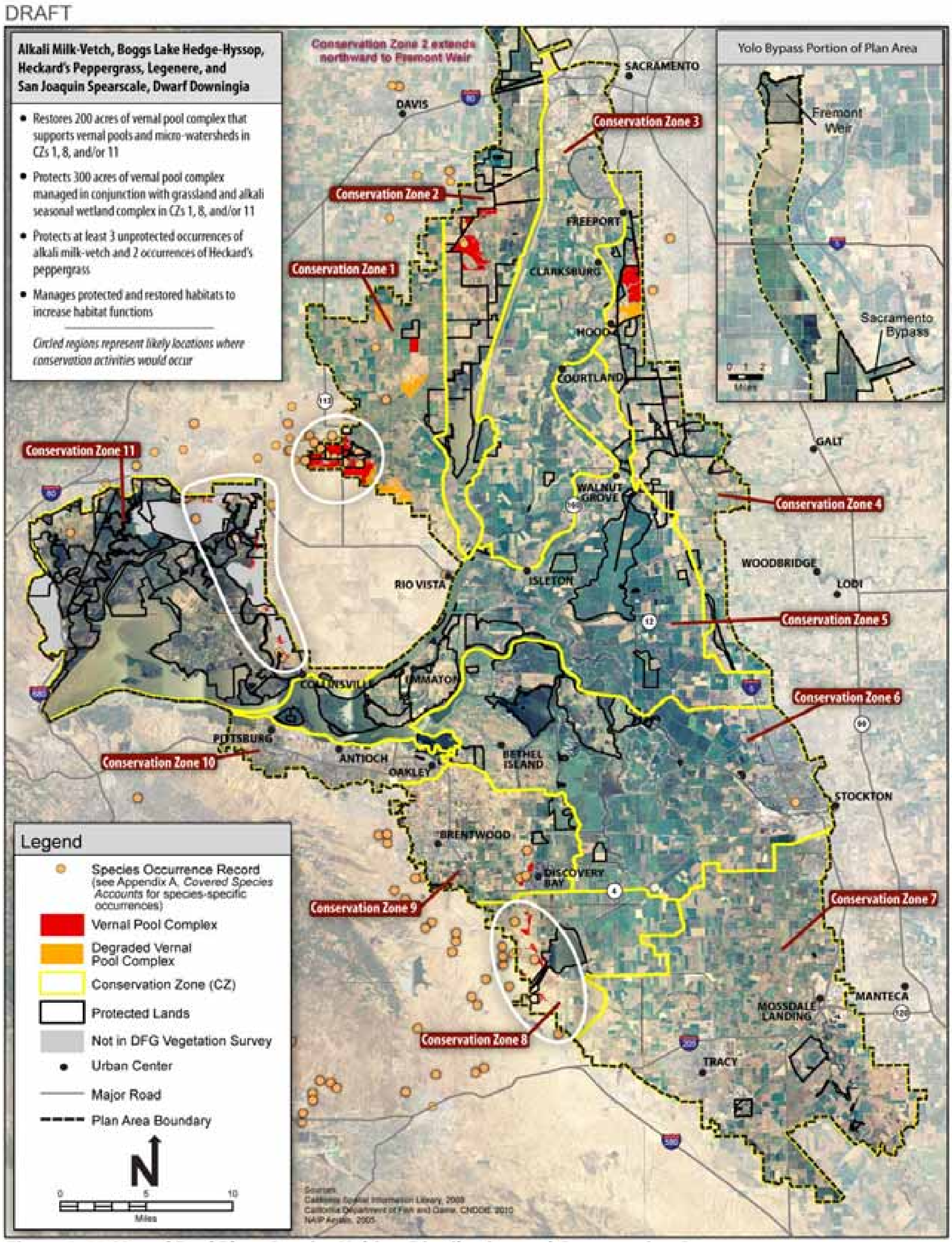

Figure 3-40. Vernal Pool Plant Species Habitat Distribution and Conservation Strategy

3.3.2.4.28 Heartscale and Brittlescale

Heartscale and brittlescale are found only in very limited habitat types in close proximity to hydrological features such as stream corridors and playa pools which are located on either alluvium associated with the Montezuma Block along the western boundary of the Plan Area or on alluvium associated with tertiary formations located along the southwest boundary of the Plan Area. The population sizes of the occurrences tend to be very small. Throughout its range it has been impacted by development, agricultural intensification, conversion of habitat to waterfowl habitat, and invasive species. BDCP tidal restoration activities could potentially affect some occurrences.

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

Goal AWNC1: The expected outcome is protected alkali seasonal wetland complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective AWNC1.1**: Protect 400 acres of alkali seasonal wetland complex natural community in Conservation Zones 1, 8, and/or 11.

Goal AWNC2: The expected outcome is biologically diverse alkali seasonal wetland complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective AWNC2.1**: Maintain and, where habitat functions for covered species can be increased, increase the diversity and relative cover of native grasses and forbs.

Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective VPNC1.1**: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.

Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective VPNC2.1**: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.

> **Objective VPNC2.2**: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.

Species-Specific Goals and Objectives

Goal HART/BRIT1: The expected outcome is protected and expanded alkali seasonal wetland complex natural community-associated covered species populations.

> **Objective HART/BRIT1.1:** Of the 400 acres of protected alkali seasonal wetland complex natural community, protect 150 acres that support heartscale and brittlescale habitat.

> **Objective HART/BRIT1.2**: Protect at least 3 unprotected occurrences of heartscale in Conservation Zones 1 and /or 11.

> **Objective HART/BRIT1.3**: Protect at least 3 unprotected occurrences of brittlescale in Conservation Zones 1, 8, or 11.

> **Objective HART/BRIT1.4**: Maintain and enhance the habitat functions of preserved heartscale and brittlescale habitat over the term of the BDCP.

Rationale and Conservation Approach

Heartscale and brittlescale are both endemic to California and within the Plan Area are found in meadows, seeps, and vernal pools with alkaline clay soils (CNPS 2009). The primary stressors to these species are agricultural intensification, development, nonnative plants, overgrazing, and trampling (CNDDB 2009, CNPS 2009). Because habitat loss and incompatible land management practices are the primary stressors on these species, preserving and enhancing heartscale and brittlescale habitat is expected to help maintain and potentially increase the abundance and distribution of these species.

Conservation of heartscale and brittlescale will be directed at known occurrences and protecting and enhancing currently unprotected heartscale and brittlescale habitat that supports the known elements (e.g., soils, hydrology) of their habitat. Priority will be given to protecting three unprotected occurrences and protecting habitat that supports species occurrences or is within the watersheds that support known occurrences. Conservation will be provided through protecting and enhancing 150 acres of stream corridors and appropriate buffers on alkaline soils in the same general locations as clay alluvium vernal pools and playa pools, Montezuma Block vernal pools and playa pools, and alkaline sink/meadow vernal pools and associated grassland and alkali seasonal wetland complex (see Section 2.3.4.9, *Vernal Pool Complex*) that support heartscale and brittlescale habitat in Conservation Zones 1, 8, and 11 (Figure 3-41).

Protection and enhancement of their habitat will be conducted in conjunction with the protection, enhancement, and restoration of grassland, alkali seasonal wetland complex, and vernal pool complex natural communities in those Conservation Zones. To the extent practicable, heartscale and brittlescale habitat will be protected in the largest possible linear corridor extents, and management of protected habitat (e.g., control of nonnative invasive species, restoration of natural hydrological regime, appropriate grazing intensity, etc.) will be designed to enhance habitat functions for heartscale, brittlescale and other covered associated species. Following full implementation of the BDCP, 277 acres (56 percent) of the modeled heartscale and brittlescale habitat in the Plan Area will be protected (Table 3-10).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

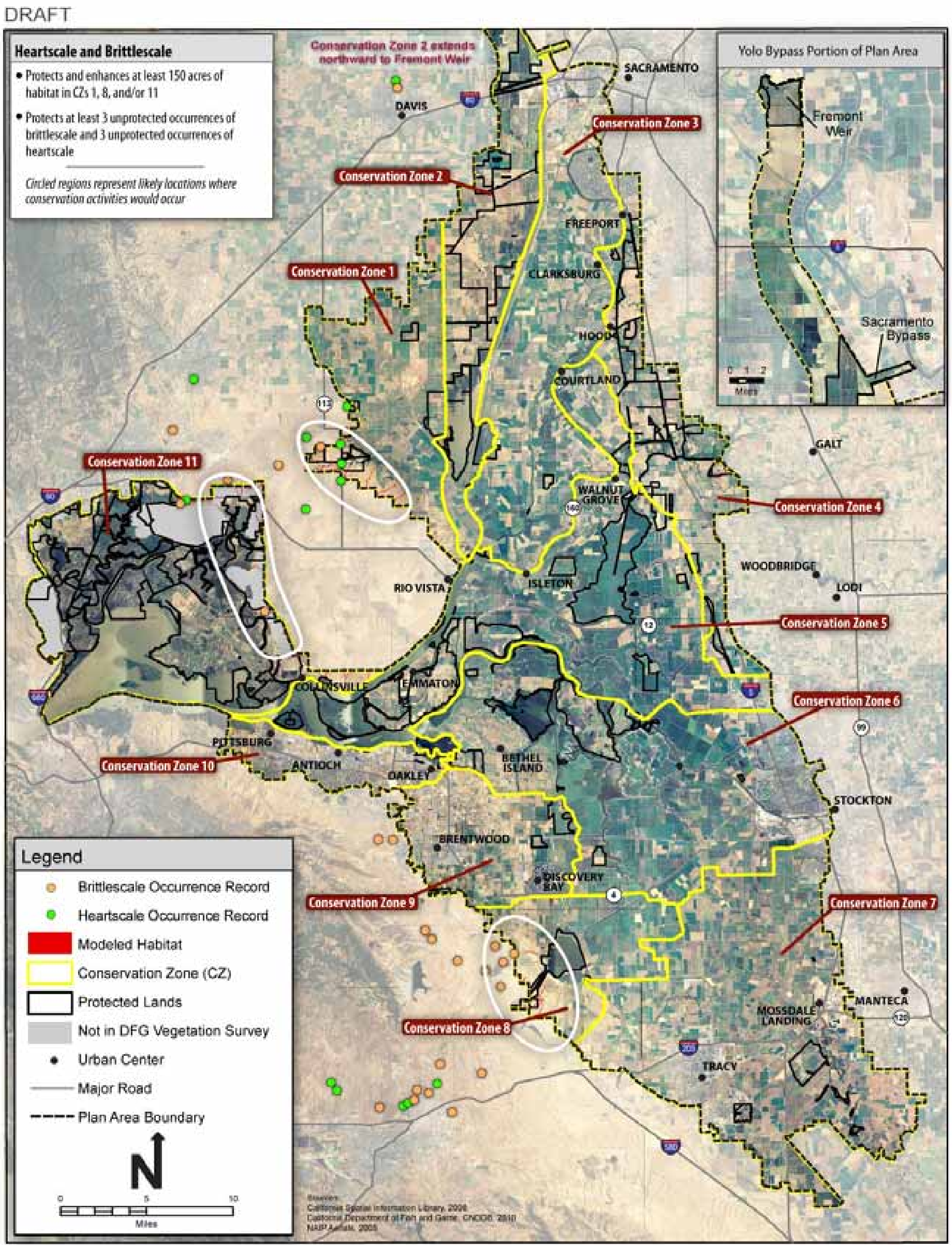

Figure 3-41. Heartscale and Brittlescale Habitat Distribution and Conservation Strategy

3.3.2.4.29 Slough Thistle

Slough thistle is endemic to the San Joaquin Valley and has been reported from San Joaquin County in the north and in Kings and Kern counties in the south (CNPS 2009). Slough thistle occurs in the southern end of the Plan Area in the San Joaquin River. There are seven records from near Lathrop and Vernalis; all but two of which have been extirpated by agriculture or urbanization (CNDDB 2009). The locations reported in the southern San Joaquin Valley are all along or adjacent to high flood flow areas (CNDDB 2009). Historically slough thistle was likely present in lesser flow channels as well. It is generally found within the portions of river channels that flood at high water and on the banks of flood water conveyance canals and drains (T. Griggs pers. comm. 2009, R. Hansen pers. comm. 2009). Historical and current records of this species indicate that its distribution within the Plan Area is limited to the floodplain of the San Joaquin River (Figure 3-42). Based on its distribution in the southern San Joaquin Valley, its habitat is likely to be areas along the river that have been disturbed by flood events and are being colonized by willow scrub vegetation.

Conversions of suitable habitat to agricultural land uses and competition from nonnative plants have been reported as the primary threats to slough thistle (CNPS 2009). In the southern San Joaquin Valley, other threats include removing vegetation from the banks of drains and canals, and weed control efforts (T. Griggs pers. comm. 2009, R. Hansen pers. comm. 2009).

Slough thistle has been reported from freshwater marshes and swamps, and in chenopod scrub and riparian scrub habitats (CNPS 2009). Under natural conditions, it almost always occurs in wetlands (Calflora 2009). The locations reported in the southern San Joaquin Valley are all along or adjacent to high flood flow areas (CNDDB 2009) such as the Hacienda Spillway where high flows from the Kern River broke through the Sand Ridge and flowed into Tulare Lake (R. Hansen pers. comm. 2009). Because these high flow areas have been preserved, albeit in a modified condition, for floodwater conveyance, some habitat has been preserved in what is now an area of intensive agricultural production. Historically slough thistle was likely present throughout the Tulare Basin in lesser flow channels as well. It is generally found within the portions of channels that flood at high water and on the banks of flood water conveyance canals and drains (T. Griggs pers. comm. 2009, R. Hansen pers. comm. 2009).

Applicable Natural Community Goals and Objectives

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Rationale and Conservation Approach

Conservation of slough thistle will be directed at restoring floodplain habitat along the San Joaquin River that provides slough thistle habitat which consists of seasonally scoured areas within the floodplain and corresponding channel morphology (Figure 3-42). Reestablishing patterns of flood flows to floodplain that were historically occupied by this species is expected to sustain the species within the Plan Area and provide for increases in species distribution and abundance.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM5 Seasonally Inundated Floodplain Restoration
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

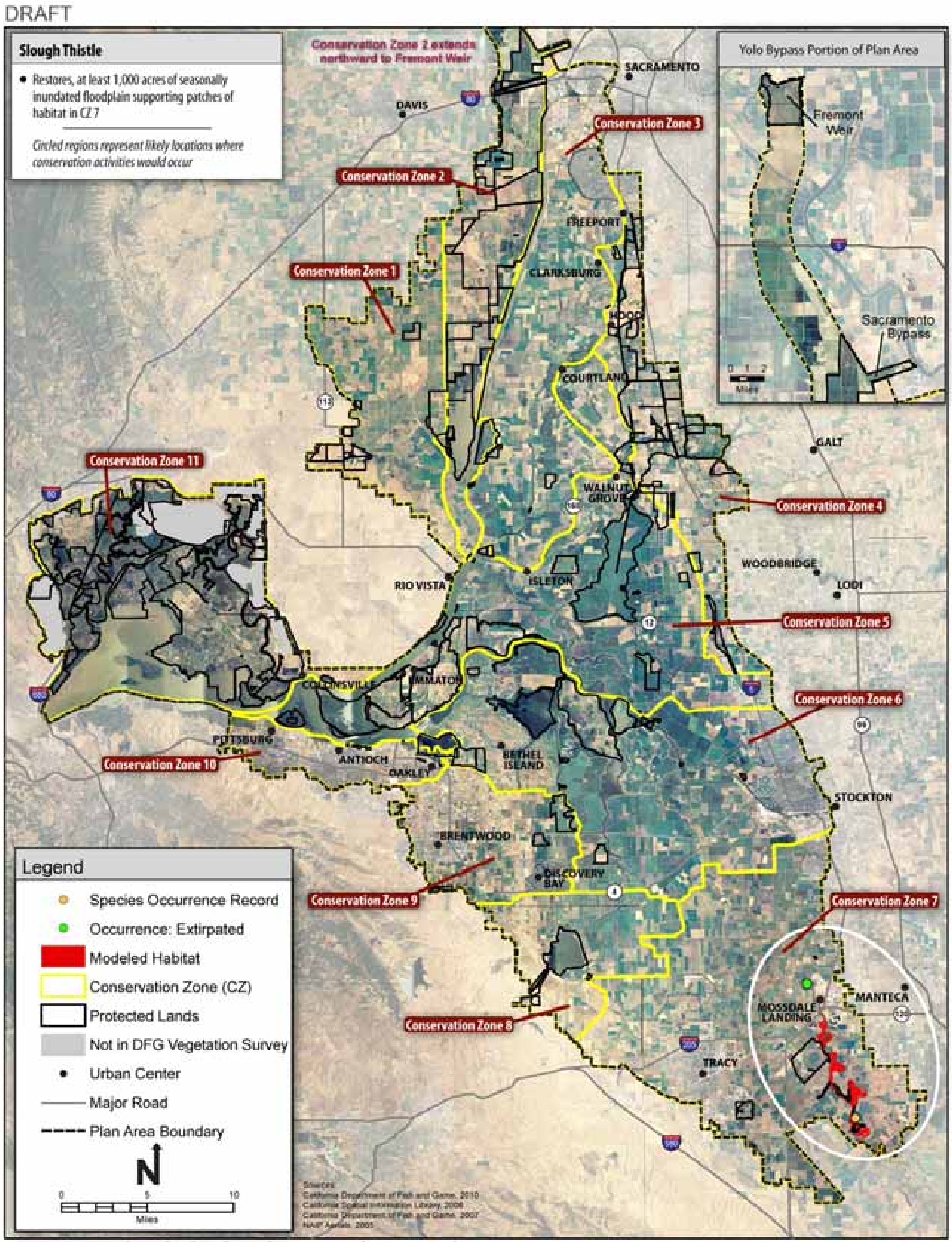

Figure 3-42. Slough Thistle Habitat Distribution and Conservation Strategy

3.3.2.4.30 Suisun Thistle and Soft Bird's-beak

Suisun thistle and soft bird's-beak co-occur in Suisun Marsh. Suisun thistle is found only in the tidal brackish marshes of Suisun Marsh (62 FR 61916, USFWS 2009a, b) and is almost always found adjacent to first-order channels or mosquito control ditches that link to first-order channels (Fiedler et al. 2007, USFWS 2009a, b). In 1975, Suisun thistle was presumed to be extinct because it had not been observed for 15 years (62 FR 61916, USFWS 2009a); however, extensive surveys conducted at Suisun Marsh in 1989 rediscovered this species at two locations. Historically, the range of soft bird's-beak extended from tidal marshes of Napa and Solano counties in the north, Contra Costa County in the south, Sonoma and Marin counties in the west, and Sacramento and San Joaquin counties in the east. It is now believed to be extirpated from Marin, San Joaquin, Sonoma, and Sacramento counties; and extant in Napa, Solano, and Contra Costa counties (CNDDB 2010).

The tidal brackish emergent wetland natural community that is suitable habitat for Suisun thistle and soft bird's-beak has been lost mostly through development, dredge disposal, waterfowl habitat creation, agricultural conversion, and diking of tidal marshes. Diked marshes generally lack rare tidal marsh species. It is believed that the conditions brought about by dikes favor robust generalist species that can better tolerate the long inundation periods in diked managed wetlands (Goals Project 2000). Current threats to Suisun thistle include: the nonnative and highly invasive perennial pepperweed, feral pigs, and fire during sensitive periods of the species' lifecycle (Fiedler et al. 2007, USFWS 2009a). Other potential but unquantified threats specific to Suisun thistle include hybridization with bull thistle and seed predation by the introduced biocontrol thistle weevil (Fiedler et al. 2007, USFWS 2009a). Threats specific to soft bird's-beak include overgrazing and trampling by livestock and the invasion of its habitat by nonnative annual plants that are inappropriate hosts, and invasion of its habitat by perennial pepperweed (Grewell et al. 2003, Grewell 2005, Fiedler et al 2007, CNDDB 2008, USFWS 2009b, USFWS 2010).

Applicable Natural Community Goals and Objectives

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Species-Specific Goals and Objectives

Goal SUTH1: The expected outcome is protected and expanded Suisun thistle populations.

> **Objective SUTH1.1:** Protect 3 unprotected occurrences of Suisun thistle in Suisun Marsh in Conservation Zone 11.

> **Objective SUTH1.2**: Maintain and enhance the habitat functions of preserved Suisun thistle habitat over the term of the BDCP.

Goal SOBB1: The expected outcome is protected and expanded soft bird's-beak populations.

> **Objective SOBB1.1:** Protect 3 unprotected occurrences of soft bird's-beak in Suisun Marsh in Conservation Zone 11.

> **Objective SOBB1.2**: Maintain and enhance the habitat functions of preserved soft bird's-beak habitat over the term of the BDCP.

Rational and Conservation Approach

Conservation of Suisun thistle and soft bird's-beak will be directed at protecting 3 unprotected occurrences of each species and restoring 3,600-4,800 acres[29] of tidal brackish emergent wetland that supports the known elements (e.g., soils, hydrology, etc.) of their habitat (Figures 3-43 and 3-44). The conservation actions are consistent with and help to achieve the draft recovery objectives for Suisun thistle and soft bird's-beak identified in the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (USFWS 2010).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

[29] Restored tidal habitat acreage ranges are a component of the 65,000 acre target for restored tidal habitat. Acreage ranges are based on the results of hydrodynamic modeling of realistic hypothetical restoration designs. While these ranges are not the acreage targets for restored tidal habitats, but rather the results of modeling, the hypothetical designs provided verification of the practicability of achieving restoration targets.

DRAFT

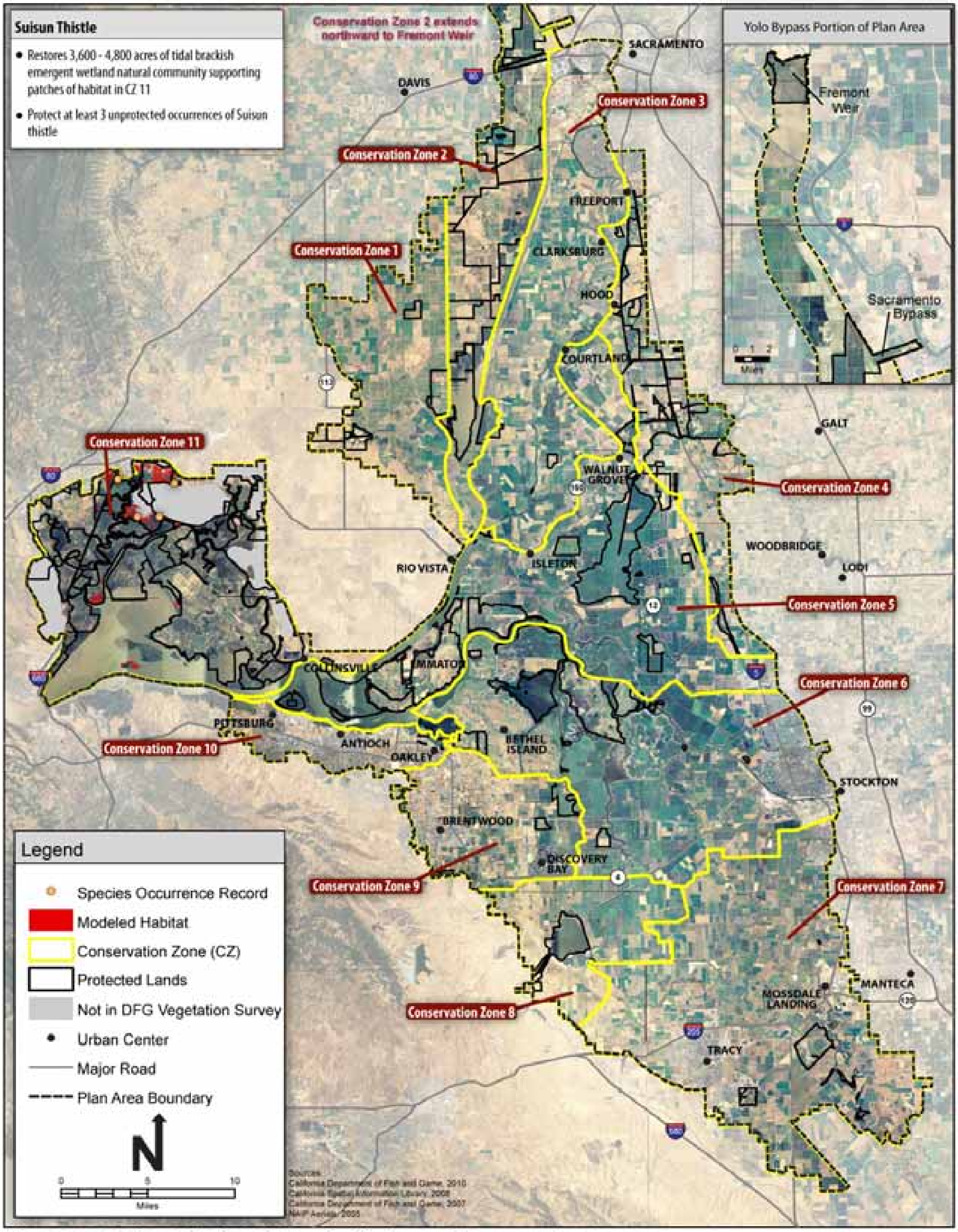

Figure 3-43. Suisun Thistle Habitat Distribution and Conservation Strategy

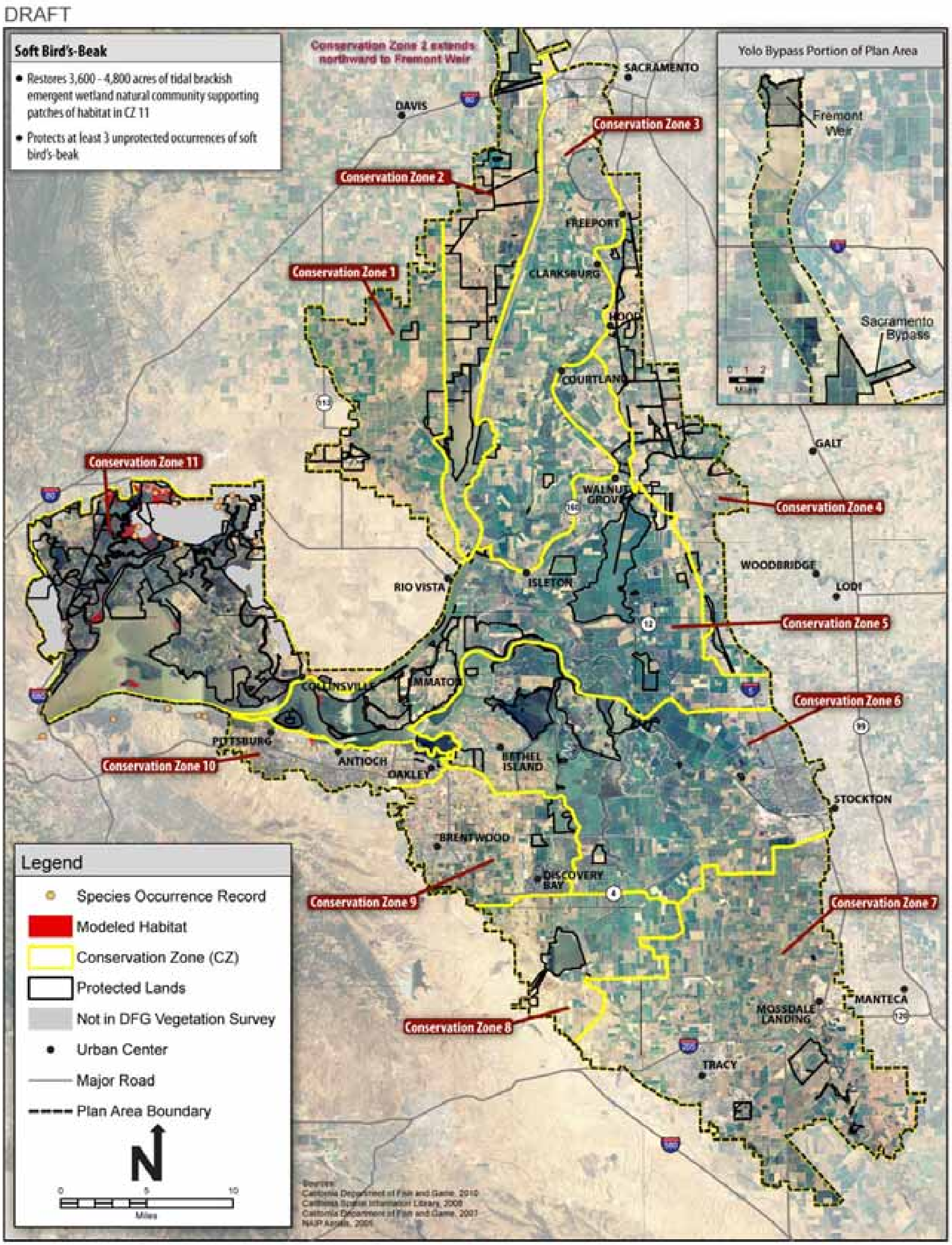

Figure 3-44. Soft Bird's-Beak Habitat Distribution and Conservation Strategy

3.3.2.4.31 Delta Button-celery

Delta button-celery is endemic to the San Joaquin Valley of California and is listed as endangered under the California Endangered Species Act (see Appendix A, *Covered Species Accounts*). It occurs in two habitat types: (1) seasonally scoured and inundated swales, depressions, and clay flats in the floodplain of the San Joaquin River (D. Woolington pers. comm.); (2) alkaline clay deltas of Coast Range tributaries that are deposited immediately above the flood basin of the San Joaquin River where plant cover is typical alkaline sink vegetation (NatureServe 2008). The primary threats to Delta button-celery include habitat loss through agricultural habitat conversion, channelization and channel maintenance activities and other impacts that include overgrazing, invasive nonnative plant species. Six of all 26 recorded occurrences have been extirpated by agricultural expansion and disturbance (NatureServe 2008). Thus, where the Delta button-celery still occurs – including both locations where it has been recorded in the Plan Area, land preservation is important to protect it from any further extirpation. BDCP implementation will tie in with habitat preservation on public lands such as Caswell Memorial State Park and the San Joaquin County Multi-species Habitat Conservation and Open Space Plan.

<u>*Applicable Natural Community Goals and Objectives*</u>

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

> **Objective VRNC2.3**: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.

Goal AWNC1: The expected outcome is protected alkali seasonal wetland complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective AWNC1.1**: Protect 400 acres of alkali seasonal wetland complex natural community in Conservation Zones 1, 8, and/or 11.

Goal AWNC2: The expected outcome is biologically diverse alkali seasonal wetland complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective AWNC2.1**: Maintain and, where habitat functions for covered species can be increased, increase the diversity and relative cover of native grasses and forbs.

Species-Specific Goals and Objectives

Goal DEBC1: The expected outcome is protected and expanded Delta button-celery populations.

> **Objective DEBC1.1:** Of the 400 acres of protected alkali seasonal wetland complex natural community, protect at least 100 acres that support Delta button-celery habitat.

> **Objective DEBC1.2**: Maintain and enhance the habitat functions of preserved Delta button-celery habitat over the term of the BDCP.

Rationale and Conservation Approach

Conservation of Delta button-celery will be directed at preserving at least 100 acres of currently unprotected alkali seasonal wetland complex that supports the known elements (e.g., soils, hydrology, etc.) of one of its habitat types and restoring at least 1,000 acres of floodplain habitat along the San Joaquin River that provide its other form of habitat which consists of seasonally scoured areas within the floodplain and channel (Figure 3-45). Protection of existing unprotected habitat will occur in Conservation Zone 8 and priority will be given to protecting habitat that supports occurrences or which will connect patches of occupied habitat. Restored floodplain habitat will be restored in Conservation Zone 7 and will be designed and managed to support patches of suitable habitat (e.g., soils, flood disturbance regime, etc.) (Figure 3-45). If appropriate, this species may be translocated to establish new occurrences within restored habitat. Protecting remaining occupied habitat areas and reestablishing patterns of flood flows to floodplain historically occupied by this species is expected to sustain the species within the Plan Area and provide for increases in the species distribution and abundance.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM5 Seasonally Inundated Floodplain Restoration
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

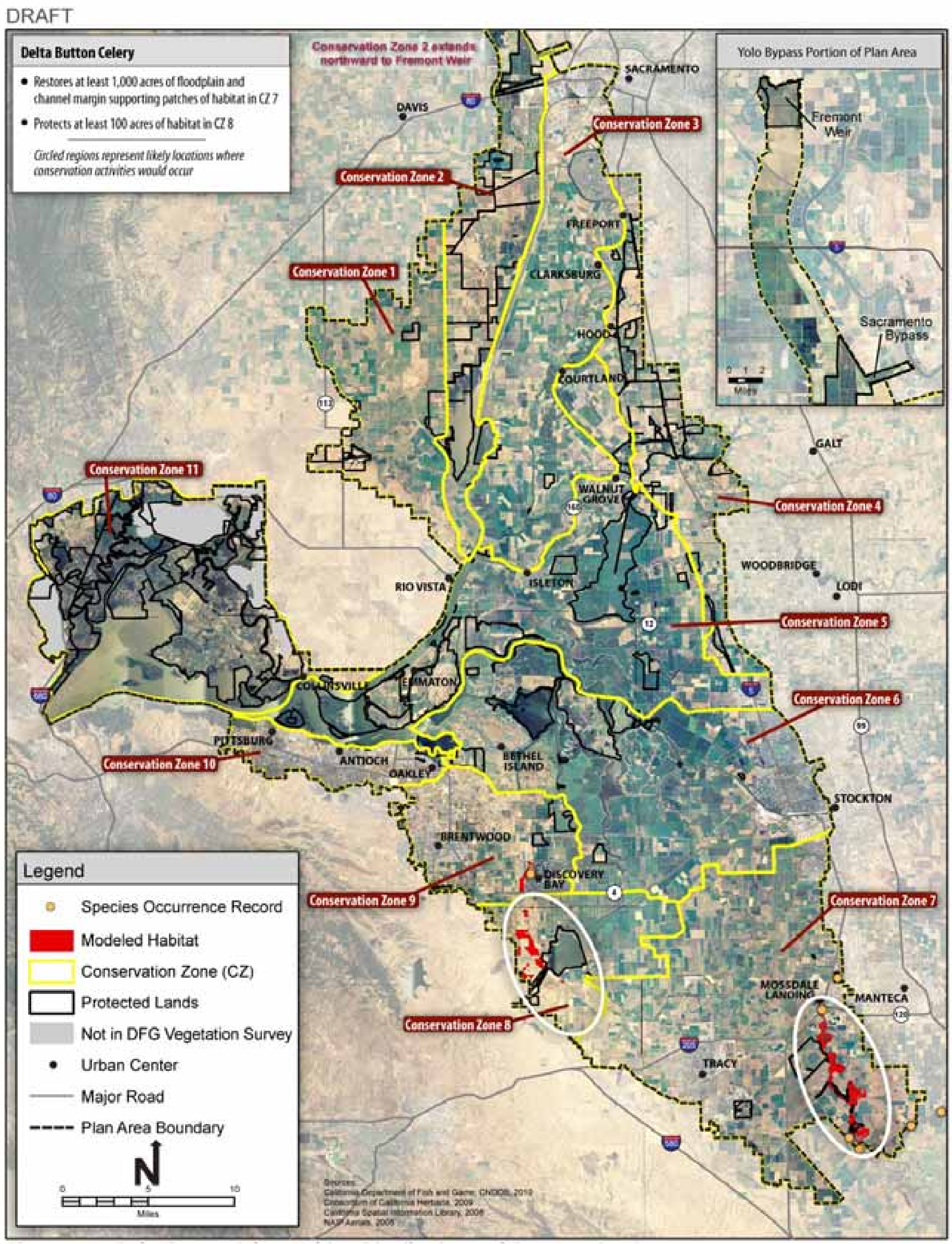

Figure 3- 45. Delta Button Celery Habitat Distribution and Conservation Strategy

3.3.2.4.32 Contra Costa Wallflower and Antioch Dunes Evening Primrose

Contra Costa wallflower and Antioch Dunes evening primrose are listed as endangered under both the federal Endangered Species Act and the California Endangered Species Act. They are endemic to the former Antioch Dune and persist on the small remnant of the dune. The extent of the former dune has been reduced to 20 acres plus an unknown amount on two Pacific Gas & Electric (PG&E) parcels that total 12 acres. The 20-acre known extent is protected on the Antioch Dunes National Wildlife Refuge (ADNWR) while the PG&E parcels are being managed under an MOU with USFWS. All existing habitat has been degraded by nonnative invasive plant species.

The current USFWS management plan for the ADNWR provides for invasive nonnative plant species control efforts that include hand pulling of individual invasive plants through the efforts of volunteers, targeted herbicide application, the restoration of some dune-like topography, and the planting of nursery grown stock and seed of Contra Costa wallflower and Antioch Dunes evening primrose.

The known natural occurrences of Contra Costa wallflower and Antioch Dunes evening primrose within the Plan Area are located exclusively within the ADNWR and on the two adjacent PG&E properties and are fully protected by ownership and conservation MOUs. These protected lands are completely isolated from other terrestrial habitats by development to the west, south, and east, and by the San Joaquin River to the north. Consequently, to increase the level of conservation benefits provided to inland dune scrub species, the inland dune scrub conservation will be implemented through the funding support of appropriate management actions and studies.

Applicable Natural Community Goals and Objectives

Goal IDSC1: The expected outcome is support for funding of the USFWS management and enhancement of the inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge.

> **Objective IDSC1.1:** The BDCP will support the funding of the USFWS program for management, enhancement, and monitoring of inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge at an annual amount of $XX.XX for X years.

Species-Specific Goals and Objectives

Goal CCWF/ADEP1: The expected outcome is funding support for the USFWS implementation of the propagation and out-planting program for Contra Costa wallflower and Antioch Dunes evening primrose.

> **Objective CCWF/ADEP1.1:** The BDCP will support the funding of the USFWS program for propagation and out-planting program for Contra Costa wallflower and Antioch Dunes evening primrose at an annual amount of $XX.XX for X years.

Rationale and Conservation Approach

After the recent 5-year review of the recovery plan by USFWS found that Contra Costa wallflower and Antioch Dunes evening primrose were declining significantly at the ADNWR and appeared to be headed towards extinction, USFWS began an out-planting of nursery grown stock and direct seeding into restored sandy habitat in 2005 and 2006 which appears to have stopped the decline. However, the populations are not yet considered to be self-sustaining because of invasive species problems (USFWS 2008). The current ADNWR management plan is designed to meet the recovery needs for the species of the ADNWR and provides for invasive nonnative plant species control efforts, restoration of dune-like topography, and the out-planting of nursery-grown stock and seed.

Conservation of Contra Costa wallflower and Antioch Dunes evening primrose will be provided through the support of funding for the USFWS planting and seeding program and its management of the ADNWR (Figure 3-46).

Applicable Conservation Measures

- CM11 Natural Communities Enhancement and Management

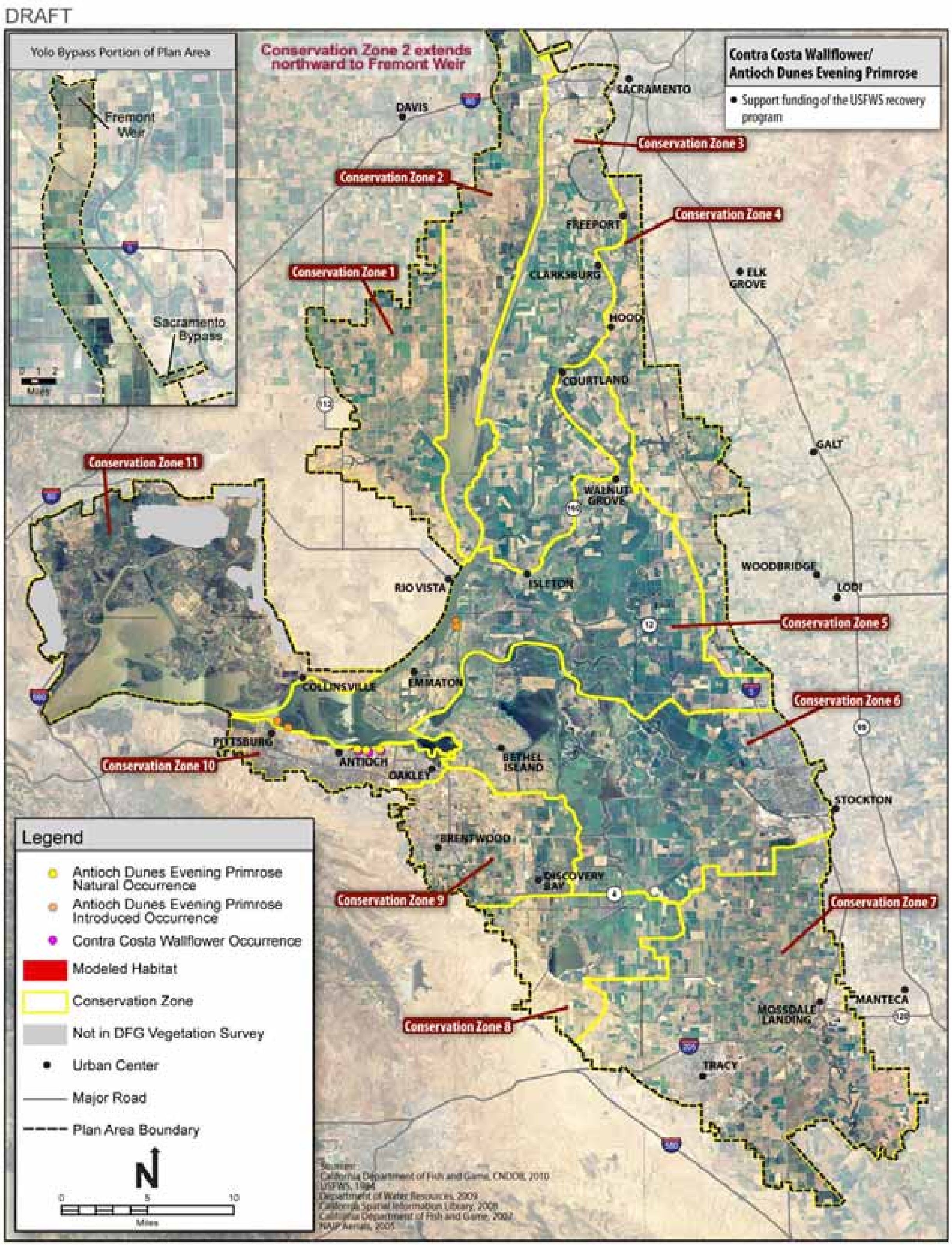

Figure 3- 46. Contra Costa Wallflower and Antioch Dunes Evening Primrose Habitat Distribution and Conservation Strategy

3.3.2.4.33 Carquinez Goldenbush

Carquinez goldenbush is known only from a very limited geographic range in Solano County, California (Nesom 1991, Hickman 1993, CNDDB 2009, CNPS 2009). It appears to be restricted to alluvial soils along ephemeral drainages associated with the Tehama geological formation and the Montezuma Block north and west of the Montezuma Hills in Solano County (Hickman 1993, Graymer et al. 2002, CNPS 2009, NRCS 2009). Carquinez goldenbush has been affected by agricultural land conversion, grazing, road widening, and development (CNPS 2009). Because Carquinez goldenbush is known only from 13 occurrences and its small populations are within the potential Impacts Area and in adjacent area immediately outside of the Plan and Impacts Areas, the emphasis of BDCP conservation measures will be on the protection of land with potential Carquinez goldenbush habitat.

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

Goal AWNC1: The expected outcome is protected alkali seasonal wetland complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.

> **Objective AWNC1.1**: Protect 400 acres of alkali seasonal wetland complex natural community in Conservation Zones 1, 8, and/or 11.

Goal AWNC2: The expected outcome is biologically diverse alkali seasonal wetland complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.

> **Objective AWNC2.1**: Maintain and, where habitat functions for covered species can be increased, increase the diversity and relative cover of native grasses and forbs.

Species-Specific Goals and Objectives

Goal CAGB1: The expected outcome is protected and expanded Carquinez goldenbush populations.

> **Objective CAGB1.1:** Protect at least 3 unprotected occurrences of Carquinez goldenbush in Conservation Zones 1 and/or 11.

> **Objective CAGB1.2**: Maintain and enhance the habitat functions of preserved Carquinez goldenbush habitat over the term of the BDCP.

Rationale and Conservation Approach

Conservation of Carquinez goldenbush will be directed at preserving 300 acres of currently unprotected habitat that supports the known elements (e.g., soils, hydrology, etc.) of its habitat and 3 unprotected occurrences (Figure 3-47). Priority will be given to protecting habitat that supports occurrences or are connected to occupied habitat in Conservation Zones 1 and 11 (Figure 3-47). Protection of Carquinez goldenbush habitat will be achieved through the preservation and enhancement of its habitat in stream corridors with appropriate buffers and in localized patches along the margin of Suisun Marsh in the same general locations as Montezuma Block vernal pools and playa pools and associated grassland and alkali seasonal wetland complex natural communities (see Section 2.3.4.9, *Vernal Pool Complex*) in Conservation Zones 1 and 11 (Figure 3-47).

Protection and enhancement of Carquinez goldenbush habitat will be conducted in conjunction with the protection, enhancement, and restoration of grassland and alkali seasonal wetland complex natural communities in that conservation zone. To the extent practicable, Carquinez goldenbush habitat will be protected in the largest possible linear corridor extents and management of protected habitat (e.g., control of nonnative invasive species, restoration of natural hydrological regime, appropriate grazing intensity, etc.) will be designed to enhance habitat functions for Carquinez goldenbush and other covered associated species.

Protected habitat will be incorporated within larger patches of protected grassland and vernal pool complex habitats that will complement their wetland habitat functions and will be managed to improve habitat conditions for these species (e.g., control of invasive nonnative plant species). If desirable and consistent with adjacent conservation plans, unpreserved occupied habitat may be protected adjacent to the Plan Area.

The protection of Carquinez goldenbush habitat is expected to help maintain and provide the basis for potentially increasing the distribution and abundance Carquinez goldenbush in the Plan Area. Following implementation of BDCP actions, approximately 67 percent of the species' habitat will be preserved in the Plan Area.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM9 Vernal Pool Complex Restoration
- CM11 Natural Communities Enhancement and Management

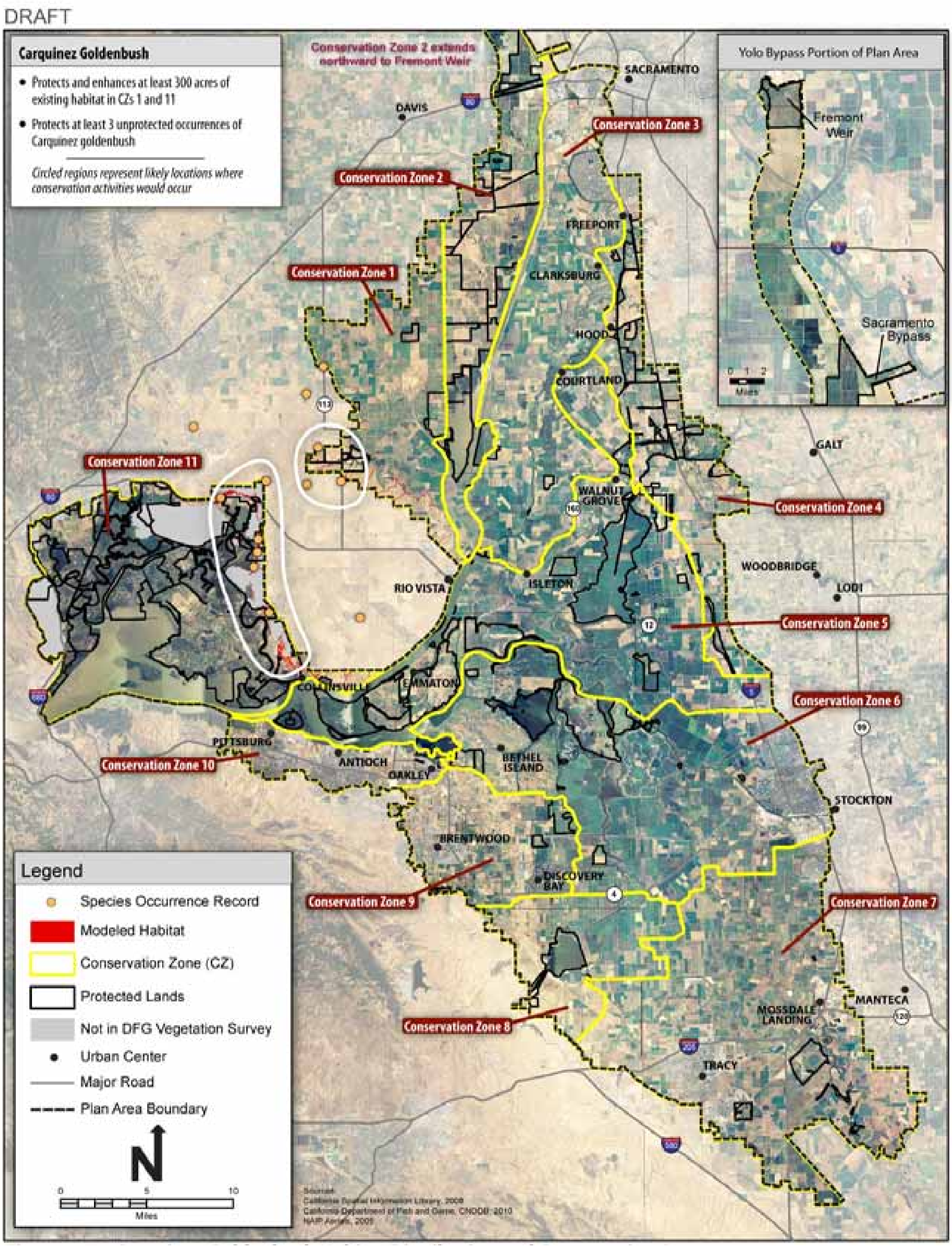

Figure 3- 47. Carquinez Goldenbush Habitat Distribution and Conservation Strategy

3.3.2.4.34 Delta Tule Pea and Suisun Marsh Aster

Delta tule pea and Suisun Marsh aster occur from Sacramento and Solano counties in the north, Napa and Sonoma counties in the west, and Contra Costa and San Joaquin counties in the south. Historically, Suisun Marsh aster was also known from marshes in the East Bay portion of San Francisco Bay (California State Coastal Conservancy 2003). Within the Plan Area, these species occur in tidal areas throughout Suisun Marsh and the west and central Delta with scattered occurrences in the north and south Delta (Figure 3-48). Typically they occur on the upper margins of tidal brackish and tidal freshwater marshes, river channels, creek channels, and sloughs in the ecotone with terrestrial habitats (Goals Project 2000). The tidal marsh habitat and channel margin habitat suitable for Delta tule pea and Suisun marsh aster has been lost mostly through development, dredge disposal, waterfowl habitat creation, agricultural conversion, and levee and dike building.

Applicable Natural Community Goals and Objectives

Goal MFNC1: The expected outcome is areas of tidal mudflat that provide foraging habitat for shorebirds and wading birds, and substrates suitable for the natural establishment of BDCP covered plant species.

> **Objective MFNC1.1:** Restore or create 20 linear miles of edge areas within other natural communities that serve as tidal mudflat substrate and which will support habitat for tidal mudflat-associated species as a component of BDCP restored tidal brackish emergent wetland and tidal freshwater emergent wetland natural communities and channel margin enhancement.

> **Objective MFNC1.2:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal mudflat as a component of BDCP restored brackish and freshwater tidal habitat and channel margin enhancement for covered and other native species over the term of the BDCP.

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

Rationale and Conservation Approach

Because habitat loss and exotic species are the primary stressors on Delta tule pea and Suisun Marsh aster, protecting, enhancing, and restoring tidal natural communities is expected to help maintain and potentially increase the abundance and distribution of these species. Conservation of Delta tule pea and Suisun Marsh aster will be directed at restoring a total of between 16,970 and 26,470 acres of tidal freshwater emergent wetland, floodplain, and valley/foothill riparian habitat in Conservation Zones 1, 2, 5, 6, 7, and 11 (Figure 3-48). The conservation actions are consistent with and help to achieve the draft recovery objectives for Delta tule pea identified in the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (USFWS 2010).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM6 Channel Margin Habitat Enhancement
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

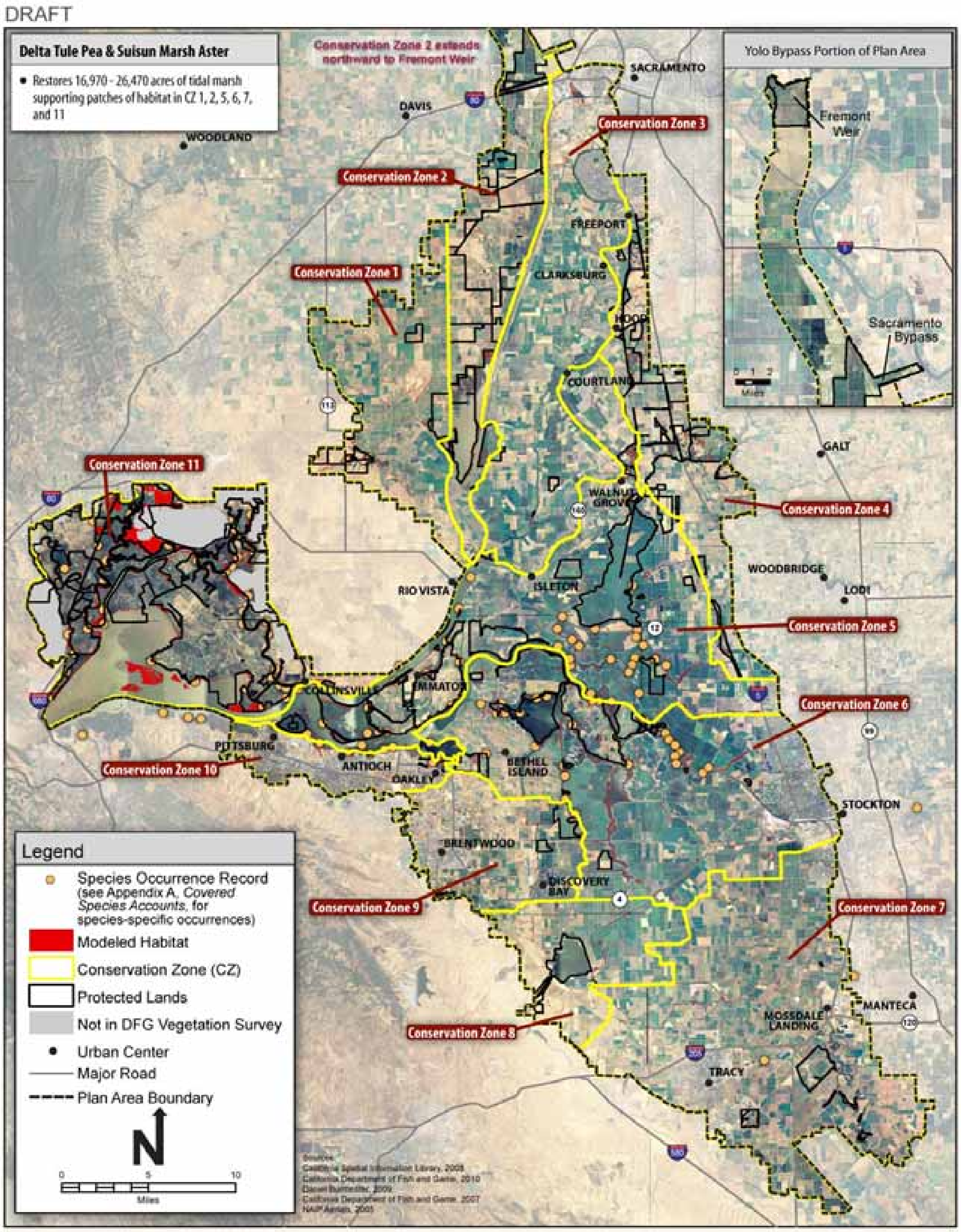

Figure 3-48. Delta Tule Pea and Suisun Marsh Aster Habitat Distribution and Conservation Strategy

3.3.2.4.35 Mason's Lilaeopsis and Delta Mudwort

Mason's lilaeopsis is endemic to California (Calflora 2007) while Delta mudwort can be found outside of California in British Columbia, on the east coast of North America, and in Europe (Hickman 1993). The range of Mason's lilaeopsis extends from Napa and Solano counties in the north, to Contra Costa and Alameda counties in the south, to Marin County in the west, and Sacramento and San Joaquin counties in the east while Delta mudwort only extends as far west as Suisun Marsh (CNDDB 2008).

Both species are found in relatively unvegetated areas within tidal brackish or tidal freshwater habitats that are inundated by waves or tides such as estuarine wetlands and immediately below the banks of tidal sloughs, rivers, and creeks (Golden and Fiedler 1991, Fiedler and Zebell 1993, DFG 2000, CNPS 2008). They are colonizing species that establish on newly deposited or exposed sediments (CNPS 2008) and prefer low tidal mudflats on clayey or silty soils (Witham and Kareofelas 1994).

The tidal marsh and tidal channel margin habitats suitable for Mason's lilaeopsis and Delta mudwort has been lost mostly through development, dredge disposal, waterfowl habitat creation, agricultural conversion, and levee and dike building.

Applicable Natural Community Goals and Objectives

Goal MFNC1: The expected outcome is areas of tidal mudflat that provide foraging habitat for shorebirds and wading birds, and substrates suitable for the natural establishment of BDCP covered plant species.

> **Objective MFNC1.1:** Restore or create 20 linear miles of edge areas within other natural communities that serve as tidal mudflat substrate and which will support habitat for tidal mudflat-associated species as a component of BDCP restored tidal brackish emergent wetland and tidal freshwater emergent wetland natural communities and channel margin enhancement.

> **Objective MFNC1.2:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal mudflat as a component of BDCP restored brackish and freshwater tidal habitat and channel margin enhancement for covered and other native species over the term of the BDCP.

Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.

> **Objective BMNC1.1:** Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).

Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective BMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Rationale and Conservation Approach

Because habitat loss and exotic species are the primary stressors on Mason's lilaopsis and Delta mudwort, protecting, enhancing, and restoring tidal natural communities is expected to help maintain and potentially increase the abundance and distribution of these species. Conservation of Mason's lilaopsis and Delta mudwort will be directed at restoring between 16,980 and 26,560 acres of tidal marsh, floodplain, and riparian habitat in Conservation Zones 1, 2, 4, 5, 6, 7, and 11 (Figure 3-49).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM11 Natural Communities Enhancement and Management

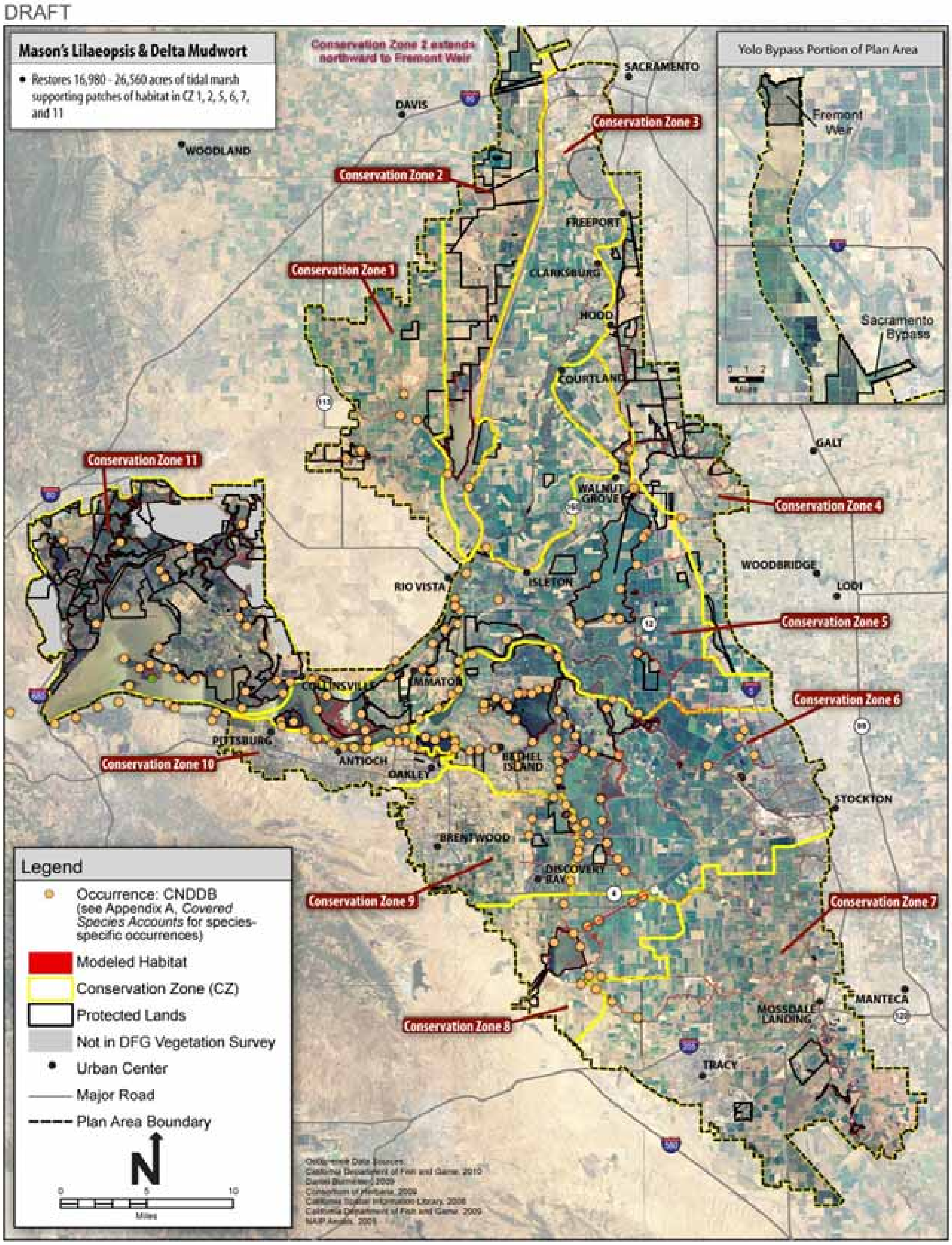

Figure 3- 49. Mason's Lileaopsis and Delta Mudwort Habitat Distribution and Conservation Strategy

3.3.2.4.36 Side-flowering Skullcap

Side-flowering skullcap is known only from a very limited geographic range in California, all of which are in the Delta around Bouldin Island in San Joaquin County, Delta Meadows State Park area, and Sycamore Slough (CNDDB 2010). The Bouldin Island location was recorded in 1892, and the exact location of the collection is unknown. The Delta Meadows State Park occurrence was recorded in 1993. During botanical surveys of the Plan Area conducted by DWR/DHCCP in the summer of 2009, side-flowering skullcap was found growing on rotting pilings and stumps in and along the channels of Snodgrass Slough, Lost Slough, and the Mokelumne River. In the Pacific Northwest it is found on similar coarse woody debris substrates.

Applicable Natural Community Goals and Objectives

Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.

> **Objective FMNC1.1:** Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).

Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.

> **Objective FMNC2.1:** Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.

Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.

> **Objective VRNC1.1**: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.

Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.

> **Objective VRNC2.1**: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.

Rationale and Conservation Approach

Most side-flowering skullcap plants found in the Plan Area are located within or directly adjacent to Delta Meadows State Park, a California State Park that was established to preserve and protect one of the last remaining areas of the northern Sacramento-San Joaquin River Delta that possesses large stands of fairly mature valley/foothill riparian vegetation (California State Parks 2010). Historically, it may have existed on decaying fallen trees and stumps along riparian channels and sloughs at the lower margin of valley/foothill riparian and the upper margin of tidal freshwater emergent wetland natural communities.

The CALFED Bay-Delta Ecosystem Restoration Program (ERP) Plan's Multi-Species Conservation Strategy designation for side-flowering skullcap is "Maintain" (CALFED Bay-Delta Program 2000). This designation indicates that the ERP will undertake actions to maintain the species by avoiding, minimizing, and compensating for any adverse effects to the species created by ERP restoration actions. It also means that the species' population and habitat are unlikely to be affected by ERP actions.

As part of valley/foothill riparian restoration and channel margin enhancement, coarse woody debris substrate will be made available for side-flowering skullcap establishment. Where side-flowering skullcap is found to already be present on stumps or other substrate, the movement and transplantation of the substrate and plants to appropriate sites in the immediate vicinity will be used to minimize impacts (Figure 3-50).

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM4 Tidal Habitat Restoration
- CM6 Channel Margin Habitat Enhancement
- CM7 Riparian Habitat Restoration
- CM11 Natural Communities Enhancement and Management

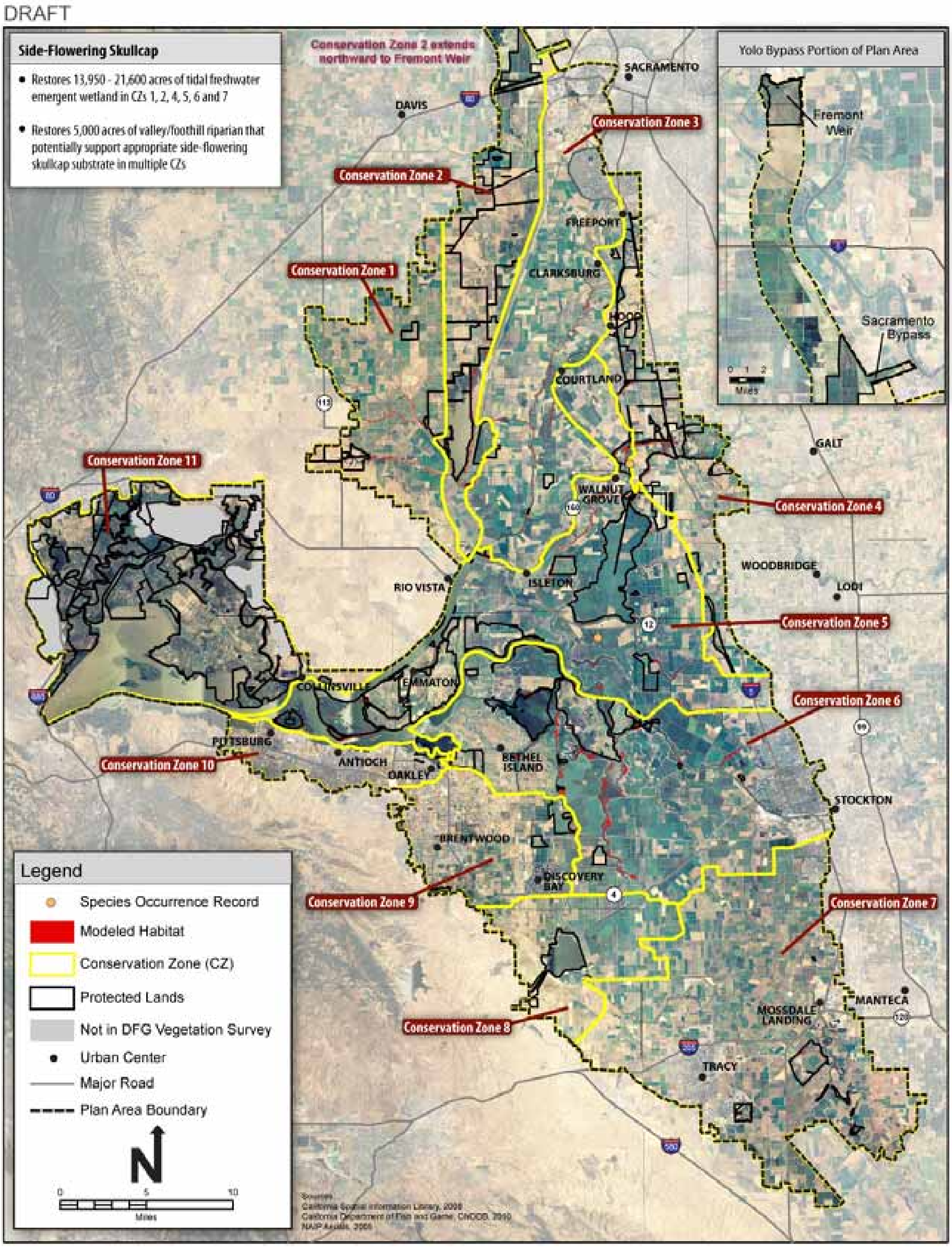

Figure 3-50. Side-Flowering Skullcap Habitat Distribution and Conservation Strategy

3.3.2.4.37 Caper-Fruited Tropidocarpum

Caper-fruited tropidocarpum is endemic to California, where its distribution is extremely limited (Appendix A, *Covered Species Accounts*). With only 19 observations of this plant and most known occurrences facing threats, caper-fruited tropidocarpum is considered by the California Native Plant Society to be seriously endangered (CNPS 2009). The reasons for its limited abundance and distribution are not known, but based on its historical distribution in the Plan Area, most impacts appear to have occurred through intensive agriculture and urbanization or other development activities. Caper-fruited tropidocarpum occurs on valley and foothill grassland habitats on moderately alkaline soils (CNPS 2009) or in foothill oak woodland on slightly alkaline clay soils (CNDDB 2009).

The protection of caper-fruited tropidocarpum habitat in the Plan Area is expected to provide the basis for potentially increasing the species' distribution and abundance. Caper-fruited tropidocarpum was historically distributed along the southwestern boundary of the Plan Area, but today may only reside as seeds in a long-lived soil seed bank. It is sporadically distributed in the inner southern Coast Range. Its potential habitat in the Plan Area ranges from pastures to abandoned dry-farmed grainlands to areas that were not farmed, but which have been invaded by nonnative annual grasses. Based on its historical distribution in the Plan Area, most impacts have occurred through intensive agriculture and urbanization or other development activities. The protection of caper-fruited tropidocarpum habitat in the Plan Area is expected to provide the basis for potentially increasing the species' distribution and abundance.

Applicable Natural Community Goals and Objectives

Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.

> **Objective GRNC1.1**: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.

> **Objective GRNC1.2**: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.

Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.

> **Objective GRNC2.1**: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.

> **Objective GRNC2.2**: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.

Species-Specific Goals and Objectives

Goal CFTR1: The expected outcome is protection and expansion of caper-fruited tropidocarpum populations.

> **Objective CFTR1.1**: Protect occurrences of caper-fruited tropidocarpum that reestablish on BDCP conservation lands.

> **Objective CFTR1.2**: Maintain and enhance the habitat functions of protected caper-fruited tropidocarpum occurrences over the term of the BDCP.

> **Objective CFTR1.3**: Protect and maintain 100 acres of unprotected caper-fruited tropidocarpum grassland habitat in Conservation Zone 8.

Rationale and Conservation Approach

Conservation of caper-fruited tropidocarpum will include protecting and maintaining 100 acres of its remaining unprotected grassland habitats in Conservation Zone 8 (Figure 3-51). All caper-fruited tropidocarpum occurrences have apparently been extirpated in the Plan Area although the species may be present as a persistent seed bank. Protected habitat will be contiguous with and managed in conjunction with other protected habitats in Conservation Zone 8. Protected habitat will be monitored to determine if plants germinate in future years and any located occurrences will be protected and managed to encourage the expansion of such occurrences. Based on the level of BDCP habitat effects, the proposed preservation of caper-fruited tropidocarpum habitat is expected to provide for the conservation of caper-fruited tropidocarpum.

Applicable Conservation Measures

- CM3 Natural Communities Protection
- CM8 Grassland Communities Restoration
- CM11 Natural Communities Enhancement and Management

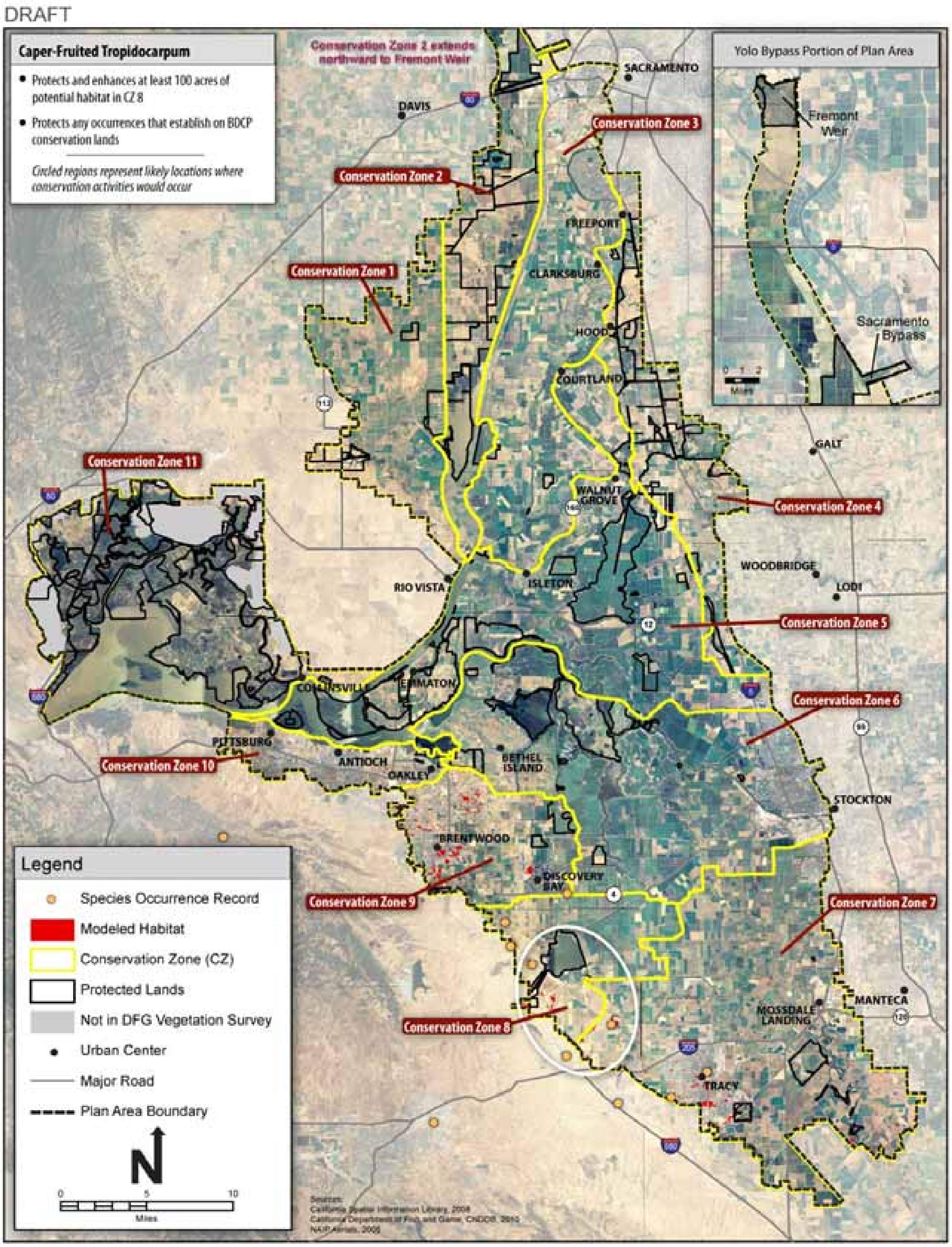

Figure 3-51. Caper-Fruited Tropidocarpum Habitat Distribution and Conservation Strategy

3.4 CONSERVATION MEASURES

This section presents the BDCP conservation measures that will be implemented by the BDCP Implementation Office to protect and improve the ecological function of natural communities; avoid, minimize, and compensate for impacts on covered species associated with implementation of covered activities; and provide for the conservation of covered species. Collectively the conservation measures are expected to achieve the BDCP biological goals and objectives. As described in Section 3.3, *Biological Goals and Objectives*, conservation measures address conveyance and water operations; protection, enhancement, and restoration of physical habitats that support covered species; and reductions in the effect of other stressors on covered species. Conservation measures were developed to address stressors at three ecological scales: ecosystem, natural community, and species-specific. Ecosystem-level conservation measures are presented in Section 3.4.2, natural community-level and species-specific conservation measures are presented in Sections 3.4.3 and 3.4.4, and avoidance and minimization measures for covered wildlife and plant species are presented in Section 3.4.5.

A summary list of BDCP conservation measures and the biological goals and objectives they serve is provided in Table 3-12. As is demonstrated in Table 3-12, many of the conservation measures address multiple goals and objectives. The following information is provided with each conservation measure, as appropriate, in Sections 3.4.2-3.4.4.

- **Problem Statement.** This section describes the ecological problems that are intended to be addressed by the conservation measure.
- **Hypothesized Benefits.** This section describes the hypotheses that justify the approach reflected in the conservation measure. Uncertainties and risks that could be associated with DRERIP-evaluated conservation measures are described in Appendix F, *DRERIP Evaluation Results*.

Table 3-12. Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives

Goals and Objectives	Applicable Conservation Measures
Ecosystem-Level Goals and Objectives	
Goal ECSY1: Protect and restore large landscapes representing a range of physical and biological attributes (e.g., hydrology, soil, and plant associations) necessary to sustain viable populations of covered species, and to preserve native species biodiversity.	
Objective ECSY1.1: Protect 25,000-41,000 acres of existing natural communities that support covered species.	CM3 Natural Communities Protection CM6 Channel Margin Habitat Enhancement
Objective ECSY1.2: Protect a range of environmental gradients (e.g., hydrology, elevation, and soils) across a diversity of natural communities.	CM3 Natural Communities Protection
Objective ECSY1.3: Restore or create up to 65,000 acres of tidally influenced habitat consisting of subtidal, mudflat, tidal marsh, and transitional upland habitat for sea level rise accommodation that supports a gradient of natural communities and habitat for covered species.	CM4 Tidal Habitat Restoration
Objective ECSY1.4: Restore or create up to 10,000 acres of seasonally inundated floodplain and 20 miles of channel margin habitat.	CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement
Objective ECSY1.5: Manage protected and restored or created habitats to enhance habitat functions for associated covered and other native species over the term of the BDCP.	CM11 Natural Communities Enhancement and Management
Goal ECSY2: Provide hydrodynamic conditions within Delta waterways that are more reflective of natural patterns of flow within the BDCP Plan Area and Suisun Marsh.	
Objective ECSY2.1: Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancements CM16 Non-Physical Fish Barriers
Objective ECSY2.2: Support the movement of adult life stages of native fish species to natal spawning habitats.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancements
Objective ECSY 2.3: Promote water quality conditions within the Delta that help restore native fish habitat.	CM12 Methylmercury Management CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels
Objective ECSY2.4: Maintain or increase life history diversity of native fishes and a diversity of rearing conditions for native fishes over time.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancements CM4 Tidal Habitat Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement CM7 Riparian Habitat Restoration
Objective ECSY 2.5: Promote greater connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic species.	CM1 Water Facilities and Operation CM4 Tidal Habitat Restoration

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Ecosystem-Level Goals and Objectives	
Goal ECSY3: Provide for connectivity among protected lands to provide for the movement of native organisms among habitat areas and to facilitate genetic exchange among populations.	
Objective ECSY3.1: Protect corridors of habitat that provide linkages among protected habitat areas within and adjacent to the Plan Area.	CM3 Natural Communities Protection
Objective ECSY3.2: Improve habitat corridors that allow covered and other native species to move into protected habitats from adjacent areas and to move among habitat areas within protected lands.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement CM7 Riparian Habitat Restoration CM8 Grassland Communities Restoration CM11 Natural Communities Enhancement and Management
Goal ECSY4: Promote ecosystem processes that support natural communities, covered species, other native species, and the habitats of those species.	
Objective ECSY4.1: Maintain and improve disturbance regimes and other processes that support functioning natural communities.	CM4 Tidal Habitat Restoration CM5 Seasonally Inundated Floodplain Restoration CM11 Natural Communities Enhancement and Management
Goal ECSY5: Increase aquatic primary and secondary production in the Delta, Yolo Bypass and Suisun Marsh to increase the abundance and availability of food for native aquatic organisms.	
Objective ECSY5.1: Over the term of the BDCP, increase the abundance and productivity of zooplankton that provide food and support food production for covered fish species in Delta waterways.	CM2 Yolo Bypass Fisheries Enhancements CM4 Tidal Habitat Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement
Objective ECSY5.2: Over the term of the BDCP, increase the abundance and productivity of aquatic invertebrate species that provide food and support food production for covered fish species in Delta waterways.	CM2 Yolo Bypass Fisheries Enhancements CM4 Tidal Habitat Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement
Goal ECSY6: Reduce the adverse predation effects of non-native species on covered fish species.	
Objective ECSY6.1: Manage the distribution and abundance of established non-native predators in the Delta to reduce predation on native covered fishes.	CM13 Nonnative Aquatic Vegetation Control CM15 Predator Control
Objective ECSY6.2: Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancements CM16 Non-Physical Fish Barriers
Goal ECSY7: Protect lands with a sufficient range of habitat conditions to accommodate anticipated shifts in the distributions of covered species and natural communities in response to climate change.	
Objective ECSY7.1: Protect sufficient upland transitional habitat area adjacent to restored brackish and freshwater tidal emergent wetland to permit the future upslope natural establishment of tidal emergent wetland communities with sea level rise.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Natural Community Goals and Objectives	
Tidal Perennial Aquatic	
Goal TANC1: The expected outcome is tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic food web processes.	
Objective TANC1.1: Restore or create 10,000 to 20,000 acres of tidal perennial aquatic in the BDCP Restoration Opportunity Areas (Conservation Zones 1, 2, 4, 5, 7, and 11) that supports aquatic food production and habitat for covered and other native species.	CM4 Tidal Habitat Restoration
Goal TANC2: The expected outcome is biologically diverse tidal perennial aquatic natural community that is enhanced for native species and sustained by natural ecological processes.	
Objective TANC2.1: Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal perennial aquatic community for covered and other native species over the term of the BDCP.	CM4 Tidal Habitat Restoration
Tidal Mudflat	
Goal MFNC1: The expected outcome is areas of tidal mudflat that provide foraging habitat for shorebirds and wading birds, and substrates suitable for the natural establishment of BDCP covered plant species.	
Objective MFNC1.1: Restore or create 20 linear miles of edge areas within other natural communities that serve as tidal mudflat substrate and which will support habitat for tidal mudflat-associated species as a component of BDCP restored tidal brackish emergent wetland and tidal freshwater emergent wetland natural communities and channel margin enhancement.	CM4 Tidal Habitat Restoration CM6 Channel Margin Habitat Enhancement
Objective MFNC1.2: Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal mudflat as a component of BDCP restored brackish and freshwater tidal habitat and channel margin enhancement for covered and other native species over the term of the BDCP.	CM1 Water Facilities and Operation CM11 Natural Communities Enhancement and Management
Tidal Brackish Emergent Wetland	
Goal BMNC1: The expected outcome is restored large expanses and interconnected patches of tidal brackish emergent wetland natural community.	
Objective BMNC1.1: Restore or create 3,600 to 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh ROA (Conservation Zone 11).	CM4 Tidal Habitat Restoration
Goal BMNC2: The expected outcome is biologically diverse tidal brackish emergent wetland that is enhanced for native species and sustained by natural ecological processes.	
Objective BMNC2.1: Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal brackish emergent wetland for covered and other native species over the term of the BDCP.	CM11 Natural Communities Enhancement and Management

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Natural Community Goals and Objectives	
Tidal Freshwater Emergent Wetland	
Goal FMNC1: The expected outcome is restored large, interconnected patches of tidal freshwater emergent wetland natural community.	
Objective FMNC1.1: Restore or create 13,900 to 21,600 acres of tidal freshwater emergent wetland in the Cache Slough, West Delta, Cosumnes-Mokelumne, and South Delta ROAs (Conservation Zones 1, 2, 4, 5, 6, and 7).	CM4 Tidal Habitat Restoration
Goal FMNC2: The expected outcome is biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes.	
Objective FMNC2.1: Maintain and enhance the habitat and ecosystem functions of BDCP restored tidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.	CM11 Natural Communities Enhancement and Management
Nontidal Freshwater Perennial Emergent Wetland	
Goal NWNC1: The expected outcome is nontidal freshwater perennial emergent wetland natural community that supports habitat for covered and other native species.	
Objective NWNC1.1: Create 400 acres of nontidal freshwater marsh (including components of nontidal perennial aquatic and perennial emergent wetland communities) that functions as habitat for the giant garter snake, tricolored blackbird, and western pond turtle within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4 and the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.	CM10 Nontidal Marsh Restoration
Goal NWNC2: The expected outcome is biologically diverse nontidal freshwater emergent wetland communities that are enhanced for native species and sustained by ecological processes.	
Objective NWNC2.1: Maintain and enhance the habitat functions of protected and created nontidal freshwater emergent wetlands for covered and other native species over the term of the BDCP.	CM11 Natural Communities Enhancement and Management
Nontidal Perennial Aquatic	
Goal NANC1: The expected outcome is nontidal perennial aquatic communities that support habitat for covered and other native species. ***Note:*** *The objective for nontidal perennial aquatic community Goal NANC1 is the same as that described under nontidal freshwater emergent wetland Goal NWNC1.*	
Objective NANC1.1: Restore 400 acres of nontidal marsh as per Objective NWNC1.1.	CM10 Nontidal Marsh Restoration
Goal NANC2: The expected outcome is biologically diverse nontidal perennial aquatic communities that are enhanced for native species and sustained by ecological processes.	
Objective NANC2.1: Maintain and enhance the habitat functions of protected and created nontidal open water habitats for covered and other native species over the term of the BDCP.	CM11 Natural Communities Enhancement and Management

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Natural Community Goals and Objectives	
Valley/Foothill Riparian	
Goal VRNC1: The expected outcome is restored large expanses and interconnected corridors of valley/foothill riparian natural community.	
Objective VRNC1.1: Restore or create 5,000 acres of valley/foothill riparian in Conservation Zones 1, 2, 4, 5, 6, 7, and/or 11.	CM7 Riparian Habitat Restoration
Goal VRNC2: The expected outcome is biologically diverse valley/foothill riparian natural community that supports native species and is sustained by natural ecological processes.	
Objective VRNC2.1: Maintain and enhance the habitat and ecosystem functions of BDCP restored valley/foothill riparian and patches of riparian forest and scrub present on BDCP preserved lands over the term of the BDCP.	CM11 Natural Communities Enhancement and Management
Objective VRNC2.2: Establish seasonal buffers around riparian habitats occupied by covered species to minimize disturbance during the breeding season.	CM7 Riparian Habitat Restoration
Objective VRNC2.3: Restore connectivity of valley/foothill riparian corridors along linear watercourses to enhance habitat for covered species and facilitate wildlife movement.	CM7 Riparian Habitat Restoration
Grassland	
Goal GRNC1: The expected outcome is grassland comprised of large interconnected patches or contiguous expanses.	
Objective GRNC1.1: Protect a minimum of 8,000 acres of grassland in Conservation Zones 1, 8, and 11. At least 1,000 acres will be protected in Conservation Zone 8, with the remainder distributed throughout these three Conservation Zones.	CM3 Natural Communities Protection
Objective GRNC1.2: Restore 2,000 acres of grassland to connect fragmented patches of protected grassland.	CM8 Grassland Communities Restoration
Goal GRNC2: The expected outcome is biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.	
Objective GRNC2.1: Restore and sustain a mosaic of grassland vegetation alliances, reflecting local water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.	CM8 Grassland Communities Restoration
Objective GRNC2.2: Increase the relative cover of native grasses and forbs in native grassland vegetation alliances.	CM8 Grassland Communities Restoration
Objective GRNC2.3: Increase opportunities for wildlife movement through grassland habitat.	CM8 Grassland Communities Restoration
Objective GRNC2.4: Increase burrow availability for burrow-dependent species.	CM8 Grassland Communities Restoration
Objective GRNC2.5: Increase prey, especially small mammals and insects, for grassland-foraging species.	CM8 Grassland Communities Restoration

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Natural Community Goals and Objectives	
Alkali Seasonal Wetland Complex	
Goal AWNC1: The expected outcome is protected alkali seasonal wetland complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.	
Objective AWNC1.1: Protect 400 acres of alkali seasonal wetland complex natural community in Conservation Zones 1, 8, and/or 11.	CM3 Natural Communities Protection
Goal AWNC2: The expected outcome is biologically diverse alkali seasonal wetland complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.	
Objective AWNC2.1: Maintain and, where habitat functions for covered species can be increased, increase the diversity and relative cover of native grasses and forbs.	CM11 Natural Communities Enhancement and Management
Vernal Pool Complex	
Goal VPNC1: The expected outcome is protected vernal pool complex natural community that represents a range of environmental conditions and is adjacent to other conserved lands.	
Objective VPNC1.1: Protect 300 acres of vernal pool complex in Conservation Zones 1, 8, and 11.	CM3 Natural Communities Protection
Goal VPNC2: The expected outcome is restored biologically diverse vernal pool complex natural community with improved native biodiversity, habitat heterogeneity, and the ability to support populations of covered and other native species.	
Objective VPNC2.1: Restore 200 acres of vernal pool complex natural community in Conservation Zones 1, 8, and/or 11 within patches of protected grassland that supports habitat for the western spadefoot toad, California tiger salamander, and the covered vernal pool shrimp and plant species.	CM9 Vernal Pool Complex Restoration
Objective VPNC2.2: Maintain and, where habitat functions for covered species can be enhanced, increase the diversity and relative cover of native grasses and forbs.	CM8 Grassland Communities Restoration CM9 Vernal Pool Complex Restoration
Inland Dune Scrub	
Goal IDSC1: The expected outcome is support for funding of the USFWS management and enhancement of the inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge.	
Objective IDSC1.1: The BDCP will support the funding of the USFWS program for management, enhancement, and monitoring of inland dune scrub natural community on the Antioch Dunes National Wildlife Refuge at an annual amount of $XX.XX for X years.	CM11 Natural Communities Enhancement and Management

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Agricultural Habitats	
Goal ALNC1: The expected outcome is increased habitat functions for covered and other native species that are supported by agricultural land cover types and management practices.	
Objective ALNC1.1: Maintain and protect the functions of 4,600 acres of rice lands as habitat for giant garter snake, western pond turtle, tricolored blackbird, white-tailed kite, waterfowl, and migrant shorebirds in Conservation Zone 2. This objective may be partially or fully achieved by maintaining an equivalent extent of natural or managed lands that support habitat functions similar to rice lands for associated covered and other native wildlife species.	CM3 Natural Communities Protection
Objective ALNC1.2: Maintain and protect the functions of 12,020 to 28,040 acres of non-rice agricultural lands as foraging habitat for Swainson’s hawk, white-tailed kite, and tricolored black bird that are located within 8 miles of occupied Swainson’s hawk nesting habitat.	CM3 Natural Communities Protection
Objective ALNC1.3: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain at least 3,000 acres of pasture that supports moderate-value western burrowing owl foraging habitat. This objective may be partially or fully achieved through preservation of other land cover types that provide moderate-value or greater habitat function for the western burrowing owl.	CM3 Natural Communities Protection
Objective ALNC1.4: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain at least 4,800 acres that supports greater sandhill crane foraging habitat within its Winter Use Area and within 2 miles of known roosting sites in Conservation Zones 3, 4, 5 and/or 6.	CM3 Natural Communities Protection
Objective ALNC1.5: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands and 4,600 acres of rice lands, maintain and protect 1,000 acres within or adjacent to habitat occupied by the Yolo/Willow Slough giant garter snake subpopulation in Conservation Zone 2.	CM3 Natural Communities Protection
Objective ALNC1.6: Of the maintained 12,020 to 28,040 acres of non-rice agricultural lands, maintain and protect 1,000 acres within or adjacent to habitat occupied by the Caldoni Marsh/White Slough giant garter snake subpopulation in Conservation Zone 4.	CM3 Natural Communities Protection
Objective ALNC1.7: Target agricultural land conservation to provide connectivity between other protected lands.	
Objective ALNC1.8: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved agricultural lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and wetlands.	CM3 Natural Communities Protection

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Managed Wetland	
Goal MWNC1: The expected outcome is maintenance of the current level of habitat functions provided by existing managed wetlands in the Plan Area through enhancement and restoration of natural communities on BDCP conservation lands, such that those wildlife functions do not preclude achievement of the Central Valley Joint Venture (CVJV) Implementation Plan's waterfowl and shorebird conservation targets for the Delta and Yolo Basin.	
Objective MWNC1.1: Maintain the level of wintering and breeding waterfowl habitat functions currently supported by habitats in the Plan Area through protection, restoration, and management of habitat of equivalent function on BDCP conservation lands.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration CM8 Grassland Communities Restoration
Objective MWNC1.2: Maintain the current level of migrant shorebird habitat functions currently supported by habitats in the Plan Area through protection, restoration, and management of habitat of equivalent function on BDCP conservation lands.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration
Goal MWNC2: The expected outcome is biologically diverse managed wetlands that are enhanced for native species.	
Objective MWNC2.1: Maintain and enhance the habitat functions of BDCP managed wetlands present on BDCP preserved lands over the term of the BDCP.	CM11 Natural Communities Enhancement and Management
Other Natural Seasonal Wetland	
Goal ONSW1: The expected outcome is increased habitat functions that support BDCP covered species in other natural seasonal wetland natural community within maintained and protected agricultural habitat areas.	
Objective ONSW1.1: Integrate management of other natural seasonal wetland natural community with management of BDCP maintained and protected agricultural lands to increase habitat functions for covered species.	CM3 Natural Communities Protection
Species-Specific Goals and Objectives *[**Note to Reviewers:** This table will be revised to indlcude the covered fish species pending further development of the covered fish species goals and objectives.]*	
Riparian Woodrat	
Goal RIWR1: The expected outcome is restored and protected habitat for the riparian woodrat.	
Objective RIWR1.1: Of the 5,000 acres of restored valley/foothill riparian, restore and manage 300 acres to meet the ecological requirements of the riparian woodrat in Conservation Zone 7.	CM7 Riparian Habitat Restoration
Riparian Brush Rabbit	
Goal RIBR1: The expected outcome is restored and protected habitat for riparian brush rabbit.	
Objective RIBR1.1: Of the 5,000 acres of riparian restoration, restore and manage at least 300 acres to meet the ecological requirements of the riparian brush rabbit in Conservation Zones 7 or 8.	CM7 Riparian Habitat Restoration
California Least Tern	
Goal CALT1: The expected outcome is an expanded California least tern population in the Plan Area.	
Objective CALT1.1: Create two patches of California least tern nesting habitat during restoration of tidal marsh communities.	CM11 Natural Communities Enhancement and Management

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	***Applicable Conservation Measures***
Species-Specific Goals and Objectives	
Greater Sandhill Crane	
Goal GSHC1: The expected outcome is expansion and protection of greater sandhill crane winter range.	
Objective GSHC1.1: Create 320 acres of seasonally managed greater sandhill crane roosting habitat within Conservation Zones 3, 4, 5, or 6.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Giant Garter Snake	
Goal GGSN1: The expected outcome is high quality upland and aquatic habitat containing a mosaic of features provided for extant giant garter snake populations.	
Objective GGSN1.1: Create functional landscapes on giant garter snake preserves that include a mosaic of restored freshwater marsh intermixed with protected agricultural lands and interconnected water conveyance canals and natural drainages.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration CM10 Nontidal Marsh Restoration CM11 Natural Communities Enhancement and Management
Goal GGSN2: The expected outcome is protected giant garter snake corridors facilitating movement and linking populations.	
Objective GGSN2.1: Establish connectivity between giant garter snake preserve lands, restored tidal wetlands, and protected agricultural lands in Conservation Zone 4 to facilitate movement into unoccupied portions of the Delta and with the Badger Creek subpopulation.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration CM10 Nontidal Marsh Restoration CM11 Natural Communities Enhancement and Management
Objective GGNS2.2: Establish a giant garter snake north-south corridor that includes protected agricultural lands and restored tidal and nontidal wetlands between Coldani Marsh/White Slough and the Stone Lakes National Wildlife Refuge.	CM3 Natural Communities Protection CM4 Tidal Habitat Restoration CM10 Nontidal Marsh Restoration CM11 Natural Communities Enhancement and Management
California Red-Legged Frog	
Goal CRLF1: The expected outcome is enhanced breeding California red-legged frog populations in the Plan Area.	
ObjectiveCRLF1.1: Enhance stock ponds in grassland in Conservation Zone 8 through partial livestock exclusion and predator control.	CM11 Natural Communities Enhancement and Management
Lange's Metalmark Butterfly	
Goal LMMB1: The expected outcome is funding support for the USFWS captive breeding and reintroduction program for Lange's metalmark butterfly.	
Objective LMMB1.1: The BDCP will provide funding to support the USFWS program for the captive breeding and release of Lange's metalmark butterfly at an annual amount of $XX.XX for X years.	CM11 Natural Communities Enhancement and Management
Vernal Pool Plant Species **(**Alkali Milk-vetch, San Joaquin Spearscale, Dwarf Downingia, Boggs Lake Hedge-hyssop, Legenere, and Heckard's Peppergrass**)**	
Goal ALMV1: The expected outcome is protected and enhanced alkali milk-vetch populations.	
Objective ALMV1.1: Protect at least 3 unprotected occurrences of alkali milk-vetch in Conservation Zones 1 and/or 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective ALMV1.2: Maintain and enhance the habitat functions of preserved alkali milk-vetch habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Species-Specific Goals and Objectives	
Vernal Pool Plant Species **(**Alkali Milk-vetch, San Joaquin Spearscale, Dwarf Downingia, Boggs Lake Hedge-hyssop, Legenere, and Heckard's Peppergrass**)**	
Goal HEPE1: The expected outcome is protected and enhanced Heckard's peppergrass populations.	
Objective HEPE 1.2: Protect at least 2 unprotected occurrences of Heckard's peppergrass in Conservation Zones 1, 8, or 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective HEPE1.2: Maintain and enhance the habitat functions of preserved Heckard's peppergrass habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Heartscale and Brittlescale	
Goal HART/BRIT1: The expected outcome is protected and expanded alkali seasonal wetland complex natural community-associated covered species populations.	
Objective HART/BRIT1.1: Of the 400 acres of protected alkali seasonal wetland complex natural community, protect 150 acres that support heartscale and brittlescale habitat.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective HART/BRIT1.2: Protect at least 3 unprotected occurrences of heartscale in Conservation Zones 1 and /or 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective HART/BRIT1.3: Protect at least 3 unprotected occurrences of brittlescale in Conservation Zones 1, 8, or 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective HART/BRIT1.4: Maintain and enhance the habitat functions of preserved heartscale and brittlescale habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Suisun Thistle and Soft Bird's-Beak	
Goal SUTH1: The expected outcome is protected and expanded Suisun thistle populations.	
Objective SUTH1.1: Protect 3 unprotected occurrences of Suisun thistle in Suisun Marsh in Conservation Zone 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective SUTH1.2: Maintain and enhance the habitat functions of preserved Suisun thistle habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Goal SOBB1: The expected outcome is protected and expanded soft bird's-beak populations.	
Objective SOBB1.1: Protect 3 unprotected occurrences of soft bird's-beak in Suisun Marsh in Conservation Zone 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective SOBB1.2: Maintain and enhance the habitat functions of preserved soft bird's-beak habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Delta Button-Celery	
Goal DEBC1: The expected outcome is protected and expanded Delta button-celery populations.	
Objective DEBC1.1: Of the 400 acres of protected alkali seasonal wetland complex natural community, protect at least 100 acres that support Delta button-celery habitat.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective DEBC1.2: Maintain and enhance the habitat functions of preserved Delta button-celery habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management

Table 3-12. Terrestrial Conservation Measures that Meet BDCP Conservation Strategy Goals and Objectives (continued)

Goals and Objectives	*Applicable Conservation Measures*
Species-Specific Goals and Objectives	
Contra Costa Wallflower and Antioch Dunes Evening Primrose	
Goal CCWF/ADEP1: The expected outcome is funding support for the USFWS implementation of the propagation and out-planting program for Contra Costa wallflower and Antioch Dunes evening primrose.	
Objective CCWF/ADEP1.1: The BDCP will support the funding of the USFWS program for propagation and out-planting program for Contra Costa wallflower and Antioch Dunes evening primrose at an annual amount of $XX.XX for X years.	CM11 Natural Communities Enhancement and Management
Carquinez Goldenbush	
Goal CAGB1: The expected outcome is protected and expanded Carquinez goldenbush populations.	
Objective CAGB1.1: Protect at least 3 unprotected occurrences of Carquinez goldenbush in Conservation Zones 1 and/or 11.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective CAGB1.2: Maintain and enhance the habitat functions of preserved Carquinez goldenbush habitat over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Caper-Fruited Tropidocarpum	
Goal CFTR1: The expected outcome is protection and expansion of caper-fruited tropidocarpum populations.	
Objective CFTR1.1: Protect occurrences of caper-fruited tropidocarpum that reestablish on BDCP conservation lands.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective CFTR1.2: Maintain and enhance the habitat functions of protected caper-fruited tropidocarpum occurrences over the term of the BDCP.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management
Objective CFTR1.3: Protect and maintain 100 acres of unprotected caper-fruited tropidocarpum grassland habitat in Conservation Zone 8.	CM3 Natural Communities Protection CM11 Natural Communities Enhancement and Management

3.4.1 Development Process

The BDCP conservation measures were developed on the basis of the best available scientific and commercial information, including input of a broad range of technical experts and an extensive body of scientific study and analysis compiled over the past several decades. The conservation measures further reflect the recommendations of independent scientists with extensive knowledge of Delta ecological issues. The conservation measure development process, including descriptions of technical evaluations, is described in Appendix D, *Background on the Process of Developing the BDCP Conservation Measures.* On several occasions, the Steering Committee convened these scientists to provide guidance and insight on a range of issues important to the development of a comprehensive conservation strategy for the BDCP, the recommendations of which are are reflected in many of the conservation measures set out in this section (see Appendix G, *Independent Science Advisors Reports*).

The BDCP conservation measures were initially developed to address the conservation needs of the covered fish species and the aquatic ecosystem by groups of technical experts convened by the Steering Committee. To guide initial development of potential conservation measures, these experts, based on review of the body of relevant scientific information and input from the Fishery Agencies and topical experts, identified important environmental stressors affecting the covered fish species and aquatic ecosystem. The groups then identified the range of potential conservation measures that could reduce or remove the effects of these stressors on the covered fish species. The conservation measure development process was informed through application of several tools and processes described in the following paragraphs. Following development of a range of potential conservation measures, the groups iteratively screened and refined the conservation measures based on evaluations of their likely biological effectiveness and implementability.

A large body of information on the Delta ecosystem and approaches to ecosystem and species conservation has been developed over many years that provided a starting point for the development of the BDCP conservation measures. Important sources of scientific information and conservation approach ideas included the CALFED Bay Delta Program, particularly the Science Program and Ecosystem Restoration Program; the Interagency Ecological Program; two reports on the Delta prepared by the California Public Policy Institute; the Delta Vision Program, various plan and technical documents; and the Delta Risk Management Strategy. Building on this knowledge base, the BDCP conservation measures to address aquatic resources were developed using additional investigations, state-of-the-art physical models, specially developed conceptual models, and expert input from a large number of scientists and resource managers.

At several stages in the development of the conservation measures, interim evaluations where conducted to assess the potential for measures under consideration to improve ecological conditions within the Delta for the covered fish species. Central to these assessments were the conceptual ecological models and detailed evaluation processes that were developed under the CALFED Ecosystem Restoration Program to gauge the likely effect of potential actions on Delta fish and ecosystem processes. This process, known as the Delta Regional Ecosystem Restoration

Implementation Plan (DRERIP) Scientific Evaluation Process, was used to evaluate draft BDCP conservation measures in December 2008-March 2009 (see Appendix F, *DRERIP Evaluation Results*). Under the DRERIP process, potential conservation measures were evaluated individually to assess their benefits and drawbacks without factoring in potential synergies with other actions. To account for interrelationships with other potential measures, the BDCP Synthesis Team was established to review the results of the DRERIP process and identify instances in which combinations of measures would likely provide benefits greater than the sum of the individual measures. The Synthesis Team assessed potential synergies and conflicts between various measures and suggested modifications to the draft conservation measures to improve the overall effectiveness of measures. Based on input from the DRERIP Evaluation and the Synthesis Team, the conservation measures were revised to improve their potential effectiveness.

Following development of draft conservation measures for the aquatic ecosystem and covered fish species, the Steering Committee assembled a team of technical experts to develop conservation measures to address the nontidal natural communities and covered wildlife and plant species. These experts reviewed and refined the draft habitat restoration measures intitially developed to address aquatic resources to ensure that the measures included elements that would also support high functioning habitat for the associated covered wildlife and plant species. Using the best available information, additional conservation measures to protect, enhance, restore, and manage nontidal habitats were developed based on assessments of each covered wildlife and plant species conservation needs. These assessments included consideration for each species distribution within the Plan Area, known species stressors, the extent and distribution of existing protected and unprotected habitat areas, effects of implementing the BDCP actions on each species and their habitats, opportunities to protect and improve habitat corridors, and opportunities to improve habitat connectivity among habitat areas within and adjacent to the Plan Area in accordance with the principles of conservation biology.

3.4.2 Ecosystem-Level Conservation Measures

Ecosystem-level conservation measures include water operations and the spatial distribution of landscape-scale protection and restoration of natural communites to improve the processes and ecological functions supported by the Plan Area's aquatic and terrestrial ecosystems. Water operations are designed to enhance aquatic foodweb processes to improve food abundance and availability and to improve the hydrodynamic and water quality conditions that support the habitat and movement of the covered fish and other native aquatic organisms. Large-scale protection and restoration of connected natural communities are designed to maintain and increase the extent of high functioning habitat areas for the covered and other native wildlife and plant species and that support the movements of covered and other native wildlife. Because these conservation measures will have a systemic effect on ecosystem condtions within the Plan Area, they are designed to complement and guide implementation of the natural community-level conservation measures described in Section 3.4.3, *Natural Community-Level Conservation Measures*.

3.4.2.1 CM1 Water Facilities and Operation

*[**Note to Reviewers:** On January 29, 2010 the BDCP Steering Committee approved, for the purposes of the detailed Effects Analysis, a set of BDCP initial long-term operating criteria. A table of these criteria can be found in the February 11 Steering Committee agenda packet on the BDCP web site. A companion document titled "Aquatic Conservation Measures Proposed for Effects Analysis under BDCP" can also be found in the February 11 agenda packet and describes the steps that were used to develop this set of criteria. These criteria reflected the thinking of the Steering Committee at that time for the purpose of a comprehensive Effects Analysis. The Steering Committee noted that these criteria might become the final criteria or they might be modified based on the results of the Effects Analysis, evaluation of alternatives under CEQA and NEPA, or efforts to optimize them and permit achievement of the ecosystem and water supply goals of the BDCP. The Steering Committee envisioned an iterative process to refine the conservation strategy, including the development of the final set of initial long-term operating criteria and the adaptive range for these criteria.*

An effects analysis has been underway by the SAIC team over the past 10 months and the Steering Committee has been given several presentations on the preliminary results of that analysis. The Effects Analysis continues to be reviewed by the technical staff of the Steering Committee representatives and will be revised as necessary. To date, several issues have been identified that necessitate analysis of potential changes to the initial long-term operating criteria by January 2011. These include:

- *North Delta intake configuration related to predation concerns (in-river vs on-bank)*
- *Spring-run salmon egg mortality on the Sacramento River in the fall*
- *Reduced Sacramento River flows downstream of the north Delta intakes*
- *Refinement of April-May south Delta operations*
- *Winter-spring X2 and outflow effects on longfin smelt*
- *Summer and fall X2 and delta smelt abiotic habitat*

A process has begun to evaluate how modifications to some of the conservation measures, including initial long-term operating criteria, might address some of these issues in a manner that provides a refined approach to fishery protection while being sensitive to the water supply goals. This will lead to an iteration process that will take place for the purpose of describing the final conservation strategy and the initial long-term operating criteria for complete evaluation in the effects analysis. Also, as part of this process, an adaptive range for the operational criteria will be developed.]

This conservation measure provides for significant proposes changes to water operations in the Delta under the BDCP. This conservation measure includes two major components: (1) construction of new water facilities, and (2) operations of new operational control facilities or changes to the operations of existing operational control facilities. The evaluation of proposed new conveyance facilities (or changes to existing facilities) addresses two core issues that are separate and distinct, but are also closely interrelated. The first is the design issue associated with the new facility; that is, whether the new facility itself may enable improvements in flows and hydrodynamics if operated properly, and how to design the facility to achieve those improvements. The second issue is the operational issue; that is, what types of operational parameters would be most appropriate for the new facility to contribute to BDCP goals and objectives. It is important to recognize that these two aspects of proposed new water conveyance facilities are separate and distinct yet also closely joined, and must be evaluated as such.

The proposed new north Delta diversion facility offers an instructive example of this distinction. The appropriateness of the north Delta facility as a major new conservation measure for the BDCP demonstrates how both issues must be addressed together. There is a relatively broad agreement within the fisheries conservation community that a properly operated new north Delta facility will provide substantial benefits for certain listed species over the existing system, for all of the reasons enumerated below. The far more energetic debate focuses on what constitutes the proper operating parameters for the new facility, and less on the design parameters of the north Delta facility itself – although both are essential components of the proposal. Determining the appropriateness of the north Delta facility, therefore, considers the operational parameters that will govern it as much as the reliability of the governance structures that will apply those parameters. Hence, clearly distinguishing the design features from the operational features is important for an accurate appraisal of the merits of the measure overall.

The lower Sacramento River, Delta, and Suisun Bay and Marsh provide habitat for a diverse and complex assemblage of resident and migratory fish and other aquatic organisms. Section 3.2.3 *Development of the Aquatic Resources Component of the Conservation Strategy*, describes the BDCP approach to conservation and outlines the basic principles governing the approach. Several of these principles apply directly to the design of the conservation measure proposed in this section and are, therefore, expanded upon here. Development of water operations conservation measure as part of the BDCP is based, in large part, on the balance of seasonal and interannual variation in hydrologic conditions occurring within the watershed, and seasonal variation in the habitat requirements and geographic distribution of each of the lifestages of the covered fish within the estuary and tributary rivers, as well as many other factors. These include the beneficial interactions between establishing new aquatic habitats and hydrodynamics, a variety of flow-based and other mechanisms affecting the habitat quality and availability for these species and their food supplies, growth, survival, reproduction, and overall population dynamics in response to implementation of conservation measures. In addition, the water operations conservation measure is designed to provide a reliable water supply in a manner that avoids and reduces adverse effects to covered species and their habitat.

The proposed water operations also reflect the fact that the covered fish and other aquatic species have evolved in the Central Valley rivers and Delta. Their life histories are keyed to seasonal changes that naturally occur in flows, water temperatures, and other environmental cues that affect processes such as the seasonal timing of juvenile emigration downstream through the Delta, seasonal timing of reproduction, seasonal patterns in phytoplankton and zooplankton production that are food for covered fish and other aquatic species, seasonal inundation of floodplain habitat, and other important biological mechanisms.

One factor considered in the development of the water operations conservation measure is unidirectional downstream sweeping flows across the new fish screens proposed for the lower Sacramento River as part of long-term dual facility operations. Another consideration is the downstream transport of planktonic fish eggs and larvae, organic material, phytoplankton, and zooplankton from the lower Sacramento River into the Delta and Suisun Bay. A third factor is the consideration of sufficient flows in the lower Sacramento River during the primary migration period for juvenile Chinook salmon, steelhead, and other species (December-June) to reduce the frequency of bidirectional tidal flows in areas like Sutter and Steamboat Sloughs that are thought to reduce migration rates and increase the risk of juvenile fish to mortality from sources such as predation. Another factor that is taken into account is the provision of operations to maintain and improve habitat quality and availability for aquatic species in areas such as the Cache Slough complex, the lower Sacramento River, Delta and the low salinity zone located in the western Delta and Suisun Bay. The long-term water operations described below were developed to meet these and other biological objectives, water supply objectives, and water quality objectives of the BDCP.

In addition to reducing direct entrainment loss as a result of BDCP covered activities, the new water facilities and operations are designed to reduce other sources of harm to listed species, both direct and indirect (e.g. stranding, loss of homing ability, and reduced predation). In addition, implementation will be adaptively managed to optimize benefits to covered species while maintaining water supply reliability (see Section 3.7, *Adaptive Management Program*). Uncertainties concerning these actions will be managed through ongoing monitoring and research under the BDCP monitoring and adaptive management programs.

Water operations in the Delta are an integrated collection of actions that affect flow and water quality. This water facilities and operational conservation measure is closely intertwined with other components of the conservation strategy, including measures that will restore habitat and address other stressors to covered species. For example, the ability of habitat restoration in the south Delta to increase the amount of biological productivity transported to the western Delta and Suisun Bay will be realized only after preferential operation of the north Delta diversion facility over south Delta facilities begins (i.e., long-term operations).

Where applicable, criteria (quantitative values) are identified here for each parameter for specific times of year and specific water year types.

Water Facilities

This section presents an introduction to and summary of the proposed new and existing water facilities operated by the SWP and CVP within and near the Plan Area (Figure 3-52). These facilities include physical control structures such as gates, intakes, and pumps that can modify flows and affect Delta hydrodynamics in the immediate vicinity of the structure and often across large portions of the surrounding Delta. The physical construction and modification of these facilities are described and evaluated separately from the operations of the facilities under the BDCP.

The following is a list of new and existing water facilities and brief description of their functions:

1. North Delta Diversion Facilities and Tunnel/Pipeline – The north Delta diversion facilities will include five new intakes along the Sacramento River between Freeport and Courtland (Figure 3-52). Intakes will be equipped with state-of-the-art positive barrier fish screens to reduce entrainment of fish and will connect to tunnel/pipeline to carry water to a new regulating forebay adjacent and connected to existing south Delta SWP and CVP export facilities. More detail on specific features of the tunnel/pipeline facility is provided in Chapter 4, *Covered Activities*. *[**Note to Reviewers:** The design and location of the new intakes and conveyance facilities to be included in the proposed BDCP have not been determined.]*

2. Fremont Weir Operable Gates – New operable gates on the Fremont Weir will allow for the control of the timing, duration, and frequency of inundation of the Yolo Bypass during periods when the Sacramento River would not currently spill over the Fremont Weir into the Yolo Bypass. Operations for Fremont Weir Operable Gates are described in Section 3.4.2.2. *CM2 Yolo Bypass Fishery Enhancement*.

3. Delta Cross Channel Gates – Delta Cross Channel Gates are existing radial gates that control the flow of Sacramento River water through the Delta Cross Channel into the interior Delta.

4. Montezuma Slough Salinity Control Gate – Existing gate at the eastern opening of Montezuma Slough that controls the flow of fresh and salt water into Montezuma Slough.

5. South Delta Diversions – Two existing diversion facilities, the CVP Jones Pumping Plant and the SWP Banks Pumping Plant, divert water from the south Delta to meet water supply demands outside the Delta.

   In addition to the above listed facilities, the existing Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct (NBA) for delivery in Napa and Solano counties. New diversion from the Sacramento River proposed as the North Bay Aqueduct Alternative Intake would operate in conjunction with the existing North Bay Aqueduct intake at Barker Slough.

Near-Term Water Operations

*[**Note to Reviewers**: At this time, BDCP does not have proposed near-term operations.]*

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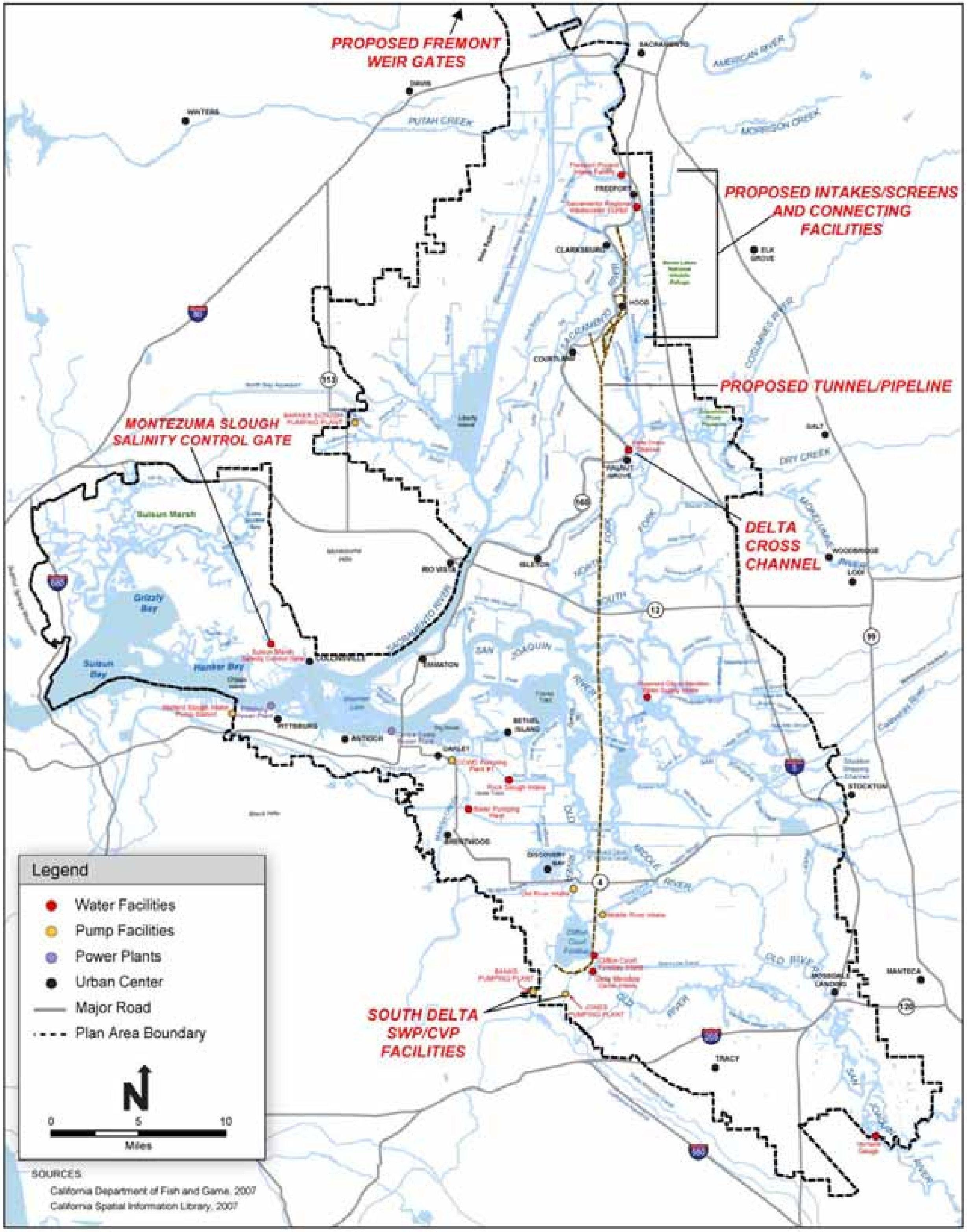

Figure 3-52. Water Operations Facilities in the Delta (Existing and Proposed)

Long-Term Water Operations

This section provides descriptions of the long-term water operations for multiple parameters across the Delta. Long-term operations are made possible by facilities constructed during the near-term implementation period (e.g., new north Delta diversions, tunnel/pipeline, and new gates at Fremont Weir). In the long-term implementation period, dual operations of the existing south Delta diversion facilities and the new north Delta diversion facilities will provide greater flexibility to benefit covered fish and water exports not possible during the near-term implementation period. Long-term operations under the dual facility will allow water to be diverted from the lower Sacramento River using state-of-the-art positive barrier fish screens that are expected to substantially reduce the risk of entrainment of covered fish and other aquatic organisms, but will also provide positive benefits resulting from a reduction in the rate of water diversions occurring from the south Delta when covered fish species are present. Long-term water operations described in this section will replace certain near-term water operations once the new north Delta diversions and the new tunnel/pipeline are completed and functional.

Construction and Preferential Operation of a New Water Diversion Facility in the North Delta.

Five new water diversion facilities with 3,000 cfs capacity each (combined 15,000 cfs capacity) will be constructed and operated on the Sacramento River in the north Delta to minimize impacts on fish at the SWP and CVP south Delta diversion facilities. A tunnel/pipeline facility with a 15,000 cfs capacity will be constructed to convey water from the new diversion facilities to the south Delta, where it will join existing SWP and CVP diversion facilities. The capacity of the new facilities will be 15,000 cfs, which is approximately the capacity of existing export pumps at SWP and CVP facilities in the southern Delta. The new tunnel/pipeline will follow a route through the Delta (Figure 3-52). Each new intake will be screened with state-of-the-art positive barrier fish screens and have a pump station, power lines, access roads, and other associated infrastructure.

Five locations for intakes have been identified in the north Delta (Figure 3-52). Selection of locations is based on multiple considerations including, but not limited to, maximizing function and effectiveness of screens; minimizing impacts to in-channel, on-bank, and terrestrial resources; applicable navigational and flood conveyance regulations; channel geometry and bathymetry; location relative to tidal influence and ranges of covered fish; future climate change and sea level rise; and proximity to other infrastructure (e.g., Sacramento Regional Wastewater outfall, existing developed land, and other intakes). Each intake will be engineered to allow variable rate pumping to handle variation in the location of covered fish and tidally-induced flows, as well as sea level rise from climate change. The influence of tides, which could produce reverse or stagnant flows in channels, attenuates upstream such that the most northern intakes are expected to be less influenced by tides than downstream intakes, particularly during higher river flow.

After the comprehensive evaluation of three types of intake/screens structures (on-bank, near-shore, and in-channel screens) for flood control, effects to covered fish species, and feasibility, it was concluded that on-bank structures would best meet these criteria for this reach of the river Fish screens will be designed to NMFS, DFG, and USFWS criteria to include specific screen mesh sizes (1.75 mm open area), a maximum approach velocity of 0.2 feet per second (ft/sec), sweeping velocity of at least two times the approach velocity (0.4 ft/sec), screen cleaning mechanisms, and monitoring systems. Three types of screening materials are currently being investigated: stainless steel, copper-nickel, and plastic. The advantages and disadvantages of each will be considered in the ultimate decision by the Implementation Office of which material to use. Further, with the high risk of invasion into the Delta by quagga and zebra mussels in the future, the use of anti-fouling material or alternative cleaning systems is also being considered.

The tunnel/pipeline will route water through the Delta to a new 600-acre forebay on Byron Tract (Figure 3-52). Water will be conveyed from the five intakes via pipelines to either an intake tunnel or a 750-acre Intermediate Forebay. A 33.5-mile tunnel will convey water from the Intermediate Forebay to the Byron Tract Forebay, where it will tie into existing SWP and CVP facilities.

Although construction of the new north Delta facility and associated infrastructure will be initiated as early as practicable following BDCP authorization, operation of the new facility will not start until and defines the beginning of the long-term implementation period (estimated at implementation year 10). The north Delta diversion facility will be operated in conjunction with, but preferentially to (except during summer months and at other times where necessary to meet the goals of fish conservation and water supply), existing south Delta SWP and CVP diversion facilities to minimize adverse effects on fish in the Delta while maintaining water supply reliability as described in Chapter 4, *Covered Activities*. The quantity and timing of diversions will be affected by specific parameters described in this chapter.

The new intake facilities will be operated to maintain flows in the Sacramento River to meet five primary objectives for flows at and downstream of the new north Delta facilities:

1. Maintain fish screen sweeping velocities,
2. Minimize undesirable upstream transport of water and aquatic resources from downstream channels,
3. Support fish transport to regions of suitable habitat,
4. Minimize predation effects downstream, and
5. Maintain or improve rearing habitat in the north Delta.

These north Delta facilities “bypass flows” represent the rate of flow at which the Sacramento River must pass downstream of the new diversion points. Bypass flows are intended to serve as an operational parameters to limit or otherwise manage water diversions from the new north Delta diversion facilities to minimize and reduce the effects of those diversions on downstream hydrodynamics (e.g., reduce Sacramento River flow downstream of the point of diversion) needed to support functions within and downstream of the river. Bypass flows for the Sacramento River act as an operational criteria in which water diversions will only occur when flows are maintained above the minimum criteria. The minimum bypass flow rates act as restrictions on water diversions during those years and seasons when flow in the Sacramento River is low. To meet water supply goals (see Chapter 4, *Description of Covered Activities*), constraints on the amount of water diverted from north Delta facilities may require commensurate increases in diversions from the south Delta SWP and CVP facilities. To maintain water quality in the south and central Delta during low flow periods on the San Joaquin River in summer months (July-September), existing south Delta pumps will be preferentially operated up to 3000 cfs (see *Delta water quality maintenance* below).

In addition to establishing the minimum bypass flow rates as one set of operating criteria, two additional operating criteria will be implemented in response to low river flow conditions. The first operational condition is preferential operation of the new diversion facilities located the farthest upstream to reduce the effects of low Sacramento River flow on tidal reversal in the vicinity of the diversion (maintain positive downstream flows across the intake structures and reduce the likelihood that larval and juvenile fish will move upstream into the area of potential entrainment/impingement at the diversion). Results of hydrodynamic modeling indicate that a higher level of Sacramento River flow needs to be maintained to avoid tidal flow reversal downstream (e.g., near Walnut Grove) when compared to the flow needed to maintain downstream river flows at more upstream sites. A second operational response to low Sacramento River flow conditions is to implement preferential diversion operations in response to tidal conditions (e.g., divert water during ebb tide stage to maintain sweeping velocity and avoid tidal flow reversal) and then reduce or curtail diversion during the flood tide stage.

Factors considered in developing north Delta diversion bypass flows included:

- Seasonal timing of various life stages of covered fish inhabiting the Sacramento River in the vicinity of the proposed water diversion locations;
- Changes in the biological processes and relationship in response to river flow that occur seasonally (e.g., differences in the biological processes of phytoplankton and zooplankton production between winter-spring and summer-fall);
- The relationship between bypass flows and hydrologic synchrony of flows and environmental cues within the Sacramento River watershed;
- The relationship between river bypass flow rate and constraints on water diversions and water supplies;
- The relationship between downstream transport rate of planktonic particles (simulating larval delta and longfin smelt transport between the upstream spawning areas, such as Cache Slough, and the downstream estuarine habitat where first feeding and juvenile rearing occur) and river flow rate;

- The relationship between river flow and downstream transport of phytoplankton, zooplankton, and organic material;
- The relationship between fall river flows and attraction and migration flows in the mainstem river for adult upstream migration by fall-run and late fall-run Chinook salmon, steelhead, delta and longfin smelt, splittail, and other upstream migrating adults;
- Relationships between river flow rate and juvenile transit time through the lower river (a factor thought to affect vulnerability to predation mortality), juvenile survival rates, and river flow;
- Relationships between river flow and habitat conditions for predatory fish (e.g., largemouth bass, smallmouth bass, pikeminnow, and striped bass) in the river and sloughs;
- The relationship between river flow rate and tidal dynamics (e.g., changes in water velocity and direction in response to flood and ebb tide conditions) and the river flows at various potential diversion locations that maintain a net unidirectional downstream flow over all tidal conditions;
- The relationship between mainstem river flows and seasonal flows into a floodplain habitat such as the Yolo Bypass and the resultant effects on hydrodynamic conditions in the river at the points of diversion;
- The relationship between existing and expanded tidal marsh habitat within the Cache Slough complex and tidal hydrodynamics within the river at various potential points of diversion;
- The relationships between seasonal timing of juvenile winter-run Chinook salmon downstream migration and pulse flows down the lower Sacramento River (del Rosario and Redler 2010); and
- The relationship between river flow, channel geometry, and resulting sweeping velocities across a positive barrier fish screen at each potential diversion location. Sweeping velocity is intended to transport fish downstream in a timely manner to reduce their exposure to entrainment and impingement at the diversion and to help remove accumulated debris from the fish screen surface to maintain approach velocities.

Analysis of seasonal timing of juvenile winter-run Chinook salmon migration (del Rosario and Redler 2010) suggests that pulse flows provide an environmental cue that stimulates the downstream migration of juvenile winter-run Chinook salmon into the Delta and subsequently their migration into coastal marine waters. Pulse flows provide a change in river flow over a short time period and are also typically associated with increases in turbidity and suspended sediments within the water column. Increased turbidity has been identified as an important environmental condition affecting pre-spawning adult delta smelt geographic distribution within the Delta and lower reaches of the Sacramento River. Therefore, bypass operations include provisions for operations in response to seasonal pulse flow events.

Operational Criteria and Adaptive Limits. The north Delta facilities operations and bypass flow requirements will apply in the BDCP long-term implementation period following completion of facilities construction. Specifics on the operational criteria and adaptive range of north Delta facilities bypass flows are provided in Table 3.13. The bypass operations will be based on three parameters "Constant Low Flow Pumping," "Initial Pulse Protection," and "Post-Pulse Operations." Table 3.14 provides post-pulse flows criteria.

To allow for flexible and responsive implementation of the BDCP, several conservation measures include a defined "adaptive range" that establishes the parameters within which a conservation measure may be adjusted to improve its effectiveness or respond to changing biological conditions. Adaptive Ranges are specifically established upper and lower boundaries and limits that govern the scope of changes that can be made to water operations criteria for specific operational parameters under this conservation measure pursuant to the adaptive management program. These adaptive ranges are expected to be included within the bounds of BDCP regulatory authorizations and provide for both flexibility to change operation criteria to improve conservation or water supply performance and limitations to clearly define the confines of the Plan. Adjustments to the water operations criteria set out in the BDCP and reflected in its associated authorizations, and within the adaptive range for water operations described Tables 3-13 and 3-14, may only be conducted through the process identified in Section 3.7.3.2, *Decision Process for Adjusting Water Operations within the Adaptive Range.*

[***Note to Reviewers:*** *Adaptive range limits have not been determined at this time. Tables 3-13 and 3-14 provide "analytical ranges" used in the BDCP Effects Analysis as a step in the process of development of adaptive ranges.]*

Problem Statement: For decades, water has been diverted directly from the south Delta through SWP and CVP facilities to meet agricultural and urban water demands south and west of the Delta. These diversions both require and create an artificial north-to-south flow of water through the Delta (as opposed to the natural general east-to-west flow pattern) and have resulted in the development of reverse flows in major Delta channels that result in entrainment of fish, invertebrates, nutrients, and other organic material. Existing diversion facilities are equipped with louvers that guide juvenile and larger fish into salvage facilities. Salvaged fish are subsequently transported to release locations on the lower Sacramento and San Joaquin Rivers where they are subject to high predation pressure (Miranda et al. 2010). Planktonic eggs, larvae, and small juveniles are not effectively salvaged and do not survive when carried into conveyance facilities. Smelt and juvenile salmonids that are drawn into Clifton Court Forebay are subject to predation from the large populations of predatory fish that are present there as well as other sources of mortality (Gingras 1997, Clark et al. 2009, Castillo et al. 2009).

Table 3-13. Proposed Long-Term Operational Criteria and Adaptive Range Limits

*[**Note to Reviewers:** Table 3-13 and table 3-14 provide the proposed BDCP long term water operations for evaluation in the BDCP Effects Analysis. The criteria in these tables do not represent criteria agreed to by the Steering Committee; its purpose is for use in the Effects Analysis. These two tables are the same as the tables provided to the Steering Committee in February 2010. The operational criteria identified in these tables are the criteria agreed to by the BDCP Steering Committee on January 29, 2010 as documented in the handout titled: "SAIC Consultant Team Recommendations for Long Term Operations (January 29, 2010 draft D) – revised version based on SC input.]*

North Delta Diversion Bypass Flows

Objectives include flows of the functional equivalent thereof to (1) maintain fish screen sweeping velocities, (2) reduce upstream transport from downstream channels, (3) support salmonid and pelagic fish transport to regions of suitable habitat, (4) reduce predation effects downstream, and (5) maintain or improve rearing habitat in the north Delta.

Analytical Range A Operational Criteria[30]	Initial Operational Criteria	Analytical Range B Operational Criteria[1]
Constant Low-Level Pumping (Dec-Jun): • Diversions up to 10% of river flow for flows greater than 5,000 cfs. No more than 300 cfs at any one intake.	**Constant Low-Level Pumping (Dec-Jun):** • Diversions up to 6% of river flow for flows greater than 5,000 cfs. No more than 300 cfs at any one intake.	**Constant Low-Level Pumping (Dec-Jun):** • Diversions up to 2% of river flow for flows greater than 5,000 cfs. No more than 300 cfs at any one intake.
Initial Pulse Protection: • No pulse flow protection criteria implemented.	**Initial Pulse Protection:** • Low level pumping maintained through the initial pulse period. For the purpose of monitoring, the initiation of the pulse is defined by the following criteria: (1) Wilkins Slough flow changing by more than 45% over a five day period and (2) flow greater than 12,000 cfs. Low-level pumping continues until (1) Wilkins Slough returns to pre-pulse flows (flow on first day of 5-day increase), (2) flows decrease for 5 consecutive days, or (3) flows are greater than 20,000 cfs for 10 consecutive days. After pulse period has ended, operations will return to the bypass flow table (Table 3-6). These parameters are for modeling purposes. Actual operations will be based on real-time monitoring of fish movement. • If the first flush begins before Dec 1, May bypass criteria must be initiated following first flush and the second pulse period will have the same protective operation.	**Initial Pulse Protection:** • No range. (Same as initial operations)
Post-Pulse Operations: • After initial flush(es), go to Level I post-pulse bypass rule (see Table 3-6) until **10** total days of bypass flows above 20,000 cfs. Then go to the Level II post-pulse bypass rule until **20** total days of bypass flows above 20,000 cfs. Then go to the Level III post-pulse bypass rule.	**Post-Pulse Operations:** • After initial flush(es), go to Level I post-pulse bypass rule (see Table 3-6) until **15** total days of bypass flows above 20,000 cfs. Then go to the Level II post-pulse bypass rule until **30** total days of bypass flows above 20,000 cfs. Then go to the Level III post-pulse bypass rule.	**Post-Pulse Operations:** • After initial flush(es), go to Level I post-pulse bypass rule (see Table 3-6) until **20** total days of bypass flows above 20,000 cfs. Then go to the Level II post-pulse bypass rule until 45 total days of bypass flows above 20,000 cfs. Then go to the Level III post-pulse bypass rule.

[30] Analytical ranges represent the operational range limits for which the Effects Analysis will evaluate operational parameters. These analytical ranges are part of the process of identifying adaptive management ranges. It is expected that the eventual adaptive management range limits would fall within these analytical ranges.

Table 3-13. Proposed Long-Term Operational Criteria and Adaptive Range Limits (continued)

South Delta Channel Flows

Minimize take at south Delta pumps by reducing incidence and magnitude of reverse flows during critical periods for pelagic species.

Analytical Range A Operational Criteria

OMR Flows

Old and Middle River flows no less than the values below:

Combined Old and Middle River flows no less than values below* (cfs)					
Month	**W**	**AN**	**BN**	**D**	**C**
Jan	-6000	-6000	-6000	-6000	-6000
Feb	-6000	-6000	-6000	-6000	-6000
Mar	-6000	-6000	-6000	-6000	-6000
Apr	-6000	-6000	-6000	-6000	-6000
May	-6000	-6000	-6000	-6000	-6000
Jun	-6000	-6000	-6000	-6000	-6000
Jul	N/A	N/A	N/A	N/A	N/A
Aug	N/A	N/A	N/A	N/A	N/A
Sep	N/A	N/A	N/A	N/A	N/A
Oct	N/A	N/A	N/A	N/A	N/A
Nov	N/A	N/A	N/A	N/A	N/A
Dec	-7200	-7200	-7200	-7200	-7200

* Values are monthly average for use in modeling. December 20-31 targets are -6000 cfs and are averaged with an assumed background of -8000 cfs for December 1-19.

No Range.

Initial Operational Criteria

OMR Flows

FWS smelt and NMFS BO's model of adaptive restrictions (temperature, turbidity, salinity, smelt presence)

Table below provides a rough representation of the current estimate of "most likely" operation under FWS and NMFS BO's for modeling purposes.

Combined Old and Middle River flows no less than values below* (cfs)					
Month	**W**	**AN**	**BN**	**D**	**C**
Jan	-4000	-4000	-4000	-5000	-5000
Feb	-5000	-4000	-4000	-4000	-4000
Mar	-5000	-4000	-4000	-3500	-3000
Apr	-5000	-4000	-4000	-3500	-2000
May	-5000	-4000	-4000	-3500	-2000
Jun	-5000	-5000	-5000	-5000	-2000
Jul	N/A	N/A	N/A	N/A	N/A
Aug	N/A	N/A	N/A	N/A	N/A
Sep	N/A	N/A	N/A	N/A	N/A
Oct	N/A	N/A	N/A	N/A	N/A
Nov	N/A	N/A	N/A	N/A	N/A
Dec	-6800	-6800	-6300	-6300	-6100

* Values are monthly average for use in modeling. December 20-31 targets are -5000 cfs (W, AN), -3500 cfs (BN, D), and -3000 cfs (C), and are averaged with an assumed background of -8000 cfs for December 1-19. Values are reflective of the "most likely" operation under the FWS Delta Smelt Biological Opinion. Values for modeling may be updated based on review by fishery agencies.

South Delta Export – San Joaquin Inflow Ratio[31]

- Sliding scale for flows above the established OMR to share additional SJR flows between export and environment; export share would increase at higher flows
- Time value of benefit; crediting outside of period in which flows are acquired
- [Note that Conveyance WG/HOTT recommends continuing to evaluate the concept of isolating Old River to address south Delta channel flows.][32]

Analytical Range B Operational Criteria

OMR Flows

- Old and Middle River flows same as proposed Operations during December, January, and June
- Old and Middle River flows no less than -5,000 cfs between July and November

South Delta Export – San Joaquin Inflow Ratio

- 50% Feb & Mar
- 25% April & May

[31] The effects of potential increased San Joaquin River inflows on BDCP goals and objectives will be evaluated separately from the BDCP Effects Analysis.

Table 3-13. Proposed Long-Term Operational Criteria and Adaptive Range Limits (continued)

Fremont Weir/Yolo Bypass		
Considerations include (1) increasing spawning and rearing habitat for splittail and rearing habitat for salmonids for >30 days, (2) providing alternate migration corridor to the mainstem Sacramento River, and (3) increasing effectiveness of habitat and food transport in Cache Slough.		
Analytical Range A Operational Criteria	**Initial Operational Criteria**	**Analytical Range B Operational Criteria**
No Range.	• Sacramento Weir - No change in operations; improve upstream fish passage facilities • Lisbon Weir - No change in operations; improve upstream fish passage facilities • Fremont Weir – Improve fish passage at existing weir elevation; construct opening and operable gates at elevation 17.5 feet with fish passage facilities; construct opening and operable gates at a smaller opening with fish passage enhancement at elevation 11.5 feet	No Range.
Fremont Weir – Improve fish passage at existing weir elevation; construct opening and operable gates at elevation 17.5 feet with fish passage facilities		No Range.
Fremont Weir Gate Operations		
December 1-March 30 open the 17.5 foot elevation gates when Sacramento River flow at Freeport is greater than 25,000 cfs (provides local and regional flood control benefit and coincides with pulse flows and juvenile salmonid migration cues) to provide Yolo Bypass inundation of 3,000 to 6,000 cfs depending on river stage. Operating the gates to allow Yolo Bypass inundation when Sacramento River flow is greater than 25,000 cfs will reduce impacts to water supply associated with Hood bypass flow constraints. Potential impacts to water supply would be avoided or minimized through an operations plan.	December 1-March 30 (extend to May 15, depending on hydrologic conditions and measures to minimize land use and ecological conflicts) open the 17.5 foot and 11.5 foot elevation gates when Sacramento River flow at Freeport is greater than 25,000 cfs (provides local and regional flood control benefit and coincides with pulse flows and juvenile salmonid migration cues, provides seasonal floodplain inundation for food production, juvenile rearing, and spawning) to provide Yolo Bypass inundation of 3,000 to 6,000 cfs depending on river stage. Operating the gates to allow Yolo Bypass inundation when Sacramento River flow is greater than 25,000 cfs will reduce impacts to water supply associated with Hood bypass flow constraints. Potential impacts to water supply would be avoided or minimized through an operations plan.	No Range.
Close the 17.5 foot elevation gates when Sacramento River flow at Freeport recedes to less than 25,000 cfs	Close the 17.5 foot elevation gates when Sacramento River flow at Freeport recedes to less than 20,000 cfs but keep 11.5 foot elevation gates open to provide greater opportunity for fish within the bypass to migrate upstream into the Sacramento River; close 11.5 foot elevation gates when Sacramento River flow at Freeport recedes to less than 15,000 cfs	No Range.

[32] The concept of isolating Old River to address south Delta channel flows will be evaluated separately from the BDCP Effects Analysis.

Table 3-13. Proposed Long-Term Operational Criteria and Adaptive Range Limits (continued)

Delta Inflow & Outflow		
Considerations include (1) Provide sufficient outflow to maintain desirable salinity regime downstream of Collinsville during the spring, (2) explore range of approaches toward providing additional variability to Delta inflow and outflow.		
Analytical Range A Operational Criteria	**Initial Operational Criteria**	**Analytical Range B Operational Criteria**
Delta Outflow: Jul-Jan: Per D-1641 Feb-Jun: Per D-1641*, except no Roe Island triggering * Current relaxation of Collinsville standard to 4,000 cfs in May and June revised to state when the Eight River Index is 10.0 or less as established on May 1. ** Proportional Reservoir Release concept will continue to be evaluated to the extent that it provides similar response to outflow, inflow, and upstream storage conditions	**Delta Outflow:** Jul-Jan: Per D-1641 Feb-Jun: Per D-1641 * Proportional Reservoir Release concept will continue to be evaluated to the extent that it provides similar response to outflow, inflow, and upstream storage conditions	**Delta Outflow:** **Summer, Winter, and Fall:** Jul-Aug & Dec-Jan: Per D-1641 Sep-Nov: Fall X2 per FWS Smelt BO **Spring:** Feb-Jun: NGO X2-Eight River Index approach in all years (storage off-ramps in all year types will be refined to avoid upstream coldwater storage impacts on all reservoirs). * Proportional Reservoir Release concept will continue to be evaluated to the extent that it provides similar response to outflow, inflow, and upstream storage conditions ** Continue analysis of NGO watershed unimpaired runoff approach as it relates to PREs and parties outside of BDCP. Carry into "related action" alternative.
Delta Cross Channel Gate Operations		
Considerations include (1) reduce transport of outmigrating Sacramento River fish into central Delta, (2) maintain flows downstream on Sacramento River, (3) and providing sufficient Sacramento River flow into interior Delta when water quality for M&I and AG may be of concern.		
No Range.	Oct-Nov: DCC gate closed if fish are present (assume 15 days per month; may be open longer depending on presence of fish) Dec-Jun: DCC gate closed Jul-Sep: DCC gate open	No Range.
Rio Vista Minimum Instream Flows		
Maintain minimum flows for outmigrating salmonids and smelt.		
No Range.	Sep-Dec: Per D-1641 Jan-Aug: Minimum of 3,000 cfs	No Range.

Table 3-13. Proposed Long-Term Operational Criteria and Adaptive Range Limits (continued)

Operations for Delta Water Quality and Residence Time		
Considerations include (1) maintain a minimum level of pumping from the south Delta during summer to provide limited flushing for general water quality conditions (reduce residence times), (2) for M&I and AG salinity improvements, and (3) to allow operational flexibility during other periods to operate either north or south diversions based on real-time assessments of benefits to fish and water quality.		
Analytical Range A Operational Criteria	**Initial Operational Criteria**	**Analytical Range B Operational Criteria**
No Range.	**Assumptions for analysis:** Jul-Sep: Prefer south delta pumping up to 3,000 cfs before diverting from north Oct-Jun: Prefer north delta pumping (real-time operational flexibility)	No Range.
In-Delta Agricultural and Municipal & Industrial Water Quality Requirements		
Existing M&I and ag salinity requirements.		
No Range.	Existing D-1641 North and Western Delta AG and MI standards EXCEPT move compliance point from Emmaton to Three Mile Slough juncture. Maintain all water quality requirements contained in the NDWA/ DWR Contract and other DWR contractual obligations.[33]	No Range.

[33] The results of the water quality modeling from the effects analysis will be used to determine if other actions are needed to address water quality issues that may arise, including water quality in the southern and central Delta for both Agricultural and M*I due to the BDCP long-term operations.

Table 3-14. Post-Pulse Operations for North Delta Diversion Bypass Flows

*[**Note to Reviewers:** Table 3-13 and table 3-14 provide the proposed BDCP long term water operations for evaluation in the BDCP Effects Analysis. The criteria in these tables do not represent criteria agreed to by the Steering Committee; its purpose is for use in the Effects Analysis. These two tables are the same as the tables provided to the Steering Committee in February 2010. The operational criteria identified in these tables are the criteria agreed to by the BDCP Steering Committee on January 29, 2010 as documented in the handout titled: "SAIC Consultant Team Recommendations for Long Term Operations (January 29, 2010 draft D) – revised version based on SC input.]*

Level I Post-Pulse Operations

Based on the objectives stated above, it is recommended to implement the following operating criteria:

- Bypass flows sufficient to prevent upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough and (2) Sacramento River downstream of Georgiana Slough. These points are used to prevent upstream transport toward the proposed intakes and to prevent upstream transport into Georgiana Slough.

Dec - Apr

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping (see main table)
15,000 cfs	17,000 cfs	15,000 cfs plus 80% of the amount over 15,000
17,000 cfs	20,000 cfs	16,600 cfs plus 60% of the amount over 17,000 cfs
20,000 cfs	no limit	18,400 plus 30% of the amount over 20,000 cfs

Level II Post-Pulse Operations

Based on the objectives stated above, it is recommended to implement the following operating criteria:

- Bypass flows sufficient to prevent upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough and (2) Sacramento River downstream of Georgiana Slough. These points are used to prevent upstream transport toward the proposed intakes and to prevent upstream transport into Georgiana Slough.

Dec - Apr

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping (see main table)
11,000 cfs	15,000 cfs	11,000 cfs plus 60% of the amount over 11,000
15,000 cfs	20,000 cfs	13,400 cfs plus 50% of the amount over 15,000 cfs
20,000 cfs	no limit	15,900 cfs plus 20% of the amount over 20,000 cfs

Level III Post-Pulse Operations

Based on the objectives stated above, it is recommended to implement the following operating criteria:

- Bypass flows sufficient to prevent upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough and (2) Sacramento River downstream of Georgiana Slough. These points are used to prevent upstream transport toward the proposed intakes and to prevent upstream transport into Georgiana Slough.

Dec - Apr

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping (see main table)
9,000 cfs	15,000 cfs	9,000 cfs plus 50% of the amount over 9,000
15,000 cfs	20,000 cfs	12,000 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	13,000 cfs plus 0% of the amount over 20,000 cfs

Table 3-14. Post-Pulse Operations for North Delta Diversion Bypass Flows (continued)

Level I Post-Pulse Operations

May

If Sacramento River flow is over---	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping (see separate table)
15,000 cfs	17,000 cfs	15,000 cfs plus 70% of the amount over 15,000
17,000 cfs	20,000 cfs	16,400 cfs plus 50% of the amount over 17,000 cfs
20,000 cfs	no limit	17,900 plus 20% of the amount over 20,000 cfs

Jun

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping (see separate table)
15,000 cfs	17,000 cfs	15,000 cfs plus 60% of the amount over 15,000
17,000 cfs	20,000 cfs	16,200 cfs plus 40% of the amount over 17,000 cfs
20,000 cfs	no limit	17,400 plus 20% of the amount over 20,000 cfs

Jul-Sep: 5,000 CFS
Oct-Nov: 7,000 cfs

Level II Post-Pulse Operations

May

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping (see separate table)
11,000 cfs	15,000 cfs	11,000 cfs plus 50% of the amount over 11,000
15,000 cfs	20,000 cfs	13,000 cfs plus 35% of the amount over 15,000 cfs
20,000 cfs	no limit	14,750 cfs plus 20% of the amount over 20,000 cfs

Jun

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping (see separate table)
11,000 cfs	15,000 cfs	11,000 cfs plus 40% of the amount over 11,000
15,000 cfs	20,000 cfs	12,600 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	13,600 cfs plus 20% of the amount over 20,000 cfs

Jul-Sep: 5,000 CFS
Oct-Nov: 7,000 CFS

Level III Post-Pulse Operations

May

If Sacramento River flow is over---	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping (see separate table)
9,000 cfs	15,000 cfs	9,000 cfs plus 40% of the amount over 9,000
15,000 cfs	20,000 cfs	11,400 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	12,400 cfs plus 0% of the amount over 20,000 cfs

Jun

If Sacramento River flow is over--	But not over--	The bypass is:
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping (see separate table)
9,000 cfs	15,000 cfs	9,000 cfs plus 30% of the amount over 9,000
15,000 cfs	20,000 cfs	10,800 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	11,800 cfs plus 0% of the amount over 20,000 cfs

Jul-Sep: 5,000 CFS
Oct-Nov: 7,000 CFS

The Sacramento River, in addition to its upstream tributaries, is the primary migration corridor and spawning/rearing habitat for Chinook salmon, Central Valley steelhead, green and white sturgeon, and Pacific and river lamprey spawning in the Sacramento River watershed. Further, both delta smelt and longfin smelt are thought to spawn in the lower Sacramento River (Wang 1986, Bennett 2005). Important fishery issues with respect to seasonal river flows include: (1) adult Chinook salmon, steelhead, green and white sturgeon, and Pacific and river lamprey attraction flows and upstream migration; (2) juvenile Chinook salmon, steelhead, and Pacific and river lamprey downstream migration and survival; (3) downstream transport of planktonic fish eggs and larvae; (4) downstream transport of food and other organic material; and (5) habitat for both resident and migratory covered fish species within the lower Sacramento River. The importance of river flows to each life stage of the covered fish species varies seasonally depending life history and habitat requirements for each species. Because of the importance of the Sacramento River as a migration route and habitat for covered fish species, maintaining sufficient flows within the river to support this function is an important operational objective for covered fish species.

Hypotheses: Relocation and operation of the primary point of SWP and CVP water diversions from the south Delta to multiple facilities on the Sacramento River between Freeport and Courtland and conveying water through a tunnel/pipeline facility are hypothesized to provide a broad range of benefits to covered fish species, the Delta ecosystem, and water supply if operated according to an appropriate set of operational parameters, which are described as part of this conservation measure. The following hypotheses provide the justification for the relocation of the primary point of diversion:

1. Relocation and operation of the primary point of diversion to the north Delta will substantially reduce entrainment of the larvae of covered fish species by reducing the spatial overlap of diversion intakes and covered fish species. The location of the existing south Delta export facilities is within the influence of all covered fish species for at least part of the year. However, the population centers of resident estuarine species, particularly delta and longfin smelt, are downstream of the reach of the Sacramento River where the north Delta intakes could be installed (Wang 1986, Bennett 2005).

2. Equipping facility intakes with state-of-the-art positive barrier fish screens will substantially reduce entrainment and impingement losses of juveniles and adults of covered fish species. These screens will be engineered to provide a maximum approach velocity coupled with a minimum unidirectional sweeping velocity to protect covered fish species when fish are within the vicinity of intakes.

3. Constructing multiple intakes (rather than one or few) along the Sacramento River between Freeport and Courtland will substantially reduce entrainment and impingement losses of juveniles and adults of covered fish species. Multiple intakes will reduce the distance fish must travel past each fish screen, allowing individuals to

rest between intake locations. Early estimates indicated that, if one 15,000 cfs intake were constructed, a single fish screen nearly a mile long will need to be constructed to meet approach and sweeping velocity criteria. This distance would expose fish to screens for longer periods, potentially exhausting them, reducing their swimming ability, and increasing their vulnerability to impingement.

4. Reducing water diversions in the tidal region of the Delta will substantially reduce entrainment and impingement losses of juveniles and adults of covered fish species. Reverse flows associated with tidal oscillations increase the zone of influence of existing diversion facilities in many south Delta channels, potentially increasing the risk of entrainment of covered fish species. Relocating the primary point of diversion farther upstream will reduce the tidal influence on diversions, which will reduce entrainment of covered fish species. Further, for positive barrier fish screens to function properly to minimize fish entrainment and impingement risk, a minimum unidirectional sweeping velocity must be maintained. Opportunities for such velocity improve as tidal influence decreases farther upstream.

5. Relocation and operation of the primary point of diversion to the north Delta will reduce the export of nutrients, phytoplankton, zooplankton, macroinvertebrates, and other organic material from the estuary. The location of existing south Delta diversion facilities is thought to be in an area that exports higher concentrations of nutrients, phytoplankton, zooplankton, macroinvertebrates, and other organic material than will occur with the new proposed reach of the Sacramento River. As a result, the loss of Delta productivity may be lower if water is diverted at north Delta facilities compared to existing south Delta facilities.

6. Improving hydrodynamics within Delta channels will improve fishery and aquatic habitat within the Delta. Existing flow patterns in the Delta have been altered to maintain high water quality in the south Delta for project exports, as well as for local agricultural and other urban water uses. Such alterations include north to south flows through the man-made Delta Cross Channel and reverse flows in Old and Middle Rivers, generating adverse effects on fish and aquatic processes.

7. Relocation and operation of the primary point of diversion to the north Delta will reduce or eliminate mortality of covered fish species associated with collection, handling, transport, and release of salvaged fish from the existing export facilities and predation within these facilities. A north Delta diversion facility will be designed to avoid altogether the need to salvage fish by constructing in-river or on-river facilities.

8. Relocation and operation of the primary point of diversion to the north Delta will improve water supply reliability and flexibility under conditions of future environmental change. Because of their location, new diversion facilities could withstand predicted future sea level rise in ways that existing diversion facilities will not. Multiple intakes will add flexibility in operations to handle variation in the location of covered fish and tidally-induced flows.

9. Reducing artificial north-to-south through-Delta flows when covered fish are present will increase hydraulic residence time and improve aquatic productivity in the interior Delta. Existing Delta operations promote north-to-south flow of water via the Delta Cross Channel to offset high salinities and lower inflows from the San Joaquin River. By reducing South Delta diversions, less water will move from north to south, resulting in increased residence time of nutrients and organic matter, allowing these materials to be assimilated into the Delta food web.

10. Reducing the reliance on through-Delta conveyance via the Delta Cross Channel and intakes in the south Delta will provide greater opportunity for effective physical habitat restoration and enhancement in the western, eastern, and southern Delta. Decreased south Delta pumping will reduce the export of primary and secondary ecological production that may result from restored habitat, which would other reduce or eliminate the expected benefits of the habitat restoration also proposed by the BDCP. Restoration in these parts of the Delta, as well as Delta-wide hydrodynamic changes expected from a north Delta diversion, will reestablish ecosystem complexity by improving aquatic ecosystem processes, distribution, connectivity, migration, transport, and residence time in ways that the current water conveyance system cannot accommodate.

11. Reducing the reliance on through-Delta conveyance via the Delta Cross Channel and intakes in the south Delta will substantially reduce the effects of existing water projects on salmonids in the San Joaquin River system and tributaries, Mokelumne River, and other east side tributaries. Such artificial flow patterns are thought to entrain outmigrating juvenile salmonids in these channels towards the pumps and confuse the upstream migration cues of adults. Although the potential for adverse effects on Sacramento River salmonids may increase, these effects are predicted to be avoided or minimized by the positive fish screen and sweeping and approach velocity criteria (see #2-4 above) and other operational parameters.

12. Relocation and operation of the primary point of diversion to the north Delta will facilitate the implementation of some other conservation measures focused on non-flow and non-habitat related stressors.

13. Relocation and operation of the primary point of diversion to the north Delta will allow for the emulation of more natural physical patterns (e.g., salinity regimes, flow patterns) and processes in the Delta under which native resident species evolved. For example, a change in the hydrograph could favor native species by providing proper timing of biological processes from physical cues, such as those needed to initiate upstream or downstream migration, and create conditions that disfavor non-native species, such as reduced summer inflows, which are currently higher than would occur naturally.

The following hypotheses provide the basis for maintaining bypass flows past the proposed new north Delta diversions:

1. Maintaining bypass flows will maintain adequate flows in the mainstem Sacramento River and distributaries downstream of the points of diversion for covered fish species. Of particular interest are flow rates within Sutter and Steamboat Sloughs. These sloughs are existing channels that convey water from the Sacramento River in the general vicinity of Courtland downstream to approximately Rio Vista where they re-enter the lower Sacramento River. Both channels currently have a hydraulic capacity greater than 500 cfs. Benefits maintaining adequate flows in Sutter and Steamboat Sloughs include:

   - Providing an alternative migration route for salmonids (Perry and Skalski 2008) and possibly splittail, sturgeon, and lamprey that circumvents the Delta Cross Channel and Georgiana Slough, thereby reducing the likelihood of covered fish species moving into the interior Delta where they may be exposed to higher predation pressure and entrainment into the south Delta pumps.
   - Providing high quality juvenile rearing habitat and adult holding habitat for salmonids, sturgeon, and splittail. Both slough channels support substantially more woody riparian vegetation and greater habitat diversity (e.g., water depths, velocities, in-channel habitat, etc.) than is present along the mainstem Sacramento River between Courtland and Rio Vista.
   - Providing high quality spawning habitat for splittail during dry periods without floodplain inundation.

   Despite these anticipated benefits, Perry and Skalski (2009) and Perry et al. (2010) indicate that survival rates of juvenile Chinook salmon in Sutter and Steamboat sloughs are highly variable relative to the mainstem Sacramento River; in their studies, they have found that survival has been higher than, lower than, and similar to survival rates in the mainstem Sacramento River rates. Recent hydrodynamic modeling indicates that substantial habitat restoration in the Cache Slough area (see Section 3.4.3.2), in combination with bypass flow requirements for the north Delta diversions, will enhance downstream flows in Sutter and Steamboat sloughs substantially above those present under current conditions without facility north Delta diversion facility (A. Munevar unpubl. data). Further, the BDCP proposes to enhance channel margin habitat in Sutter and Steamboat sloughs in part to create habitat that is unfavorable to non-native predators that may be reducing survival of Chinook salmon, and likely other covered species in these sloughs. Therefore, in combination with these other conservation measures, maintaining bypass flows is expected to improve survival of salmonids, sturgeon, and splittail in Sutter and Steamboat sloughs.

2. Maintaining bypass flows will provide transport flows necessary for downstream movement of delta and longfin smelt. Newly hatched larval delta and longfin smelt, called yolk-sac larvae, have a yolk sac attached to them with an oil globule (Wang

1986). The yolk sac provides nourishment for delta smelt larvae for approximately 4 to 6 days (Bennett 2005) and is thought to be similar for longfin smelt. These larvae are very weak swimmers and drift downstream with flows from the Sacramento River to the low salinity zone, where they can find suitable prey. To avoid starvation, this downstream movement must take place before the entire yolk sac is absorbed. Because downstream yolk-sac larval movement is driven nearly entirely by downstream flows, a minimum bypass flow criteria that allows this movement to occur is necessary.

3. Maintaining minimum bypass flows will provide downstream transport of food and organic material. The Sacramento River is used as a major corridor through which food and other organic material from upstream are transported downstream to the Delta and bays. The Delta and bays acquire production from upstream habitats to support their ecosystems.

4. Maintaining minimum bypass flows will provide necessary attraction flows for upstream migration of adult Chinook salmon, steelhead, and green and white sturgeon, including attraction flows through Sutter and Steamboat Sloughs.

5. Maintaining minimum bypass flows will minimize tidally driven bidirectional flows near diversion intakes, reducing the exposure duration of covered fish species to predators that will likely reside near intake structures. Unidirectional flows past intakes may also affect local current patterns and hydrodynamics in the vicinity of the screen surface that may affect fish entrainment or impingement, debris loading, effectiveness of fish screen cleaning mechanisms in removing debris from the screen surface, and maintaining a uniform approach velocity within the screen design criterion.

Developing bypass flow criteria for the north Delta diversion facilities involved consideration of the seasonal timing of various life stages of covered fish species within the lower Sacramento River, relationships between river flow, water velocity, transport time, and residence time, and the growth, survival, and distribution of various life stages of the covered species.

Adaptive Management Considerations: Results of the biological monitoring would be used adaptively in a variety of ways that include, but are not limited to: (1) changes in diversion operations within a range of adopted diversion parameters that are based on “real-time” monitoring of the occurrence of covered fish in the area; (2) selectively operating diversions based on the geographic distribution of covered fish within the river; and (3) changing diversion operations based on tidal velocity and river flows to increase sweeping velocity and the rate of fish movement past fish screens.

Results of both biological and operational monitoring throughout the Delta could be used within the BDCP adaptive management framework to refine and modify river bypass flow rates. For example, additional information on the actual timing of fish migration downstream within the Sacramento River within a given year could result in modification to the river bypass flows to facilitate migration past the points of diversion and fish screens. The adaptive management ranges provided for operational criteria under this conservation measure (Tables 3-13 and 3-14) provide flexibility to incorporate new knowledge gained through monitoring and research and to respond to changes in the system.

South Delta Diversion Operations and Old and Middle River Flows.

To reduce the impacts of south Delta diversions on covered fish species and the Delta environment, Old and Middle River reverse flows will meet the operational criteria described in Table 3-13. These rivers are subject to reduced or reverse flows as a result of low San Joaquin River inflow, flood tides, and water exports at SWP and CVP facilities. These flow conditions can result in increased risk of entrainment of fish, invertebrates, phytoplankton, and other organic material.

Diversions from the south Delta SWP and CVP facilities will be reduced considerably during wetter periods with dual operation of new north Delta diversion facilities. During wetter periods in the BDCP long-term implementation period, water will be diverted from the south Delta to augment north Delta diversions and may be diverted in appropriate circumstances to improve circulation and maintain water quality conditions in the interior and southern Delta.

Operational Criteria and Adaptive Limits. The operational criteria for south Delta operations and Old and Middle River flows during the BDCP long-term implementation periods are described in Table 3-13.

With operation of north Delta diversion facilities in the long-term implementation period, the existing south Delta SWP and CVP export facilities will be operated as part of a dual conveyance facility and exports from the south Delta will be substantially reduced (the north Delta diversion facilities will be equipped with state-of-the-art positive barrier fish screens and will be the primary point of long-term diversion during wetter periods). The dual export system will be operated to meet water supplies.

> **Problem Statement:** Export operations of the SWP and CVP diversion facilities in the South Delta, in combination with San Joaquin and Sacramento River flows, tidal effects, and substantially reduced inflows into the Delta, have been identified as primary factors in altering hydrodynamic conditions within Delta channels and associated fishery habitat (DWR 2006, Baxter et al. 2008). Export operations of the SWP and CVP pumping plants contribute to local changes in water current patterns, water quality, and direct entrainment and losses of fish, macroinvertebrates, nutrients, phytoplankton, and zooplankton from the Delta environment (DWR 2006).
>
> Although the response of various lifestages of covered species to flows within Old and Middle rivers is dynamic and variable within and among species, there is a positive relationship between the magnitude (average monthly) of reverse flows within Old and Middle rivers and the occurrence of pre-spawning adult delta smelt in SWP and CVP fish

salvage during the winter months (Kimmerer 2008, USFWS 2009c). Further, particle tracking model simulations predict that there is a greater risk that planktonic early lifestages of covered fish species (e.g., larval delta smelt) will be vulnerable to entrainment at the SWP and CVP export facilities when reverse flows within Old and Middle rivers increase. In addition, a number of the covered fish, including the juvenile and adult lifestages of Chinook salmon, steelhead, delta smelt, longfin smelt, sturgeon, lamprey, and splittail are expected to use hydrodynamic cues (e.g., channel flow direction and magnitude) to help guide movement through the Delta. Reverse flows in Delta channels are thought to contribute to false attraction to migration cues, longer migration routes that may expose fish to sources of mortality such as predation, exposure to seasonally elevated water temperatures and other stressors, and increased vulnerability to entrainment at the SWP and CVP south Delta export facilities.

Reverse flows within the channels of Old and Middle rivers are also hypothesized to affect local and regional habitat conditions for covered fish and other aquatic species. Changes in channel velocity and flow patterns affect hydraulic residence time in the area and the production of phytoplankton and zooplankton that are important to the diet of covered fish. Channel velocities, scour, and deposition patterns affect habitat for benthic organisms and other macroinvertebrates. Changes in tidal hydrodynamics, especially channel velocity, affect habitat suitability for covered fish and other aquatic species in the area.

Relationships between the magnitude of reverse flows in Old and Middle rivers and corresponding changes in salvage of various covered fish, such as juvenile Chinook salmon, steelhead, splittail, longfin smelt, lamprey, and sturgeon, are highly variable. Analyses and evaluations are ongoing to further assess the potential biological benefits of managing SWP and CVP south Delta exports based on direct diversion rates or changes in the magnitude of reverse flows in Old and Middle rivers.

Hypotheses: Reducing diversions in the South Delta are hypothesized to:

- Reduce the risk of entrainment mortality of salmonids, smelt, splittail, sturgeon and lamprey;
- Reduce the risk of predation mortality of salmonids, smelt, lamprey, and splittail in Clifton Court Forebay; and
- Reduce the risk of entrainment of organic matter and food for salmonids, smelt, splittail, and sturgeon.

Adaptive Management Considerations: Results of biological monitoring will be used within the BDCP adaptive management framework to refine and modify seasonal operations of Old and Middle River flows. The adaptive management ranges provided for operational criteria under this conservation measure (Tables 3-13 and 3-14) provide flexibility to incorporate new knowledge gained through monitoring and research and to respond to changes in the system.

Delta Cross Channel Gate Operations

The Delta Cross Channel gates will be operated during the long-term implementation period to improve fish migration, hydrodynamics (including hydraulic residence time), and food and organic material transport while minimizing changes to water quality for agriculture, municipal, and industrial uses in the interior and southern Delta.

Delta Cross Channel gates are located on the Sacramento River near Walnut Grove (Figure 3-52). The Delta Cross Channel serves as a conveyance facility for water to move from the Sacramento River into the interior Delta. Water quality in the central and south Delta can degrade during low San Joaquin River flows. The Delta Cross Channel was constructed to move higher quality Sacramento River towards the central and south Delta to improve water quality there. Juvenile Chinook salmon, and presumably a number of other fish species, move from the Sacramento River into the interior Delta when the gate is open (Brandes and McLain 2001). Results of survival studies using coded wire tagged and radio tagged fish suggest that survival juvenile Chinook salmon passing into the Delta through the Delta Cross Channel is lower than survival of those migrating down the mainstem Sacramento River (Brandes and McLain 2001, Perry and Skalski 2009, Perry et al. 2010). Based on results of these studies, closure of Delta Cross Channel gates between February 1 and May 20 was established under D-1641 for fish benefits.

Operational Criteria and Adaptive Limits. The operational criteria for the Delta Cross Channel gates during the BDCP long-term implementation period are described in Table 3-13.

Problem Statement: When the Delta Cross Channel is open, fish move into the interior Delta with Sacramento River water (Brandes and McLain 2001). Survival of juvenile Chinook salmon, and likely other fish species, within the interior Delta is lower than survival in the mainstem Sacramento River (Baker and Morhardt 2001, Brandes and McLain 2001, CALFED 2001, Perry and Skalski 2009, Perry et al. 2010), although it is unknown whether this reduced survival has a population level effect on Chinook salmon (Manly 2002, 2008).

Current seasonal operations of the Delta Cross Channel gates designated by D-1641 are designed to prohibit the migration of juvenile fish from the Sacramento River into the interior Delta through the Delta Cross Channel during the spring. However, adverse effects of an open DCC operation to anadromous fish, and other fish, also occur outside of this closure period. Furthermore, open gates decrease velocities and increase bi-directional flows in the Sacramento River and its distributaries, slowing the migration of covered species and increasing their vulnerability to predation or mortality from poor habitat. Therefore, lengthening the closure period or operating on a tidal or daily cycle may improve survival of salmonids and other covered fish species.

Hypotheses: Revised operations of Delta Cross Channel gates are hypothesized to:

- Increase the survival of juvenile Chinook salmon and possibly other covered fish species by: (1) improving downstream migration of fish in the Sacramento River and tributaries, which will reduce their risk to predation and other sources of mortality; and (2) reducing the proportion of fish entering the interior Delta, where survival of juvenile Chinook salmon is lower (Baker and Morhardt 2001, Brandes and McLain 2001, CALFED 2001, Perry and Skalski 2009, Perry et al. 2010). Several hypotheses have been suggested to explain reduced survival of juvenile Chinook salmon in the interior Delta relative to the mainstem Sacramento River, including, but not limited to: (1) increased exposure to unscreened water diversions within the Delta channels; (2) exposure to seasonally elevated water temperatures and potentially toxic contaminants; (3) increased residence time and longer migration routes leading to longer exposure to environmental conditions within the Delta and increased vulnerability to predation mortality; (4) delayed migration as a result of altered hydrologic conditions in Delta channels as a result of SWP and CVP export operations; and (5) direct losses as a result of entrainment, predation, or salvage mortality at the south Delta SWP and CVP export facilities (Baxter et al. 2008).

- maintain sufficient water quality in the south Delta in combination with minimal year-round pumping in the south Delta (see Section 3.4.2.1, CM1). Seasonally elevated water temperatures and an accumulation of toxics can occur in the central and south Delta, likely as a result of high residence times associated with low inflows from the San Joaquin River. These impairments can have lethal and sublethal effects on covered fish species inhabiting the south and central Delta. In addition, modeling results indicate that drinking water quality standards for the south Delta under D-1641 would not be violated under this revised set of operational criteria (A. Munevar pers. comm.).

- Improve the strength of migration cues and avoid false cues for adult migrating steelhead, Chinook salmon, and sturgeon on the Sacramento and San Joaquin Rivers. When the Delta Cross Channel is open, water from the Sacramento River mixes with water from the Mokelumne, Cosumnes, and San Joaquin Rivers, reducing the strength of migration cues to salmonids and sturgeon migrating upstream. Therefore, increasing the duration of Delta Cross Channel closure will allow more anadromous fish below the Delta Cross Channel to directly sense migration cues to upstream habitat, thus increasing the ability to move upstream and reducing delays to spawning; and

- Improve downstream flows and downstream transport of fish eggs, larvae, juveniles, food, and organic material within the Sacramento River into the Delta.

Adaptive Management Considerations: Results of biological monitoring will be used within the BDCP adaptive management framework to refine and modify seasonal operations of Delta Cross Channel gates.

Rio Vista Flows

Sufficient Rio Vista flows will be maintained during the long-term implementation period for the benefit of covered fish species. The lower Sacramento River serves as an important part of the aquatic habitat within the Delta. Diversion of water at new north Delta Diversion Facilities, as well as diversion of water from the mainstem river into side channels (e.g., Delta Cross Channel) or seasonally inundated floodplain habitat (e.g., Yolo Bypass), has a direct effect on flow rates in the Sacramento River at Rio Vista. Identification of a minimum flow requirement at Rio Vista is intended to support fishery and aquatic habitat in the reach of the Sacramento River located between Sacramento and Rio Vista. Flow in the mainstem Sacramento River at Rio Vista is augmented by the flow contribution from Cache Slough, the Yolo Bypass, Sutter and Steamboat Sloughs, and other local tributaries. Minimum river flows at Rio Vista in the fall are included in current regulations (D-1641, biological opinions).

Operational Criteria and Adaptive Limits. The operational criteria for Rio Vista flows during the BDCP long-term implementation periods are described in Table 3-13.

Problem Statement: The Sacramento River, in addition to its upstream tributaries, is the primary migration corridor in the Delta for Chinook salmon, Central Valley steelhead, sturgeon, and lamprey from the Sacramento River basin. In addition, both delta and longfin smelt likely spawn in the lower river in the general vicinity of Rio Vista. Key fishery issues with respect to seasonal river flows at Rio Vista have primarily focused on adult Chinook salmon and steelhead attraction and upstream migration flows during the fall months. The importance of river flows to each of the species and lifestages of covered fish species varies seasonally depending on the life history and habitat requirements of the species.

Hypotheses: Maintaining sufficient flows past Rio Vista is hypothesized to:

- Maintain sufficient attraction and upstream migration flows for adult salmonids, sturgeon, and lamprey in the Sacramento River;
- Maintain sufficient downstream migration of juvenile Chinook salmon, steelhead, and lamprey from the Sacramento River basin;
- Maintain sufficient downstream transport of planktonic fish eggs and larvae;
- Maintain sufficient downstream transport of organic material, phytoplankton, and zooplankton; and
- Provide high quality habitat for both resident and migratory species within the lower river.

Adaptive Management Considerations: Results of biological monitoring will be used within the BDCP adaptive management framework to refine and modify the seasonal river flow criteria at Rio Vista.

Delta Outflows

Sufficient Delta outflows will be maintained during the long-term for the benefit of covered fish species. Delta outflows provide for downstream transport of fish and other aquatic organisms as well as organic material and prey for covered species into the lower reaches of the Delta and Suisun Bay. In balance with upstream salinity intrusion from the bay, Delta outflows also control the location of the low salinity region of the estuary (Baxter et al. 1999, Kimmerer 2004). The abundance of life stages of a number of fish species, including some covered fish species (longfin smelt), has been positively correlated with the location of the low salinity zone (generally measured as X2) within the estuary (Baxter et al. 1999, Kimmerer 2004). Suisun Bay and the western Delta represent important low salinity habitat areas within the estuary. Open water habitat in this region serves as larval and juvenile rearing, adult holding, and foraging habitat for resident and anadromous fish and a wide variety of other aquatic and wildlife species, and as a migration corridor for anadromous species such as salmon, steelhead, sturgeon, and lamprey. Based on the information regarding the relationship between fish abundance and X2 location, the State Water Quality Control Board's D-1641 and the USFWS Biological Opinion include requirements for maintaining the X2 location during the late winter and spring within Suisun Bay.

Operational Criteria and Adaptive Limits. The operational criteria for Delta outflow during the BDCP long-term implementation period are described in Table 3-13.

Problem Statement: Fishery monitoring studies conducted by DFG (Baxter et al. 1999) suggest that abundances of juvenile lifestages of many fish (e.g., starry flounder, splittail, longfin smelt, and striped bass) and macroinvertebrates are correlated with the location of the low salinity zone during the late winter and spring (e.g., February through June [Kimmerer 2004]). For example, longfin smelt juvenile abundance indices increased as the location of X2 moved further downstream (west) within Suisun Bay (Kimmerer 2004). Recent analyses have suggested that previous correlations between X2 location and fish abundance indices have changed (Kimmerer 2004). The changes observed in these relationships have been hypothesized to be the result of the introduction and rapid colonization of Suisun Bay by the filter feeding Asian overbite clam (*Corbula*) and a subsequent reduction in phytoplankton and zooplankton as food supplies for juveniles within Suisun Bay (Kimmerer 2004). Another change in this relationship has occurred since 2001 in conjunction with the pelagic organism decline, although the cause of this change is currently unknown (Baxter et al. 2008).

Factors that may contribute to the relationship between Delta outflow (as well as X2 location) and juvenile fish abundance are heavily debated, but may include increased productivity and availability of high quality habitat within Suisun Bay; downstream transport of fish, food, and organic matter; reduced temperature and/or toxics exposure with lower X2; inundation of backwater and floodplains with high flows; and the distribution of early lifestages of fish into habitats that are located further downstream with decreased vulnerability to direct and indirect effects of south Delta SWP and CVP export operations.

Hypotheses: Allowing Delta outflow in the adaptable range above is hypothesized to:

- Provide for downstream transport of fish and other aquatic organisms into the lower reaches of the Delta and Suisun Bay;
- Provide sufficient flushing of the Delta to avoid and prolonged exposure to high water temperatures and toxics by covered fish species;
- Provide a suitable location for the low salinity zone; and
- Provide for downstream transport of organic material and prey for covered species into the lower reaches of the Delta and Suisun Bay.

Adaptive Management Considerations: Based on results and analysis of monitoring data, adaptive modifications to management of Delta outflow under the BDCP adaptive management framework could occur by modifying operational criteria by season or water-year type (hydrology) or by addressing other stressors and factors that may affect the survival or abundance of a covered fish species.

Delta Water Quality Maintenance.

Dual conveyance facilities in the Delta will be operated during the long-term implementation period to balance flows and exports for fish protection and water quality for both fish and humans while maintaining water supply reliability. Preferential south Delta operations during summer months when flows in the San Joaquin River are lowest will provide flushing the south and central Delta water with fresh Sacramento River water, thus reducing hydraulic residence time and improving water quality for fish, agriculture, and M&I uses in the south and central Delta.

Considerations regarding dual operations of conveyance facilities include: (1) providing limited flushing for general water quality conditions (reduce residence times) during low San Joaquin River flow periods, (2) maintaining adequate M&I and agricultural salinity in the central and south Delta, and (3) allowing operational flexibility during other periods to operate either north or south Delta diversions based on real-time assessments of benefits to fish, water quality, and operational constraints.

Operational Criteria and Adaptive Limits. The operational criteria for dual conveyance operations, including operations to maintain Delta water quality, during the BDCP long-term implementation periods are described in Table 3-13.

Problem Statement: The balance of fish protection, water supply reliability, and water quality for both fish and humans is dependant, in part, on hydrologic and water quality (e.g., salinity, dissolved oxygen, etc.) conditions occurring within Delta channels, densities of covered fish in the general region of the central and south Delta, and the magnitude of effect of south Delta exports on reverse flows in Old and Middle rivers.

Hypotheses: Dual operation of conveyance facilities in the long-term implementation period according to the operational criteria in Table 3-13 is hypothesized to:

- Reduce entrainment mortality of all covered fish species at south Delta facilities;
- Reduce toxic-related mortality and sublethal effects to all covered fish species in the central and south Delta;
- Reduce the effects of the proliferation of noxious algae, such as Microcystis, in the central and south Delta. Microcystis tends to grow in warm, slowly moving water (Lehman et al. 2008). Microcystis is known to disrupt the food web by being toxic to zooplankton and macroinvertebrates (Resources Agency 2007, Baxter et al. 2008); and
- Reduce the effects of the proliferation of SAV, such as Egeria, in shallow areas of the central and south Delta. Egeria tends to establish and grow at faster rates in warm, slowly moving water (Barko and Smart 1981, Gantes and Caro 2001) (see Section 3.4.3.10 *SAV/FAV Control* for detail on effects to these covered species),

Adaptive Management Considerations: Effectiveness monitoring of water quality parameters, including EC, temperature, selenium, and other toxics as deemed necessary by the BDCP Implementation Office, in central and south Delta before and after preferential south Delta operations begin will inform adaptive management decisions to change pumping rates at the south Delta.

In-Delta Agricultural, Municipal, and Industrial Water Quality Requirements.

In the long-term implementation period, D-1641 North and Western Delta agricultural and municipal and industrial (M&I) standards will be maintained, except that the D-1641 compliance point will be moved from Emmaton to the Three Mile Slough juncture. All water quality requirements contained in the North Delta Water Agency/DWR Contract and other DWR contractual obligations will be maintained.

Operational Criteria and Adaptive Limits. The operational criteria for in-Delta agricultural, municipal, and industrial water quality requirements during the BDCP long-term implementation period are described in Table 3-13.

Problem Statement. Salinity in the Delta is primarily a function of freshwater flowing from tributary rivers and saltwater intrusion from the Pacific Ocean. Areas located downstream such as Suisun Bay and further west are characterized by increasing salinity gradients. The northern and eastern Delta is characterized by primarily freshwater aquatic habitats. The lower San Joaquin River and southern Delta are characterized by low salinity waters, primarily resulting from saline agricultural drainage returns with elevated salt concentrations discharging into the San Joaquin River (DWR et al. 2006). If salinity increases to levels above standards dictated in D-1641, agricultural and M&I use of exported water can be severely limited.

Hypotheses. Maintaining existing D-1641 North and Western Delta agricultural and municipal and industrial (M&I) standards and all water quality requirements contained in the North Delta Water Agency/DWR Contract and other DWR contractual obligations would permit existing agricultural and M&I uses of water in these areas.

Adaptive Management Considerations. Within the BDCP framework of adaptive management, the BDCP Implementing Entity will monitor and adaptively manage salinity in the Delta in response to any adverse impacts resulting from the operational criteria described above

Montezuma Slough Salinity Control Gate Operations.

Coordination will occur with the Suisun Marsh Charter Group over the term of the BDCP to seek amendments to the Suisun Marsh Plan (in development) that will provide for reducing the long-term operation of the Montezuma Slough Salinity Control Gate. This action will allow more water to flow past Chipps Island and will improve access of covered fish species to existing and future restored intertidal marsh habitats.

Suisun Marsh is currently managed largely to provide seasonal freshwater wetland habitat, primarily to support waterfowl habitat and recreation. There are approximately 150 waterfowl hunting clubs in the Suisun Marsh, and wetland managers flood their ponds in early October and drain them after the end of the waterfowl season in January. The Montezuma Slough Salinity Control Gate was originally installed and operated as a tidal pump to reduce salinity within the marsh: the one-way gates were opened on the ebb tide to allow freshwater from upstream to enter the slough and closed on the flood tide to prohibit saline water from entering the slough. Operation of the gates also results in a net flow of water from east to west. The salinity control structure (the gates and associated flashboards) not only alters local hydrodynamics and water quality conditions but also impedes the migration and passage of various fish species. The gates are operated on average 10 days every year, all during the period of early October through May (B. Burkhard, pers. comm.). Operation of the gates is based on tidal stage and triggered by high salinity readings in the marsh. DWR and USBR are required to meet water salinity standards for the Suisun Marsh established by the SWRCB under D-1641.

Operational Criteria and Adaptive Limits. In the beginning of BDCP implementation, Montezuma Slough Salinity Control Gates will continue to operate in the same way as existing standards. However, as land use changes during the 50 year implementation period, the gates may stay open for longer up to possibly remaining open year-round, as determined through adaptive management (see Section 3.7 *Adaptive Management*).

Problem Statement. The Montezuma Slough Salinity Control Gate has been identified as an impediment to migration and passage of species such as Chinook salmon, steelhead, and green sturgeon through Montezuma Slough (Fujimura et al. 2000). In addition, existing operations of the control structure alter local current patterns and tidal hydrodynamics within Montezuma Slough, in large regions of Suisun Marsh, and in the main river channel between the control gate and Suisun Bay (DWR 1999). For example, operation of the control structure during the late fall in dry years can cause a significant upstream shift in X_2 location, potentially increasing the risk of entrainment at the SWP/CVP export facilities of smelt and other species that are situated near X_2 location (D. Fullerton pers. comm. 1). These changes in environmental conditions are thought to have resulted in adverse effects on covered species and other aquatic resources within the area.

As levees are breached for tidal restoration, salinity levels may increase through much of Suisun Marsh, complicating the feasibility of discontinuing the operation of the salinity control gates, or eliminating the gates. First, rising salinity could negatively affect the managed wetlands of the remaining waterfowl hunting clubs. Secondly, salinity standards at the Suisun Marsh may have to be revised. Assuming that the Suisun Marsh's current salinity standards are maintained, tidal restoration could even lead to an increase in the operation of the salinity control gates under the Suisun Marsh Plan (S. Chappell pers. comm.).

Hypotheses: A reduction in operation of the Montezuma Slough Salinity Control Gate is hypothesized to:

- Reduce delays in outmigration of juvenile salmonids and sturgeon by allowing more water and fish to flow past Chipps Island; and
- Improve access of splittail, salmonids, and sturgeon to existing and future restored intertidal marsh habitats in Suisun Marsh.

Adaptive Management Considerations: As land use changes over the period of the Plan, monitoring and adaptive management could be used to alter operations of the salinity control gates.

3.4.2.2 CM2 Yolo Bypass Fishery Enhancement

*[**Note to Reviewers:** Yolo County has proposed specific edits to the content of this conservation measure that will be posted to the BDCP website. These proposed edits will be considered in subsequent versions of this conservation measure developed prior to the release of the public draft of the BDCP in 2011.]*

The purpose of this conservation measure is to improve upstream and downstream fish passage, reduce straying and stranding of native fish, increase availability of floodplain fish rearing and spawning habitat, and stimulate the food web in the Yolo Bypass and to investigate the potential for food web export from the Yolo Bypass to the Delta. The conservation measure requires the preparation and implementation of a Yolo Bypass Fishery Enhancement Plan (YBFEP) that details the specific actions to be implemented to achieve the biological objectives of this measure. Key benefits to covered fish species include reduced migratory delays and loss of salmon, steelhead, and sturgeon at Fremont Weir and other structures; enhanced rearing habitat for Sacramento River Basin salmonids; enhanced spawning and rearing habitat for splittail; and potential improvement of food sources of Delta smelt in habitat downstream of the Bypass. The YBFEP will:

- Evaluate alternative actions to restore passage and reduce stranding, including, but not limited to, physical modifications to the Fremont Weir and Yolo Bypass to manage the timing, frequency, and duration of inundation of the Yolo Bypass (Figure 3-53) with gravity flow from the Sacramento River, and to improve upstream fish passage past barriers including Fremont and Lisbon Weirs;
- Based on the evaluation, identify the actions, including, but not limited to, the physical modifications to the Fremont Weir and the Yolo Bypass, that will be implemented;
- Describe the YBFEP's biological objectives, performance goals, and monitoring metrics in detail;
- Ensure compatibility with the flood control functions of the Yolo Bypass;
- Identify specific funding sources from the BDCP funding commitments;
- Discuss regulatory and legal constraints and how the constraints will be addressed; and
- Provide an implementation schedule with milestones for key actions.

The BDCP Implementing Entity will consult with the U.S. Army Corps of Engineers, DWR, DFG, NMFS, and USFWS in development of the YBFEP and will coordinate with Yolo and Solano counties, affected reclamation districts, other flood control entities, and the Yolo Bypass Working Group on a wide range of issues during preparation of the YBFEP. During implementation of this conservation measure, the BDCP Implementing Entity will coordinate with the U.S. Army Corps of Engineers, DWR, reclamation districts, and other flood control entities, as appropriate, to ensure that fish passage improvements, bypass improvements, and Fremont Weir improvements and operations are constructed in accordance with the YBFEP and particularly the compatibility with the flood control functions of the Yolo Bypass.

The YBFEP analysis of alternative actions will focus on the construction of physical improvements and modifications from Fremont Weir downstream to the Lisbon Weir to (1) reduce migratory delays and loss of salmonids and sturgeon at Fremont Weir; and (2) enhance seasonal floodplain habitats for salmonids, splittail, and other covered aquatic species. The YBFEP will also evaluate the need for actions that may be necessary to optimize the number of juvenile salmonids entering the bypass when the water is being diverted through the modified Fremont Weir. In addition, a gated channel that could provide flows from the Sacramento River, Colusa Basin Drain, Knights Landing Ridge Cut, or other sources into the Yolo Bypass along the west side will be evaluated.

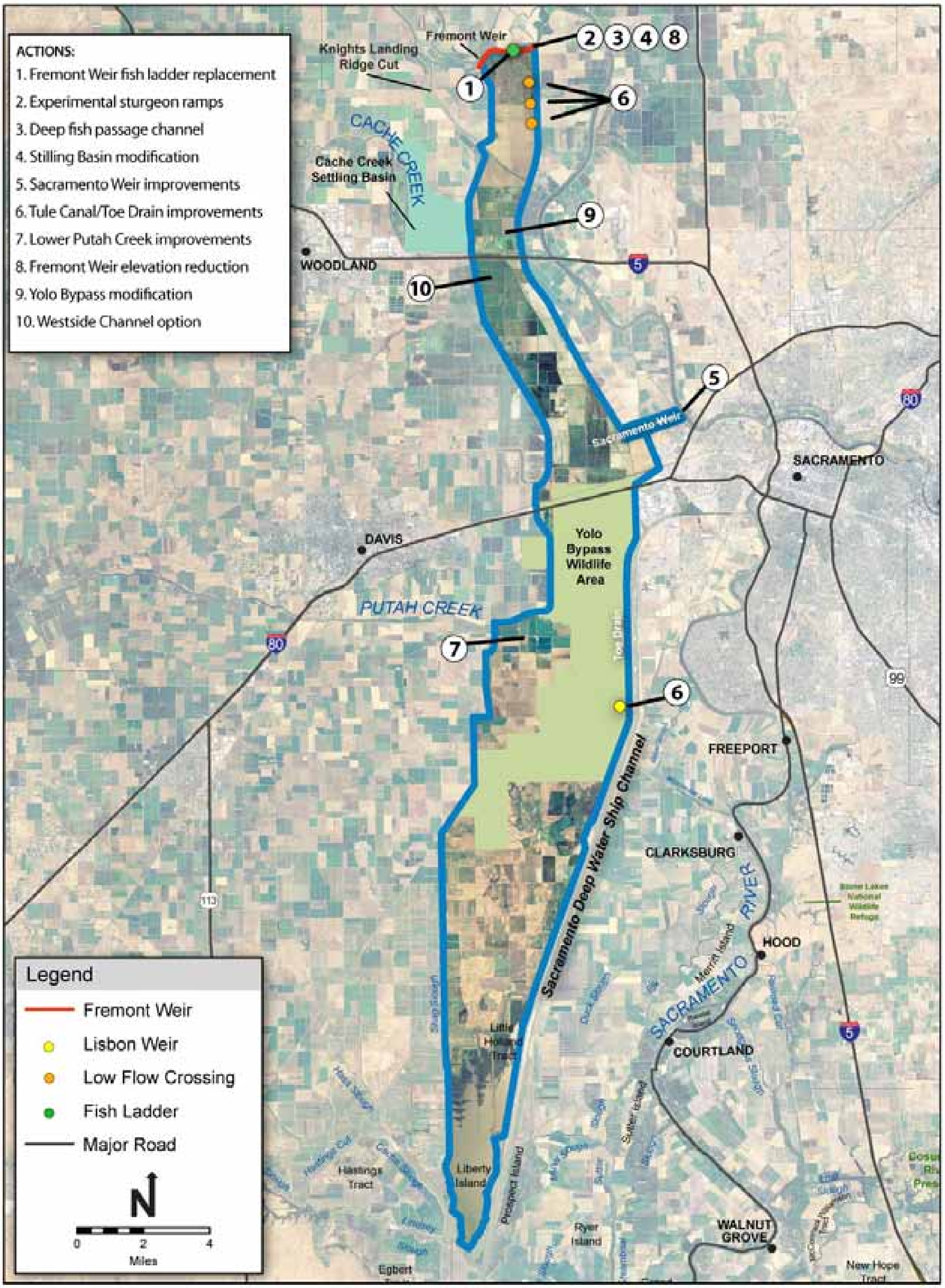

Figure 3-53. Yolo Bypass Fishery Enhancement Conservation Measure (CM2)

All of the actions identified below will be evaluated in the YBFEP. If supported by the evaluation (i.e., would achieve the biological objectives of this conservation measure), all of these actions will be further developed in the YBFEP and implemented. If the YBFEP evaluation does not support implementation of one or more of the actions--because the action would not be effective, is not needed because of the effectiveness of other actions, would have unacceptable effects on flood control, or for other reasons--the action will not be implemented. However, the YBFEP will identify for implementation specific actions that together are sufficient to achieve the biological objectives identified in the YBFEP.

Actions to Reduce Migratory Delays and Loss of Salmonids and Sturgeon at Fremont Weir

1. Fremont Weir Fish Ladder Replacement. The existing Fremont Weir Denil fish ladder will be removed and replaced with new salmonid passage facilities designed to allow for the effective passage of adult salmonids and sturgeon from the Yolo Bypass past the Fremont Weir and into the Sacramento River when the river overtops the weir. Specific design criteria of the ladder have not yet been determined. This facility will incorporate monitoring technologies to allow for collection of information to evaluate its efficacy at passing adult fishes.

2. Experimental Sturgeon Ramps. An experimental ramp(s) will be constructed at the Fremont Weir to allow for the effective passage of adult sturgeon and lamprey from the Yolo Bypass over the Fremont Weir and into the Sacramento River at flows when the new Fremont Weir Fish Ladder will also be operated when the river overtops the weir by approximately 3 feet (Figure 3-54). Specific design criteria of ramps have not yet been determined. This facility will incorporate monitoring technologies to allow for collection of information to evaluate its efficacy at passing adult fishes.

3. Deep Fish Passage Gates and Channel. To enhance adult fish passage through the Fremont Weir, as part of modifications to the Fremont Weir (see action #8, below), a deep fish passage notch will be cut through a much smaller section of the Fremont Weir to an elevation of 11.5 feet (NAVD88). This notch will be fitted with operable “fish passage gates” that will allow controlled flow into the Yolo Bypass when the Sacramento River stage is between 11.5 and 17.5 feet (NAVD88). A “fish passage channel” will be excavated to convey water from the Sacramento River to the new fish passage gates, and from the fish passage gates to the Tule Canal to convey water from the Sacramento River, through the gates, and to the Tule Canal and Toe Drain.

4. Stilling Basin Modification. Modifications will be made to the existing Fremont Weir stilling basin to ensure that the basin drains sufficiently into the deep fish passage channel. Effective drainage of the stilling basin will prevent stranding of juvenile and adult fish that are attracted to pooled water in the stilling basin during drainage of the floodplain.

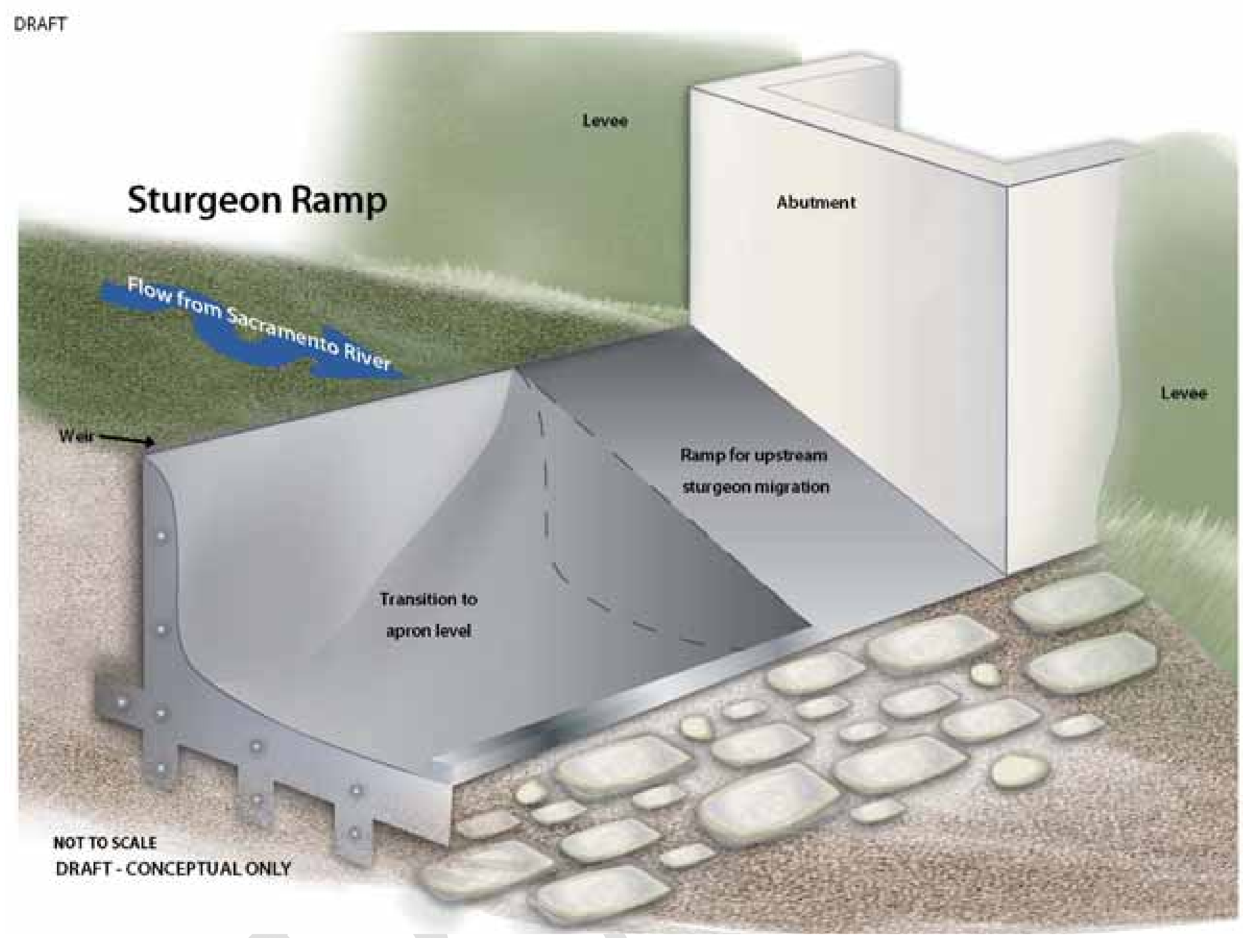

Figure 3-54. Conceptual Design for Experimental Sturgeon Ramp (CM2)

5. Sacramento Weir Improvements. Modifications will be made to reduce leakage at the Sacramento Weir and therefore reduce attraction of fish from the Yolo Bypass to the weir where they are blocked and could become stranded. For comparative analysis purposes, the plan will review the benefits and necessity of constructing fish passage facilities at the Sacramento Weir to reduce juvenile fish stranding and improve upstream adult fish passage. This action may require excavation of a channel to convey water from the Sacramento River to the Sacramento Weir and from the Sacramento Weir to the Toe Drain, construction of new gates at a portion of the weir, and minor modifications to the stilling basin of the weir to ensure proper basin drainage. Specific design criteria of ramps would need to be determined.

6. Tule Canal/Toe Drain and Lisbon Weir Improvements. The YBFEP will include physical modifications to passage impediments, including road crossings and agricultural impoundments in the Tule Canal/Toe Drain to improve fish passage and survival. The plan will evaluate the benefits of replacing three existing structures at the northern end of the Tule Canal with bridges or other structures to allow adult fish passage. Lisbon Weir will be redesigned to improve fish passage while maintaining or improving water capture efficiency for irrigation.

7. Lower Putah Creek Improvements. The YBFEP will include a realignment of Lower Putah Creek. The YBFEP will include a realignment sufficient to improve upstream and downstream passage of Chinook salmon and steelhead in Putah Creek and floodplain habitat restoration to provide benefits for multiple species on existing public lands. This action will be designed so that it will not create stranding or migration barriers for juvenile salmon.

Actions to Increase Seasonal Floodplain Habitats for Salmonids, Splittail, and other Covered Aquatic Species

1. Fremont Weir Modification. The YBFEP will include engineering designs to physically modify the Fremont Weir to manage the timing, frequency, and duration of inundation of the Yolo Bypass with Sacramento River flows. In the BDCP Effects Analysis, it was assumed a section of the Fremont Weir will be lowered to 17.5 feet (NAVD88) (lower elevations may be considered if necessary to satisfy inundation targets or fish passage needs) and fitted with operable gates that will allow for controlled flow into the Yolo Bypass when the Sacramento River stage at the weir exceeds 17.5 feet. Separate operable gates will be designed and operated to provide for the efficient upstream and downstream passage of sturgeon and salmonids to and from the Yolo Bypass into the Sacramento River (as described in action #3 above). The YBFEP will explain how this modification will provide significantly increased acreage of seasonal floodplain rearing habitat with biologically appropriate durations and magnitudes on a return rate of one to three years, depending on water year type.

2. Yolo Bypass Modification. Grading, removal of existing berms, levees, and water control structures, construction of berms or levees, re-working of agricultural delivery

channels, and earthwork or construction of structures to reduce Tule Canal/Toe Drain channel capacities will be conducted to the extent necessary to improve the distribution (e.g., wetted area) and hydrodynamic characteristics (e.g., residence times, flow ramping, and recession) of water moving through the Yolo Bypass. The YBFEP will include modifications that will allow water to inundate in certain areas of the bypass to maximize biological benefits and keep water away from other areas to reduce stranding of covered fish species in isolated ponds, minimize impacts to terrestrial covered species, including giant garter snake, and accommodate other existing land uses (e.g., wildlife, public, and agricultural use areas). If necessary, lands will be acquired, in fee-title and through conservation or flood easements.

3. Westside Option. The YBFEP will include a feasibility study and evaluation of a gated channel to provide flows into Yolo Bypass along the west side. Potential flow sources are the Sacramento River, Colusa Basin Drain or Sacramento River flows through Knights Landing Ridge Cut, or augmentation of other western tributaries. Some modification of the existing configuration of the discontinuous channels along the western edge of the Yolo Bypass may also be required. If effective at meeting biological objectives, this option could be included in the implementation of the conservation measure.

Operational Criteria and Adaptive Limits

The YBFEP will include operational criteria as well as a strategy for adaptive management. The YBFEP will describe how a modified Fremont Weir will be operated to manage the timing and increase the frequency and duration of inundation of a portion of the Yolo Bypass with Sacramento River flows via the Fremont Weir to achieve the biological goals and objectives. The YBFEP will take into account both Weir and tributary inflows.

In the Effects Analysis, inundation timing, frequency, and duration in the Yolo Bypass within the period of December 1 through March 31 (with occasional extension to May 15, depending on hydrologic conditions and measures to minimize land use and ecological conflicts) at the reduced weir elevation of 17.5 feet was considered. In evaluating this scenario, target flows into the bypass were between 3,000 and 6,000 cfs. In the Effects Analysis, flow through modified Fremont Weir gates was limited to maximum spills of 6,000 cfs when the Sacramento River was not spilling over the 33 foot crest of the weir. For the Effects Analysis, no management of the gates was assumed to limit lower flows (e.g., <3,000 cfs). The YBFEP will further refine these operational criteria to provide the specific biological objectives, restoration actions, and locations necessary to meet performance goals including habitat attributes, juvenile and adult metrics, and inundation depth and duration criteria. The YBFEP will include criteria for rare situations to limit flooding when, as determined by the BDCP Implementing Entity, inundation could cause more harm than benefit to covered species. Gates will remain closed in such situations

Under existing conditions the Fremont Weir is overtopped and spills into the Yolo Bypass in about 70 percent of years. The proposed notch and gates could increase that frequency to about 75-95 percent of years with a modified weir height of 17.5 feet (NAVD88) compared to the existing weir height of 33 feet (NAVD88). The frequency of Fremont Weir spills of at least 30 days at 3,000 cfs between 1984 and 2007 would double with a modified weir height of 17.5 feet compared to the existing weir height of 33 feet (Table 3-15). Once the targeted duration of inundation is achieved and the river is below the top of the Fremont Weir, the weir gates could be operated to reduce diversion of flow from the Sacramento River to allow for drainage of the Bypass while still allowing for fish passage. The basic flood control functions of the Fremont Weir will not be changed; at flood stage, the weir will overtop as it does currently.

Table 3-15 Number of Floodwater Spills Overtopping the Fremont Weir under Current and Proposed Weir Elevations.

	Events during Water Years 1984-2008[1]		*Events during Water Years 1929-2008*[1]	
	Current Weir[2]	**Proposed Notch**[2]	**Current Weir**[2]	**Proposed Notch**[2]
Less than 30 days	17[3] (10)[4]	42[3] (20)[4]	48[3] (29)[4]	137[3] (62)[4]
At least 30 days	9 (9)	18 (14)	11 (10)	70 (52)
At least 45 days	4 (4)	11 (11)	5 (5)	46 (41)

[1]Flows between October 1, 1929 and December 31, 1983 have been reconstructed from the hydrologic record

[2]Current weir elevation = 33 ft NAVD88; Proposed weir elevation = 17.5 ft NAVD88.

[3]Number of events with consecutive spills producing at least 3,000 cfs over the Fremont Weir. Assumes no more than a 7-day gap in flooding to count as the same event

[4]Number of water years in which events took place with spills producing at least 3,000 cfs over the Fremont Weir. Water Year is defined as August 1 of the previous year through July 31 of the current year. For example, Water Year 2005 is August 1, 2004 to July 31, 2005.

Problem Statement

The majority of historical floodplain in the Sacramento and San Joaquin River systems have been lost, particularly floodplains that flow directly into the Delta. This loss of floodplains has resulted in a reduction of highly productive rearing habitat for juvenile salmon and spawning and rearing habitat for other native species such as splittail. Loss of floodplain habitat has reduced the seasonal input of organic and inorganic material and food resources into adjoining riverine habitat and the downstream bay and estuary. Inundation of the Yolo Bypass from the Sacramento River is currently limited to times when the Fremont Weir is overtopped, limiting the availability of habitat for covered fish species and inputs to the food web from the Yolo Bypass.

The current configuration of the Yolo Bypass and Fremont Weir creates passage impediments and potential stranding for adult Chinook salmon, steelhead, green and white sturgeon, and river and Pacific lamprey and stranding hazards for juvenile Sacramento splittail, sturgeon, Chinook salmon, and steelhead. First, the Denil fish ladder at the Fremont Weir, designed for adult salmonid passage, is not effective at passing salmon, adult sturgeon and lamprey. Second, the stilling basins immediately downstream of the Sacramento and Fremont weirs have higher stranding rates of juvenile Chinook salmon than do earthen ponds as floodwater recedes (Sommer et al. 2005). Third, there are road crossings and agricultural impoundments in the Tule Canal/Toe Drain that block hydrologic connectivity, and therefore, fish passage. Fourth, the Lisbon Weir, which was built to impound agricultural water in the Toe Drain upstream of the weir, creates a passage impediment for fish at low stage when riprap is exposed or shallowly submerged.

Putah Creek is used for spawning habitat by a small population of Chinook salmon and steelhead. The Los Rios Check Dam, an irrigation impoundment structure, is seasonally removed but remains in place for several months while adult salmon and steelhead are attempting to migrate upstream. The reach of channel downstream of the check dam runs through a straight ditch to the Toe Drain. Putah Creek often breaks through its bank a short distance upstream of the Los Rios Check Dam, requiring periodic road maintenance at the Yolo Bypass Wildlife Area.

Hypothesized Benefits

Modifying the Fremont Weir and its operations and improving fish passage will reduce the adverse effects of stressors related to food availability, habitat availability, passage, harvest, stranding, predation, and entrainment for some of the covered fish species. Specifically, this conservation measure will:

- Create additional spawning habitat for Sacramento splittail (Sommer et al. 2001a, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006). Because splittail are primarily floodplain spawners, successful spawning is predicted to increase with increased floodplain inundation;
- Create additional juvenile rearing habitat for Chinook salmon, Sacramento splittail, and possibly steelhead (Sommer et al. 2001a,b, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006). Growth and survival of larval and juvenile fish is higher in the floodplain compared to those rearing in the mainstem Sacramento River (Sommer et al. 2001b);
- Increase downstream juvenile passage of Chinook salmon, Sacramento splittail, river and Pacific lamprey, and possibly steelhead. An inundated Yolo Bypass is used as an alternative to the mainstem Sacramento River for downstream migration of salmonids, splittail, river lamprey, and sturgeon. Sommer et al. (2003, 2004a) found that, other than steelhead and Pacific lamprey, juveniles from all of these species inhabit the Yolo Bypass during periods of inundation. Based on the timing and life history traits of steelhead relative to Chinook salmon, steelhead likely also benefit from inhabiting the Yolo Bypass. Similarly, based on the timing and life history traits of Pacific lamprey relative to river lamprey, Pacific lamprey likely also benefit from inhabiting the Yolo Bypass
- Increase adult upstream passage of fall-, late fall-, winter-, and spring-run Chinook salmon, steelhead, green and white sturgeon, and river and Pacific lamprey. It is thought that an inundated Yolo Bypass is used as an alternative route by upstream migrating adults of these species when Fremont Weir is spilling ;

- Increase food production for rearing salmonids, splittail, and other covered species on the floodplain (Sommer et al. 2001a,b, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006). During periods when the bypass is flooded, there is relatively high production of zooplankton and macroinvertebrates that serve, in part, as the forage base for many of the covered fish species (Benigno and Sommer 2008);
- Increase the availability and production of food in the Delta, Suisun Marsh, and bays downstream of the bypass, including restored habitat in Cache Slough, for delta smelt, longfin smelt, and other covered species by exporting organic material and phytoplankton, zooplankton, and other organisms produced from the inundated floodplain into the Delta (Schemel et al 1996, Jassby and Cloern 2000, Mitsch and Gosselink 2000, Moss 2007, Lehman et al. 2008). The co-occurrence of suitable food supplies (zooplankton) and various life stages of delta smelt (e.g., larval and juvenile life stages) has been assumed to be an important factor affecting delta smelt survival and abundance (Feyrer et al. 2007a, Miller 2007b). The relationship between longfin smelt abundance and Delta outflow has experienced two step-declines: one after the invasion of *Corbula* and one during the POD years, although the slope of the relationship has not changed, suggesting that longfin smelt are food-limited (Baxter et al. 2008). Hobbs et al. (2006) found evidence of food limitation in early-stage juvenile longfin smelt, although spatially and temporally variable;
- Increase the duration that the floodplain is inundated during periods that the Yolo Bypass is receiving water from both the Fremont Weir and the westside tributaries (e.g., Cache and Putah Creeks);
- Reduce losses of adult Chinook salmon, sturgeon, and other fish species to stranding and illegal harvest by improving upstream passage at the Fremont Weir. When flows in the Sacramento River recede, the Fremont Weir stops spilling, trapping fish downstream of the weir. Many of these fish remain in the shallow water near the weir, providing easy access to illegal harvesters. Under this conservation measure, the Fremont Weir will be modified to reduce stranding when Sacramento River flows recede;
- Reduce the exposure and risk of outmigrating juvenile fish migrating from the Sacramento River into the interior Delta through the Delta Cross Channel and Georgiana Slough, thus decreasing the risk for predation losses (Brandes and McLain 2001);
- Reduce the exposure of outmigrating juvenile fish to entrainment or other adverse effects associated with the intakes of the proposed north Delta water diversion facilities by passing juvenile fish into the Yolo Bypass upstream of the proposed intake locations; and
- Improve fish passage, and possibly increase and improve seasonal floodplain habitat availability, by retrofitting Los Rios Check Dam with a fish ladder, or creating another, fish-passable route for water from Putah Creek to reach the Toe Drain.

Increasing the frequency and duration of inundation within the Yolo Bypass is the largest opportunity for enhancing seasonally inundated floodplain habitat in the Central Valley . The

Yolo Bypass provides the only opportunity for increasing the frequency and duration of inundation of a floodplain in the Planning Area without restoration of historical floodplain surfaces presently in more highly developed, year-round land uses.

Adaptive Management Considerations

Implementation of this conservation measure by the Management Entity will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Results of both biological and operational monitoring in the Yolo Bypass and the mainstem Sacramento River will be used within the BDCP adaptive management framework to refine and modify project structures and operations and fish passage improvements.

Timeline for Implementation

The Yolo Bypass Fishery Enhancement Plan will be completed within 6 months of approval of BDCP. The Plan shall include: (1) specific biological objectives, restoration actions, and locations; (2) specific operational criteria; (3) a timeline with key milestones, (4) performance goals and associated monitoring, including habitat attributes, juvenile and adult metrics, and inundation depth and duration criteria; (5) specific actions to minimize stranding or migration barriers for juvenile salmon; and (6) identification of regulatory and legal constraints that may delay implementation, and a strategy to address those constraints. Construction of capital improvements identified in the Plan will be completed within five years of completion of the Plan.

3.4.2.3 CM3 Natural Communities Protection

This conservation measure provides the mechanism and guidance for the acquisition of lands and the establishment of a system of conservation lands in the Plan Area necessary to meet natural community and species habitat protection objectives established in Section 3.3, *Biological Goals and Objectives*. This system of conservation lands will be built over the term of the BDCP implementation to protect and enhance areas of existing natural communities and covered species habitat, protect and maintain occurrences of selected plant species with very limited distributions, provide sites suitable for restoration of natural communities and covered species habitat, and provide habitat connectivity among the various BDCP conservation land units in the system. This conservation measure describes the overall approach to land acquisition procedures including the extent of land acquisition, a discussion of pre-acquisition surveys, as well as site selection criteria.

Approach to Land Acquisition

The BDCP Implementation Office will establish a system of conservation lands that encompasses all BDCP protected and restored natural communities. Lands may be acquired through the following mechanisms:

- Purchase in fee title;
- Permanent conservation easements;
- Limited term conservation easements;
- Change to more protective land use designation on federal or state owned lands ;
- Permanent agreements with state, federal, and local flood control agencies that enable the restoration, enhancement, and management of floodplain and channel margin habitats along levees and lands under flood easements; and
- Purchase of mitigation credits from private mitigation banks.

The BDCP Implementation Office may acquire conservation lands in partnership with other conservation organizations or through grants of land from participating entities where such lands will serve to achieve the biological goals and objectives of the Plan. The conservation lands system will be comprised of: 1) conservation areas (lands that are under direct management of the Implementation Office or a Supporting Entity and lands protected through permanent conservation easements); and 2) lands that are covered by limited term conservation easements.

It is anticipated that lands acquired for habitat restoration and enhancement actions will primarily be those that are currently in public ownership or those that are acquired in fee title because these conservation measures could preclude other land uses. Lands acquired for the protection and maintenance of existing habitat functions may be acquired through conservation easements that specify the range of permitted land uses and practices that will maintain the intended habitat functions of the acquired lands. Limited-term conservation easements may be used to conserve agricultural habitats for a specified period, after which the easement would expire and the Implementation Office will be required to conserve additional habitat to replace the habitat that was protected through the expired conservation easement.

The BDCP habitat conservation target acreage commitments for the natural communities are presented in Table 3-4. Acquisition of these lands will also fulfill the target acreage requirements for each of the covered species for which habitat conservation targets are established (Table 3-5). These targets represent the minimum extent of land that will be acquired; the actual extent that will be acquired will likely be greater because acquired parcels may not be comprised wholly of habitat types that contribute towards achieving conservation target acreage.

Pre-acquisition Surveys and Assessments

The BDCP Implementation Office will develop and implement protocols for assessing physical and biological resources and infrastructure present on lands being considered for acquisition to determine the degree to which they are suitable for achieving habitat protection and restoration objectives. Pre-acquisition surveys would be conducted by qualified biologists and other qualified scientists or technical experts as appropriate under agreements with the landowners. Surveys will assess the physical and biological attributes of the lands, including, but not limited to:

- The extent and quality of existing covered species habitats;
- Connectivity with other habitat areas;
- Presence of covered species;
- Infrastructure supporting existing habitats or necessary to restore habitats;
- Potential constraints to long-term management and maintenance of habitats; and
- Other conservation-related opportunities and constraints.

The BDCP Implementation Office will apply, and revise when necessary, the following criteria for evaluating and prioritizing acquisition of lands for achieving habitat protection and restoration targets. Criteria for evaluating the suitability of lands supporting grassland, alkali seasonal wetland complex, and vernal pool complex include:

- Level of benefits the acquisition will provide for covered species;
- Presence and abundance of covered species;
- Presence of uncommon site specific attributes (e.g., soil types) required by covered species with narrow range of habitat requirements;
- Likely effects of adjacent land uses on the ability to maintain or improve desired ecological functions into the future;
- Habitat patch size relative to the habitat patch size of the covered species intended to benefit from the habitat;
- Opportunities for effectively implementing management actions to enhance ecological functions;
- Level of contribution for maintaining local and regional ecological processes;
- Level of connectivity provided between and among existing preserved habitat areas;
- Level of contribution for preserving natural environmental gradients;
- Level of contribution towards establishment of large preserve areas;
- Likely effects of climate change on future ecological functions;

- Role in maintaining and complementing the habitat functions of adjoining natural communities for covered and other native species;
- Level of contribution towards protection of a heterogeneous mix of natural communities and native species, including native grasses and forbs;
- Effectiveness in contributing towards achieving multiple biological goals and objectives;
- Likely contribution towards achieving biological objectives for approved and planned HCPs and NCCPs overlapping or adjacent to the Plan Area; and
- Additionally, restoration of vernal pool complex will only be permitted on lands that historically supported vernal pools and that currently support suitable soils for restoration.

Criteria for the selection of agricultural habitats to be maintained under the Plan include:

- Proximity to active Swainson's hawk nesting territories;
- Proximity to greater sandhill crane roost sites;
- Ability to support crops that provide high value Swainson's hawk and/or greater sandhill crane foraging habitat;
- Proximity to habitat occupied by the Caldoni Marsh/White Slough and Yolo Bypass/Willow Slough giant garter snake populations;
- Opportunities to incorporate riparian corridors into agricultural preserves; and
- Opportunities to preserve patches of other high value non-agricultural habitats (e.g., oak groves, wetlands, tree and hedge rows) that are supported among farmed fields.

For acquisition of land for restoring tidal, riparian, nontidal marsh, and seasonally inundated floodplain habitats, the BDCP Implementation Office will develop site selection criteria based on the ability of lands under consideration to:

- Achieve biological goals and objectives;
- Suitability and cost effectiveness for restoring target habitats;
- Suitability for supporting the restored habitat over time; and
- Level of management necessary to maintain desired ecological functions into the future.

Lands acquired for protection of existing habitats must be acquired within the Conservation Zones indicated in Table 3-4 to be credited as contributing towards achieving the biological goals and objectives. Land acquired for restoration of tidal habitat is expected to be located within the ROAs as indicated in CM4 Tidal Habitat Restoration, but may occur elsewhere if suitable lands are available. Seasonally inundated floodplain restoration and channel margin habitat enhancement may be located at appropriate sites within the geographic boundaries indicated in CM6 Channel Margin Habitat Enhancement and CM5 Seasonally Inundated Floodplain Restoration. Riparian habitats are expected to be restored within tidal habitat restoration, channel margin habitat enhancement, and seasonally inundated floodplain restoration sites (see CM7 Riparian Habitat Restoration). The Implementation Office is committed to the acquisition of a sufficient extent of land to achieve the seasonally inundated floodplain, channel margin habitat, and riparian habitat conservation targets described in CM5 (*Seasonally Inundated Floodplain Restoration*), CM6 (*Channel Margin Habitat Enhancement*), and CM7 (*Riparian Habitat Restoration*); these commitments, however, are not tied to specific Conservation Zones, but rather to the geographies identified in the conservation measures and therefore are not described in the Conservation Zone acquisition requirements described below.

The existing extent of unprotected and protected natural communities and their distribution within each of the Conservation Zones are presented in Tables 3-1a through 3-1c.

Conservation Zone 1 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 1 are directed at protecting and restoring grassland and associated seasonal wetlands, acquiring lands necessary for the restoration of tidal and associated riparian habitats, protecting cultivated agricultural foraging habitats, and protecting occurrences of selected plant species with very limited distributions.

*Tidal Aquatic and Wetland Natural Communities***.** Lands sufficient to restore at least 5,000 acres of tidal habitat within the Cache Slough Complex ROA, which includes lands in Conservation Zones 1and 2, will be acquired. Additional lands will be acquired to the extent that additional restoration of tidal habitat is needed in this Conservation Zone to achieve the total conservation target of restoring 65,000 acres of tidal habitat. Restored tidal habitat includes restored gradient of habitats ranging from shallow subtidal aquatic habitat, to mudflat, emergent marsh plain, riparian (in suitable locations) and transitional uplands. Transitional uplands will include sufficient land to accommodate future upslope establishment of marsh plain vegetation with sea level rise and will support habitat for grassland associated species. Restored tidal aquatic, marsh plain and associated transitional upland habitats are expected to support habitat for the California black rail; aquatic and possible upland nesting habitat for the California least tern; nesting habitat for the tricolored blackbird; upland and aquatic habitat for the giant garter snake where a narrow tidal range exists; and upland and aquatic habitat for the western pond turtle. The restoration of tidal marsh communities in CZ1 may help achieve the recovery objectives for giant garter snake identified in the giant garter recovery plan (USFWS 1999a). Tidal marsh plain and mudflat habitats are also expected to support substrates suitable for colonization and establishment of Delta tule pea and Suisun Marsh aster, Mason’s lilaeopsis, and Delta mudwort.

Grasslands and Associated Seasonal Wetland Natural Communities. The grassland and associated seasonal wetland community group is comprised of the grassland, alkali seasonal wetland complex, and vernal pool complex natural communities. A portion of the 300 acres of existing vernal pool complex, 400 acres of existing alkali seasonal wetland, and 8,000 acres of existing grassland to be protected under the BDCP will be acquired and protected in Conservation Zone 1. The goal of these acquisitions is to protect lands in large contiguous grassland landscapes that encompass the range of vegetation, hydrologic, and soil conditions that characterize these communities within the Conservation Zone. The extent of existing protected and unprotected grassland, alkali seasonal wetland complex, and vernal pool complex is shown in Figure 3-1a.

Conserved lands will be located to maintain habitat connectivity with protected grassland landscapes immediately adjacent to the Plan Area (e.g., Jepson Prairie Preserve) and with transitional uplands associated with tidal habitats restored in the Cache Slough Complex ROA. Specific land acquisition requirements include the protection of at least two occurrences of Heckard’s peppergrass. This approach to the conservation of these natural communities will conserve foraging habitat for the tricolored blackbird, western burrowing owl, Swainson’s hawk, and white-tailed kite; upland habitat for the giant garter snake and western pond turtle; breeding and upland habitat for the western spadefoot toad and California tiger salamander; and habitat for the covered vernal pool shrimp species, alkali milk-vetch, San Joaquin spearscale, dwarf downingia, Boggs Lake hedge-hyssop, Heckard’s peppergrass, legenere, heartscale, brittlescale, Delta button-celery, and Carquinez goldenbush (see details on benefits to each of these species in Section 3.3, *Biological Goals and Objectives*).

These conserved lands will be evaluated and managed to maintain and enhance their existing habitat functions for these species over the term of the BDCP (see Conservation Measure CM11, Natural Communities Enhancement and Management). The protection and restoration of vernal pool complex will help achieve the recovery objectives for Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid- valley fairy shrimp, vernal pool tadpole shrimp, alkali milk-vetch, Boggs Lake hedge-hyssop, and legenere identified in the Vernal Pool Recovery Plan (USFWS 2005).

Some or all of the 2,000 acres of grassland and 200 acres of vernal pool complex to be restored under the Plan may be restored within Conservation Zone 1. Lands that are suitable for the restoration of these habitats as described in Conservation Measures CM9 Vernal Pool Complex Restoration, and CM8 Grassland Communities Restoration will be acquired. Lands acquired for grassland restoration will be located such that they will increase connectivity among currently fragmented patches of grassland and seasonal wetlands and/or provide high value transitional upland habitat adjacent to restored tidal marsh plain habitats. Lands acquired for vernal pool complex restoration will be located on lands that historically supported vernal pools and will be inoculated with seeds of vernal pool plants, and soil inoculum where the donor vernal pools are free of exotic species such as swamp timothy, perennial pepperweed, and Italian ryegrass, collected from vernal pools in Conservation Zones 1 and/or 2. These restored habitats are expected to support habitat for the covered species described above for lands acquired to protect grassland and associated seasonal wetlands.

*Agricultural Lands and Managed Wetlands***.** Agricultural lands will be acquired in Conservation Zone 1 to achieve a substantial proportion of the overall agricultural habitat conservation target established for the Plan Area (Table 3-4). Agricultural lands will be acquired that support foraging habitat for tricolored blackbird, Swainson's hawk, and other agricultural-associated species. These conserved lands will be located within 8 miles of Swainson's hawk foraging flight distances from riparian nesting habitats to ensure that conserved habitats function as foraging habitat for the species. Individual agricultural land acquisitions will be at least 80 acres in size unless high value sites are contiguous or potentially contiguous with other conserved lands; with the intent of creating contiguous agricultural preserves of at least 400 acres. As indicated in CM11 agricultural lands will be managed to provide high value foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird. A portion of the conserved agricultural lands will be maintained as pasture to also meet the foraging habitat requirements of burrowing owl. Other habitat elements on protected agricultural lands (e.g., wetlands, riparian corridors, grasslands, hedgerows, tree rows and groves, and isolated trees) will be retained and enhanced as needed as covered species habitat within the agricultural matrix. The specific parcels of conserved agricultural habitat will vary among years to the extent that they are acquired through limited term conservation easements.

*Plant Species Occurrences***.** Protect and enhance at least 3 occurrences of alkali milk-vetch, brittlescale, and heartscale in Conservation Zones 1, 8, and/or 11. Protect and enhance 2 occurrences of Heckard's peppergrass in Conservation Zones 1, 8, and/or 11. Preserve at least 3 occurrences of Carquinez goldenbush in Conservation Zones 1 and/or 11.

Conservation Zone 2 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 2 are directed at protecting and restoring grassland and associated seasonal wetlands, acquiring lands necessary for the restoration of tidal and associated riparian habitats and nontidal wetlands, and protecting cultivated agricultural foraging habitats.

Tidal Aquatic and Wetland Natural Communities. Lands sufficient to restore at least 5,000 acres of tidal habitat within the Cache Slough Complex ROA, which includes lands in Conservation Zones 1and 2, will be acquired. The criteria for restoring tidal habitat and the anticipated benefits for associated covered species are the same as described above for restoration of tidal habitat in Conservation Zone 1.

*Grasslands and Associated Seasonal Wetland Natural Communities***.** There is no specific acquisition target for grassland and associated seasonal wetlands established for Conservation Zone 2. However, acquisitions may occur if there are high value grassland or seasonal wetland habitats that connect to existing protected grassland landscapes (e.g., Yolo Bypass Wildlife Area). Conserved lands will be evaluated and managed to maintain and enhance their existing habitat functions for covered species over the term of the BDCP. In addition, small and fragmented patches of grassland associated with maintained agricultural habitats (e.g., vegetated levee slopes), however, may be protected that will serve as upland habitat for giant garter snake and western pond turtle, and foraging habitat for Swainson's hawk and white-tailed kite. Grassland conservation in Conservation Zone 2 will conserve habitat for the tricolored blackbird, western burrowing owl, Swainson's hawk, white-tailed kite, giant garter snake, and western pond turtle (see details on benefits to each of the species in Section 3.3, *Biological Goals and Objectives*).

*Nontidal Aquatic and Wetland Natural Communities***.** The nontidal aquatic and wetland natural communities group is comprised of nontidal freshwater perennial emergent wetland and nontidal aquatic natural communities. Lands will be acquired in Conservation Zone 2 to restore up to 200 acres of nontidal marsh that functions as aquatic habitat for the giant garter snake. Nontidal freshwater marsh will be restored in locations to benefit the Yolo/Willow Slough subpopulation of giant garter snake. The specific amount of marsh that will be restored will be determined based on results of site-specific habitat assessments of the Yolo/Willow Slough and Caldoni Marsh/White Slough (Conservation Zone 4) subpopulations to determine the extent of marsh needed to be restored in each location to maximize conservation benefits for the species. Marsh will be restored within or adjacent to habitats occupied by these subpopulations and within larger patches of protected giant garter snake upland and agricultural habitats. The BDCP Implementation Office will consult with species experts and use guidance provided in the giant garter snake recovery plan (USFWS 1999a) to determine specific locations, patch sizes, and develop specific restoration design criteria and implementation guidance (e.g., vegetation associations, edge habitat, bank slopes, wetland to upland ratio, etc.). In addition to benefiting the giant garter snake, restored tidal marsh habitats are expected to provide nesting habitat for tricolored blackbird and aquatic habitat for the western pond turtle. Increased flying insect production associated with restored marshes relative to the existing upland habitats that will be restored to marsh is expected to improve foraging habitat conditions for the Townsend's Big-eared Bat.

*Agricultural Lands and Managed Wetlands***.** Agricultural lands will be acquired in Conservation Zone 2 to achieve a substantial proportion of the overall agricultural habitat conservation target established for the Plan Area (Table 3-4). Agricultural lands will be acquired that support foraging habitat for tricolored blackbird, Swainson's hawk, giant garter snake, and other agricultural-associated species. A total of 4,600 acres will be maintained in rice or equivalent habitat value to provide habitat for the giant garter snake. Other conserved agricultural lands will be located within 8 miles of Swainson's hawk foraging flight distances from riparian nesting habitats to ensure that conserved habitats function as foraging habitat for the species. Agricultural lands will be managed to provide high value foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird. Other habitat elements on protected agricultural lands (e.g., wetlands, riparian corridors, grasslands, hedgerows, tree rows and groves, and isolated trees) will be retained and enhanced as needed as covered species habitat within the agricultural matrix. Criteria for acquisition of agricultural lands to provide habitat for Swainson's hawk are the same as described above for Conservation Zone 1. A portion of the conserved agricultural lands may also be maintained as pasture to meet the foraging habitat requirements of western burrowing owl.

A portion of the conserved agricultural lands will need to be acquired and maintained within or adjacent to habitat occupied by the Yolo/Willow Slough subpopulation of giant garter snake to establish a 1,000-acre preserve for this subpopulation. The Implementation Office will consult with giant garter snake species experts to determine appropriate agricultural land acquisitions relative to the proximity of the existing subpopulation, proximity and connectivity with existing and restored nontidal freshwater marsh, and opportunities for population protection and expansion. The specific parcels of conserved agricultural habitat will vary among years to the extent that they are acquired through limited term conservation easements.

Conservation Zone 3 Acquisition Requirements

No specific conservation land acquisition targets are identified for Conservation Zone 3. Agricultural lands that support Swainson's hawk and greater sandhill crane foraging habitats, which may be conserved in multiple Conservation Zones to achieve the objectives for these species, may be acquired in Conservation Zone 3. Any acquired Swainson's hawk foraging habitat will be located within 8 miles of its riparian nesting habitat and acquired greater sandhill crane foraging habitat will be located within 2 miles of roosting habitat to ensure that conserved habitats function as foraging habitat for these species.

Conservation Zone 4 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 4 are directed at acquiring lands necessary for the restoration of tidal and associated riparian habitats and nontidal wetlands, and protecting cultivated agricultural habitats.

Tidal Aquatic and Wetland Natural Communities. Lands sufficient to restore at least 1,500 acres of tidal habitat within the Cosumnes/Mokelumne ROA in Conservation Zone 4 will be acquired. The criteria for restoring tidal habitat and the anticipated benefits for associated covered species are the same as described above for restoration of tidal habitat in Conservation Zone 1. The restoration of tidal marsh communities in CZ4 may help achieve the recovery objectives for giant garter snake identified in the giant garter snake recovery plan (USFWS 1999a) by providing additional habitat connectivity between the Caldoni Marsh/White Slough subpopulation and the Stone Lakes National Wildlife Refuge lands to the north and additional connectivity between the Delta and the Badger Creek giant garter snake subpopulation to the east.

Grasslands and Associated Seasonal Wetland Natural Communities. There is no specific acquisition target for grassland and associated seasonal wetlands established for Conservation Zone 4 because high value grassland habitats in the Conservation Zone are currently protected. Small and fragmented patches of grassland associated with maintained agricultural habitats (e.g., vegetated levee slopes), however, may be protected that will serve as upland habitat for giant garter snake and western pond turtle, and foraging habitat for Swainson's hawk and white-tailed kite.

*Nontidal Aquatic and Wetland Natural Communities***.** Lands will be acquired in Conservation Zone 4 to restore up to 200 acres of nontidal marsh that functions as aquatic habitat for the giant garter snake. Nontidal marsh will be restored in locations to benefit the Caldoni Marsh/White Slough giant garter snake subpopulation. The criteria for restoring nontidal marsh and the anticipated benefits for associated covered species are the same as described above for restoration of nontidal marsh in Conservation Zone 2.

*Agricultural Lands and Managed Wetlands***.** Agricultural lands will be acquired in Conservation Zone 4 to achieve a proportion of the overall agricultural habitat conservation target established for the Plan Area (Table 3-4). Agricultural lands will be acquired that support habitat for tricolored blackbird, Swainson's hawk, greater sandhill crane, and giant garter snake. Other habitat elements on protected agricultural lands (e.g., wetlands, riparian corridors, grasslands, hedgerows, tree rows and groves, and isolated trees) will be retained and enhanced as needed as covered species habitat within the agricultural matrix. Criteria for acquisition of agricultural lands to provide habitat for Swainson's hawk are the same as described above for Conservation Zone 1. Protection of agricultural lands in Conservation Zone 4 will also focus on increasing the connectivity of protected lands along the eastern edge of the Plan Area to further facilitate movement and expansion of giant garter snake and other covered species populations between the Stone Lakes National Wildlife Refuge and the Caldoni Marsh/White Slough giant garter snake subpopulation.

A portion of the conserved agricultural land in Conservation Zone 4 will need to be acquired and managed as foraging habitat for the greater sandhill crane to meet the requirements of 4,000 conserved acres within the crane's primary zone. In addition, a portion of the 300 acres of greater sandhill crane managed wetland roosting habitat can be acquired in Conservation Zone 4. Individual agricultural land and managed wetland acquisitions for greater sandhill crane foraging and roosting habitat will be at least 80 acres in size unless high value sites are contiguous or potentially contiguous with other conserved lands. The BDCP Implementation Office will consult with species experts to determine the suitability of potential acquisitions relative to proximity to foraging habitats within the primary zone, and to establish restoration design criteria for crane roosting habitat.

A portion of the conserved agricultural lands will also need to be acquired and permanently maintained within or adjacent to habitat occupied by the Caldoni Marsh/White Slough subpopulation of giant garter snake to establish a 1,000 acre preserve for this subpopulation. The Implementation Office will consult with giant garter snake species experts to determine appropriate agricultural land acquisitions relative to the proximity of the existing subpopulation, proximity and connectivity with existing and restored nontidal perennial freshwater emergent wetland, and opportunities for population protection and expansion. The specific parcels of conserved agricultural habitat will vary among years to the extent that they are acquired through limited term conservation easements.

Conservation Zone 5 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 5 are directed at acquiring lands necessary for the restoration of tidal habitat. Agricultural lands that support Swainson's hawk and greater sandhill crane foraging habitats, which may be conserved in multiple Conservation Zones to achieve the objectives for these species may also be acquired in Conservation Zone 5 if needed to achieve the overall agricultural habitat conservation target (Table 3-4). The extent of subsided lands that may be acquired in Conservation Zone 5, however, is limited to the extent of existing Swainson's hawk and greater sandhill crane foraging habitat located below sea level that would be removed by BDCP actions.

*Tidal Aquatic and Wetland Natural Communities***.** Lands sufficient to restore at least 2,100 acres of tidal habitat within the West Delta ROA will be acquired. The criteria for restoring tidal habitat and the anticipated benefits for associated covered species are the same as described above for restoration of tidal habitat in Conservation Zone 1.

Agricultural Lands. Agricultural lands may be acquired in Conservation Zone 5 to achieve a proportion of the overall agricultural habitat conservation target established for the Plan Area (Table 3-4). Agricultural lands would be acquired that support habitat for tricolored blackbird, Swainson's hawk, greater sandhill crane, and giant garter snake. Other habitat elements on protected agricultural lands (e.g., wetlands, riparian corridors, grasslands, hedgerows, tree rows and groves, and isolated trees) will be retained and enhanced as needed as covered species habitat within the agricultural matrix. Criteria for acquisition of agricultural lands to provide habitat for Swainson's hawk and greater sandhill crane are the same as described above for Conservation Zone 1 and 4, respectively.

In addition, lands necessary to create a portion of the 320 acres of greater sandhill crane roosting habitat can be acquired in Conservation Zone 5. Criteria for acquisition is the same as described above for Conservation Zone 4.

Conservation Zone 6 Acquisition Requirements

No specific conservation land acquisition targets are identified for Conservation Zone 6. This Conservation Zone encompasses deeply subsided islands of the Delta that are dominated by agricultural habitats and generally only support small fragmented patches of non-agricultural habitats. Some tidal habitat restoration could occur in Conservation Zone 6 in the West Delta ROA. Agricultural lands that support Swainson's hawk and greater sandhill crane foraging and roosting habitats, which may be conserved in multiple Conservation Zones to achieve the objectives for these species, may be acquired in Conservation Zone 6. Criteria for acquisition of agricultural lands to provide habitat for Swainson's hawk and greater sandhill crane are the same as described above for Conservation Zone 4. The extent of subsided lands that may be acquired in Conservation Zone 6, however, is limited to the extent of existing Swainson's hawk and greater sandhill crane foraging habitat located below sea level that would be removed by BDCP actions.

Conservation Zone 7 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 7 are directed at acquiring lands necessary for the restoration of tidal and associated riparian habitats, restoration of seasonally inundated floodplains and associated riparian habitat, restoration of riparian habitats specifically to support riparian brush rabbit, and protecting cultivated agricultural habitats.

*Tidal Aquatic and Wetland Natural Communities***.** Lands sufficient to restore at least 5,000 acres of tidal habitat within the South Delta ROA will be acquired. The criteria for restoring tidal habitat and the anticipated benefits for associated covered species are the same as described above for restoration of tidal habitat in Conservation Zone 1. In addition, tidal wetland restoration in Conservation Zone 7 is also expected to benefit the greater sandhill crane by providing potential foraging and roosting habitats and facilitating possible expansion of the species' winter range southward.

*Riparian Natural Community***.** Lands sufficient to restore a substantial portion of the 10,000-acre seasonally inundated floodplain target included within would be most of the 5,000-acre riparian natural community target will be acquired. Floodplain habitat and associated riparian habitat would be restored by setting back levees on major river channels including the San Joaquin, Old, and Middle rivers. Riparian habitat restoration would support habitat for riparian brush rabbit, riparian woodrat, Townsend's Big-eared Bat, yellow-breasted chat, white-tailed kite, Swainson's hawk, and valley elderberry longhorn beetle.

Of the 5,000 acres of restored riparian, 300 acres will be specifically restored to meet the ecological requirements of the riparian brush rabbit and 300 additional acres will be restored to meet the ecological requirements of the riparian woodrat. The BDCP Implementation Office will consult with species experts to determine appropriate restoration locations, minimum patch size, species composition, and to develop other restoration design criteria and implementation guidance.

*Grasslands and Associated Seasonal Wetland Natural Communities***.** There is no specific acquisition target for grassland and associated seasonal wetlands established for Conservation Zone 7. Small and fragmented patches of grassland associated with maintained agricultural habitats (e.g., vegetated levee slopes), however, may be protected that will serve as upland habitat for giant garter snake and western pond turtle, and foraging habitat for Swainson's hawk and white-tailed kite.

*Agricultural Lands and Managed Wetlands***.** Agricultural lands will be acquired in Conservation Zone 7 to achieve a substantial proportion of the overall agricultural habitat conservation target established for the Plan Area (Table 3-4). Agricultural lands will be acquired that support foraging habitat for Swainson's hawk and habitat for other agricultural-associated covered species. Other habitat elements on protected agricultural lands (e.g., wetlands, riparian corridors, grasslands, hedgerows, tree rows and groves, and isolated trees) will be retained and enhanced as needed as covered species habitat within the agricultural matrix. Criteria for acquisition of agricultural lands to provide habitat for Swainson's hawk are the same as described above for Conservation Zone 1. The specific parcels of conserved agricultural habitat will vary among years to the extent that they are acquired through limited term conservation easements.

Conservation Zone 8 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 8 are directed at protecting and restoring grassland and associated seasonal wetlands, and protecting occurrences of selected plant species with very limited distributions. Agricultural lands may also be acquired in this Conservation Zone to provide habitat for Swainson's hawk and other agricultural-associated covered species as described above for Conservation Zone 3.

*Grasslands and Associated Seasonal Wetland Natural Communities***.** At least 1,000 acres of existing grassland will be acquired and protected in Conservation Zone 8; and a portion of the 300 acres of existing vernal pool complex and 400 acres of existing alkali seasonal wetland to be protected under the BDCP will be acquired and protected in Conservation Zone 8. The goal of these acquisitions is to protect lands in large contiguous grassland landscapes that encompass the range of vegetation, hydrologic, and soil conditions that characterize these communities within the Conservation Zone south of Highway 4. Conserved lands will be located to maintain habitat connectivity with protected grassland landscapes within and immediately adjacent to the Plan Area. Protection of these habitat areas will maintain connectivity with lands that have been protected or may be protected in the future under the East Contra Costa HCP/NCCP.

This approach to conservation of these natural communities will conserve habitat for the San Joaquin kit fox, tricolored blackbird, western burrowing owl, Swainson's hawk, white-tailed kite, western pond turtle, western spadefoot toad, California red-legged frog, California tiger salamander, the covered vernal pool shrimp species, alkali milk-vetch, San Joaquin spearscale, dwarf downingia, Boggs Lake hedge-hyssop, Heckard's peppergrass, legenere, heartscale, brittlescale, Delta button-celery, and caper-fruited tropidocarpum (see details on benefits to each of these species in Section 3.3, *Biological Goals and Objectives*). Protection and management of grasslands and associated seasonal wetlands in Conservation Zone 8 will help achieve recovery plan objectives for the San Joaquin kit fox (USFWS 1998a), the California red-legged frog (USFWS 2002), Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid-valley fairy shrimp, vernal pool tadpole shrimp, alkali milk-vetch, Boggs Lake hedge-hyssop, and legenere (USFWS 2005). These conserved lands will be evaluated and managed to maintain and enhance their existing habitat functions for these species over the term of the BDCP. Following full BDCP implementation, an estimated __ percent of grassland, vernal pool complex, and alkali seasonal wetland remaining in Conservation Zone 8 will be protected.

*Plant Species Occurrences***.** Protect and enhance at least 3 occurrences of alkali milk-vetch, brittlescale, heartscale in Conservation Zones 1, 8, and/or 11. Protect and enhance 2 occurrences of Heckard's peppergrass in Conservation Zones 1, 8, and/or 11. Protect occurrences of caper-fruited tropidocarpum that reestablish in Conservation Zone 8.

Conservation Zone 9 Acquisition Requirements

No specific conservation land acquisition targets are identified for Conservation Zone 9. This Conservation Zone is comprised primarily of urban lands (e.g., Brentwood and Discovery Bay are located in this zone) and non-urban areas are dominated by agricultural habitats. Non-agricultural habitats generally are present in small patches that are fragmented and disconnected from other natural habitats. Agricultural lands that support Swainson's hawk foraging habitat, which may be conserved in multiple Conservation Zones to achieve the objectives for this species, may be acquired in Conservation Zone 9 as described above for Conservation Zone 3.

Conservation Zone 10 Acquisition Requirements

No conservation land acquisition targets are identified for Conservation Zone 10. This Conservation Zone encompasses the City of Antioch and is comprised almost entirely of urban lands.

Conservation Zone 11 Acquisition Requirements

Land acquisition (includes fee title and easement) requirements for Conservation Zone 11 are directed at protection of grassland and associated seasonal wetland habitats, acquiring lands necessary for the restoration of tidal habitats, and protecting occurrences of selected plant species with very limited distributions.

*Grasslands and Associated Seasonal Wetland Natural Communities***.** A portion of the 300 acres of existing vernal pool complex, 400 acres of existing alkali seasonal wetland, and 8,000 acres of existing grassland to be protected under the BDCP will be acquired and protected in Conservation Zone 11. These communities are located along the upland fringe of Suisun Marsh and the goal of these acquisitions is to protect these lands to maintain connectivity with much larger protected (e.g., Jepson Prairie Preserve) and unprotected grassland landscapes that are immediately adjacent to the zone. Specific land acquisition requirements include the protection of at least three occurrences of alkali milk-vetch. This approach is expected to result in conservation of a gradient of natural habitats that range from grassland upland communities down slope to existing and restored tidal wetland communities.

Grassland, vernal pool complex, and alkali seasonal wetland complex communities fringing Suisun Marsh support several rare plant species that will be brought under protection and management through these acquisitions. This approach to conservation of these natural communities will serve to conserve habitat for the tricolored blackbird, western burrowing owl, Swainson's hawk, white-tailed kite, giant garter snake, western pond turtle, western spadefoot toad, California tiger salamander, the covered vernal pool shrimp species, alkali milk-vetch, San Joaquin spearscale, dwarf downingia, Boggs Lake hedge-hyssop, Heckard's peppergrass, legenere, heartscale, brittlescale, and Carquinez goldenbush (see details on benefits to each of these species in Section 3.3, *Biological Goals and Objectives*). These conserved lands will be evaluated and managed to maintain and enhance their existing habitat functions for these species over the term of the BDCP. The protection and restoration of vernal pool complex will help achieve the recovery objectives for Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, mid- valley fairy shrimp, vernal pool tadpole shrimp, alkali milk-vetch, Boggs Lake hedge-hyssop, and legenere identified in the Vernal Pool Recovery Plan (USFWS 2005). Following full BDCP implementation, an estimated __ percent of grassland, vernal pool complex, and alkali seasonal wetland remaining in Conservation Zone 11 will be protected.

*Tidal Aquatic and Wetland Natural Communities***.** Lands sufficient to restore at least 7,000 acres of tidal habitat, including 3,000 acres of tidal brackish emergent wetland will also be acquired in Conservation Zone 11 within the Suisun Marsh ROA. Restored tidal habitat includes restored gradient of habitats ranging from shallow subtidal aquatic habitat, to mudflat, emergent marsh plain, and transitional uplands. Transitional uplands will include sufficient land to accommodate future upslope establishment of marsh plain vegetation with sea level rise and will support habitat for grassland associated species. Restored tidal marsh plains and mudflats are expected to support habitat for the salt marsh harvest mouse, Suisun shrew, Townsend's big-eared bat, tricolored blackbird, Suisun song sparrow, California black rail, California clapper rail, western pond turtle, Suisun thistle, soft bird's-beak, Delta tule pea, Suisun marsh aster, Mason's lilaeopsis, and Delta mudwort. Restoration and protection of transitional uplands will provide flood refugia habitat for salt marsh harvest mouse, Suisun shrew, California black rail, and California clapper rail during high water events. Restoration of shallow subtidal aquatic habitat will also support California least tern foraging habitat and aquatic habitat for the western pond turtle.

*Plant Species Occurrences***.** Protect and enhance at least three occurrences of alkali milk-vetch, brittlescale, heartscale in Conservation Zones 1, 8, and/or 11. Protect and enhance 2 occurrences of Heckard's peppergrass in Conservation Zones 1, 8, and/or 11. Protect and enhance 3 occurrences each of Suisun thistle and soft bird's-beak in Suisun Marsh Conservation Zones 11. Preserve at least 3 occurrences of Carquinez goldenbush in Conservation Zones 1 and/or 11.

Inter-Conservation Zone Connectivity

In addition to the spatial distribution requirements among the Conservation Zones for protection of natural communities and covered species, conservation lands will also need to be distributed within and among some Conservation Zones to provide connectivity for some covered species habitats across specific segments within or adjacent to the Plan Area. Specific efforts will focus on two ecological corridors described below. It is expected that the corridors can be established through meeting the natural community conservation targets presented in Table 3-4. Corridor width will follow the recommendations from the *California Essential Habitat Connectivity Project* (DFG/CALTRANS 2010), to the extent that it is practicable and within the natural community conservation targets.

Grassland/Vernal Pool Complex Corridor. Vernal pool complex natural community in Conservation Zones 1 and 11 are situated at elevations that are suitable for serving as upland habitats adjacent to restored tidal habitats and can be protected to build upon existing and planned preserves in Solano County between these conservation zones. Protection of additional vernal pool complex natural community in this area will protect an important connection between Suisun Marsh and the Cache Slough area. Establishing a protected corridor in this area will also facilitate movement of several covered species including California tiger salamander and western spadefoot toad from occupied habitats in the Montezuma Hills and Jepson Prairie into the grassland and vernal pool complex habitats in Conservation Zone 1.

The Implementation Office will explore opportunities through coordination with Solano County to acquire and protect additional lands between Suisun Marsh and the Cache Slough area in order to establish a protected corridor comprised of contiguous patches of grassland, vernal pool complex, tidal wetlands, and other seasonal wetlands.

Giant Garter Snake Corridor. Habitat connectivity, particularly hydrologic connectivity that supports giant garter snake movement and dispersal, is essential for protection of giant garter snake populations, and is a key element of the species' recovery plan (USFWS 1999a). Focusing agricultural land conservation along a north-south corridor within Conservation Zone 4 along with restoration of tidal wetlands in that area, will enhance connectivity and facilitate giant garter snake movement between the Coldani Marsh-White Slough subpopulation north to the Cosumnes River Preserve and to Stone Lakes National Wildlife Refuge.

A corridor will be protected that is comprised of contiguous patches of agricultural, restored tidal and nontidal wetlands, grassland, vernal pool complex, and other seasonal wetlands between the Coldani Marsh/White Slough giant garter snake subpopulation area north to Stone Lakes National Wildlife Refuge and to the extent possible connecting the Cosumnes River Preserve. The corridor will be configured such that there is contiguous giant garter snake movement habitat along this north-south corridor. To serve as a movement corridor to meet the needs of the giant garter snake, the width of the corridor may not be less than 3,200 feet wide in any location.

Invasive Species Control Program

The BDCP Implementation Office will develop and implement a plan for the control of invasive animal and plant species that could substantially degrade the functions of protected natural communities as habitat for covered and other native species on BDCP lands.

Elements of the plan will include:

- Protocols for periodically surveying for and assessing the abundance of nonnative predators and competitors on BDCP lands;
- Protocols for periodically surveying for and assessing the occurrence and abundance of invasive nonnative plants on BDCP lands;

- A brown-headed cowbird monitoring and control program (see discussion below);
- Methods for assessing degree of biological effect nonnative species have on covered and other native species within BDCP lands;
- Methods for assessing threats of establishment of nonnative animals and plants on lands adjacent to BDCP lands;
- Methods for assessing threats of the spread of nonnative plants from BDCP lands onto adjacent lands;
- A decision-making process for determining the need for implementing management actions to control nonnative species;
- A description of potential nonnative species control methods; and
- A process for developing and implementing monitoring necessary to assess the effectiveness of implemented control methods.

Monitoring and control requirements that may be developed for specific preserve lands will be incorporated into preserve-specific management plans (see CM11 Natural Communities Enhancement and Management).

Examples of nonnative plant species currently of concern include waxy mannagrass, Italian ryegrass, barbed goatgrass, medusahead grass, yellow starthistle, Himalayan blackberry, giant reed, and parrot feather. Animal species that could degrade the habitat functions for covered species include feral domesticated animals (e.g., feral cat predation on ground-nesting birds) and brown-headed cowbirds.

The brown-headed cowbird is a native species that has expanded its range substantially with conversion of historical Central Valley habitats to agriculture. The brown-headed cowbird is a frequent brood parasite of yellow-breasted chats and other native birds and can affect local reproduction of chats. On conserved lands that support nesting yellow-breasted chats, surveys will be conducted to identify and monitor brown-headed cowbird populations, the extent of brood parasitism of yellow-breasted chats, and the reproductive trend of nesting yellow-breasted chats. If it is determined that cowbirds are substantially affecting nesting success of yellow-breasted chats such that local populations are or could decline, cowbird control measures will be implemented to reduce local cowbird populations.

3.4.3 Natural Community-Level Conservation Measures

Natural community conservation measures include the protection, restoration, enhancement, and management of natural communities and the covered species that are dependent upon them. The overarching goal of restoration and protection of natural communities is to create and maintain an ecologically functioning landscape that successfully combines both native and working landscape elements and that meets natural community and species goals and objectives. Natural community conservation measures provide the mechanisms for achieving restoration and protection goals and objectives using the following the guiding principles:

- Restore natural communities such that they contribute to and enhance an ecologically functional landscape;
- Manage and enhance working landscapes (e.g., agricultural lands) such that they protect covered species habitat values and facilitate expansion of covered species populations while maintaining their agricultural production and economic value;
- Emphasize natural ecological gradients and connectivity among and between restored and existing natural communities that provide a range of conditions to provide for shifting or expanding species distributions; and
- Protect, restore, and enhance habitats for covered species such that implementation of the BDCP provides a significant contribution to their long-term conservation in the Plan Area.

3.4.3.1 CM4 Tidal Habitat Restoration

BDCP implementation will provide for the restoration of 65,000 acres of freshwater and brackish tidal habitat within the BDCP ROAs (Figure 3-3). The extent of restored tidal habitat includes a contiguous habitat gradient encompassing restored shallow subtidal aquatic habitat[34], restored tidal mudflat, restored tidal marsh plain habitat[35], and adjoining transitional upland habitat. This upland habitat will accommodate approximately 3 feet of sea level rise that could function as tidal marsh plain at some future time, if necessary. Additional upland habitat, however, would be protected and enhanced to provide habitat for terrestrial species.

Of the 65,000-acre restoration target, 22,000 acres will be distributed among the ROAs as described below in Minimum Restoration Targets for Freshwater Tidal Habitat in ROAs and Minimum Restoration Target for Brackish Tidal Habitat in the Suisun ROA. The remaining 43,000 acres of the target total will be distributed among the ROA's at the discretion of the BDCP Implementation Office based on land availability, biological value, and practicability considerations. The freshwater and brackish tidal habitat restoration targets will be achieved on the following time schedule:

- 14,000 acres developed[36] within the first 10 years of plan implementation;
- 25,000 acres (cumulative) developed by year 15 of plan implementation; and
- 65,000 acres (cumulative) developed by year 40 of plan implementation.

[34] Restored shallow subtidal habitat extends approximately from the mean lower low water [MLLW] elevation to 9 feet below the MLLW elevation.

[35] Restored tidal marsh plain extends from the MLLW elevation to the mean higher high water [MHHW] elevation.

[36] In achieving these targets the term "developed" means the completion of reintroduction of tidal inundation to areas expected to develop as tidal habitat. These target values represent the habitat area developed at the points in time identified. Development of fully functioning restored habitat may take years subsequent to initial tidal inundation through the effects of natural processes on the constructed surface.

Actions to restore freshwater and brackish tidal habitat, as appropriate to site-specific conditions, will include:

- Acquiring lands, in fee-title or through conservation easements, suitable for restoration of tidal habitats and protecting sufficient adjacent uplands to accommodate 3 feet of future sea level rise;
- Consulting with covered species experts to assist with the design and implementation of avoidance and minimization measures;
- Breaching and lowering levees and dikes to reintroduce tidal exchange to currently leveed former tidelands;
- Reconnecting disconnected remnant sloughs to Suisun Bay and removing remnant slough levees to reintroduce tidal connectivity to slough watersheds;
- Constructing new or enhancing existing levees to provide flood protection for adjacent landowners and protecting existing land use against seepage and erosion of existing levees;
- Constructing new levees to isolate deeply subsided lands from tidal flooding;
- Restoring natural remnant meandering tidal channels;
- Excavating channels to encourage the development of dendritic channel networks within restored marsh plain;
- Modifying ditches, cuts, and levees to encourage more natural tidal circulation and better flood conveyance based on local hydrology;
- Restoring tributary stream functions to establish more natural patterns of sediment transport to improve spawning conditions for delta smelt and other fish and macroinvertebrates;
- Prior to breaching, re-contouring the surface to maximize the extent of surface elevation suitable for establishment of tidal marsh vegetation (“marsh plain”) by scalping higher elevation land to provide fill for placement on subsided lands to raise surface elevations;
- Prior to breaching, importing dredge or fill and placing it in shallowly subsided areas to raise ground surface elevations to a level suitable for establishment of tidal marsh vegetation (“marsh plain”);
- Prior to breaching, cultivating stands of tules through flood irrigation for sufficiently long periods to raise subsided ground surface to elevations suitable to support marsh plain and breaching levees when target elevations are achieved; and
- Designing levee and dike breaches to maximize the development of tidal marsh plain and minimize hydrodynamic conditions that favor nonnative predatory fish.

Measures for addressing the potential for methylation of mercury in restored tidal habitats will be addressed through implementation of CM12 Methylmercury Management.

Freshwater Tidal Habitat Restoration

Freshwater tidal habitats will be restored to provide the ecological benefits for covered species described under *Hypothesized Benefits* below. Freshwater tidal habitats will be restored by breaching or removing levees along Delta waterways to reestablish tidal connectivity to reclaimed lands. Tidal habitat restored on deeply subsided Delta tracts and islands may require construction of cross levees or berms to isolate deeply subsided lands from inundation, avoiding the creation of large areas of subtidal habitats that could favor nonnative predator/competitor species and disfavor covered fish species. Where required, levees or berms will be constructed to prevent inundation of adjacent lands.

Where practicable and appropriate, portions of restoration sites will be raised to elevations that will support tidal marsh vegetation following breaching. Depending on the degree of subsidence and location, lands may be elevated by grading higher elevations to fill subsided areas, importing dredged or fill material from other locations, or planting tules or other appropriate vegetation to raise elevations in shallowly subsided areas over time through organic material accumulation. Surface grading will provide for a shallow elevation gradient from the marsh plain to the upland transition habitat. Based on assessments of local hydrodynamic conditions, sediment transport, and topography, restoration activities may be designed and implemented in a manner that accelerates the development of tidal channels within restored marsh plains. Following reintroduction of tidal exchange, tidal marsh vegetation is expected to establish naturally at suitable elevations relative to the tidal range. Depending on site-specific conditions and monitoring results, patches of native emergent vegetation may be planted to accelerate the establishment of native marsh vegetation on restored marsh plain surfaces. A conceptual illustration of restored freshwater tidal habitat is presented in Figure 3-55.

Restoration variables that will be considered by the BDCP Implementation Office in the design of restored freshwater tidal habitat include:

- Spatial distribution of restored tidal marsh habitats within the Delta;
- Extent, location, and configuration of restored tidal habitat areas;
- Predicted tidal range at tidal habitat restoration sites following reintroduction of tidal exchange;
- Size and location of levee breaches;
- Cross sectional profile of tidal habitat restoration sites (elevation of marsh plain, topographic diversity, depth, and slope); and
- Density and size of restored tidal habitat channels appropriate to each restoration site.

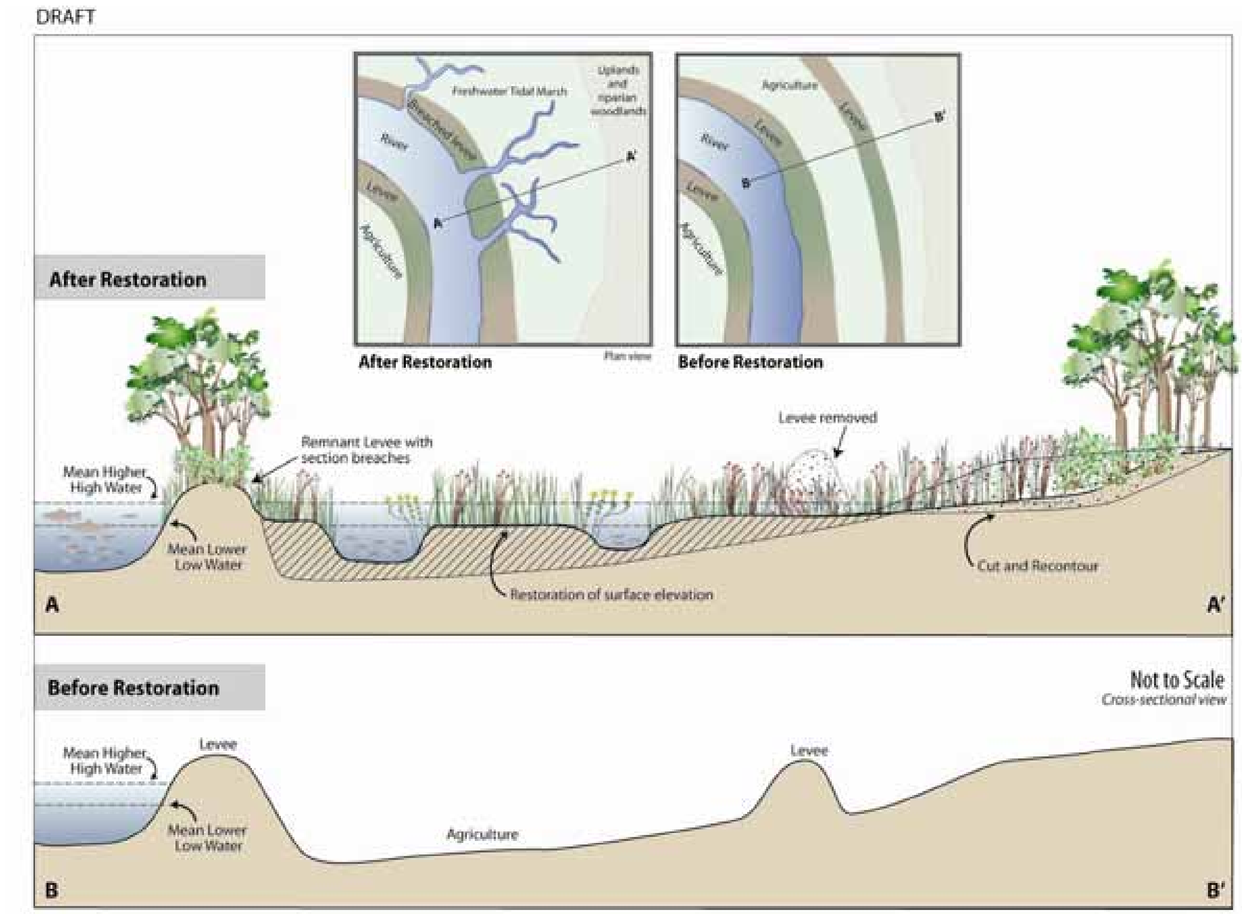

Figure 3-55. Conceptual Design for Restored Freshwater Tidal Marsh Habitat (CM4)

Restoration design considerations for freshwater tidal habitat will include the following.

*Marsh Plain Vegetation***.** To provide for high functioning habitat, restored tidal marsh plains will be vegetated primarily with tules and other native freshwater emergent vegetation to reflect the historical composition and densities of Delta tidal marshes. Following establishment of tidal exchange, restored habitat will be monitored to assess the establishment of native and invasive nonnative plants. If indicated by monitoring results, the Implementation Office will implement invasive plant control measures to help ensure the establishment of native marsh plain plant species.

*Hydrodynamic Conditions***.** Tidal habitat restoration will be designed, within restoration site constraints, to produce sinuous, high density, dendritic networks of tidal channels that promote effective tidal exchange throughout the marsh plain and provide foraging habitat for covered fish species. Effective tidal exchange is expected to enhance ecological functions that support covered species, including:

- The export of productivity from the marsh plain into adjacent Delta waterways in support of aquatic food web processes;
- Production and export of phytoplankton and zooplankton from tidal channels into adjacent Delta waterways in support of the aquatic food web; and
- Maintenance of cooler localized water temperatures preferred by covered fish species through nocturnal thermal exchange on marsh plains.

Marsh channels and levee breaches will also be designed to maintain flow velocities that minimize conditions favorable to the establishment of nonnative submerged and floating aquatic vegetation and habitat for nonnative predatory fish.

Following breaching and reintroduction of tidal action to restoration sites, tidal action will begin the natural process of sediment movement and the restored bottom contours will evolve. A discussion of such the types of changes expected is provided in Appendix N-4 [*marsh evolution document*].

*Environmental Gradients***.** As determined by site-specific constraints, tidal habitat restoration actions will be designed to provide an ecological gradient among subtidal, tidal mudflat, tidal marsh plain, riparian, and upland habitats to accommodate the movement of fish and wildlife species and provide flood refuge habitat for marsh-associated wildlife species during high water events. In addition, by protecting higher elevation lands adjacent to restored marsh plains, these areas will be available for future marsh establishment that may occur as a result of sea level rise.

*Shallow subtidal aquatic habitat***.** Restored shallow subtidal aquatic habitat is expected to support, depending on location, delta smelt, longfin smelt, juvenile salmonid rearing, sturgeon, and lamprey habitat. Shallow freshwater subtidal aquatic habitat in some portions of the Delta support large numbers of nonnative predatory fish and extensive beds of nonnative submerged aquatic vegetation that adversely affect covered fish species. In other portions of the Delta, shallow subtidal habitat provides suitable habitat for native species, such as delta smelt in the Liberty Island/Cache Slough region, and does not promote the growth of nonnative submerged aquatic vegetation. Because it may generate habitat for nonnative predators, it is not a goal of the BDCP to restore large areas of shallow subtidal aquatic habitat; rather, shallow subtidal aquatic habitat will result as part of the restoration of freshwater tidal marsh plain where land surface elevations within restoration sites are subsided below elevations that would support tidal marsh vegetation. Tidal habitat restoration projects will be designed to minimize the likelihood of establishment of nonnative submerged aquatic vegetation, which may serve as habitat for nonnative predators. Early restoration projects will be monitored to assess the response of nonnative species to restoration designs and local environmental conditions. This information will be used to modify restoration designs and implementation methods, if necessary, over time to further improve habitat conditions for covered fish species. As described in CM13 Nonnative Aquatic Vegetation Control, the BDCP Implementation Office will engage in active removal of submerged and floating aquatic vegetation in subtidal portions of tidal restoration sites to reduce the levels of establishment of nonnative predators.

*Minimum Restoration Targets for Freshwater Tidal Habitat in ROAs***.** At a minimum, the BDCP Implementation Office will restore the following amounts of tidal habitat in each of the Delta ROAs (Figure 3-2) as described below.

- **Restore at least 5,000 acres of freshwater tidal habitat within the Cache Slough Complex ROA.** The BDCP Implementation Office will restore a minimum of 5,000 acres of freshwater tidal habitat in the Cache Slough Complex ROA. Areas suitable for restoration include, but are not limited to, Haas Slough, Hastings Cut, Lindsey Slough, Barker Slough, Calhoun Cut, Liberty Island, Little Holland, the Westlands property ("Yolo Ranch"), Shag Slough, Little Egbert Tract, and Prospect Island. The Cache Slough Complex has been recognized as possibly the best functioning existing tidal habitat area of the Delta. The complex includes Liberty Island, which is likely the best existing model for freshwater tidal habitat restoration in the Delta for native fishes. The Complex supports multiple covered fish species and may be one of the last areas where Delta smelt spawn and rear successfully. Restoring the target amount of freshwater tidal habitat within the Cache Slough Complex ROA and protecting associated upland habitat would benefit multiple covered species and the Delta ecosystem. In conjunction with floodplain enhancement in the Yolo Bypass, the habitat restoration in the Cache Slough ROA will re-establish the ecological gradient from river to floodplain to tidal estuary and to provide tidal wetland adjacent to open channel habitat that is characteristic of less altered estuaries. Hydrodynamic modeling indicates that increased tidal exchange in the Cache Slough area resulting from 5,000-10,000 acres of tidal habitat restoration will reduce bidirectional flows in Steamboat and Sutter Sloughs and the mainstem Sacramento River compared to tidal action under present conditions, thus significantly enhancing movement of juvenile salmonids through these waterways and potentially reducing their exposure to predators.

Additionally, the Cache Slough Complex encompasses a substantial area of land with elevations suitable for freshwater tidal habitat restoration that would involve few impacts on existing infrastructure or permanent crops relative to other areas of the north Delta. The Cache Slough Complex provides an excellent opportunity to expand habitat supporting multiple aquatic and terrestrial covered species. Restoration of freshwater tidal habitat will be designed to support the physical and biological attributes that benefit covered species. Based on existing land elevations, approximately 21,000 acres of public and private lands in the area are potentially suitable for restoration of tidal habitat. Areas for restoration would be identified by working with interested landowners.

- **Restore at least 1,500 acres of freshwater tidal habitat within the Cosumnes-Mokelumne ROA.** The BDCP Implementation Office will restore a minimum of 1,500 acres of freshwater tidal habitat in the Cosumnes/Mokelumne ROA. Areas suitable for restoration within the Cosumnes-Mokelumne ROA (Figure 3-2) include McCormack-Williamson Tract, New Hope Tract, Canal Ranch Tract, Bract Tract, Terminous Tract north of State Highway 12, and lands adjoining Snodgrass Slough, South Stone Lake, and Lost Slough. Depending on site-specific conditions, levees may be constructed to avoid inundation of deeply subsided lands.
- **Restore at least 2,100 acres of tidal habitat within the West Delta ROA.** The BDCP Implementation Office will restore a minimum of 2,100 acres of freshwater tidal habitat in the West Delta ROA. The west Delta includes multiple small areas where tidal habitat can be restored. Areas suitable for restoration include Dutch Slough, Decker Island, portions of Sherman Island, Jersey Island, Bradford Island, Twitchell Island, Brannon Island, Grand Island, and along portions of the north bank of the Sacramento River where elevations and substrates are suitable. The purpose of restoring tidal habitat in the west Delta is to provide a continuous reach of tidal marsh and subtidal aquatic habitat associated with food productivity between current and future restored habitats in the Cache Slough Complex and Suisun Marsh and Bay and to provide tidal marsh plain habitat within the anticipated future eastward position of the biologically important low salinity zone of the estuary with sea level rise.
- **Restore at least 5,000 acres of tidal habitat within the South Delta ROA.** The BDCP Implementation Office will restore a minimum of 5,000 acres of freshwater tidal habitat in the South Delta ROA. To maximize benefits associated with restoration of tidal habitat in the south Delta, tidal habitat will not be restored until the north Delta diversion facilities become operational. Potential sites for restoring freshwater tidal habitat include Fabian Tract, Union Island, Middle Roberts Island, and Lower Roberts Island. Sites selected for restoration would be dependent on the location and design of the selected conveyance pathway and operations for the through-Delta component of the dual conveyance facility. Selected sites would be those that would provide substantial species and ecosystem benefits with the selected through-Delta conveyance configuration and most effectively avoid potential adverse effects of south Delta SWP/CVP operations. In conjunction with dual conveyance operations, tidal habitat restoration in the South Delta

ROA may support the expansion of the current distribution of delta smelt into formerly occupied habitat areas.

Tidal habitat restoration sites will be designed to support habitat mosaics and an ecological gradient of shallow subtidal aquatic, tidal mudflat, tidal marsh, transitional upland and riparian habitats, and uplands (e.g., grasslands, agricultural lands) for sea level rise accommodation, as appropriate to specific restoration sites.

Problem Statement

The majority of historical freshwater tidal marsh in the Sacramento/San Joaquin Delta has been lost. Historically, approximately 350,000 acres of tidal marsh was present in the Delta, of which less than 10,000 acres of freshwater tidal marsh remains. This loss of tidal marsh has greatly reduced the availability and quality of spawning and rearing habitat for many native fish species, by reducing the input of organic and inorganic material and food resources into adjoining deep water habitats (sloughs and channels) and the downstream bay and estuary. This loss of freshwater tidal marsh has also greatly reduced the extent and quality of habitat for native wildlife and plants adapted to the tidal marsh environment, including many of the covered species.

Hypothesized Benefits

Restoration of freshwater tidal habitat is hypothesized to provide a range of ecosystem and covered species benefits. These anticipated benefits are described below for the freshwater tidal habitat restoration proposed in each of the ROAs. As described in Chapter 5, *Effects Analysis*, and Appendix F, *DRERIP Evaluation Results*, however, there are a number of uncertainties regarding the level of benefits that may be provided by tidal habitat restored in each of the ROAs as well as risks for adverse consequences. These uncertainties will be addressed through effectiveness monitoring, research, and the adaptive management program (see Sections 3.6 and 3.7).

Restoring freshwater tidal habitat within the Cache Slough ROA is expected to:

- Increase rearing habitat area for Chinook salmon (Sacramento River runs), Sacramento splittail, white sturgeon, and green sturgeon (Healey 1991, Brown 2003, Appendix F, *DRERIP Evaluation Results*);
- Increase the local production of food for rearing salmonids, splittail, delta smelt, green and white sturgeon (Kjelson et al. 1982, Siegel 2007);
- Increase the export of food in the Delta downstream of Rio Vista available to juvenile salmonids, splittail, delta smelt, white sturgeon, and green sturgeon by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in tidal channels into the Delta and Suisun Marsh (Siegel 2007);
- Expand habitat available for colonization by Mason's lilaeopsis, Suisun Marsh aster, Delta mudwort, and Delta tule pea; and

- Expand habitat for tricolored blackbird, California black rail, and giant garter snake (in locations with a muted tidal range).

Restoring freshwater tidal habitat within the Cosumnes/Mokelumne River ROA is expected to:

- Increase rearing habitat area for Cosumnes/Mokelumne fall-run Chinook salmon, steelhead, delta smelt, and Sacramento splittail (Healey 1991, Brown 2003);
- Increase the local production of food for Cosumnes/Mokelumne fall-run Chinook salmon, steelhead, delta smelt, and Sacramento splittail migrating to and from the Cosumnes and Mokelumne Rivers (Kjelson et al. 1982, Siegel 2007);
- Increase the availability and production of food in the east and central Delta available to juvenile salmonids, splittail, delta smelt, white sturgeon, and green sturgeon by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in tidal channels into the Delta (Siegel 2007);
- Increase the extent of habitat available for colonization by side-flowering skullcap, Mason’s lilaeopsis, Suisun Marsh aster, and Delta tule pea; and
- Expand habitat for tricolored blackbird, California black rail, greater sandhill crane, and giant garter snake (in locations with a muted tidal range).

Restoring freshwater tidal habitat in the West Delta ROA is expected to:

- Increase rearing habitat area for Chinook salmon (Sacramento, San Joaquin, and Mokelumne river runs), Sacramento splittail, and possibly steelhead (Healey 1991, Brown 2003);
- Improve future rearing habitat areas for delta smelt and longfin smelt within the anticipated eastward movement of the low salinity zone with sea level rise;
- Increase the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982; Siegel 2007);
- Increase the availability and production of food in the western Delta and Suisun Bay by exporting organic material via tidal flow from the marsh plain and organic carbon, phytoplankton, zooplankton, and other organisms produced in tidal channels into adjacent open water areas (Siegel 2007);
- Provide an important linkage between current and future upstream restored habitat with downstream habitat in Suisun Marsh and Bay;
- Provide additional refugial habitat for migrating and resident covered species;
- Increase the extent of habitat available for colonization by Mason’s lilaeopsis, Suisun Marsh aster, Delta mudwort, and Delta tule pea; and
- Expand habitat for tricolored blackbird, California black rail, and giant garter snake (in locations with a muted tidal range).

Restoring freshwater tidal habitat in the South Delta ROA is expected to:

- Increase rearing habitat area for Sacramento splittail, Chinook salmon produced in the San Joaquin River and other eastside tributaries, and possibly steelhead (Healey 1991, Brown 2003);
- Increase the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982, Siegel 2007);
- Increase the availability and production of food in the Delta and Suisun Bay by export from the south Delta of organic material via tidal flow from the new marsh plain and organic carbon, phytoplankton, zooplankton, and other organisms produced in new tidal channels (Siegel 2007);
- Increase the extent of habitat available for colonization by Mason's lilaeopsis, Delta mudwort, and Delta tule pea; and
- Expand habitat for tricolored blackbird, California black rail, greater sandhill crane, and giant garter snake (in locations with a muted tidal range).

Adaptive Management Considerations

Implementation of freshwater tidal habitat restoration actions and subsequent management of restored tidal habitats by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results, likely elements of this measure that could be adjusted through the adaptive management process include considerations for selecting restoration locations and sequencing restoration of tidal habitat among the ROAs; methods for establishing marsh plain vegetation, including the establishment of marsh-associated covered plant species; methods and designs for elevating subsided land surfaces to increase restored marsh plain area; design and location of levee breaches; designs for encouraging the development of a high functioning network of tidal channels; and nonnative vegetation and wildlife control techniques.

Brackish Tidal Habitat Restoration

Brackish tidal habitat will be restored within Suisun Marsh ROA in coordination with the Suisun Marsh Habitat Restoration and Management Plan, currently under development. Brackish tidal habitat will be restored to provide the ecological benefits for covered species described under Hypothesized Benefits below. Brackish tidal habitat will be restored by breaching or removing dikes along Montezuma and other Suisun Marsh sloughs and channels and Suisun Bay to reestablish tidal connectivity to reclaimed lands. Tidal habitat restored adjacent to farmed lands or lands managed as freshwater seasonal wetlands may require construction of dikes to maintain those land uses. Where appropriate, portions of restoration sites will be raised to elevations that would support tidal marsh vegetation.

Depending on the degree of subsidence, location, and likelihood for natural accretion through sedimentation, lands may be elevated by grading higher elevations to fill subsided areas, importing dredged or fill material from other locations, or planting appropriate native vegetation to raise elevations in shallowly subsided areas over time through organic material accumulation prior to breaching dikes. Surface grading will be designed to result in a shallow elevation gradient from the marsh plain to the upland transition habitat. Remnant disconnected tidal channels will be restored if present within restoration sites to accelerate development of marsh functions. Existing tidal channels may also be deepened and or widened if necessary to increase tidal flow. Based on assessments of local hydrodynamic conditions, sediment transport, and topography, restoration sites may be graded to accelerate the development of tidal channels within restored marsh plains. Following reintroduction of tidal exchange, tidal marsh vegetation would be expected to naturally establish at suitable elevations relative to the tidal range. Depending on site-specific conditions and monitoring results, patches of native emergent vegetation may be planted to accelerate the establishment of native marsh vegetation on restored marsh plain surfaces. A conceptual illustration of restored brackish tidal habitat is presented in Figure 3-56.

Restoration variables that will be considered by the BDCP Implementation Office in the design of restored brackish tidal habitat include:

- Extent, location, and configuration of other existing and proposed restored tidal habitat areas;
- Distribution of restored tidal habitats along salinity gradients to optimize the range of habitat conditions for covered species and food production;
- Predicted tidal range at tidal habitat restoration sites following reintroduction of tidal exchange;
- Size and location of dike breaches;
- Cross sectional profile of tidal habitat restoration sites (elevation of marsh plain, topographic diversity, depth, and slope);
- Density and size of tidal marsh plain channels appropriate to each restoration site; and
- Potential hydrodynamic and water quality effects on other areas of the Delta.

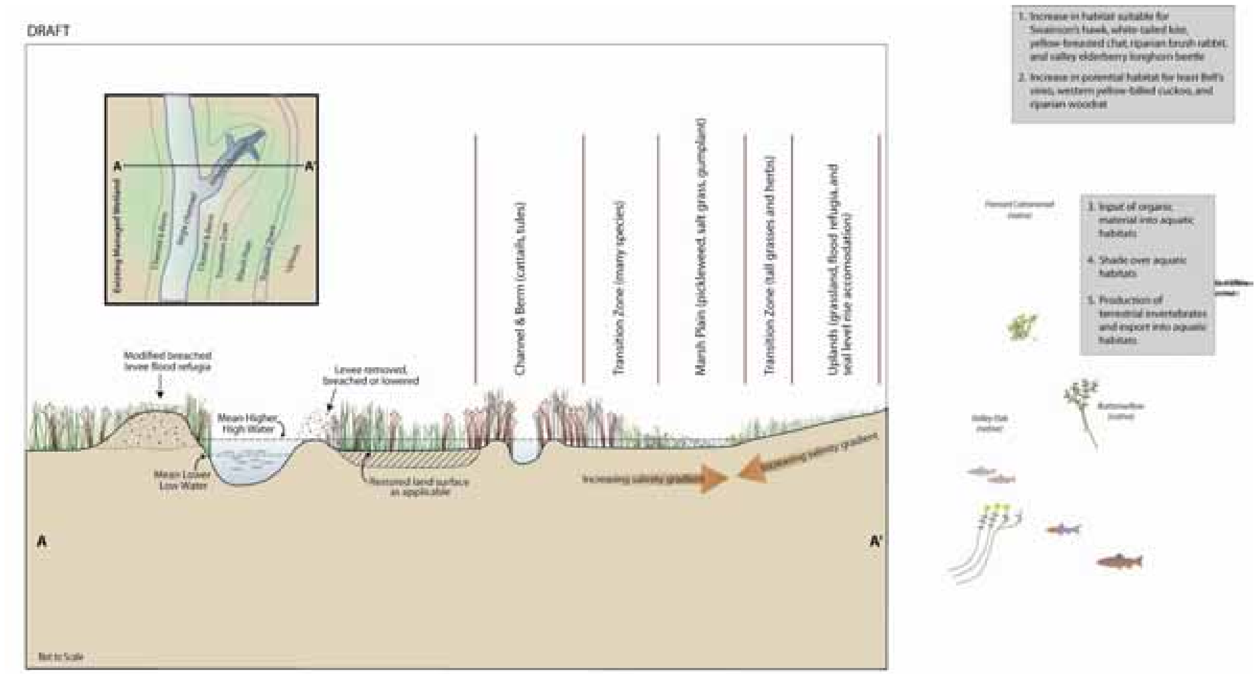

Figure 3-56. Conceptual Design for Restored Brackish Tidal Marsh Habitat (Suisun Marsh ROA) (CM4)

Restoration design considerations for brackish tidal habitat include the following.

*Marsh Plain Vegetation***.** To provide high functioning habitat, restored tidal marsh plains will be dominated by native brackish marsh vegetation (e.g., pickleweed, saltgrass) appropriate to marsh plain elevations, mimicking the composition and densities of historical Suisun Bay brackish tidal marshes. Vegetated marsh plains will also be expected to filter non-point source pollution from surface or subsurface infiltration that otherwise would flow into Suisun Bay. Following establishment of tidal exchange, restored habitat will be monitored to assess the establishment of invasive nonnative plants. If indicated by monitoring results, the BDCP Implementation Office will implement invasive plant control measures to help ensure the establishment of native marsh plain plant species.

*Hydrodynamic Conditions***.** Restored brackish tidal habitat will be designed to provide hydrodynamic conditions similar to those described for freshwater tidal habitat. In addition to desired biological and ecological attributes, the selection and design of restored tidal habitat in Suisun Marsh will need to consider potential hydrodynamic and water quality effects of the proposed restoration, including the effect on salinity intrusion, tidal mixing, and Delta salinity.

*Environmental Gradients***.** Restored brackish tidal habitat will be designed to provide environmental gradients similar to those described for freshwater tidal habitat. Because land surface elevations within Suisun Marsh are relatively homogenous, opportunities to provide linkages to upland habitats are limited to restoration sites that are located along the fringe of Suisun Marsh. Dikes constructed to restore tidal habitat in the interior of Suisun Marsh will be designed with low gradient slopes supporting high marsh and upland vegetation to provide flood refuge habitat. Where appropriate, higher elevation islands of upland habitat within restored tidal habitat may also be created to provide flood refuge for marsh wildlife.

Minimum Restoration Targets for Brackish Tidal Habitat in Suisun ROA. The BDCP Implementation Office will restore at least the following amount of brackish tidal habitat in the Suisun Marsh ROA.

*Restore at least 7,000 acres of brackish tidal habitat within the Suisun Marsh Restoration Opportunity Area***.** The BDCP Implementation Office will restore a minimum of 7,000 acres of brackish tidal habitat in the Suisun Marsh ROA. Restored brackish tidal habitat will be designed to support the physical and biological attributes described above in Brackish Tidal Marsh Habitat Restoration. Restored tidal habitat will be designed to create ecological gradients that support a mosaic of tidal marsh, tide flat, shallow subtidal aquatic, and transitional upland habitats as appropriate to specific restoration sites. The Suisun Marsh ROA encompasses a substantial area with elevations suitable for tidal habitat restoration that would have minimal effect on infrastructure or permanent crops relative to other suitable lands within the Delta.

The Suisun Marsh Habitat Restoration and Management Plan (currently under development) will include an evaluation of alternatives, including options that contemplate the restoration of up to

7,000 acres of brackish tidal habitat. Much of Suisun Marsh is currently at elevations that could be restored to tidal habitat.

Hydrodynamic modeling conducted for the Suisun Marsh Restoration Plan (J. DeGeorge pers. comm.) indicates that restoring tidal habitat north of Montezuma Slough would shift the low salinity zone westward and restoring tidal habitat at sites adjacent to Suisun Bay would shift the low salinity zone eastward, potentially adversely affecting delta smelt habitat and water quality in the west Delta. Consequently, implementation of tidal habitat restoration projects in north and south Suisun Marsh will be sequenced such that these potential effects would be minimized.

As described in CM1 *Water Facilities and Operation*, future reoperation of the Montezuma Slough Salinity Control Gate will increase the benefits of restoring brackish tidal habitat in Suisun Marsh by increasing access for covered fish species to existing and restored tidal aquatic habitat within a large area of Suisun Marsh.

Problem Statement

Suisun Marsh is the largest brackish water marsh complex in the western United States. The majority of historical brackish tidal marsh has been lost, of which approximately 8,300 acres remains in Suisun Marsh. This loss of tidal marsh has greatly reduced the availability and quality of spawning and rearing habitat for many native species, by reducing the input of organic and inorganic material and food resources into adjoining deep water habitats (sloughs and channels) and the downstream bay and estuary. This loss of brackish tidal marsh has also greatly reduced the extent and quality of habitat for native wildlife and plants adapted to the tidal marsh environment, including many of the covered species.

Hypothesized Benefits

Restoration of brackish tidal habitat in Suisun Marsh is hypothesized to provide a range of ecosystem and covered species benefits. As described in Chapter 5, *Effects Analysis,* and Appendix F, *DRERIP Evaluation Results*, however, there are a number of uncertainties regarding the level of benefits that may be provided by tidal habitat restored as well as risks for adverse consequences. These uncertainties will be addressed through effectiveness monitoring, research, and the adaptive management program (see Sections 3.6 and 3.7).

Restoring brackish tidal habitat within the Suisun Marsh ROA is expected to:

- Increase rearing habitat area for Chinook salmon, Sacramento splittail, and possibly steelhead (Healey 1991, Siegel 2007);
- Increase the local production of food for rearing salmonids, splittail, and other covered species (Kjelson et al. 1982);
- Provide an important linkage between current and future upstream restored habitat, such as Yolo Bypass/Cache Slough with Suisun Marsh/Bay;

- Increase the availability and production of food in Suisun Bay for delta and longfin smelt by exporting organic material via tidal flow from the marsh plain and phytoplankton, zooplankton, and other organisms produced in tidal channels into the Bay;
- Locally provide areas of cool water refugia for delta smelt (C. Enright pers. comm.);
- Reduce periodic low dissolved oxygen events associated with the discharge of waters from lands managed as seasonal freshwater wetlands that would be restored as brackish tidal habitat (Siegel 2007, C. Enright pers. comm.);
- Increase the extent of habitat available for colonization by Suisun marsh aster and soft-bird's-beak; and
- Enhance and increase the extent of salt marsh harvest mouse, Suisun shrew, California clapper rail, California black rail, and Suisun song sparrow habitat.

Adaptive Management Considerations

Implementation of brackish tidal habitat restoration actions and subsequent management of restored brackish tidal habitats by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results, likely elements of this measure that could be adjusted through the adaptive management process include considerations for selecting restoration locations and sequencing restoration of tidal habitat within Suisun Marsh to maintain desirable salinity gradients; methods for establishing marsh plain vegetation, including the establishment of marsh-associated covered plant species; methods and designs for elevating subsided land surfaces to increase restored marsh plain area; design and location of dike breaches; designs for encouraging the development of a high functioning network of tidal channels; and nonnative vegetation and wildlife control techniques.

3.4.3.2 CM5 Seasonally Inundated Floodplain Restoration

The BDCP Implementation Office will provide for the restoration of 10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or south Delta. Because of the long-lead time needed to plan for and implement floodplain restoration it is not expected that new floodplain would be restored in the first 10 years of Plan implementation. The following are the temporal targets for seasonally inundated floodplain restoration:

- At least 1,000 acres restored by year 15 of plan implementation; and
- 10,000 acres (cumulative) restored by year 40 of plan implementation.

Although seasonally inundated floodplain may be restored along channels in many locations in the north, east, and south Delta, the most promising opportunities for large-scale restoration are in the south Delta along the San Joaquin River, Old River, and Middle River channels based on benefits to covered fish species, practicability considerations, and compatibility with potential flood control projects. Criteria that will be considered in selecting seasonally inundated floodplain restoration sites include:

- Relative importance of the adjacent channel as migration pathways for juvenile salmonids;
- Estimated frequency and duration of inundation periods; and
- Compatibility with flood control programs and level of flood control benefits provided relative to other potential restoration sites.

Actions to restore seasonally inundated floodplain habitats, as appropriate to site-specific conditions, include but are not limited to:

- Acquiring lands, in fee-title or through conservation easements, suitable for restoration of seasonally inundated floodplain;
- Setting back levees along the selected river corridor and removing the existing levees or sections of the existing levees;
- Removing existing riprap along channel banks to allow for channel meander between the set-back levees through the natural processes of erosion and sedimentation;
- Grading restored floodplain surfaces to provide for drainage of over bank flood waters such that the potential for fish stranding is minimized ;
- Lowering the elevation of restored floodplain surfaces to increase inundation frequency and duration and to establish elevations suitable for the establishment of riparian vegetation;
- Discontinuing farming within the setback levees and allowing riparian vegetation to naturally establish on the floodplain;
- Where farming is continued consistent with achieving biological and flood control objectives, engaging in farming practices and crop types that provide high benefits for covered fish species; and
- Actively establishing riparian habitat where necessary to accelerate formation of habitat for specific covered species (see the description of CM7 Riparian Habitat Restoration).

Measures for addressing the potential for methylation of mercury in restored tidal habitats will be addressed through implementation of CM12 Methylmercury Management.

A conceptual illustration of restored seasonally inundated floodplain is presented in Figure 3-57. Because restoration requires modification of levees that serve flood control functions, restored floodplain habitats will be implemented such that flood control functions are maintained or improved.

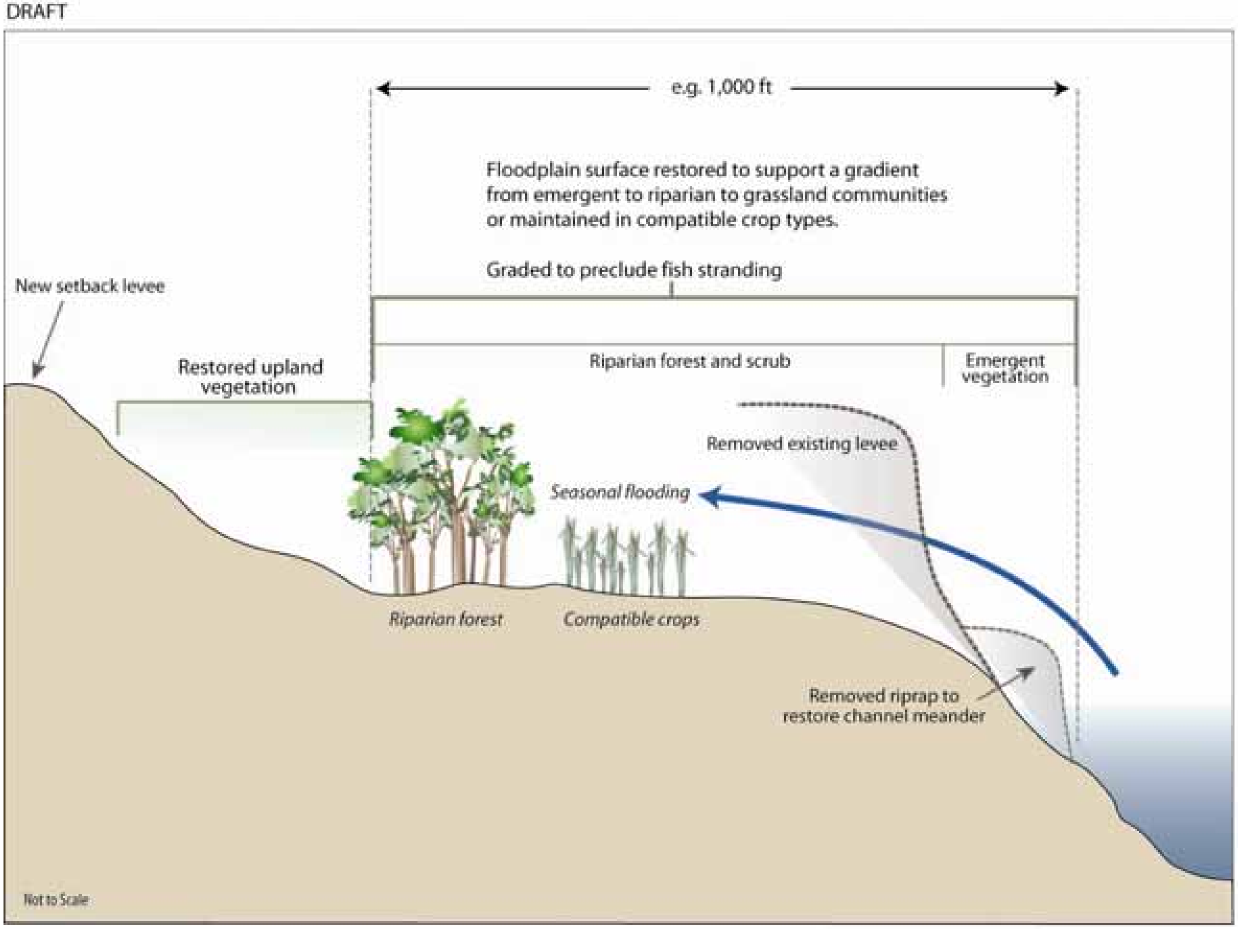

Figure 3-57. Conceptual Design for Restored Seasonally Inundated Floodplain Habitat (CM5)

The BDCP Implementation Office will coordinate floodplain restoration planning with the flood control planning efforts of USACE, DWR, the Central Valley Flood Protection Board, and other flood control agencies to assess the desirability and feasibility for setting back levees in potentially suitable locations. Seasonally inundated floodplain habitat will be designed to support the physical and biological attributes described below in Seasonally Inundated Floodplain Habitat Restoration Concepts and to provide the ecological benefits for covered species described below in Hypothesized Benefits.

Seasonally Inundated Floodplain Habitat Restoration Concepts

Restoration variables that will be considered in the design of restored seasonally inundated floodplain habitat include:

- Modeled timing, duration, interannual frequency, and spatial extent of inundation;
- Connectivity with tidal marsh and channel habitats;
- Accessibility to migrating fish;
- Stranding risk and effects on fish passage;
- Vegetation type and cover;
- Dry season land use (compatible farming practices); and
- Topography and slope.

Restoration design considerations for seasonally inundated floodplain habitat include the following.

*Floodplain Topography***.** Where appropriate, the topography of restored floodplains would be sculpted to reduce the risk for fish stranding by improving drainage and to provide topographic variability to increase hydrodynamic complexity.

*Connectivity***.** Where suitable landform is present, restored floodplains will be located and designed such that flows exiting the floodplain would pass through existing or restored tidal marsh to recreate historical landscape relationships and to provide for connectivity with adjacent uplands that result in transitional habitats and accommodate species movement.

*Habitat Restoration on Restored Floodplains***.** Riparian forest and scrub vegetation will be actively and passively established in restored floodplain areas to the extent consistent with floodplain land uses and flood control requirements. Restored floodplains provide the largest area for meeting the 5,000-acre target for restoration of woody riparian habitat under CM7 Riparian Habitat Restoration, and it is expected that about four-fifths of the riparian habitat restoration will occur at these restored floodplain sites. Established woody riparian vegetation would support habitat for riparian-associated covered species and provide cover and hydrodynamic complexity for covered fish species during inundation periods. Riparian vegetation would also serve as sources of instream woody material for fish habitat, organic carbon in support of the aquatic food web, and macroinvertebrates (e.g., insects) that provide food for covered fish species.

*Land Use on Restored Floodplains***.** Restored floodplains will be managed for ongoing agricultural uses or to support native wildlife habitats. Farmed floodplains will be managed to minimize the use of persistent herbicides and pesticides that are toxic to aquatic organisms and to provide structure and types of residual crop biomass to provide cover and hydrodynamic complexity for fish and provide sources of organic carbon in support of aquatic food web processes during inundation periods.

Problem Statement

Extensive channelization and levee construction has disconnected river channels from their historical floodplains over much of the Central Valley, including the Planning Area, resulting in substantial reduction in the availability of high functioning spawning and rearing habitats that historically support several of the covered fish species. Restoring connectivity of Delta river channels to their historical floodplains will substantially increase the extent of floodplain that can be inundated by overbank flows, thus restoring high functioning spawning and rearing habitat for Sacramento splittail and rearing habitat for salmonids. The restoration of floodplain habitat would allow for establishment of riparian forest and scrub natural community that would support habitat for a large number of covered wildlife and plant species.

Hypothesized Benefits

Restoration of seasonally inundated floodplain habitat is hypothesized to provide the ecosystem and covered species benefits described below. As described in Chapter 5, *Effects Analysis*, and Appendix F, *DRERIP Evaluation Results*, however, there are a number of uncertainties regarding the level of benefits that may be provided by restored floodplain habitats as well as risks for adverse consequences. These uncertainties will be addressed through effectiveness monitoring, research, and the adaptive management program (Sections 3.6 and 3.7).

Restoring seasonally inundated floodplain habitat is expected to:

- Increase spawning habitat for Sacramento splittail by expanding floodplain habitat area and providing in-channel spawning habitat by creating backwaters (Sommer et al. 2001a, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006).
- Depending on the location of restored floodplain, increase rearing habitat for Sacramento and San Joaquin Basin runs of Chinook salmon, Sacramento splittail, and possibly steelhead (Sommer et al. 2001a,b, 2002, 2007, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006).

- Increase the production of food for rearing salmonids, splittail, and other covered species (Sommer et al. 2001a,b, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006).
- Increase the availability and production of food in Delta channels downstream of restored floodplain habitat for delta smelt, longfin smelt, and other covered species by exporting organic material and phytoplankton, zooplankton, and other organisms produced from the inundated floodplain into Delta channels (Mitsch and Gosselink 2000, Moss 2007).
- Increase in nesting habitat for Swainson's hawk and white-tailed kite and habitat for yellow-breasted chat, least Bell's vireo, yellow-billed cuckoo, and valley elderberry longhorn beetle associated with riparian forest and scrub established in floodplain restoration sites.
- Increase in habitat for riparian brush rabbit and riparian woodrat within riparian scrub established in the south Delta restored floodplains (CITATION).
- Increase in habitat area for the establishment of slough thistle and Delta button-celery depending on the location of restored floodplain.

Adaptive Management Considerations

Implementation of seasonally inundated floodplain restoration actions and subsequent management of restored floodplain habitats by the Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results, likely elements of this measure that could be adjusted through the adaptive management process include modifications to floodplain surfaces to increase inundation frequency and duration, reduce the potential for fish stranding, and changes in floodplain vegetation to increase functions related to food production and habitat conditions during periods of inundation.

3.4.3.3 CM6 Channel Margin Habitat Enhancement

The BDCP Implementation Office will provide for the enhancement of 20 linear miles of channel margin habitat in the Delta. This conservation measure is directed at improving habitat conditions for covered fish, wildlife, and plant species along Delta channel banks (as measured along one bank line of channels) by improving channel geometry and restoring riparian, marsh, and mudflat habitats along levees. Channel margin habitat will be enhanced only along channels that serve as important rearing and outmigration habitat for juvenile salmonids. Although channel margin enhancements are intended to provide specific benefits for salmonids, enhancement of these habitats is also expected to improve or restore habitat for other species of covered fish, wildlife, and plants that inhabit channel margin habitats. This measure will be implemented along channels protected by federal Project and/or non-Project levees within the

Plan Area. Channel margin habitat enhancements associated with Project levees will be not be implemented on the levee, but rather on benches to the outboard side of such levees (Figure 3-X [*to come*]). Based on results of effectiveness monitoring for this conservation measure, the BDCP Implementation Office may elect to enhance up to an additional 20 miles of channel margin (for a total of 40 miles) through the adaptive management decision making process. Channel margin habitat enhancement is measured along one side of a channel.

Channel margin enhancement actions will be located along channels that serve as primary rearing and outmigration habitat for juvenile salmonids. These locations include the Sacramento River between Freeport and Walnut Grove, the San Joaquin River between Vernalis and Mossdale, and Steamboat and Sutter Sloughs that are protected by federal Project levees and salmonid migration channels in the interior Delta, such as the North and South Forks of the Mokelumne River, that are protected by non-Project levees. The following are minimum geographic requirements for the 20 miles of channel margin enhancement under this measure:

- At least 5 miles will be located along the Sacramento River between Freeport and Walnut Grove;
- At least 5 miles will be located along the San Joaquin River between Vernalis and Mossdale; and
- The remaining 10 miles will be distributed among the channels described in the preceding paragraph.

The following are the temporal targets for implementation of the 20 miles of channel margin habitat enhancements:

- At least 5 miles enhanced by year 10 of Plan implementation;
- At least 5 miles enhanced by year 20 of Plan implementation;
- At least 5 miles enhanced by year 25 of Plan implementation; and
- At least 5 miles enhanced by year 30 of Plan implementation.

Actions to enhance channel margin habitats, as appropriate to site-specific conditions include, but are not limited to:

- Modifying the outboard side of levees or setting back levees to create low floodplain benches designed with variable surface elevations to create hydrodynamic complexity and that support emergent vegetation to provide an ecological gradient of habitat conditions, and higher elevation benches that support riparian vegetation;
- Planting riparian and emergent wetland vegetation on created benches;
- Installing large woody material (e.g., tree trunks and stumps) could be anchored into constructed low benches or into existing riprapped levees to provide similar habitat functions;

- Removing riprap from channel margins where levees are setback to restore seasonally inundated floodplain habitat under CM5 Seasonally Inundated Floodplain Restoration; and
- Modifying channel geometry in unconfined channel reaches or along channels where levees are setback to restore seasonally inundated floodplain habitat under CM5 Seasonally Inundated Floodplain Restoration, to create backwater salmonid and splittail rearing and splittail spawning habitat.

A conceptual depiction of how channel margin habitat may be enhanced is presented in Figure 3-X [*to come*].

Because channel margin habitat enhancement is expected to require modification of channels and levees that serve flood control functions, channel margin habitat enhancements will be implemented such that flood control functions are maintained or improved. The BDCP Implementation Office will coordinate channel margin habitat enhancement planning with the flood control planning efforts of USACE, DWR, the Central Valley Flood Protection Board, and other flood control agencies to assess the desirability and feasibility for channel modifications. Channel margin habitat enhancements will be designed to support the ecological benefits for covered species described below in *Hypothesized Benefits*.

Restoration variables that will be considered in the location and design of enhanced channel margin habitat include:

- The length of habitat that can be practicably enhanced along channel margins;
- Connectivity with existing channel margin habitats supporting high functioning salmonid rearing habitat;
- The cross sectional profile of enhanced channels (elevation of habitat, topographic diversity, width, variability in edge and bench surfaces, depth, and slope);
- The amount and distribution of installed woody debris along enhanced channel margins; and
- The extent of shaded riverine aquatic overstory and understory vegetative cover needed to provide future input of large woody debris.

Problem Statement

Primary Delta channels serve as movement corridors for the covered fish species and support splittail spawning and salmonid, sturgeon, and splittail rearing habitat. These channels are now leveed and, as such, channel margin habitats lack the diversity and complexity of habitat conditions associated with unmodified channels. Increasing the diversity and complexity of channel margin habitats is expected to increase their function as habitat for covered fish species. Specifically, providing for channel margin habitat complexity along migration corridors for outmigrating juvenile Chinook salmon may increase survivorship through reductions in predation and increases in food availability.

Hypothesized Benefits

Enhancement of channel margin habitat is hypothesized to provide the following ecosystem and covered species benefits. As described in Chapter 5, *Effects Analysis,* and Appendix F, *DRERIP Evaluation Results*, however, there are a number of uncertainties regarding the level of benefits that may be provided by enhancing channel margin habitat as well as risks for adverse consequences. These uncertainties will be addressed through effectiveness monitoring, research, and the adaptive management program (Sections 3.6 and 3.7).

Enhancing channel margin habitats is expected to:

- Increase the quality of rearing habitat area for Chinook salmon, sturgeon, and possibly steelhead (Sommer et al.2001a,b, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006);
- Reducing the risk for predation on covered fish species by nonnative fish predators;
- Increase the extent of shaded riverine aquatic cover and increase instream cover by through contributions of instream woody material (USFWS 2004);
- Increasing connectivity among salmonid rearing and outmigration habitat areas;
- Provide inputs of organic material (e.g., leaf and twig drop) in support of aquatic foodweb processes;
- Increase production and export of terrestrial invertebrates into the aquatic ecosystem (Nakano and Murakami 2001);
- Create additional spawning habitat for Sacramento splittail by creating low velocity backwater habitats (Sommer et al. 2001a, 2002, 2007b, 2008, Moyle 2002, Moyle et al. 2004, Feyrer et al. 2006); and
- Create tidal mudflat substrate suitable for the establishment of Suisun Marsh aster, Mason’s lilaeopsis, Delta mudwort, and Delta tule pea and coarse woody debris substrate suitable for side-flowering skullcap.

Restoration of riparian forest and scrub that is incorporated into channel margin enhancements is also expected to support habitat for valley elderberry longhorn beetle, Swainson’s hawk, white-tailed kite, and potentially, depending on vegetative structure and patch size, yellow-breasted chat and least Bell’s vireo. Increasing the extent of large woody material will enhance habitat for western pond turtle.

Adaptive Management Considerations

Implementation of channel margin habitat enhancement actions by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results, likely elements of this measure that could be adjusted through the adaptive management process include adjusting the design of subsequent channel margin restoration actions to improve habitat functions for covered fish species and increasing the effectiveness of emergent and riparian vegetation establishment techniques.

3.4.3.4 CM7 Riparian Habitat Restoration

The BDCP Implementation Office will restore 5,000 acres of riparian forest and scrub. It is anticipated that riparian forest and scrub will be restored primarily in association with the restoration of tidal and floodplain habitats and channel margin habitat enhancements. The following are the temporal targets for riparian restoration:

- 400 acres restored by year 15 of Plan implementation; and
- 5,000 acres (cumulative) restored by year 40 of Plan implementation.

Anticipated actions to restore riparian forest and scrub, as appropriate to site-specific conditions, include, but are not limited to:

- Acquiring lands, in fee-title or through conservation easements, suitable for restoration of riparian forest and scrub;
- Allowing for the natural establishment of riparian vegetation;
- Site preparation, planting of native riparian vegetation, and maintenance of plantings;
- Irrigation of plantings; and
- Control of nonnative plants.

Patches of restored riparian forest and scrub are expected to support the range of riparian habitat conditions necessary to support habitat for each of the riparian-associated covered wildlife species. Once established, it is expected that restored riparian forest and scrub will be self-sustaining and will be monitored to determine if subsequent management actions may be required to ensure successful regeneration of native riparian plant species.

Riparian Restoration in Restored Floodplains

To the extent consistent with flood control requirements, restored floodplain habitat areas (Figure 3-57 and CM5) will allow for the natural establishment and growth of woody riparian vegetation on portions of restored floodplains that support appropriate soils and hydrology and along channels within restored floodplains. Restored floodplain riparian vegetation is expected to establish in large extensive patches relative to the typically narrow stringers of riparian vegetation that exist along channels and agricultural water conveyance features within much of the Plan Area.

Native riparian vegetation (e.g., Fremont cottonwood, Goodings' willow, box elder) will be planted if site-specific restored floodplain conditions indicate that such plantings will substantially increase the establishment of riparian forest and scrub. Elderberry shrubs will be a component of such plantings to provide habitat for the valley elderberry longhorn beetle. The development of riparian vegetation will be monitored to determine if nonnative vegetation needs to be controlled to facilitate the establishment of native riparian vegetation or if restoration success could be improved with supplemental plantings of native riparian vegetation. If indicated by monitoring, nonnative vegetation control measures and supplemental plantings will be implemented.

Riparian Restoration in Restored Tidal Habitats

Woody riparian vegetation will be allowed to naturally reestablish along the upper elevation margins of restored tidal marsh habitats within ROAs (Figure 3-2 and CM4) where soils and hydrology are suitable, including segments of stream channels that drain into restored marshes. Suitable soils for restoration are expected to be most extensive in the Cosumnes/Mokelumne, East Delta, West Delta, and South Delta ROAs. In these ROAs, riparian vegetation is expected to generally form as a band of riparian forest and scrub of variable width depending on site-specific soil and hydrologic conditions between high marsh vegetation and herbaceous uplands.

Soil salinity in the Suisun Marsh ROA and extensive clayey soils in the Cache Slough ROA are expected to limit the extent of riparian vegetation that will become established. In these ROAs, riparian vegetation is expected to generally establish in narrow stringers (e.g., along dikes) and small patches where suitable soil conditions are present. Additionally, where conditions are appropriate woody riparian vegetation will be planted on new levees that are constructed by the BDCP Implementation Office within ROAs to provide for the restoration of tidal habitat. As described for riparian restored in floodplains, native riparian vegetation may planted to initiate establishment of riparian forest and scrub and restoration areas will be monitored to determine the need for vegetation control and supplemental plantings.

Riparian Restoration on Channel Margins

Where compatible with site-specific channel margin habitat objectives, native woody riparian vegetation, including elderberry shrubs, will be planted along channel margins on benches outboard of existing levees (Figure 3-X [to come] and CM6) to enhance covered fish and wildlife species habitat. Riparian vegetation restored in these locations is expected to form narrow stringers of riparian forest and scrub along enhanced channel margins.

Directed Riparian Restoration. At least 300 acres of the 5,000 acres of restored riparian forest and scrub will be located in Conservation Zone 7 and/or 8 (Figure 3-5) within or contiguous with occupied or potentially occupied riparian brush rabbit habitat along the San Joaquin River, Old River, and/or Middle Rivers or suitable tributaries. This restored habitat will be designed and managed to specifically support riparian scrub with an open overstory that includes dense brush and thickets of wild rose, wild grape, and blackberry that supports this species habitat. An additional 300 acres will be restored in similar locations within Conservation Zone 7 to provide suitable habitat for the riparian woodrat. This restored habitat will be designed and managed to specifically support riparian habitat that includes a moderately dense midstory of willow scrub and an overstory of valley oak.

Problem Statement

Substantial reduction in the extent, distribution, and condition of Valley/foothill riparian communities that historically occurred along the upper elevational margins of the Delta and along natural levees along Delta and Suisun Marsh channels has reduced the extent and diversity of valley/foothill riparian habitats for associated covered and other native species. Most existing levees were not designed (e.g., steep banks, rip-rap) to incorporate riparian vegetation that support habitat for covered fish and wildlife species and have created increased habitat for nonnative predatory fish and thus contribute to increased predation losses of covered fish species.

A lack of riparian habitat associated with existing and restored tidal aquatic and marsh habitats limits the ecological benefits to fish and wildlife by limiting important ecological gradients and ecosystem functions that a full suite of these habitats would provide. Restoring Valley/foothill riparian habitats to establish a more natural ecological gradient extending from shallow subtidal aquatic to upland transitional habitats is expected, along with BDCP conservation of other natural communities, to increase the abundance and distribution of associated covered and other native species, improve connectivity among habitat areas within and adjacent to the Planning Area and Suisun Bay, improve genetic interchange among native riparian-associated species' populations, and contribute to the long-term conservation of riparian-associated covered species.

Hypothesized Benefits

Restoration of valley/foothill riparian forest and scrub is hypothesized to provide the following ecosystem and covered species benefits described below. As described in Appendix F, DRERIP Evaluations, however, there are a number of uncertainties regarding the level of benefits that may be provided by restored riparian habitats as well as risks for adverse consequences. These uncertainties will be addressed through effectiveness monitoring, research, and the adaptive management program (Sections 3.6 and 3.7).

Restoring valley/foothill riparian forest and scrub is expected to:

- Provide inputs of organic material (e.g., leaf and twig drop) where riparian forest and scrub is restored adjacent to channels resulting in increased production of phytoplankton, zooplankton, and macroinvertebrates that serve as or support production food for covered fish species;
- Increase the extent of shaded riverine aquatic cover and increase instream cover where riparian forest and scrub is restored adjacent to channels through contributions of instream woody material (U.S. Fish and Wildlife Service 2004);
- Increase in the production and export of terrestrial invertebrates into the aquatic ecosystem (Nakano and Murakami 2001) where riparian forest and scrub is restored adjacent to channels;
- Increase the extent of riparian brush rabbit, riparian woodrat, Swainson's hawk, white-tailed kite, yellow-breasted chat, and valley elderberry longhorn beetle habitat; and
- Increase the extent of least Bell's vireo, western yellow-billed cuckoo, and riparian woodrat for potential future occupancy by these species through future expansion of their range; and
- Create coarse woody debris substrate suitable for side-flowering skullcap.

Adaptive Management Considerations

Implementation of riparian restoration actions and subsequent management of restored riparian habitats by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results, likely elements of this measure that could be adjusted through the adaptive management process include riparian vegetation establishment methods, locations selected for restoration of riparian forest and scrub, and post-restoration management actions that may be need to be implemented to ensure that intended habitat functions of restored riparian habitats are maintained over time.

3.4.3.5 CM8 Grassland Communities Restoration

The BDCP Implementation Office will provide for the restoration of 2,000 acres of grassland within the BDCP CZs 1, 8, and/or 11 (Figure 3-6). The restored grassland habitat will be designed and located such that it supports habitat for associated covered species, improves connectivity among existing patches of grassland and other natural habitats, and improves the native wildlife habitat functions of transitional uplands adjacent to BDCP restored tidal habitats. Opportunities for improving connectivity and increasing the habitat functions of existing grassland habitats include linking or providing wildlife movement corridors to much larger habitat areas immediately outside of the Plan Area. The most strategically important areas are a connection between CZs 1 and 11 in the Jepson Prairie area and connecting BDCPs CZ 8 to other high quality grassland habitat to the west and southwest of the Plan Area.

Anticipated actions to restore grassland habitat, as appropriate to site-specific conditions, will include, but not be limited to:

- Acquiring lands, in fee-title or through conservation easements, that have site characteristics (e.g., soils, proximity to high value habitat areas) that support restoration of high functioning grassland high value habitat.
- Restoring grassland by sowing native species using a variety of techniques that include seed drilling, native hay spreading, and plugs as appropriate. Seed sown on the sites will be from collections or increases from seed collected at the nearest practicable natural site with similar ecological conditions. Restoration actions my require the recontouring of graded land as appropriate and should generally be targeted to parcels with low soil fertility and which have not been used for intensive crop production. These areas could also function as seed nurseries to produce seed that could be planted on other portions of the site.
- Potentially restoring grazing grassland habitat to modify its vegetation; this is a complex management problem if the grassland contains native bunchgrasses, geophytes, vernal pool complex, or alkali seasonal wetland complex and will require site and pasture specific solutions like those described in CM9 Vernal Pool Complex Restoration.

Problem Statement

Implementation of BDCP actions will result in the removal of grassland natural community. Restoration of grasslands, therefore, is necessary to ensure that the current habitat functions supported by affected grasslands for associated covered and other native species are maintained.

Hypothesized Benefits of BDCP Actions

Grassland habitat is distributed around the upland margin of the Sacramento/San Joaquin Delta and Suisun Bay system, and much has been lost to development and conversion to agriculture. Restoration of grassland habitat will increase the extent and quality of grassland habitat available for use by covered and other native associated species and thus contribute to their conservation. BDCP covered species predicted to benefit from restored grasslands include San Joaquin kit fox, salt marsh harvest mouse, riparian brush rabbit, Townsend’s big-eared bat, tricolored blackbird, western burrowing owl, greater sandhill crane, Swainson’s hawk, white-tailed kite, giant garter snake, western pond turtle, California red-legged frog, western spadefoot toad, California tiger salamander, heartscale, brittlescale, San Joaquin spearscale, Carquinez goldenbush, and caper-fruited tropidocarpum (see *Appendix A, Covered Species*, for specific life history requirements met by the grasslands natural community).

Adaptive Management Considerations

Implementation of grassland habitat restoration actions will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6 *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results and data compiled from other sources, likely elements of this measure that could be adjusted through the adaptive management process include considerations for selecting restoration locations; methods for establishing and maintaining the desired plant species in restored grasslands, and nonnative vegetation control techniques.

3.4.3.6 CM9 Vernal Pool Complex Restoration

The BDCP will provide for the restoration of 200 acres of vernal pool complex within Conservation Zones 1, 8, and/or 11 (Figure 3-6). The extent of restored vernal pool complex will include a matrix of grassland or alkali seasonal wetland complex in which vernal pools, swales, and saturated alkaline soil areas are adjacent or interspersed and which are found in habitat gradients that vary by Conservation Zone and include tidal freshwater or tidal brackish emergent wetlands, adjoining transitional upland habitat, grassland, alkali seasonal wetlands, and agriculture. The 200 acres will be distributed in Conservation Zones 1, 8, and 11 in a manner that will achieve conservation objectives for associated covered species. The BDCP Implementation Office will select specific restoration sites within these Conservation Zones based on the suitability of available lands for restoration, biological value, and practicability considerations.

Anticipated actions to restore vernal pool complex habitat, as appropriate to site-specific conditions, include but are not limited to:

- Acquiring lands, in fee-title or through conservation easements, suitable for restoration of vernal pool complex habitat;
- Restoring remnant natural vernal and swale topography by excavating or recontouring historical vernal pools and swales to natural bathymetry based on their characteristic visual signatures on historical aerial photographs, other historical data, and on the arrangement and bathymetry of natural reference vernal pools and swales;
- Restoring and maintaining natural hydrology by removing impediments to natural runoff such as roads, berms, field drains, storm drains, etc.;
- Restoring and maintaining natural hydrology by removing non-natural supplemental sources of surface water originating from flood irrigation, drainage and irrigation canal turnouts, impermeable surfaces, leaking stock ponds, culverts, etc.;
- Restoring and maintaining natural salt and suspended clay concentrations in vernal pool water;

- Significantly reducing or preventing the deposition of substances that increases the fertility of the habitat such as manure, runoff from cattle or sheep congregation areas, runoff from dairies, etc.;
- Controlling the cover of invasive nonnative plant species such as perennial pepperweed, swamp timothy, Italian ryegrass, etc.;
- Adjusting livestock grazing regimes in vernal pool complexes to improve habitat functions of vernal pools for covered and other native vernal pool species;
- Preventing the introduction of the propagules of invasive species during restoration, maintenance, outreach, and other activities that occur on the site; and
- Hand collecting seed and vernal pool invertebrates from the vicinity of the vernal pools to be restored will be used to establish native species. Soil inoculum should not be used to establish vernal pool plants and animals in these Conservation Zones unless the source vernal pools are free of perennial pepperweed, swamp timothy, and Italian ryegrass which establish more rapidly than native species and create dense populations that are likely to reduce the establishment success of the native plants and also create thatch problems in the vernal pools (see Barona et al. 2007 for problems of nonnative species thatch buildup due to soil inoculum).

Restored vernal pool complex habitat will be designed and managed to provide the ecological benefits for covered species described under the Hypothesized Benefits section below. Habitat will be restored on sites that historically supported vernal pool complex, thus ensuring that soil types that support vernal pools are present.

Restoration variables that will be considered by the BDCP Implementation Office in the design of restored vernal pool complex habitat include:

- The spatial distribution of existing restored vernal pool complex habitat within the Delta;
- The distribution of soils that historically supported vernal pool complex;
- An analysis of historical aerial photography, survey records, or other information and vernal pool and swale restoration will be limited to the visual signatures indicated in that data and contoured using bathymetry data from similar vernal pools in the same Conservation Zone; and
- The predicted tidal range adjacent to tidal habitat restoration sites in Conservation Zone 1 and 11.

Restoration design considerations for vernal pool complex habitat will include the following:

Vernal Pool Complex Vegetation. To provide for high functioning habitat, restored vernal pool complex will be vegetated with hand collected seed from appropriate areas within the same Conservation Zone as the planned restoration action. Soil inoculum will not be used unless the source vernal pools are free of perennial pepperweed, swamp timothy, and Italian ryegrass.

However, prior to any seed collection actions occurring, where physical restoration actions such as excavation are undertaken to restore the hydrology of vernal pool complex habitat, the hydrographs, inundation depths, and water chemistry (particularly salt and boron concentrations) of the restored vernal pool complex will be compared with reference vernal pool complex habitat in the same areas. Following establishment of restored habitat will be monitored to assess the establishment of invasive nonnative plants. If indicated by monitoring results, the BDCP Implementation Office will implement invasive plant control measures to help ensure the establishment of native vernal pool plant species.

Vernal Pool Complex Invertebrates. Propagules of covered vernal pool invertebrate species may be introduced into the restored vernal pools through the movement of individuals. Introductions will not be made through the use of soil inoculum unless the source vernal pools are free of perennial pepperweed, swamp timothy, and Italian ryegrass.

Hydrological Conditions. Vernal pool complex habitat restoration will be designed based on the historical patterns of vernal pools and swales present on the restoration site as indicated by aerial photography and vernal pool bathymetry will be based on natural undisturbed vernal pools in the same area.

Problem Statement

Implementation of BDCP actions will result in the removal of vernal pool complex. Restoration of vernal pool complex, therefore, is necessary to ensure that the current habitat functions supported by affected vernal pools for associated covered and other native species are maintained.

Hypothesized Benefits

Restoration of vernal pool complex habitat will increase the extent of habitat for vernal pool complex-dependent covered species.

Adaptive Management Considerations

Implementation of vernal pool complex habitat restoration actions and subsequent management of restored vernal pool complex habitats by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results and data compiled from other sources, likely elements of this measure that could be adjusted through the adaptive management process include considerations for selecting restoration locations within the distribution of vernal pool complex habitat among CZs 1 and 8, methods for restoring and maintaining the necessary hydrology and water chemistry, methods for establishing the desired species in the habitat, and nonnative vegetation and wildlife control techniques.

3.4.3.7 CM10 Nontidal Marsh Restoration

The BDCP will provide for the restoration of 400 acres of nontidal freshwater marsh within Conservation Zones 2 and 4 (Figure 3-4). Restored habitat will be distributed in patches of at least 25 acres and associated with occupied giant garter snake habitat within the proposed 1,000-acre giant garter snake preserves designed to enhance the Caldoni Marsh/White Slough and the Yolo Basin/Willow Slough giant garter snake populations.

Restored nontidal wetlands will also be designed and managed to support other native wildlife functions including waterfowl foraging, resting, and brood habitat and shorebird foraging and roosting habitat. Restored habitat will include preserved transitional upland habitat to provide upland habitat for giant garter snake and western pond turtle, and nesting habitat for waterfowl.

Though not a conservation target, patches of existing nontidal freshwater perennial emergent wetland present on lands acquired to protect other natural communities will also be protected and enhanced to improve habitat functions and values for covered and other native species.

Anticipated actions to restore nontidal freshwater perennial emergent wetland, as appropriate to site-specific conditions, include, but are not limited to:

- Acquiring lands, in fee-title or through conservation easements, suitable for restoration of nontidal freshwater perennial emergent wetland;
- Securing sufficient annual water to sustain habitat function;
- Creating complex habitat with open water and edge habitats, tule-dominated vegetation, bank slopes with variable angles, adjacent upland with open canopy and elevational gradient to promote mammal burrows and higher elevation refugia;
- Establishing connectivity with the existing water conveyance system and habitats occupied by giant garter snakes;
- Allowing for the natural establishment of marsh vegetation;
- Site preparation, planting of native marsh vegetation, and maintenance of plantings; and
- Control of nonnative plants.

Patches of restored nontidal freshwater perennial emergent wetland are expected to support the range of habitat conditions necessary to support habitat for each of the nontidal freshwater perennial emergent wetland-associated covered wildlife species. Once established, it is expected that restored nontidal freshwater perennial emergent wetland will be self-sustaining and will be monitored to determine if subsequent management actions may be required to ensure successful regeneration of native marsh plant species.

Nontidal freshwater perennial emergent wetland will be established where soils and hydrology are suitable through conversion of existing agricultural lands to a freshwater marsh-perennial aquatic complex. Restored marshes will also occur in association with adjacent grassland, pastureland, or cultivated uplands. Grading will be required to establish an elevation gradient to support both open water perennial aquatic habitat intermixed with shallower marsh habitat. Marsh vegetation will be allowed to naturally reestablish along the edges of perennial aquatic habitat, but will also be planted as needed to facilitate marsh development and to manage species composition. The development of marsh vegetation will be monitored to determine if nonnative vegetation needs to be controlled to facilitate the establishment of native marsh vegetation or if restoration success could be improved with supplemental plantings of native species. If indicated by monitoring, nonnative vegetation control measures and supplemental plantings will be implemented.

Problem Statement

The ecological function of nontidal freshwater perennial emergent wetland is limited because it occurs in highly fragmented and small patches within the Planning Area and adjacent lands. Associated with nontidal permanent aquatic and riparian communities, a substantial reduction in the extent, distribution, and condition of nontidal freshwater perennial emergent wetland communities that historically occurred throughout the Central Valley and along the perimeter of the Delta has reduced the extent and diversity of nontidal freshwater perennial emergent wetland habitats for many native species including the giant garter snake (Gilmer et al. 1982, The Bay Institute 1998).

While there are records of giant garter snake in tidal marshes within the Central Delta, the species is known primarily from nontidal freshwater perennial emergent wetland within the interior of the Central Valley including along the eastern perimeter of the Sacramento-San Joaquin Delta. Agricultural conversion and stream channelization have removed nontidal freshwater perennial emergent wetlands, leading to widespread giant garter snake population declines and restricting extant populations to remaining degraded or suboptimal habitats, such as irrigation channels and rice fields. A lack of nontidal freshwater perennial emergent wetland limits the ecological benefits to fish and wildlife by limiting important ecological gradients and ecosystem functions that these habitats would provide, particularly in association with other native habitats including nontidal permanent aquatic, grassland, and riparian habitats. Restoring nontidal freshwater perennial emergent wetland to re-establish a more natural ecological gradient and incorporating aquatic, riparian, and upland transitional habitats is expected, along with BDCP conservation of other natural communities, to increase the abundance and distribution of associated covered and other native species, improve connectivity among habitat areas within and adjacent to the Plan Area, improve genetic interchange among native freshwater perennial emergent wetland species' populations, and contribute to the long-term conservation of giant garter snake and other native species.

Hypothesized Benefits

Restoring nontidal freshwater perennial emergent wetland is expected to:

- Provide essential marsh and aquatic habitat for giant garter snake and western pond turtle;
- Enhance the Caldoni Marsh-White Slough and Yolo Basin-Willow Slough giant garter snake populations by increasing the extent and quality of available habitat;
- Provide nesting habitat for tricolored blackbird; and
- Increase the spatial extent and distribution of habitat available to associated covered and other native wildlife and will increase the diversity and complexity of the mosaic of habitats supported in the Plan Area and adjacent lands.

Adaptive Management Considerations

Implementation of nontidal freshwater perennial emergent wetland restoration actions and subsequent management of restored marsh habitats by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on analysis of monitoring results, likely elements of this measure that could be adjusted through the adaptive management process include marsh vegetation establishment methods, locations selected for restoration of nontidal freshwater perennial emergent wetland, and post-restoration management actions that may need to be implemented to ensure that intended habitat functions of restored nontidal freshwater perennial emergent wetland are maintained over time.

3.4.3.8 CM11 Natural Communities Enhancement and Management

Site-Specific Management Plans

The BDCP Implementation Office will prepare and implement management plans for protected natural communities and covered species habitats that are found within those communities. Management plans may be prepared for specific reserves or multiple reserve areas within a specified geographic area. Management plans will provide the information necessary to guide habitat enhancement and management actions necessary to achieve the biological objectives established for the conserved lands addressed by each plan. Within two years of acquisition of conserved parcels, the Implementation Office will conduct surveys to collect the information necessary to assess the level of ecological condition and function of conserved species habitats and supporting ecosystem processes. Based on results of the assessment, the Implementation Office will identify habitat enhancement actions to be implemented to enhance habitat functions for the target covered species and any subsequent ongoing management actions that are necessary to maintain habitat functions over time. Survey data will also collect the information necessary to establish base ecological conditions from which the effectiveness of enhancement and management measures can be evaluated through subsequent effectiveness monitoring.

The content of management plans will include, but not be limited to, a description of:

- The biological goals and objectives to be achieved with the preservation and management of the parcels;
- Base ecological conditions (e.g., habitat maps, assessment of covered species habitat functions, occurrence of covered and other native wildlife species, vegetation structure and composition, assessment of nonnative species abundance and effect on habitat functions, occurrence and extent of nonnative species);
- Vegetation management actions that: benefit covered communities, habitats, and species and reduce fuel loads as appropriate; are necessary for implementing community conservation measures; and are necessary for implementing species specific conservation measures;
- The incorporation of a fire management plan developed in coordination with the appropriate agencies and to the extent practicable, consistent with achieving the biological objectives of the BDCP;
- Infrastructure, hazards, and easements;
- Existing land uses and management practices and their relationship to covered species habitat functions;
- Applicable permit terms and conditions;
- Terms and conditions conservation easements when applicable;
- Management actions and schedules;
- Monitoring requirements and schedules;
- Established data acquisition and analysis protocols;
- Established data and report preservation, indexing, and repository protocols;
- The adaptive management approach; and
- Any other information relevant to management of the preserved parcels.

Management plans will be periodically updated to incorporate changes in maintenance, management, and monitoring requirements as they may occur over the term of the BDCP.

Based on the assessment of existing site conditions (e.g., soils, hydrology, vegetation, occurrence of covered species) and site constraints (e.g., location and size), and depending on biological objectives of the conserved lands, management plans will specify measures for enhancing and maintaining habitat as appropriate.

Management Actions

Listed below are enhancement and management actions for the natural communities described in Section 3.3.2.2, *Natural Community Goals and Objectives*. The application of these or other management actions will depend on site-specific conditions and targeted biological values. Specific management actions will be included in each site-specific management plan described above. Management actions are designed to meet the biological goals and objectives of each natural community and covered species.

Tidal Aquatic and Wetland Natural Communities

Approximately 65,000 acres of tidal habitat restoration is planned for the Plan Area. This includes 7,000 acres of brackish tidal habitat in the Suisun Marsh ROA in Conservation Zone 11 and approximately 14,000 acres of freshwater tidal habitat distributed among 4 ROAs, including 5,000 acres in the Cache Slough ROA in Conservation Zones 1 and 2; 1,500 acres in the Cosumnes/Mokelumne ROA in Conservation Zone 4; 2,100 acres in the West Delta ROA in Conservation Zones 5 and 6; and 5,000 acres in the South Delta ROA in Conservation Zone 7. This restoration will create and protect substantial habitat for several covered species including salt marsh harvest mouse, Suisun shrew, California clapper rail, California black rail, Suisun song sparrow, California least tern, Mason's lilaeopsis, Suisun Marsh aster, Delta tule pea, Delta mudwort, and soft bird's-beak. Tidal wetland restoration in Conservation Zones 4, 5, 6, and 7 is also expected to provide additional habitat for tricolored blackbird, greater sandhill crane, and giant garter snake. The following measures will be implemented to manage and enhance the tidal wetland conservation lands.

- Create or maintain upland areas that can serve as refugia during high tide events (e.g., grassland patches for salt marsh harvest mouse);
- Create two nesting habitat areas consisting of gravel or sandy elevated mounds for California least terns along the margins of tidal perennial aquatic natural community areas on BDCP lands. The BDCP Implementation Office will collaborate with species experts to determine appropriate locations, materials, and dimensions of created sites.
- Restore brackish marsh habitats in a sequenced manner to minimize disturbance to adjacent habitats;
- Maintain habitat connectivity and corridors for species' movement between restored sites and restored and existing habitats;
- Maintain appropriate habitat patch sizes for covered species. The BDCP Implementation Office will consult with species experts to determine appropriate patch sizes and other elements of restoration design relevant to covered species;
- Nonnative predatory species are an important stressor for several covered species (e.g., California black and clapper rails). The establishment and abundance of nonnative predatory species will be controlled with habitat manipulating techniques or trapping;

- Where California least terns or tricolored blackbirds are found nesting, and to the extent feasible, protect and establish appropriate buffer zones around occupied sites to minimize disturbance;
- Reduce and then maintain the population size of feral pigs in Suisun Marsh to levels at which their rooting impacts on tidal marsh plain vegetation does not significantly impact covered species;
- Exclude cattle grazing from Suisun thistle and soft bird's-beak habitat;
- Reduce and then maintain the cover of nonnative invasive plant species such as perennial pepperweed, bull thistle, and annual grasses in Suisun Marsh to levels that do not significantly impact covered species;
- Conduct research to determine if fire is beneficial for tidal marsh management and its effects on covered communities and species; and
- Conduct research to determine effective methods for increasing the extent of Suisun thistle and soft bird's-beak in Suisun Marsh.

*[**Note to reviewers:** Additional management tools to address fisheries habitat will be added to this section.]*

Nontidal Aquatic and Wetland Natural Communities

In association with the development of two 1,000 acre preserves for the giant garter snake, 400 acres of nontidal freshwater marsh will be restored. A portion of the 400 acres will be restored to support the protection and expansion of the Yolo/Willow Slough subpopulation in Conservation Zone 2 and a portion will be restored to support the protection and expansion of the Caldoni Marsh/White Slough subpopulation in Conservation Zone 4. The BDCP Implementation Office, through consultation with species experts will determine the number of acres that will be restored in each area based on the level of existing protection and available habitat, and restoration opportunities. The marsh restoration, which will include both emergent wetland and open water habitats, will be coordinated with acquisition of agricultural lands that will make up the 1,000 acre preserves. It is expected that agricultural lands within the preserves, in additional to providing the water conveyance system that will be managed as suitable giant garter snake aquatic habitat and adjacent upland habitat, will also provide suitable foraging habitat for Swainson's hawk, white-tailed kite, and tricolored blackbird. It is also expected that the restored nontidal wetland will provide habitat for nesting tricolored blackbirds and aquatic and cover habitat for western pond turtle. Management plans will be prepared for the Coldani Marsh/White Slough and the Yolo/Willow Slough giant garter snake preserves to guide nontidal wetland restoration activities and associated agricultural land management. The Implementation Office will consult with species experts to develop these plans that will describe site selection, configuration and channel design, water management, vegetation composition, and long-term management of the preserves. The following measures will be addressed in the management plans and implemented to manage and enhance the nontidal wetland and associated giant garter snake preserves.

- Vegetation density and composition, water depth, and other habitat elements will be managed to enhance habitat values for giant garter snakes;
- Upland refugia (islands or berms) will be created and maintained within the restored marsh;
- Permanent buffer zones at least 200 feet wide will be established around all developed wetland habitats to provide undisturbed (uncultivated) upland cover and aestivation habitat immediately adjacent to aquatic habitat;
- Bank slopes and upland buffer habitats will be managed to enhance giant garter snake use, provide cover, and encourage burrowing mammals for purposes of creating aestivation sites for giant garter snake;
- Establish seasonal buffer zones around aquatic habitats to reduce disturbance and improve foraging habitat for tricolored blackbirds;
- Control human and pet access into wetland areas;
- Nontidal and wetland communities may be dominated by bullfrogs and other nonnative predatory species limiting the abundance of covered amphibians and reptiles. Habitat management and enhancement will include trapping and other techniques to control the establishment and abundance of nonnative predators; and
- Limit cattle access to wetland vegetation to the extent necessary to prevent significant deterioration of habitat of covered species.

Riparian Natural Community

Over 5,000 acres of riparian scrub and woodland will be restored in the Plan Area. The majority is expected to develop in Conservation Zone 7 associated with the San Joaquin, Old, and Middle River systems, but riparian habitat will also develop in other Conservation Zones in association with tidal habitat, floodplain, and channel margin restoration. Restored valley/foothill riparian is expected to provide substantial habitat for several riparian-associated covered species. Yellow-breasted chat, least Bell's vireo, riparian brush rabbit, and riparian woodrat will benefit from the establishment of willow scrub and early successional riparian habitats that are expected to develop in association with tidal habitat and floodplain restoration; yellow-billed cuckoo, Swainson's hawk, and white-tailed kite will benefit from the future development of cottonwood-willow forest; and Swainson's hawk and white-tailed kite will benefit from all mature riparian habitats that provide suitable nesting structure. Nesting habitat for Swainson's hawk and white-tailed kite is expected to develop in association with tidal habitat and floodplain restoration and from the restoration of planted riparian habitats along channel margins. Riparian brush rabbit and riparian woodrat will also benefit from directed riparian restoration along channel margins. The following measures include those that will apply to all conserved riparian communities and where noted others apply to lands acquired to manage species-specific values.

- Control nest parasitism (e.g., through cowbird trapping);

- Control the establishment and abundance of nonnative predatory species (e.g., bullfrogs);
- Plant native plant species to improve habitat functions for covered and other native species (e.g., blue elderberry for valley elderberry longhorn beetle, willows for yellow-breasted chat);
- Establish buffers along riparian habitats to minimize the disturbance affects to nesting covered species;
- Establish uncultivated buffers adjacent to riparian habitats to protect the integrity of the stream corridor and associated riparian vegetation and to promote regeneration of riparian species;
- Manage the structure and composition of restored riparian areas to meet the habitat objectives established for riparian brush rabbit, riparian woodrat, Swainson's hawk, white-tailed kite, yellow-breasted chat, least Bell's vireo, and yellow-billed cuckoo;
- Install woody debris in stream channels to create pools to increase the diversity of micro-habitats;
- Where appropriate, remove riprap along channel banks and alter stream channel geomorphology to improve hydrologic conditions that support the regeneration of riparian vegetation and improve habitat functions for aquatic species;
- Prepare a restoration plan for the restoration of 300 acres of riparian habitat for the riparian brush rabbit and 300 acres for the riparian woodrat. Consult with species experts to determine appropriate location, species composition, structure, and patch size, and to develop management guidelines;
- Within riparian brush rabbit restoration areas, create upland refugia (i.e., bunny mounds) to provide protection against flooding. Consult with species experts to determine appropriate location, size, and composition.
- Establish and implement a nonnative species control program to control species such as Himalayan blackberry, giant reed, perennial pepperweed, black locust, and fig where their presence is undesirable; and
- Limit cattle access to riparian and other wetland vegetation to the extent necessary to prevent significant deterioration of habitat of covered species.

Grasslands and Associated Seasonal Wetland Natural Communities

Over 10,000 acres of grassland, vernal pool complex, and alkali seasonal wetland will be protected or restored in Conservation Zones 1, 8, and 11 to support and protect San Joaquin kit fox, Swainson's hawk, white-tailed kite, tricolored blackbird, California red-legged frog, California tiger salamander, and western spadefoot toad populations. The following measures include those that will apply to all conserved grassland communities and where noted others apply to lands acquired to manage species-specific values.

- To minimize uncertainty about the appropriate management regime necessary to maintain and enhance each grassland type, pilot experiments will be conducted to test the effects of management actions. The experiments will be designed to test a range of reasonable management alternatives under appropriate spatial scales and seasonal weather patterns. Long term monitoring programs will also include experimental plots that generate information describing the long term trends of management actions, and include experimental treatments for most likely management alternatives, and appropriate controls.
- Where appropriate, manipulate topography or manage vegetation to attract ground squirrels and other small mammals to: (1) increase the availability of aestivation and nesting burrows for California red-legged frog and California tiger salamander; and (2) increase prey availability for San Joaquin kit fox, Swainson's hawk, white-tailed kite, and other native wildlife predators.
- Reduce rodent control (e.g., poisoning, hunting, and trapping), where appropriate, in conserved grasslands. Note that rodent control measures will likely remain necessary in certain areas where dense rodent populations may compromise important infrastructure (e.g., levees, pond berms, road embankments, and water conveyance structures).
- Fence portions of stock ponds in Conservation Zone 8 to prevent livestock entry, encourage emergent wetland growth, and facilitate California red-legged frog and California tiger salamander use.
- Develop management protocols for stock ponds (e.g., seasonal draining) in Conservation Zone 8 grassland habitats to control bullfrogs and predatory fish and facilitate use by California red-legged frogs and California tiger salamanders.
- Protect grassland movement corridors between aquatic and upland California red-legged frog and California tiger salamander aestivation sites.
- Where lands neighboring preserves require ground squirrel management to protect agricultural uses or public health, establish a buffer zone in the preserve within which ground squirrel colonies will not be encouraged or may be controlled. The width of this buffer will be determined by the preserve manager in consultation with neighboring landowners and BDCP Implementation Office scientists. The buffer width will depend on site conditions, the size and density of the local ground squirrel population, and the intensity of control methods used adjacent to the preserve.
- Where appropriate, install artificial nesting burrows or create elevated berms, mounds, or debris piles for western burrowing owl to facilitate use of unoccupied areas.
- Install perching structures to facilitate use by western burrowing owl, Swainson's hawk, and white-tailed kite.
- For vernal pool complex and alkali seasonal wetland complex, restore and maintain natural hydrology and eliminate supplemental sources of water and structures that increase or decrease the duration of natural vernal pools. If grazed, provide grazing

animals with supplemental sources of water located in the uplands away from vernal pools.

- Livestock grazing can be used to manage vegetation for purposes of maintaining and improving habitat conditions for resident plants and animals and to reduce fuel loads for wildfires. Different grazers and different grazing intensities result in different impacts on vegetation. BDCP will develop an appropriate grazing program for enhancing and maintaining habitat for covered species for each protected area based on site specific characteristics of the community and covered species, the spatial location of important ecological features in each pasture, the history of grazing on the site, species composition of the site, grazer vegetation preference, and other relevant information. Grazing exclusion should be used as a management alternative where appropriate. Grazing practices in effect in each pasture for the 5 years prior to acquisition should be continued unless there is a specific conservation related immediate need to alter them or site specific data is acquired through scientific studies suggests that alternate management actions would better advance the sites conservation goals. Grazing in certain native grassland communities, however, may need to be reduced to maintain or enhance these communities. Note that midsummer grazing may be effective in controlling exotic grassland plant species because most native perennial grasses would be dormant in summer and not substantially damaged by grazing.
- Prescribed burning can be used to mimic short interval fire regimes. Late-spring and fall prescribed burning may be used in some grassland areas to increase native species cover in grasslands and reduce the cover of exotic species, repeating treatment on site as needed. Grazing will be used in conjunction with prescribed burns where appropriate to control exotic grasses as they germinate after winter rains.
- Herbicide application may be necessary to control heavy infestations of nonnative plants and re-seed with native species.
- Any seed supplements in native grasslands must use locally derived genetic stock. To maximize the success of seed addition, pretreatments (e.g., burning one year prior to seeding to reduce weed seeds on the surface and in litter) can be utilized.

Inland Dune Scrub

The BDCP Implementation Office will support ongoing efforts to manage and enhance inland dune scrub and to reestablish dune scrub-associated covered species populations through the following actions:

- Support the funding of the USFWS program for management, enhancement, and monitoring of inland dune scrub natural community at the Antioch Dunes National Wildlife Refuge at an annual amount of $XX.XX for X;
- Provide funding to support the USFWS program for the captive breeding and release of Lange's metalmark butterfly at an annual amount of $XX.XX for X years; and

- Support the funding of the USFWS program for propagation and out-planting programs for Contra Costa wallflower and Antioch Dunes evening primrose at an annual amount of $XX.XX for X years.

No acquisition of lands to protect inland dune scrub natural community is proposed.

Agricultural Lands and Managed Wetlands

Agricultural lands will be acquired and managed to support and protect Swainson's hawk, white-tailed kite, greater sandhill crane, tricolored blackbird, and giant garter snake populations. Between 12,000 and 28,000 acres of non-rice agricultural lands and 4,600 acres of rice lands are included in the conservation strategy and that will be managed to provide value to targeted covered species. Agricultural land acquisition is expected to occur throughout the Plan Area, but primarily in Conservation Zones 1, 2, 4, 5, and 7. The following measures include those that will apply to all conserved agricultural lands and where noted others apply to lands acquired to manage species-specific values.

- Minimize or discontinue pesticide use to reduce negative impacts on wildlife including direct, lethal toxicity, reproductive failures, and teratogenic effects.
- Retain hedgerows, wetlands, riparian communities, grassland edges, ponds, and other natural communities and habitat features that occur within the agricultural matrix.
- Retain tree rows, wood lots or other tree groves, and isolated trees to provide nesting habitat for Swainson's hawk and white-tailed kite.
- Retain or create grassland edges, levee slopes, berms, or patches that provide opportunities for burrowing owl breeding or wintering burrows.
- Enhance burrowing owl habitat along agricultural edges by managing vegetation height, installing perches and artificial nesting structures, where appropriate, and encouraging ground squirrel activity.
- Plant hedgerows on agricultural preserves to provide refugia for rodents, thus increasing rodent prey populations for both the Swainson's hawk and the white-tailed kite.
- Plant small woodlots in field corners or tree rows along field borders to provide nesting habitat for Swainson's hawk and white-tailed kite.
- On agricultural lands managed for Swainson's hawk conservation, crop types will be selected and rotated such that sufficient high value foraging habitat is maintained within the agricultural matrix and that meet the requirements for maintaining the target number of habitat units for this species. This will ensure that Swainson's hawk agricultural foraging value is consistently maintained during the term of the BDCP. To the extent practicable, conserved agricultural lands will focus on the highest value foraging habitat (i.e., alfalfa), but include other crop type rotations and agricultural land uses (e.g.,

irrigated pastures) in order to meet the habitat unit requirement (see species model in Appendix A, *Covered Species Accounts*).

- On agricultural land managed for greater sandhill cranes, crop types will be used that provide high value foraging habitat in order to meet the target number of habitat units for this species. Managed agricultural foraging habitat for cranes will include corn, wheat, alfalfa, and irrigated pasture cover types.
- To increase the value of agricultural lands for sandhill cranes, where feasible, habitat management will include deferment of the tilling of corn and grain fields until later in the fall to increase the amount and availability of forage for sandhill cranes. Also where feasible, a portion of corn or grain fields will be left unharvested to increase the quantity of forage available to sandhill cranes (forage would gradually become available as senescent plant stalks fall over as a result of weathering).
- To increase the foraging and roosting value of agricultural lands for greater sandhill cranes, shallow flooding of some corn, grain, and irrigated pastures during fall and winter will also be used. This will also improve foraging conditions for waterfowl and shorebirds.
- Create and manage two greater sandhill crane roost sites located within Conservation Zones 4, 5, and/or 6. Management actions will include 1) establishing appropriate seasonal wetland vegetation that supports crane roosting habitat; 2) incorporating upland berms situated throughout the seasonal wetland; and 3) maintaining water levels that support crane roosting habitat during the crane winter season. The BDCP Implementation Office will consult with species experts to develop specific design and management criteria for crane roost sites.
- Enhance roosting habitat for greater sandhill cranes by controlling public use.
- Establish seasonal or permanent buffers around riparian and wetland habitats to reduce disturbance of nesting tricolored blackbirds, yellow-breasted chats, and least Bell's vireo.
- Establish upland buffers around canals and ditches that support giant garter snake to reduce disturbance and possible mortality.
- Maintain water in canals and ditches during the activity period (early spring through mid-fall) for the giant garter snake, western pond turtle, and other covered species using waterways.
- Maintain and enhance emergent vegetation in irrigation and other water conveyance canals to provide basking and escape cover for giant garter snakes.
- Where managed wetlands exist, habitat management and enhancement will focus on improving and maintaining site hydrology by grading, excavating, replacing, or installing water control infrastructure.
- On agricultural lands within the giant garter snake preserves (Yolo-Willow subpopulation and Caldoni Marsh-White Slough subpopulation), and other conserved agricultural land

that potentially supports giant garter snake, retain or create connectivity of the water conveyance system to facilitate dispersal and other movement of giant garter snakes.

- To enhance protected lands for wintering waterfowl and shorebird use, where feasible flood harvested corn fields during the fall and winter months.

Results of effectiveness monitoring of enhancement and management actions will provide the information necessary to identify future changes in management of conserved lands to ensure that biological objectives are achieved over the term of the BDCP.

3.4.4 Species Level Other Stressor Conservation Measures

[***Note to Reviewers***: *The text of this section of Chapter 3, including the other stressors conservation measures described, is subject to change and revision as the BDCP planning process progresses. This section, however, has been drafted and formatted to appear as it may in a draft HCP/NCCP. Although this section includes declarative statements (e.g., the Implementation Office will…), it is nonetheless a "working draft" that will undergo further modification based on input from the BDCP Steering Committee, state and federal agencies, and the public.*]

This section describes BDCP conservation measures that address other factors potentially affecting covered fish species. These factors, collectively titled "Other Stressors," go beyond issues associated with water operations and physical habitats to address toxic contaminants, other water quality issues (e.g., dissolved oxygen), non-native species, hatcheries, harvest, and non-project diversions that are individually and collectively affecting the productivity of the Delta. As discussed more fully in the Introduction (Section 3.1) and the Methods and Approaches Used to Develop the Conservation Strategy (Section 3.2), the inclusion of these measures into the BDCP reflects the comprehensive nature of the approach to conservation that underlies the BDCP.

A number of these conservation measures address activities that are not currently within the direct control of the BDCP Implementation Office and therefore are proposed to be implemented through agreements with third parties. These agreements will establish reliable mechanisms for the execution and success of these measures by those third parties. In instances where a third party is proposed to implement the conservation measure funded by the BDCP, the BDCP Implementation Office will enter into binding Memoranda of Agreement (MOA) or similarly binding instruments with the third party. These MOAs will describe respective roles and obligations for funding and implementing conservation measures as identified through the process described in each conservation measure. Specific elements of the MOA will describe:

- the specific activities or improvements that would be funded by BDCP;
- the preparation of annual work plans for these activities and improvements;
- the expected benefits of the action for covered species and the aquatic ecosystem;
- the performance metrics that will be measured to verify that the action being implemented has the expected benefit;

- provisions for monitoring, reporting, and documenting work performed; and
- provisions for modifying or terminating MOAs.

The third party will develop annual work plans, acceptable to the BDCP Implementation Office and the fish and wildlife agencies, that describe activities or capital improvements to be funded by BDCP over the course of that year. The third party will be responsible for implementing the scope of work and submitting reports as specified in the MOA that demonstrate that work plans have been successfully implemented. The third party will also be responsible for demonstrating the effectiveness of the funded activities to meet objectives as specified in the MOA.

The BDCP Implementation Office and the fish and wildlife agencies will review progress or other relevant reports prepared by the third party to assess program effectiveness and to identify adjustments to funding levels, management practices, or other related aspects of the program that will improve the biological effectiveness of the program. Such changes will be effected through the BDCP adaptive management process and will be included in the subsequent annual work plans.

3.4.4.1 CM12 Methylmercury Management

*[**Note to Reviewers:** This completely revised version of CM12 Methylmercury Management was provided to the Steering Committee on November 18, 2010, and the Steering Committee has not had the opportunity to review it at this time.]*

The purpose of this conservation measure is to minimize the potential for habitat restoration actions, implemented under the BDCP (CM4 *Tidal Habitat Restoration*, CM5 *Seasonally Inundated Floodplain Restoration*, and CM6 *Channel Margin Habitat Enhancement*), to increase the bioaccumulation of methylmercury in covered and other native species. It is also intended to reduce potential negative effects of methylmercury on important native species that maintain natural communities through herbivory, physical disturbance activities, predator-prey interactions, and other species interactions, or through species regulation of ecosystem processes.

The BDCP Implementation Office will:

1) Conduct pre-acquisition surveys to characterize the mercury content in the soil and other factors that could lead to high rates of methylation in potential habitat restoration areas;
2) After evaluating site characteristics and site conservation goals, prepare habitat restoration designs using measures that, to the extent practicable, will minimize the bioaccumulation of methylmercury in covered and other native species;
3) Conduct monitoring, to the extent practicable, to provide data that will enable the Implementation Office to track the effects of the restoration actions on the bioaccumulation of methylmercury in covered and other native species; and

4) Implement adaptive management actions when monitoring data indicate it is necessary, to the extent practicable, to reduce the bioaccumulation of methylmercury in covered and other native species resulting from tidal habitat and floodplain restoration actions.

The Implementation Office will coordinate with DWR, DFG, the Central Valley Regional Water Quality Control Board (CVRWQCB), and other entities to identify and implement methods for minimizing the methylation of mercury in BDCP restoration areas and the bioaccumulation of methylmercury in covered and other native species.

Problem Statement

There are high concentrations of mercury in the Plan Area due to the continual transport and deposition of historical gold and mercury mining sediment through Delta tributaries. In aquatic systems, anaerobic organisms transform mercury from an inorganic state to a bioavailable and toxic form of mercury (methylmercury). The consumption and bioaccumulation of methylmercury may cause adverse effects to BDCP covered fish and wildlife species. Methylmercury bioaccumulates within individuals and biomagnifies in higher food chain level consumers (CVRWQCB 2010). Biomagnification results in approximately four-fold increases in tissue concentration with each prey-to-predator step up the food chain (Marvin-DiPasquale et al. 2007). As a result, toxic effects of methylmercury are manifested strongly in upper trophic level organisms.

Most of the covered fish species are exposed to methylmercury primarily through the consumption of pelagic prey, and secondarily through direct exposure to high concentrations in the water column; although the latter is substantially lower than the former (Alpers et al. 2008). In addition to their pelagic food web exposure, white sturgeon, North American green sturgeon, and Sacramento splittail are most likely to be affected by high methylmercury concentrations in benthic prey. These fish species are long lived and thereby may accumulate high levels of methylmercury.

Wildlife may be affected by consuming fish or other aquatic organisms that have bioaccumulated methylmercury, or by consuming tidal marsh vegetation that contains methylmercury. Patterns of methylmercury concentration in tidal marsh plant species are complex, as are the grazing dynamics of the wildlife that feed on tidal marsh plants. These factors make it difficult to predict the effects tidal marsh and floodplain restoration actions may have on wildlife species.

Effects of dietary methylmercury on fish include, but are not limited to, endocrine and reproductive problems, liver necrosis, brain lesions, and altered behavior that can result in an increased risk of predation. Bioaccumulation rates in fish may depend on a number of environmental factors in addition to methylmercury concentrations in the water column and/or prey (Alpers et al. 2008); these include growth rate (e.g., seasonality with respect to methylation cycles and/or varied prey availability), foraging in habitats (e.g., preferences can result in foraging in areas with increased propensity for methylation), and food web structure (e.g., temporal and spatial variability in trophic transfer linkages).

High concentrations of methylmercury also have negative effects on birds and terrestrial wildlife (Wolfe et al. 1998). Deleterious effects on bird species from methylmercury consumption include reproductive impairment and reduced juvenile survival (Heinz 1979, Evers et al. 2004, Albers et al. 2007, Ackerman et al. 2008). Methylmercury consumption effects on mammals include anorexia, ataxia, and death (O'Connor and Nielsen 1981, Wren et al. 1987).

Methylmercury is produced by the bacterial mediated chemical synthesis of inorganic mercury with an organic compound under fluctuating oxidation/reduction conditions. Inorganic mercury is widely distributed throughout the Delta, both from mercury mining in the Coast Range and as a legacy from the gold-mining in the Sierras where mercury was used in the mining process. Conditions most conducive to the methylation of mercury typically occur at shallow depths within inundated sediments but can also occur in anaerobic open water. Methylmercury can be lost to the atmosphere through de-methylation or be buried deeply in sediment. Net methylation, the balance between methylation and de-methylation, is controlled by an extensive set of chemical and biological factors which are not well understood, limiting the ability of current science to predict changes resulting from tidal habitat and floodplain restoration. Even less is known about how methylmercury enters the benthic and pelagic food webs and the rates at which enters. It is also not well understood how or if methylmercury is transferred between the benthic and pelagic food webs.

While the data are still being refined and augmented, the general pattern in the Plan Area is that the total mercury and methylmercury of the sediment are not tightly correlated with methylmercury content in fish and clam tissue. Sentinel species tissue concentrations in the Dutch Slough area are among the lowest in the Plan Area despite high sediment concentrations (Grassetti Environmental Consulting 2008). Perhaps the best available data are from the Blacklock dike breach restoration site in Suisun Marsh from 2006-2009 which shows that tissue concentrations of methylmercury in inland silverside (a fish) decreased in adjacent Nurse Slough despite the continual increase of methlymercury in the sediment (M. Stephensen unpublished data). Additionally, the amount of methylmercury generated by existing land use activities is highly variable with waterfowl management actions in Suisun Marsh generating more methylmercury in managed wetlands than is generated in tidal marsh habitat (USDI et al. 2010).

Methods for minimizing methylation in sediments are being developed and include capping mercury-containing sediment with uncontaminated sediment (as at the Montezuma Wetlands Restoration Project) and the addition of ferrous iron or activated carbon granules to the sediment. Continued transport of contaminated sediment into and within the Plan Area would likely limit the effectiveness of capping, and the addition of chemicals is experimental and would likely be limited to relatively small areas.

Hypothesized Benefits

Through the use of appropriate site selection protocols, design measures, construction techniques, and management actions, tidal habitat and floodplain restoration is hypothesized to:

- Minimize adverse effects of methylmercury on white sturgeon, North American green sturgeon, and Sacramento splittail;
- Minimize, and potentially reduce, adverse effects of methylmercury on covered wildlife such as salt marsh harvest mouse, Suisun shrew, and California least tern in Suisun Marsh as a result of the conversion of managed wetlands to tidal wetlands;

Adaptive Management Considerations

Implementation of this conservation measure will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Results from the long-term monitoring of sentinel species and covered species tissue concentrations of methylmercury and of sediment concentrations of methylmercury will be used to assess the effects of tidal habitat and floodplain restoration on achieving the methylmercury management objective. Effectiveness monitoring results will be used to determine whether tidal marsh and floodplain restoration actions increase tissue concentrations of methylmercury in sentinel and covered fish and wildlife species.

The following four types of monitoring and research actions could be implemented to inform the adaptive management program: (1) quantification of existing mercury and methylmercury sources; (2) remediation of mercury source areas; (3) quantification of ecological and human health effects of methylmercury in the system; and (4) testing of possible management approaches. Many of these action areas are being addressed by ongoing efforts through regional agencies, research institutions, and stakeholders, such as characterization of mercury and methylmercury in sediment and biota throughout the Plan Area, evaluation of solutions for the Cache Creek Settling Basin, research on methylmercury flux and bioaccumulation in various Delta environments, and pilot studies on management approaches such as application of ferrous iron amendments.

3.4.4.2 CM13 Nonnative Aquatic Vegetation Control

The BDCP Implementation Office will control the growth of Brazilian waterweed (*Egeria densa*), water hyacinth (*Eichhornia crassipes*), and other nonnative submerged and floating aquatic vegetation (SAV and FAV) in BDCP tidal habitat restoration areas (Figure 3-58). To implement this conservation measure, the Implementation Office will apply existing methods used by the Department of Boating and Waterways (DBW) *Egeria densa* and Water Hyacinth Control Programs. Control methods currently employed by DBW include application of herbicides and mechanical removal. BDCP methods of removal will be dictated by site-specific conditions and intended outcome or goal. Application of herbicides or other means to control SAV/FAV will be timed to eliminate or minimize potential negative effects of SAV/FAV removal on covered species.

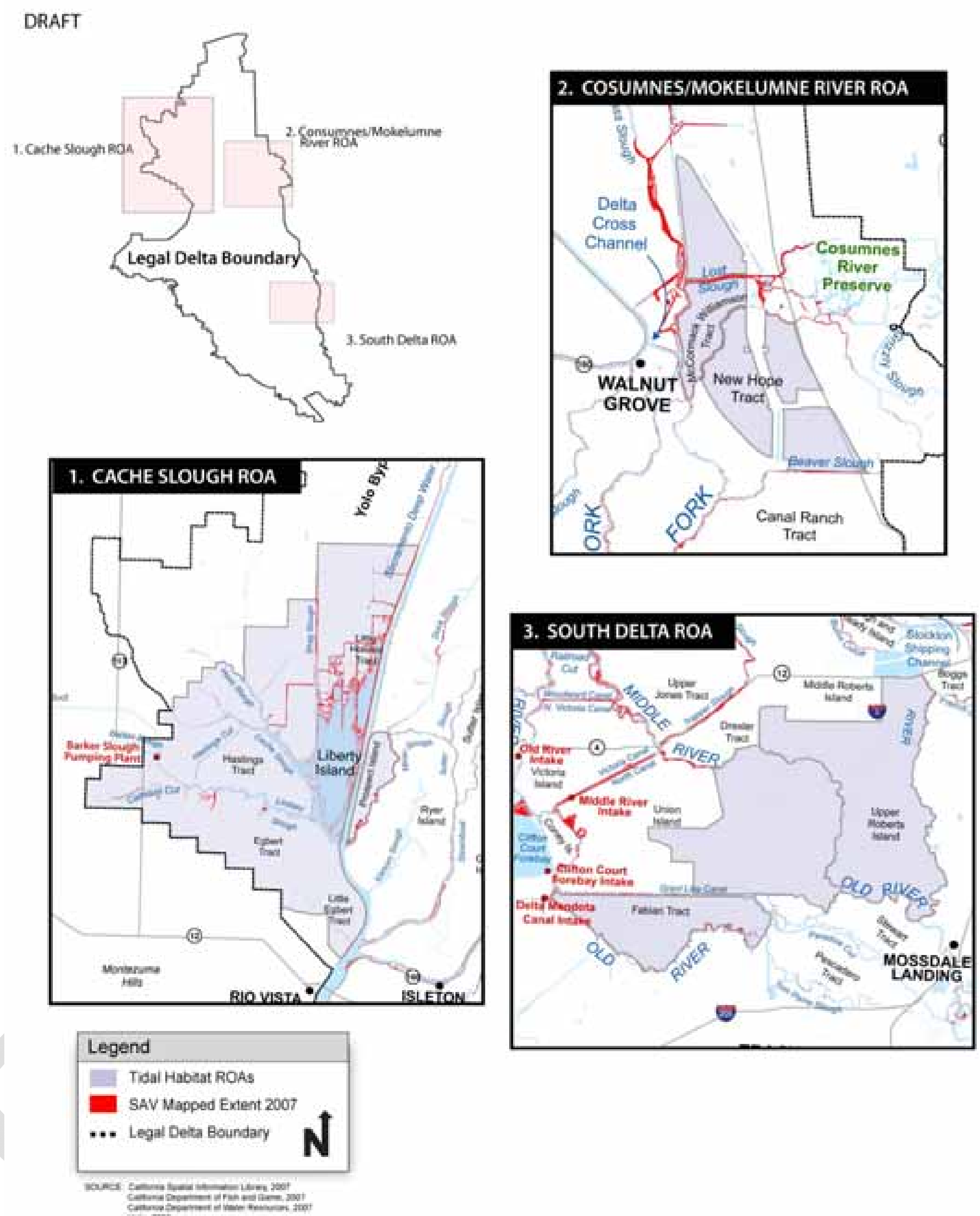

Figure 3-58. Overlap of Submerged Aquatic Vegetation in 2007 and Tidal Habitat Restoration Opportunity Areas (CM13)

Problem Statement

Although the historical extent of native SAV and FAV in the Delta ecosystem is unknown, invasive SAV and FAV species have recently colonized large areas of the Delta (Brown 2003, DFG 2008a, Ustin et al. 2008) and are continuing to expand into a greater proportion of channels and new areas (IEP 2008b). The widest spread nonnative FAV species, water hyacinth, was introduced into the Delta over 100 years ago, and severe infestations were experienced by the 1980s. The majority of the surface cover of SAV detected through the recent use of airborne hyperspectral imagery is Brazilian waterweed, although the SAV vegetation frequently contains a mixture of three invasive nonnative species: Brazilian waterweed, *Potamogeton crispus* (curlyleaf pondweed), and *Myriophyllum spicatum* (Eurasian watermilfoil) (Ustin et al. 2008). Of the 55,000 acres of the Delta surveyed in 2007, SAV cover has been estimated to be between 5,500 and 10,000 acres (Ustin et al. 2008). Nonnative SAV and FAV are thought to cause multiple negative effects on the Delta ecosystem, including providing habitat for nonnative predators of covered fish species (Brown 2003, Nobriga et al. 2005), reducing food abundance and feeding ability of covered fish species by reducing light and turbidity (Brown and Michniuk 2007), and blocking rearing habitat for juvenile salmon and splittail (IEP 2008a).

The DBW Water Hyacinth Control Program, which began in 1982, has been effective in reducing hyacinth from Delta waterways by using chemical and mechanical removal methods. DBW has developed and operated the *Egeria densa* Control Program since 2001 in response to AB 2193, which amended the Harbors and Navigation Code to designate DBW as the lead agency for the control of Brazilian waterweed in the Delta (DBW 2006, 2008). Initially, the program focused control efforts in a number of locations where Brazilian waterweed impeded navigation, tested a range of mechanical and chemical control techniques, and conducted an extensive suite of toxicology and water quality tests and sampling that were required by the terms of its National Pollution Discharge Elimination System permit and under biological opinions issued by USFWS and NOAA Fisheries (DBW 2008). In 2006, DBW concluded that its current approach was not effective at stopping the expansion of SAV in the Delta and proposed expanding the treatment area to sites across most of the legal Delta between 2006-2010 and concentrating on Franks Tract between 2006-2008 (DBW 2006).

Hypothesized Benefits

Removing nonnative SAV and FAV from tidal habitat restoration areas is hypothesized to provide benefits to covered fish species through the following mechanisms:

1. Reducing predation mortality on juvenile salmon, steelhead, and splittail by reducing habitat for nonnative predatory fish (see Appendix F, *DRERIP Evaluation Results*). SAV provides relatively high quality habitat for nonnative piscivores and is spread across large portions of the Delta in or adjacent to significant migration corridors and pelagic and subtidal open water habitat for covered species (Figure 3-59). The interior of SAV stands is good habitat for larval and juvenile centrarchids (Brown and Michniuk 2007), whereas

adult striped bass forage immediately outside of the SAV bed and feed on juvenile Chinook salmon, steelhead, splittail, delta smelt, and longfin smelt (Stevens 1966, Temple et al. 1998, Nobriga and Feyrer 2007b, 2008);

2. Reducing predation mortality of delta smelt by increasing turbidity levels (IEP 2008a, Appendix F, *DRERIP Evaluation Results*). SAV and FAV are thought to reduce local flow rates and cause suspended solids to precipitate out of the water column, resulting in a localized reduction in turbidity levels (Grimaldo and Hymanson 1999). Increased turbidity is hypothesized to improve the predator avoidance abilities of delta and longfin smelt. In addition, improved turbidity may reduce the hunting efficiency of nonnative piscivores (Nobriga et al. 2005);

3. Increasing food consumption by delta and longfin smelt by increasing turbidity levels. SAV and FAV are thought to reduce local flow rates and cause suspended particles to precipitate out of the water column, resulting in a localized reduction in turbidity levels (Grimaldo and Hymanson 1999). A reduction in turbidity is hypothesized to reduce the foraging ability of delta and longfin smelt;

4. Increasing rearing habitat for juvenile salmon (all races), steelhead, and splittail (Appendix F, *DRERIP Evaluation Results*). Dense patches of SAV and FAV physically obstruct covered fish species' access to habitat (IEP 2008a) that would become available with SAV and FAV removal and control; and

5. Increasing food availability for all covered fish species near removal locations by increasing light levels below vegetation. Phytoplankton growth is hypothesized to be light-limited in the Delta (Cole and Cloern 1984). The presence of SAV/FAV is more light-limiting for phytoplankton growth, through shading, than anticipated increases in water turbidity resulting from SAV/FAV removal. The reduction in light levels near nonnative SAV and FAV are thought to reduce local growth of phytoplankton, which can affect the local abundance of zooplankton that forms the food base for covered fish species near patches of SAV and FAV.

Adaptive Management Considerations

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. The Implementation Office will monitor the effectiveness of BDCP-funded elements of the nonnative aquatic vegetation control in successfully controlling SAV and FAV. The Implementation Office will adjust control strategies and funding levels through the BDCP adaptive management process as appropriate based on review of program reports.

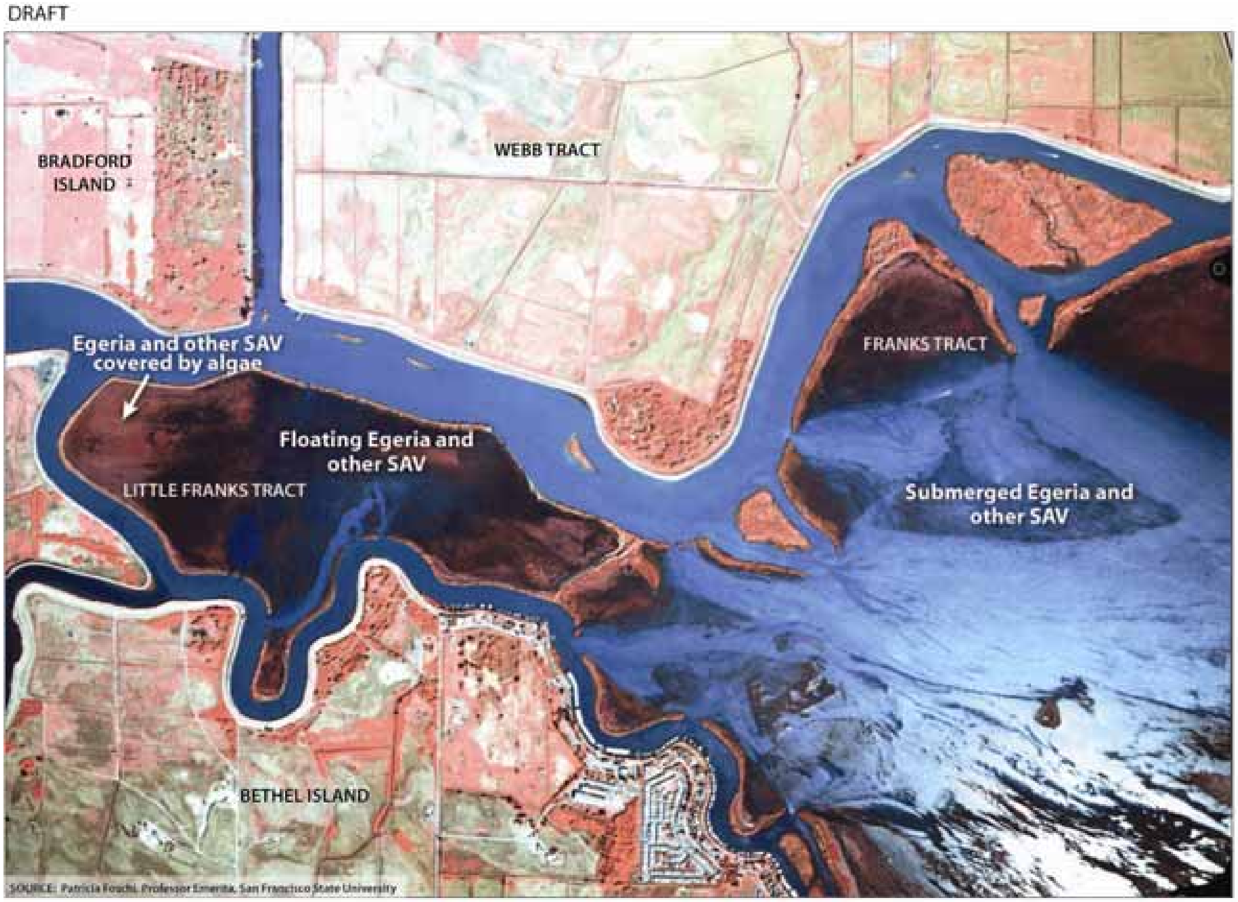

Figure 3-59. Examples of Delta Areas with Submerged Aquatic Vegetation (SAV) Infestations (CM13)

The Implementation Office will use results of effectiveness monitoring to determine if controlling SAV and FAV results in measurable benefits to covered fish species and to identify adjustments to funding levels, control methods, or other related aspects of the program that would improve the biological effectiveness of the program. Such changes, once approved through the adaptive management decision-making process, will be effected through subsequent annual work plans.

If results of monitoring indicate that removing and controlling SAV and FAV does not substantially and cost-effectively benefit covered fish species, the Implementation Office, in coordination with Fishery Agencies, may terminate this conservation measure. If terminated, remaining funding would be deobligated from this conservation measure and reallocated to augment funding for other more effective conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management

3.4.4.3 CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels

The purpose of this conservation measure is to maintain dissolved oxygen concentrations above levels that impair covered fish species in the Stockton Deep Water Ship Channel during periods when covered fish species are present. The BDCP Implementation Office will operate and maintain an oxygen aeration facility in the Stockton Deep Water Ship Channel to increase dissolved oxygen concentrations between Turner Cut and Stockton to meet Total Maximum Daily Load (TMDL) objectives established by the Central Valley Regional Water Quality Control Board (CVRWQCB) (2005) (above 6.0 mg/L from September 1 through November 30 and above 5.0 mg/L at all times). The existing aeration facility will be modified as necessary and, if necessary, additional aerators and associated infrastructure would be added to optimize oxygen delivery to the river, contingent upon results of an ongoing demonstration project conducted by DWR and effectiveness monitoring during implementation.

The Implementation Office will be responsible for developing annual work plans in coordination with Fishery Agencies that specify the extent of dissolved oxygen improvements to be implemented and will be responsible for monitoring the effectiveness of dissolved oxygen enhancement measures in improving dissolved oxygen levels.

Problem Statement

The Stockton Deep Water Ship Channel has been identified as an impaired waterway by the State Water Resources Control Board because of low dissolved oxygen concentrations during late summer and early fall (CVRWQCB 2005). The combination of low flows, high loads of oxygen-demanding substances (algae from upstream, effluent from the City of Stockton Regional Wastewater Control Facility, and other unknown sources), and channel geometry contribute to low oxygen levels in the Stockton Deep Water Ship Channel (CVRWQCB 2005). The Stockton Deep Water Ship Channel often fails to meet water quality objectives established by the Regional Board for dissolved oxygen (CVRWQCB 2007). The 7.5-mile low dissolved oxygen area of the ship channel creates a barrier for upstream migration of adult fall-run

Chinook salmon and Central Valley steelhead on the mainstem of the San Joaquin River (Hallock et al. 1970). Further, low dissolved oxygen levels can cause physiological stress on and mortality of fish, including Chinook salmon and steelhead (Jassby and Van Nieuwenhuyse 2005), and other aquatic organisms (CVRWQCB 2007). Once spring-run Chinook salmon are re-established in the San Joaquin River under the San Joaquin River Litigation Settlement, dissolved oxygen sags in the Deep Water Ship Channel will likely have similar effects on this run if sags were to occur during their adult migration period (expected to be approximately March-September). In addition, juvenile white sturgeon, which rear in the San Joaquin River, exhibit reduced foraging and growth rates at dissolved oxygen levels below 58 percent saturation (5.8 mg/l at 15 °C) (Cech and Crocker 2002).

One potential solution to dissolved oxygen sags in the Stockton Deep Water Ship Channel, a dissolved oxygen aeration system, has been installed and is currently undergoing field testing by DWR. Results suggest that the aeration facility is effective at raising dissolved oxygen levels in much of the channel. Long-term funding for operations and maintenance has not yet been secured and there are currently no mandates by the CVRWQCB that require contributors to the sag to fund the project. Under this conservation measure, the BDCP would share in funding the long term operation and maintenance costs associated with the project.

Hypothesized Benefits

Increasing dissolved oxygen concentrations in the Stockton Deep Water Ship Channel in accordance with TMDL objectives is hypothesized to result in:

- Reduced delay and inhibition of upstream and downstream migration of fall-run Chinook salmon, steelhead, white sturgeon, river and Pacific lamprey, and, once they are re-established in the San Joaquin River, spring-run Chinook salmon (Hallock et al. 1970); and
- Reduced physical stress and mortality of fall-run Chinook salmon, steelhead, white sturgeon, river and Pacific lamprey, and, once they are re-established in the San Joaquin River, spring-run Chinook salmon.

Adaptive Management Considerations

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Results from monitoring of dissolved oxygen levels at various distances from the diffuser(s) will be used to assess the performance of the facilities operations at achieving the water quality objective. The Implementation Office will use effectiveness monitoring results to determine whether aeration facility operations result in measurable benefits to covered fish species.

Based on review of performance and effectiveness monitoring results, the Implementation Office will adjust funding levels, oxygen diffuser methods, or other related aspects that will improve the performance and/or biological effectiveness of the project through the BDCP adaptive management process as appropriate. Such changes will be effected through the BDCP adaptive management process and would be included in the subsequent annual work plans.

If results indicate that the aeration facility does not substantially and cost-effectively benefit covered fish species, the BDCP Implementation Office, in coordination with Fishery Agencies, may terminate this conservation measure. If terminated, remaining funding will be deobligated from this conservation measure and reallocated to augment funding for other more effective conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management process.

3.4.4.4 CM15 Predator Control

The purpose of this conservation measure is to reduce local effects of predators on covered fish species by conducting focused predator control in high predator density locations. The BDCP Implementation Office will reduce the local effects of predators on covered fish species by conducting focused predator control using a variety of methods in locations in the Delta that are known to have high densities of predators ("hot spots").

The Implementation Office will examine existing fish monitoring data, bathymetry data, and radio and acoustic tagging study results to determine the locations and causes of predator hot spots throughout the Delta (Figure 3-X [to come]). Locations of hot spots in which focused predator control will occur include:

1. Old structures in or hanging over Delta waterways, such as pier pilings or other man-made structures, that are no longer functional or have been abandoned but affect flow fields or provide shade (target: 10-20 structures removed per year);
2. Boats that have been abandoned throughout the Delta (target: 5-10 boats removed per year);
3. New intake structures of the North Delta Diversions (target: daily focused removal when sensitive lifestages of covered fish species are present);
4. The deep hole just downstream of the Head of Old River in the San Joaquin River (target: daily focused removal when sensitive lifestages of covered fish species are present. Additional control efforts may be needed in conjunction with operation of non-physical barriers, as described in CM16);
5. Specific locations in Georgiana Slough, as identified by Fishery Agencies (target: daily focused removal in up to 3 specific locations when sensitive lifestages of covered fish species are present);

6. Specific locations in Sutter and Steamboat sloughs, as identified by Fishery Agencies (target: daily focused removal of predators in up to 2 specific locations per slough when sensitive lifestages of covered fish species are present); and
7. Release sites of salvaged fish from CVP/SWP facilities (target: weekly focused removal at each salvage release site when sensitive lifestages of covered fish species are being salvaged).

The Implementation Office will use a variety of methods to control predator populations in hot spots, including removal of predator hiding spots, modification of channel geometry, targeted removal of predators, and/or other focused methods as dictated by site-specific conditions and the intended outcome or goal. Preference for which hot spots to address will be given to areas of high overlap with covered fish species, such as major migratory routes or spawning and rearing habitats.

Site-specific control plans will be developed in consultation with the Fishery Agencies, and will include expected benefits, methods, and a monitoring design that will provide information necessary to determine the effectiveness of the action.

Problem Statement

Although a natural part of the estuarine ecosystem, predation in the Delta has been identified as a stressor to BDCP covered fish species (Appendix F, *DRERIP Evaluation Results*). Habitat for fish predators generally consists of a specific suite of attributes that allow them to forage more efficiently, such as dark locations adjacent to light locations or deep pools that allow the predator to hide and ambush their prey. There are multiple locations in the Delta that contain these physical attributes and attract predatory fish that prey upon covered fish species.

Hypothesized Benefits

Conducting localized predator control at hot spots in the Delta using a variety of control methods is expected to reduce local predator abundance, thus reducing localized predation mortality of Chinook salmon (Temple et al. 1998, Lindley and Mohr 2003), steelhead (Temple et al. 1998), Sacramento splittail (Moyle et al. 2004), and delta smelt (Stevens 1966, Thomas 1967, Moyle 2002); and possibly longfin smelt (Nowak et al. 2004), green sturgeon (J. Israel pers. obs.), and white sturgeon.

Within the Columbia River system, a predator removal program was investigated in the 1980's for the control of juvenile salmonid predators benefiting from the existence of multiple hydropower dams located along this system. The principle predators for juvenile salmonids within the Columbia River are the northern pikeminnow (*Ptychocheilus oregonensis*), and two nonindigenous species: smallmouth bass (*Micropterus dolomieu*) and walleye (*Sander vitreus*). Northern pikeminnow greater than ~10 inches were considered the primary predator of juvenile salmonids in slower moving portions of the Columbia River (i.e., near hydropower facilities).

The program, designed to reduce predation rates in these areas utilizing a bounty program, net fisheries, professional fishers, and fishing areas adjacent to hatcheries, was initiated in 1990. The bounty program targets the removal of 10 to 20 percent of the larger pikeminnow to control size classes that have the greatest juvenile salmonid predation rates, while still maintaining a sustained pikeminnow population. By maintaining a sustained pikeminnow population, the program was designed to avoid compensatory responses of other juvenile salmonid predators in the system (smallmouth bass and walleye) filling the void created by pikeminnow removal. Through the first 16 years of the program there were no indications of compensatory responses. In 2006, however, there were possible indications of localized compensatory responses, although there is insufficient data to determine whether there is a system-wide compensatory response (Takata et al. 2007, Van Dyke 2010).

Prior to the initiation of this program, Beamesderfer et al. (1996) estimated that approximately 16.4 million juvenile salmonids of the estimated 200 million downstream migrants were consumed by northern pikeminnow in the Columbia system. Another study estimated that northern pikeminnow accounted for 10 to 20 percent of juvenile salmonid mortality (as cited in Young 1997). Predation rates are greatest in the vicinity of each of the eight Columbia and Snake River reservoirs ("pools"). Within the John Day pool, it was estimated that a northern pikeminnow exploitation rate of 10 to 20 percent could reduce their predation on juvenile salmonids by 50 percent (as cited in Young 1997). From 1990 through 2008, the Northern Pikeminnow Sports Reward Fishery removed 3.3 million reward-sized (≥9 inches) northern pikeminnow from the Columbia system. From 1991-1998, system-wide exploitation rates of northern pikeminnow averaged 11.7 percent (Hankin and Richards 2000). The removal program estimates northern pikeminnow predation has been reduced by 37 percent (Northern Pikeminnow Sports Reward Fishery 2009). Although the program does not provide an estimated annual number of juvenile salmonids "spared" due to predator removal, model estimates for a reduction of 50 percent predation rate range from 5.2 to 8.2 million juvenile salmonids annually (Hankin and Richards 2000).

Adaptive Management Considerations

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Monitoring will consist of assessing the abundance, distribution, and size of predator species before and immediately after implementation of predator control actions in each hot spot to determine the performance of the action. In addition, potential changes in survival rate of covered species will be monitored using acoustic tagging studies where possible or similar techniques.

The Implementation Office, in consultation with the Fishery Agencies, will use results of effectiveness monitoring to determine whether the actions result in measurable benefits to covered fish species, and to identify adjustments to funding levels, methods, or other related aspects of the program that would improve its biological effectiveness. Such changes, once approved through the adaptive management decision-making process, will be effected through subsequent annual work plans. If results of monitoring indicate that the action does not substantially and cost-effectively benefit covered fish species, the BDCP Implementation Office, in coordination with Fishery Agencies, may terminate this conservation measure. If terminated, remaining funding will be deobligated from this conservation measure and reallocated to augment funding for other more effective conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management process.

3.4.4.5 CM16 Non-Physical Fish Barriers

The purpose of this conservation measure is to improve the survival of outmigrating juvenile salmonids by using non-physical barriers to re-direct them away from channels in which survival is lower (Figure 3-60). The BDCP Implementation Office will install non-physical barriers at the junction of channels with low survival of outmigrating juvenile salmonids to deter fish from entering these channels[37]. Non-physical barrier placement locations will include the Head of Old River, the Delta Cross Channel, Georgiana Slough, and could possibly include Turner Cut, Columbia Cut, the Delta Mendota Canal intake, and Clifton Court Forebay (Figure 3-61). Other locations may be considered in the future by the Implementation Office if, for example, future research demonstrates differential rates of survival in Sutter and Steamboat sloughs relative to the mainstem Sacramento River, or in the Yolo Bypass relative to the mainstem Sacramento River. Non-physical barriers will include a combination of sound, light, and bubbles similar to the three-component non-physical barrier used in the 2009 DWR Head of Old River Test Project (Bowen et al. 2009). Non-physical barriers will be installed and operated during October to June or when Fishery Agencies monitoring determines that salmonid smolts are present in the areas when barriers are to be installed. Non-physical barrier placement may also be accompanied by methods to reduce local predator abundance described in CM15 above if monitoring finds that barriers attract predators. Barriers will be removed and stored off-site while not in operation (M. Holderman pers. comm.).

Problem Statement

Juvenile salmonids experience low survival rates while migrating through the Delta towards the ocean. Survival rates vary among routes taken through the Delta (Brandes and McLain 2001, Perry and Skalski 2008, 2009, Holbrook et al. 2009, Perry et al. 2009) as a result of differential exposure to predation, entrainment mortality at state and federal water export facilities and small agricultural diversions, and other factors (SJRGA 2006, J. Burau pers. comm.).

[37] Previous evidence suggests that, under a non-physical barrier configuration that was effective in deterring salmon smolts, the non-physical barrier was not effective in deterring delta smelt (Bowen et al. 2008). It is currently not known whether this was a result of the configuration (e.g., sound frequency) of the non-physical barrier or the poor swimming ability of delta smelt that was swamped by high flows (Bowen et al. 2008). Reclamation is currently studying whether there are sound frequencies that deter delta smelt (M. Holderman pers. comm.). If demonstrated to be effective in deterring delta smelt and longfin smelt and deemed necessary by the Fishery Agencies, non-physical barriers could also be installed at the mouths of Old and Middle rivers and in Three Mile Slough (if salinity manipulation is not also needed) to deter these species from moving into these channels where survival is thought to be lower when present, as determined by Fishery Agencies monitoring.

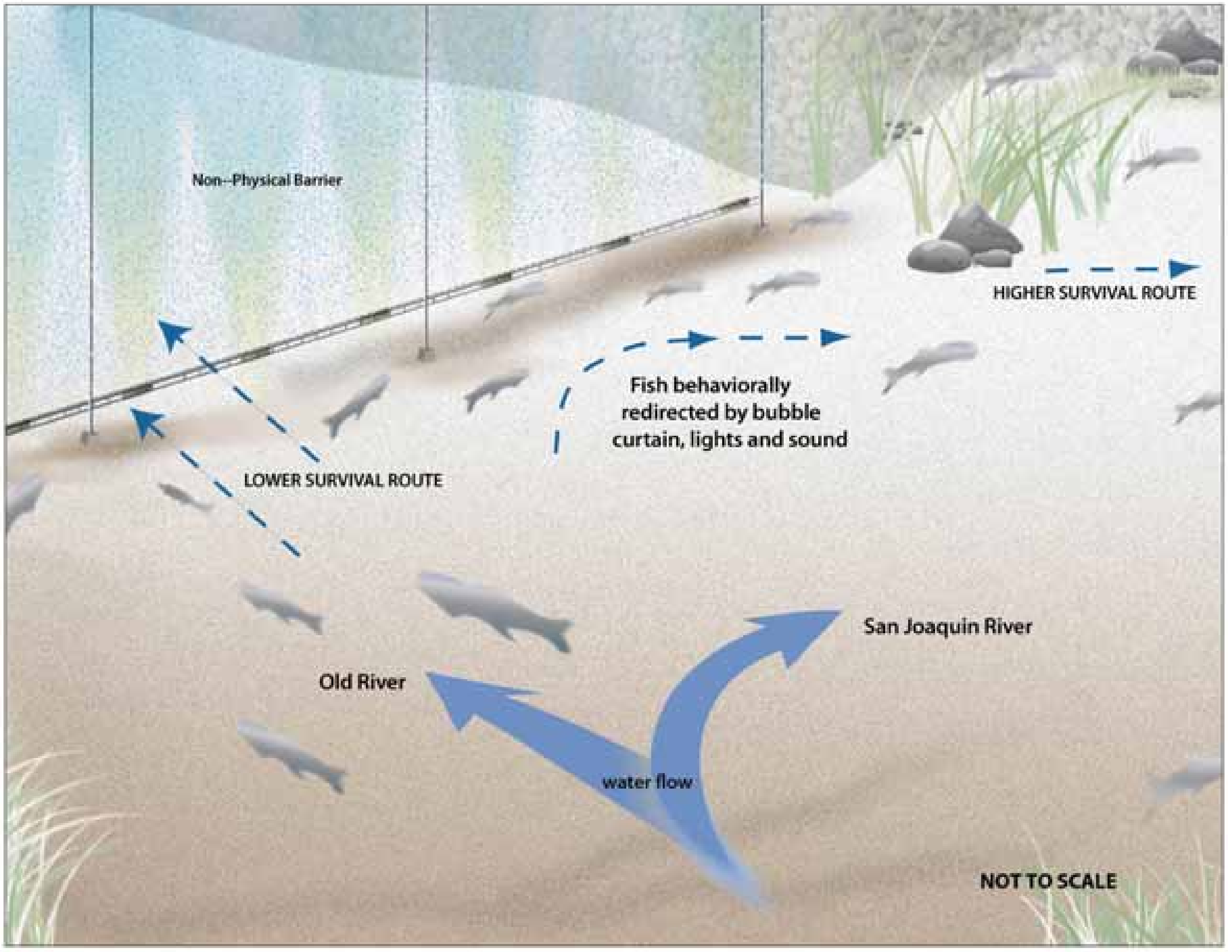

Figure 3-60. Schematic of Non-Physical Fish Barrier (CM16)

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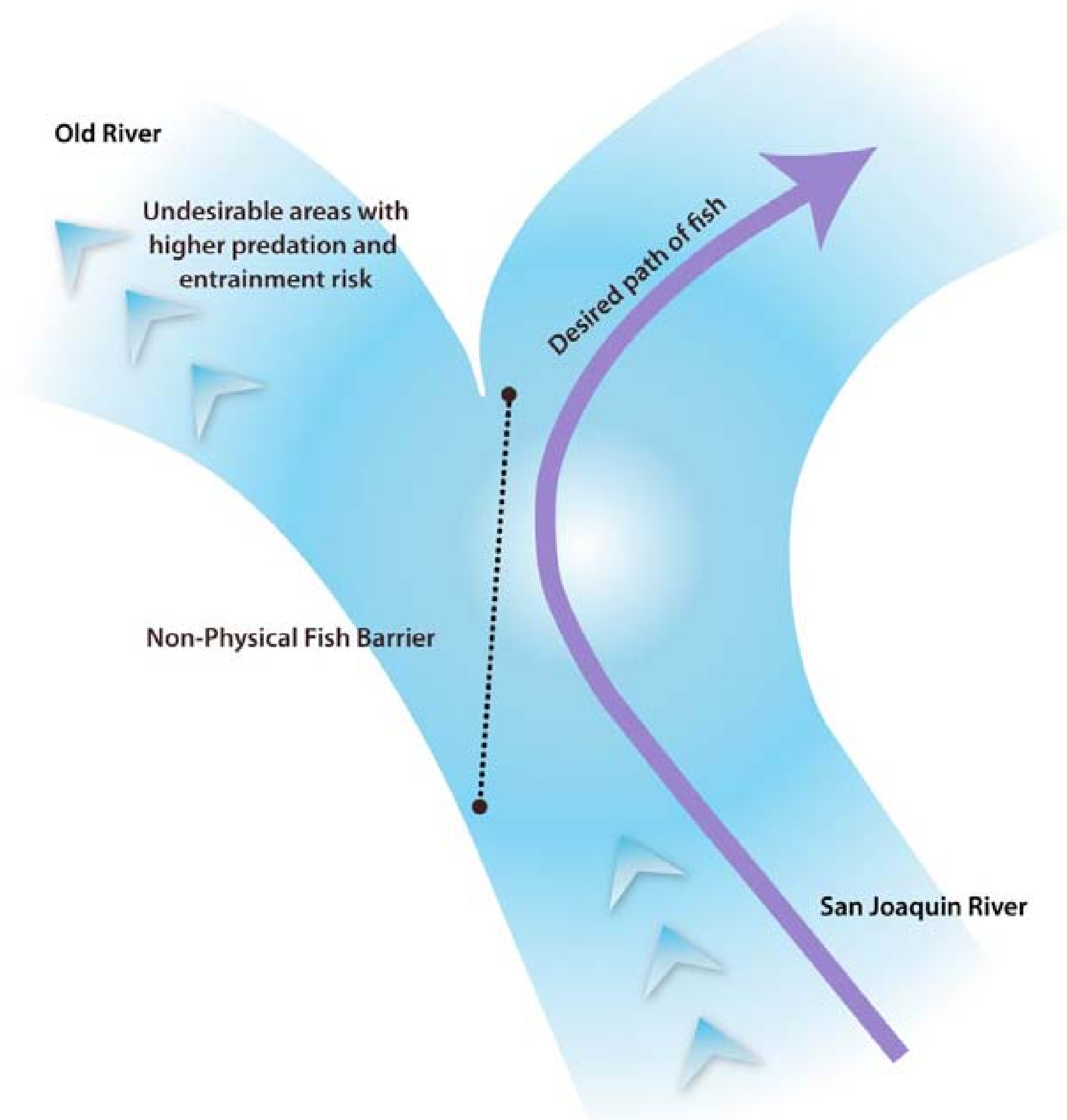

Figure 3-61. Conceptual Location of Non-Physical Fish Barrier (CM16)

Survival for routes through the interior Delta was at most 35 percent that of survival for fish remaining in the Sacramento River (Perry et al. 2010). Such low probability of survival when migrating through the interior Delta indicates that significant population level impacts could result if a sizable portion of the salmon population passed through this area. Perry and Skalski (2009) found that 19.8 to 34.5 percent of tagged salmon used Sutter and Steamboat sloughs during migration, while 26.7 percent to nearly one-third of the population entered the interior area. Low survival probabilities and high proportions of the population migrating through the interior Delta combine to significantly reduce salmon survival through the Delta during migration. Physical barriers have been used in the Delta, such as the Delta Cross Channel gates and the rock barrier at the Head of Old River, to prohibit the entry of fish into channels where survival rates are low. Physical barriers are effective at prohibiting entry of salmonids into channels, but also alter flow dynamics in these channels, likely affecting tidal flows, sediment loads, bathymetry, water supply reliability, potential for noxious algal blooms, toxic concentrations, and other water quality parameters. However, operation of non-physical barriers is predicted to cause smaller changes in the physical configuration of the channel, thus reducing flow-related effects, while improving survival of salmonids by deterring them from entering channels with a higher risk of mortality.

Hypothesized Benefits

Installation and seasonal operation of non-physical barriers is hypothesized to improve survival of juvenile salmonids migrating downstream by guiding fish into channels in which they experience higher survival rates (Welton et al. 2002, Bowen et al. 2009). The three component non-physical barrier has shown promising results in laboratory experiments on Chinook salmon emulating the Sacramento River/Georgiana Slough flow split (Bowen et al. 2008) and a field experiment on Atlantic salmon (*Salmo salar*) smolts in the River Frome, UK (Welton et al. 2002). In addition, preliminary evidence suggests that the three-component barrier was effective in deterring acoustically-tagged Chinook salmon juveniles from entering the head of Old River during a 2009 pilot study (Bowen et al. 2009). Non-physical barriers that utilize only one component, such as sound or light, have demonstrated only limited success in deterring fish during field trials. For example, out of 25 separate single-component sound and light systems placed in 21 different locations in Europe and the United States to affect the behavior of salmonids near water intakes and canals, fewer than 50 percent were effective in altering fish behavior (USBR 2006). The three-component Non-physical Barrier Test Project at the confluence of Old River and the San Joaquin River in the Sacramento-San Joaquin Delta has demonstrated greater success, successfully deterring 81.4 percent of tagged Chinook salmon smolts from entering Old River compared to conditions without the barrier operating that deterred 25.4 percent of tagged salmon smolts (Bowen et al. 2009). Sound is known to affect the behavior of salmonids (Vanderwalker 1967, Knudsen et al. 1992, 1994).

<u>*Adaptive Management Considerations*</u>

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. The Implementation Office will conduct and review monitoring to assess the effectiveness of using non-physical barriers. The Implementation Office will use results of effectiveness monitoring to determine whether operations of non-physical barriers result in measurable benefits to juvenile salmonids and to identify adjustments to funding levels, methods, or other related aspects of the program that would improve the biological effectiveness of the program. Uncertainty regarding the potential attraction of predators to non-physical barriers and the effectiveness of barriers in higher flow areas must be resolved. Such changes, once approved through the adaptive management decision-making process, will be effected through subsequent annual work plans. If results of monitoring indicate that operations of non-physical barriers do not substantially and cost-effectively benefit covered fish species, the Implementation Office, in coordination with Fishery Agencies, may terminate this conservation measure. If terminated, remaining funding will be deobligated from this conservation measure and reallocated to augment funding for other more effective conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management process.

3.4.4.6 CM17 Hatchery and Genetic Management Plans

[*Note to Reviewers*: *SAIC is in discussion with hatchery coordinators to determine the funding needs for this conservation measure. This measure will be updated as new information becomes available via continued coordination.***]**

The purpose of this conservation measure is to develop and implement hatchery and genetic management plans to minimize the potential for genetic and ecological impacts of hatchery-reared salmonids on wild salmonid stocks. The BDCP Implementation Office will minimize potential adverse effects of hatchery-reared salmonids on wild salmonid stocks by supporting the accelerated development and implementation of Hatchery and Genetic Management Plans (HGMPs) for all state Chinook salmon and steelhead hatcheries in the Central Valley. HGMPs would be implemented to reduce adverse ecological and genetic effects of hatcheries on wild fish and to be consistent with conservation and protection for listed fish species.

The Implementation Office will provide funding to:

- Expand and finalize steering groups for each hatchery HGMP process, in part to aid in determining hatchery function;
- Support DFG staff and DFG contractors to prepare HGMPs under DFG and NMFS direction;

- Staff a DFG HGMP Coordinator, a position dedicated to coordinating HGMPs from beginning through implementation. HGMP implementation and adaptive management will be an ongoing task for the life of each hatchery;
- Staff hatcheries sufficiently to carry out changes necessary to meet ESA requirements, including providing regional support for fishery biologists at each hatchery;
- Improve efforts to minimize several categories of hatchery impacts including trucking, inter-basin egg transfers, genetic stock management, monitoring (especially hatchery natural proportions and impacts of hatcheries on natural stocks), and conservation hatcheries; and
- Provide support for staffing and analysis associated with a genetic parental-based tagging system.

Funding of these efforts will be higher during development of the plans and should decline as plans are completed. The BDCP Implementation Office will enter into binding Memoranda of Agreement or similar instruments with DFG as described in Section 3.4.4, *Species Level Other Stressors Conservation Measures*.

Problem Statement

Hatchery-reared Chinook salmon and steelhead are believed to have negative effects on wild Chinook salmon and steelhead, including competition for space and food as juveniles and for spawning habitat as adults. Fish reared in hatcheries can be selected for traits that are different from those in nature, such as those that allow them to survive in an artificial, contained environment (e.g., fast growth, large size). This could result in reduced genetic isolation of hatchery fish from wild fish. It is thought that these hatchery fish outcompete their smaller wild-reared conspecifics (individuals of the same species) for food and space in natural waterways (Williams 2006). Also, as adults, straying by hatchery-reared salmon into natural spawning grounds may lead to competition for spawning habitat and genetic introgression, where offspring of wild salmon are “genetically polluted” with hatchery-selected genes, thereby reducing the fitness of wild population (ISAB 2003, Goodman 2005, Hey et al. 2005).

To address these concerns, hatcheries have begun reforming their management practices to minimize the effects that hatchery fish may have on wild fish. HGMPs serve as the foundation of hatchery management and reform to minimize genetic and ecological impacts to wild fish. HGMPs are developed to devise and evaluate practices of a hatchery to ensure the hatchery contributes to the conservation and recovery of listed salmonids.

Although required, the development of HGMPs in Central Valley hatcheries has been slow to date. The following provides a summary of the status of the progress made toward completion of HGMPs at Central Valley hatcheries (M. Lacy pers. comm.):

- Nimbus Hatchery - Draft HGMPs for both fall Chinook salmon and winter steelhead have been completed. Updates and minor revisions were made during 2008 to initial drafts. Reclamation and DFG staff are currently reviewing subsequent drafts.
- Feather River Hatchery - Draft HGMPs for spring and fall Chinook salmon and Central Valley steelhead were completed in late 2008. DWR is reviewing the spring Chinook salmon draft HGMP; fall Chinook salmon and steelhead HGMPs are both still in development by consultant staff. Updates and DWR comments are being incorporated into all drafts as appropriate.
- Mokelumne River Hatchery - A revised draft HGMP for the steelhead program was completed at the end of 2008 and has been reviewed by hatchery staff. A draft HGMP for the fall Chinook salmon is 50 percent complete.
- Merced River Hatchery - There has been no progress towards beginning work on this HGMP.
- Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery - All of the necessary HGMP information for Coleman and Livingston Stone National Fish Hatcheries are contained in the 2001 Biological Assessment (plus a subsequent addendum for Section 10 coverage for winter Chinook and amendments to respond to operational changes at Coleman National Fish Hatchery) submitted to NMFS. The Biological Opinion, including updates to the BA, is in process.

Hypothesized Benefits

Accelerating the development and implementation of HGMPs at Central Valley hatcheries is hypothesized to:

- Improve the genetics and fitness of wild salmonids (ISAB 2003, Goodman 2005, Hey et al. 2005); and
- Reduce competition for rearing and spawning habitat and food with hatchery-reared salmonids (Flagg et al. 2000, Goodman 2005).

Adaptive Management Considerations

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. The Implementation Office will review annual reports or other relevant reports to assess the performance of the HGMP teams in the accelerated development and implementation of HGMPs. The Implementation Office will coordinate with the individual hatcheries to adjust HGMP strategies and funding levels through the BDCP adaptive management process as appropriate, based on review of performance monitoring results and other relevant reports.

The Implementation Office will use effectiveness monitoring results to determine whether HGMP development and implementation results in measurable benefits to covered fish species and to identify adjustments to funding levels or other related aspects of the program that would improve the biological effectiveness of the program. Such changes will be effected through the BDCP adaptive management process and will be included in the subsequent annual work plans.

If results of review indicate that HGMP development and implementation does not substantially and cost-effectively benefit covered fish species, the Implementation Office, in coordination with Fishery Agencies, may terminate this conservation measure. If terminated, remaining funding will be deobligated from this conservation measure and reallocated to augment funding for other more effective conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management process.

3.4.4.7 CM18 Illegal Harvest

The purpose of this conservation measure is to reduce illegal harvest of Chinook salmon, Central Valley steelhead, green sturgeon, and white sturgeon in the Delta, bays, and upstream waterways. The BDCP will provide funding over the term of the BDCP to increase the enforcement of fishing regulations in the Delta and bays to reduce illegal harvest of covered salmonids and sturgeon. The BDCP Implementation Office will provide funds to DFG to hire and equip 17 additional Game Wardens and 5 supervisory and administrative staff in support of the existing field wardens assigned to the Delta-Bay Enhanced Enforcement Program over the term of the BDCP.

The DFG Delta-Bay Enhanced Enforcement Program (DBEEP) is a 10-Warden squad that was formed specifically to increase enforcement on poaching of anadromous fish species in Bay-Delta waterways. The program is funded by water contractors through the Delta Fish Agreement. The BDCP would contribute directly to this existing program by expanding its size to improve enforcement against poaching of covered species.

The BDCP Implementation Office will enter into Memoranda of Agreement or similar binding instruments with DFG as described in Section 3.4.4, *Species Level Other Stressors Conservation Measures*.

Problem Statement

California has the lowest Game Warden to population ratio in the nation with fewer than 200 field wardens for the entire state. The Delta is a particular hot spot for poaching because of the large number of sport fish, particularly gravid female white sturgeon, whose roe are used for caviar (Lt. L. Schwall, pers. comm.). Illegal harvest is thought to have high impacts on sturgeon populations, particularly white sturgeon (Beamsderfer et al. 2007). Illegal harvest of juvenile and adult Chinook salmon and steelhead in the Delta and bays is also common (DBEEP 2007).

Hypothesized Benefits

It is hypothesized that enhanced enforcement on poaching will reduce mortality, and potentially increase population sizes, of green sturgeon (Beamesderfer et al. 2007, DFG unpublished, Boreman 1997, D. Tanner pers. comm., DFG 2007b, Appendix F, *DRERIP Evaluation Results*); white sturgeon (Bay-Delta Oversight Council 1995, Boreman 1997, Schaffter & Kohlhorst 1999, Beamesderfer et al. 2007, DFG 2007b, DFG 2008c, M. Gingras pers. comm., Z. Matica pers. comm., CDFG unpubl. data, Appendix F, *DRERIP Evaluation Results*); Chinook salmon (all races) (Bay-Delta Oversight Council 1995, Williams 2006); and steelhead (DFG 2007b, DFG 2007c, DFG 2008d, Moyle et al. 2008, Appendix F, *DRERIP Evaluation Results*). Spring-run Chinook salmon are hypothesized to experience the greatest benefit because they are more susceptible to poaching than other runs due to over-summer holding and ease of locating them (Appendix F, *DRERIP Evaluation Results*). Due to the recent establishment of daily bag limits for Sacramento splittail by the Fish and Game Commission, it is hypothesized that this conservation measure will also reduce mortality and potentially increase population size of splittail.

Magnitudes of population-level benefits of this measure are expected to vary inversely with the population size of each covered species (Bay-Delta Oversight Council 1995, Begon et al. 1996, Futuyma 1998, Moyle et al. 2008).

Adaptive Management Considerations

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. The Implementation Office will coordinate with DFG to adjust enforcement strategies and funding levels through the BDCP adaptive management process as appropriate based on review of DBEEP annual reports.

3.4.4.8 CM19 Conservation Hatcheries

The purpose of this conservation measure is to establish new and expand existing conservation propagation programs for delta and longfin smelt. The BDCP Implementation Office will support: (1) the development of a delta and longfin smelt conservation hatchery by the USFWS to house a delta smelt refugial population and provide a source of delta and longfin smelt for supplementation or reintroduction, if deemed necessary by Fishery Agencies; and (2) the expansion of the refugial population of delta smelt and establishment of a refugial population of longfin smelt at the University of California, Davis Fish Conservation and Culture Laboratory to serve as a population safeguard in case of a catastrophic event in the wild.

The new facility proposed by the USFWS will house genetically-managed refugial populations of delta and longfin smelt (Clarke 2008). Further, the facility will provide fish to supplement the wild population and provide fish stocks for reintroduction, as necessary and appropriate. State-of-the-art genetic management practices will be implemented to avoid hatchery-produced fish becoming genetically different from wild fish. The facility will be designed with the ability to add other species if necessary in the future. Due to space limitations, the facility as planned will consist of two sites: a science oriented genetic refuge and research facility on the edge of the Sacramento River, and a larger supplementation production facility nearby (B. Clarke pers. comm.) (Figure 3-62). Specific rules will be established to discontinue housing refugial populations of delta and longfin smelt at the hatchery if and when populations of these species are considered recovered by the Fishery Agencies.

In addition, the UC Davis Fish Conservation and Culture Laboratory (FCCL) is in need of additional space and funds to expand the refugial population of delta smelt and establish a refugial population of longfin smelt. The FCCL and the Genomic Variation Laboratory (GVL) at UC Davis are and will be, the primary entities developing and implementing genetic management of the delta smelt refugial population over the period 2009-2015 or longer and may then play a secondary role in keeping a back-up population(s).

At both facilities, genetic management practices will be implemented to maintain wild genetic diversity, minimize genetic adaptation to captivity, minimize mean kinship, and equalize family contributions. Furthermore, genetic monitoring of wild populations will proceed to minimize risks such as genetic swamping from the hatchery population, reduction in effective population size, and changes in the census population-to-breeder population ratio over time.

The BDCP Implementation Office will enter into binding Memoranda of Agreement or similar instruments with the USFWS and University of California, Davis similar to that described in Section 3.4.4, *Species Level Other Stressors Conservation Measures*. In addition, if and when populations of these species are considered recovered by the Fishery Agencies, the Implementation Office will terminate funding for the propagation of the species and either fund propagation of an additional BDCP covered fish species, if necessary and feasible, or deobligate funds to this conservation measure and reallocate them to augment funding other conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management process.

Problem Statement

Populations of both delta and longfin smelt have dramatically declined recently (IEP 2008a, b). Although a variety of stressors are suspected, there is not a clear understanding of why these populations have declined (IEP 2008a, b). There is evidence that delta smelt continue to decline and that very low population size could result in an Allee effect causing an even more rapid decline of the species (Mueller-Solger 2007). As a result, the risk of extinction of delta smelt is hypothesized to be increasing. Longfin smelt abundance has followed a similar trend to delta smelt (IEP 2008a, b).

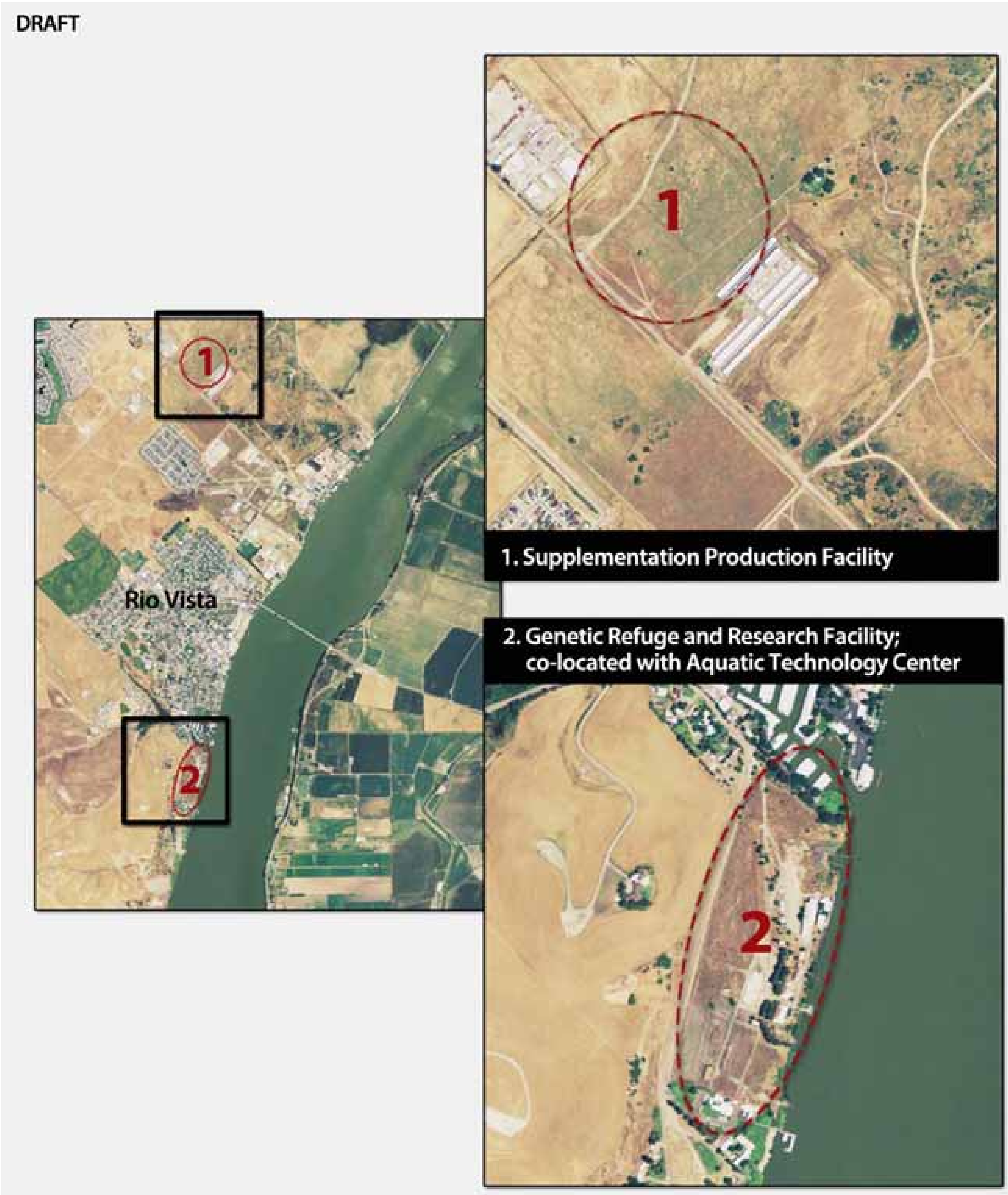

Figure 3-62. Potential USFWS Conservation Hatchery Facility Locations (CM19)

Hypothesized Benefits

Artificial propagation and maintenance of refugial populations of delta and longfin smelt are hypothesized to:

- Provide a safeguard against the possible extinction of delta and/or longfin smelt by maintaining a captive population that is genetically similar to the wild population (Lande 1988, Hedrick et al. 1995, Sveinsson & Hara 1995, Carolsfeld 1997, Sorensen 1998, USFWS 2003, Hedgecock et al. 2000, Kowalski et al. 2006, Turner et al. 2007, Nobriga 2008, Turner & Osborne 2008, B. Clarke, pers. comm., Appendix F, *DRERIP Evaluation Results*);
- Improve the knowledge base regarding threats to and management of delta and longfin smelt by increasing the ability to study the effects of various stressors on these species using hatchery-reared specimens (Appendix F, *DRERIP Evaluation Results*); and
- Contribute to increasing population sizes of delta smelt (Lande 1988, Deblois & Leggett 1991, Sveinsson & Hara 1995, Carolsfeld 1997, Sorensen 1998, USFWS 2003, Flagg et al. 2000, Richards et al. 2004, Kowalski et al. 2006, Purchase et al. 2007, Nobriga 2008, B. Clarke, pers. comm.) and longfin smelt (Sveinsson & Hara 1995, Carolsfeld 1997, Sorensen 1998, USFWS 2003, Flagg et al. 2000, Richards et al. 2004, Kowalski et al. 2006, Nobriga 2008) to self-sustaining levels in the wild when combined with effective habitat restoration and other measures to improve conditions in their natural environment.

Adaptive Management Considerations

Implementation of this conservation measure by the BDCP Implementation Office will be informed through effectiveness monitoring that will be conducted for this conservation measure as described in Section 3.6, *Monitoring and Research Program*, and the adaptive management process described in Section 3.7, *Adaptive Management Program*. Based on review of performance and effectiveness monitoring results in USFWS and UC Davis annual reports, the Implementation Office, in coordination with Fishery Agencies and UC Davis, will adjust funding levels, hatchery operations, or other related aspects that will improve the performance and/or biological effectiveness of the program through the BDCP adaptive management process as appropriate. Such changes will be effected through the BDCP adaptive management process and would be included in the subsequent annual work plans.

3.4.5 Avoidance and Minimization Measures

As required by Section 10 of the ESA, the BDCP includes avoidance and minimization measures that will be implemented by the BDCP Implementation Office to avoid and minimize adverse impacts of covered activities on the covered species. Careful design and implementation of covered activities will help avoid take of covered species, but specific avoidance and minimization measures may be required during implementation to fully meet this requirement. It is the responsibility of the Implementation Office to design and implement projects in compliance with these measures.

Biological surveys are an essential first step that will be used to assess the location, extent, and quality of suitable habitat or occurrences of covered species on BDCP project sites. Three levels of surveys, described in greater detail in the following sections, may be required for implementation of covered activities and conservation measures: planning surveys, preconstruction surveys, and construction-period monitoring.

- **Planning Surveys.** Planning surveys are used to identify the natural communities that are present in a BDCP project site, to determine whether suitable habitat for covered species is present, and to determine whether additional surveys are required to establish occupancy by covered species. Planning survey maps are used in assessing project effects on natural communities by identifying the extent of natural communities in BDCP project sites.
- **Preconstruction Surveys**. Preconstruction surveys are used to determine whether covered species are present in a BDCP project site, and whether species-specific avoidance and minimization measures must be implemented to ensure compliance with the HCP/NCCP. Agency-approved protocols are available for surveying some covered species; survey procedures for other species will be developed in cooperation with USFWS and DFG.
- **Construction Monitoring.** Construction monitoring ensures that necessary avoidance and minimization measures are implemented properly during construction activities.

3.4.5.1 General Avoidance and Minimization Measures

Avoidance and Minimization Measure (AMM) 1. Conduct planning surveys for covered wildlife and plant species. Planning surveys are reconnaissance level surveys that are intended to identify the habitats that are present in BDCP project sites, and what, if any, more intensive survey effort should be made to accurately determine the status of covered species and natural communities on the sites. Planning surveys are required for all covered activities and implementation of conservation measures. Results of planning surveys will inform project design and be used, if avoidance is not possible, to preserve the species and implement relevant conservation measures.

Planning surveys will use existing data on natural community and habitat distribution and covered species occurrences gathered during the development of the BDCP GIS mapping layers and covered species models (Appendix A, *Covered Species Accounts*) and other sources of information to assess the location, quantity, and quality of suitable habitat for covered wildlife and plant species on and near the project site. Results of planning surveys will be used to determine whether more intensive preconstruction and construction monitoring surveys are necessary. For example, if suitable habitat is not present for one of the covered species, the BDCP Implementation Office will not be required to conduct preconstruction surveys or construction monitoring for that species. For covered plant species, it is expected that follow-up floristic surveys (see AMM2) will be needed if the covered species are likely to be present on the project site but cannot be reliably identified to species at the time of the planning survey.

A survey report with the following information for the project site will be included with project application documents for covered activities and implementation of conservation measures:

- Description of the types of natural communities present in the project site, including the extent of each community;
- Description and map of locations of suitable habitat and/or habitat features for covered wildlife species;
- Description and map of potential habitat for covered plant species (e.g., vernal pools) based on soil type and land cover types;
- Map of all reported Covered Species occurrences;
- CNDDB California Native Species Field Survey Forms for all covered plants found on the site; and
- A description of the applicable avoidance and minimization measures required by the HCP/NCCP (e.g., preconstruction surveys).

Results of the planning survey will provide permit applicants with the information necessary to comply with the HCP/NCCP. Applicable avoidance and minimization measures described in this section must be incorporated into the project design and submitted with the application package. The BDCP Implementation Office will review and approve all planning survey reports before approving coverage under the HCP/NCCP. The Implementation Office will enter all relevant information in the survey reports into a database and use these data to monitor plan compliance.

*AMM2: Conduct preconstruction surveys for covered wildlife and plant species***.** If planning surveys for covered species identify suitable habitat and specific habitat elements (e.g. nest sites) described in the species habitat models (Appendix A, *Covered Species Accounts*), and if impacts cannot be avoided by modifying project design or project implementation, preconstruction surveys will be conducted. Preconstruction surveys are intended to determine the presence, status and likely impacts to covered species on the site. Results are used to identify or refine the site-specific measures required to avoid and minimize take. Permit applicants will be responsible for contracting with qualified biologists to conduct preconstruction surveys.

In general, preconstruction surveys will be conducted not less than 30 days or more than 6 months prior to commencement of construction activities on specific proposed construction sites, with the exception that preconstruction surveys may be completed up to one year in advance of construction if the sole period for reliable detection of a covered species is between May 1 and December 31. Detailed survey requirements are available for some covered species in existing

USFWS survey protocols, which will be used for the species listed in Table 3-16 (survey protocols are presented in Appendix I). It is expected that USFWS and DFG will refine these survey protocols and develop new protocols for other listed species in the future. In this case, the latest protocols and guidance from agencies will be followed.

Table 3-16. USFWS Preconstruction Survey Protocols

Covered Species	*Survey Protocol*
San Joaquin kit fox	USFWS San Joaquin Kit Fox Survey Protocol for the Northern Range (1999)
Riparian woodrat	USFWS Draft Habitat Assessment Guidelines and Survey Protocol for the Riparian Brush Rabbit and the Riparian Woodrat
Riparian brush rabbit	USFWS Draft Habitat Assessment. Guidelines and Survey Protocol for the Riparian Brush Rabbit and the Riparian Woodrat
California red-legged frog	USFWS Guidance on Site Assessments and Field Surveys for the California Red-legged Frog (2005)
California tiger salamander	USFWS Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander (2003)
Valley elderberry longhorn beetle	Document shrub and habitat conditions according to USFWS conservation guidelines

The BDCP Implementation Office will coordinate with USFWS and DFG to develop preconstruction survey protocols for the remaining covered wildlife and plant species. Components of preconstruction survey protocols for selected wildlife species are presented in Table 3-17.

Table 3-17. Preconstruction Survey Protocol Elements for Selected Wildlife Species

Covered Species	*Survey Protocol Element*
Salt marsh harvest mouse	Identify suitable habitat within 0.25 miles of the project footprint limits. Conduct preconstruction surveys of suitable habitat using USFWS and DFG approved survey protocols.
Townsend's big-eared bat	Identify suitable roost sites within 0.25 miles of the project footprint limits. Conduct preconstruction surveys of hibernation roosts and nursery roosts using USFWS and DFG approved survey protocols.
Suisun shrew	Identify suitable habitat within 0.25 miles of the project footprint limits for projects in the Suisun Marsh ROA and West Delta ROA. Conduct preconstruction surveys of suitable habitat using USFWS and DFG approved survey protocols.
Tricolored blackbird	Conduct preconstruction surveys in breeding habitat within 0.25 miles of BDCP project footprint limits (covered activities and habitat restoration projects). Preconstruction surveys will be conducted during the breeding season (approximately early April through late-August) prior to project activity, and during the construction year.
Suisun song sparrow, yellow-breasted chat, least Bell's vireo, and western yellow-billed cuckoo	Conduct preconstruction surveys of potentially-occupied breeding habitat within 0.25 miles from the project footprint limit (covered activities and habitat restoration projects). Preconstruction surveys will be conducted during the breeding season prior to project activity, and during the construction year.
Western burrowing owl	Conduct preconstruction surveys of breeding and wintering habitat within __ feet of the BDCP project footprint limit (covered activities and habitat restoration projects). Preconstruction surveys will be conducted during the breeding season (approximately March through August) or wintering season (approximately September through February) prior to project activity, and during the construction year.

Table 3-17. Preconstruction Survey Protocol Elements for Selected Wildlife Species (continued)

Covered Species	*Survey Protocol Element*
Greater sandhill crane	Conduct preconstruction surveys within the identified greater sandhill crane winter use area to determine the presence of occupied winter roost sites within 0.5 miles of the project footprint limits during late-October/early-November of each construction year.
California black rail California clapper rail	Identify suitable habitat within 0.25 miles of the project footprint limits. Conduct preconstruction surveys of suitable habitat using USFWS and DFG approved survey protocols.
White-tailed kite	Conduct preconstruction surveys of potentially-occupied breeding habitat within 0.25 miles from the project footprint limits and within 0.25 miles of planned restoration sites to locate active white-tailed kite nest sites. Preconstruction surveys will be conducted early (March-April) during the breeding season (March 1 to September 1), prior to project activity, and during the planned construction year.
Swainson's hawk	Conduct preconstruction surveys of potentially-occupied breeding habitat within 0.5 miles from the project footprint limits (covered activities and habitat restoration projects) to locate active Swainson's hawk nest sites. Preconstruction surveys will be conducted early (March 15 to April 20) during the breeding season (March 15 to September 1), prior to project activity, and during the planned construction year.
Giant garter snake	Identify suitable aquatic habitat (wetlands, ditches, canals) within project footprint limits. Conduct preconstruction surveys during active period (May 1 to September 30) of suitable habitat and 200 feet into adjacent uplands using USFWS and DFG approved survey protocols.
Western pond turtle	Identify suitable aquatic habitat and upland nesting and overwintering habitat within 0.25 miles of the project footprint limits. Conduct preconstruction surveys of suitable aquatic habitat using USFWS and DFG approved survey protocols.
Western spadefoot toad	Identify suitable aquatic habitat (vernal pools, ponds, pools along intermittent streams) for spadefoot toad within 0.25 miles of the project footprint limits. Conduct preconstruction surveys of suitable aquatic habitat during the breeding season (January to May) using USFWS and DFG approved survey protocols.

Additional survey requirements will apply to vernal pool habitats and associated plant and animal species. Surveys will be scheduled as specified in USFWS and DFG guidelines to ensure that vernal pool habitat is present. Vernal pools in BDCP project sites will be described, mapped and characterized in terms of duration, depth of ponding, and source of hydrology. Descriptive information for the site will include topography, drainage patterns and the extent of vegetative cover. Assessments should be made in consideration of "normal or average" conditions, if possible. Wildlife surveys following protocols listed in Tables 3-16 and 3-17 will include giant garter snake, western pond turtle, California red-legged frog, California tiger salamander and western spadefoot toad. The fairy shrimp and tadpole shrimp species surveys will follow USFWS-approved guidelines (USFWS Interim Survey guidelines to Permittees for Recovery Permits under Section 10(a)(1)(A) of the Endangered Species Act for the Listed Vernal Pool Branchiopods (1996)). Vernal pool plant species will be inventoried by floristic surveys following DFG Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities (2009) and USFWS Guidelines for Conducting and

Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Plants (1996). In addition to requirements listed below for survey reports, vernal pool survey reports will include estimates of the size and acreage of direct and indirect impacts (as defined by seasonal inundation and other hydrology indicators, and the presence of hydric soils) on species that occur in the pool/pool complex.

Preconstruction surveys of other covered plant species will be conducted in suitable natural communities, using general habitat distribution models for these species (Appendix A, *Covered Species Accounts*). Surveys will be conducted during the appropriate season for identification of these species (i.e. floristic surveys). If covered plants or populations are found, the location, extent, and condition of all occurrences will be documented in the survey report. Any new records of sensitive plant species will be submitted to the CNDDB.

The BDCP Implementation Office will prepare a report with results of the preconstruction surveys and recommended minimization measures, and submit it to t the USFWS and DFG. The survey report will include the following elements:

- Survey dates, methods, timing and intensity;
- Map of survey area showing proposed BDCP project footprint and locations of covered wildlife and plant species occurrences;
- Description of status of wildlife species in occupied sites, (e.g. breeding);
- Description of special habitat features used by covered species (e.g. nest trees, caves, buildings);
- CNDDB field survey forms and maps for all covered animals and plants encountered on the site;
- A description of the applicable avoidance and minimization measures required by the HCP/NCCP and incorporated into project design or project implementation (e.g., construction timing, buffer width, buffer location); and
- Occurrences of covered species and other listed species will be documented in CNDDB forms.

*AMM3: Conduct Construction Monitoring***.** Construction-period monitoring by qualified biologists focuses on the covered natural communities and species identified during planning and preconstruction surveys, and is intended to ensure proper implementation of specific avoidance and minimization measures that have been integrated into the project design and permit requirements. Construction monitoring is the responsibility of the BDCP Implementation Office.

Before implementing an approved project, the BDCP Implementation Office will prepare a construction monitoring plan. The construction monitoring plan will include the following elements:

- Summaries or copies of planning and preconstruction surveys (if applicable) for covered natural communities and species;
- Description of avoidance and minimization measures to be implemented, including a description of project-specific measures or additional measures not included in the HCP/NCCP;
- Descriptions of monitoring activities, including the specific activities to be monitored (e.g. grading activities), monitoring frequency and duration; and
- Description of the onsite authority of the monitoring biologist to modify construction activity and protocols for consultation with DFG and USFWS, if needed.

*AMM4: Implement construction best management practices***.** Construction activities have the potential to affect covered species by removing natural habitat (i.e. vegetation), disturbing soils, and transporting sediments and pollutants, creating visual and noise disturbance, and introducing invasive and exotic species. In order to avoid and minimize these impacts, best management practices (BMPs) will be used to minimize new disturbances during construction and monitoring. These measures generally apply to all covered natural communities. BMPs include, but are not limited to:

- Construction activities will be staged to avoid, as much as possible, the sensitive time period for covered species that have been determined, through preconstruction surveys, to occur on the site. The sensitive time periods are defined in avoidance and minimization measures for each species in Section 3.4.5.3, *Species-Specific Avoidance and Minimization Measures*.
- Disturbance to existing grades and vegetation will be limited to the project site and necessary access routes. Placement of roads, staging areas, and other facilities will avoid and limit disturbance to stream bank or stream channel habitat as much as possible. When possible, existing egress points will be used and/or work will be performed from the top of stream banks. Upon completion, the contours of stream channels will be restored to pre-construction or better.
- Construction by-products and pollutants such as petroleum products, chemicals, cement, or other harmful materials will not be discharged into aquatic habitats, and will be collected and transported to an authorized disposal area.
- A plan for the emergency clean up of any spills of fuel or other material will be prepared and implemented, as needed.
- Water contained mud or silt from construction activities will be treated by filtration or retention in a settling pond to prevent turbid water from entering live streams.
- Equipment will be refueled and serviced at designated construction staging areas away from aquatic habitats. All construction material and fill will be stored and contained in a designated area that is located away from aquatic habitats. A silt fence will be installed to collect any discharge, and adequate materials for spill cleanup will be maintained on site.

- Construction vehicles and equipment will be maintained to prevent contamination of soil or water from external contaminants (i.e. grease and oil) or from leaking hydraulic, fluid, fuel, oil, and grease.
- Building material storage areas containing hazardous or potentially toxic materials will have an impermeable membrane between the ground and the hazardous materials and will be bermed to prevent the discharge of pollutants to ground water and storm water runoff.
- Project proponents will implement environmentally sound practices, utilize safer alternative products such as biodegradable hydraulic fluids, where feasible, and conduct employee training programs. Employee training will emphasize prevention and reduction of pollutant discharge from construction activities to aquatic habitats, and the appropriate measures to take should a spill occur.
- In-channel work will take place only in dry channels.
- If a work site is to be temporarily de-watered or filled, the de-watering and other required maintenance will be conducted during time frames specified for covered species (i.e. giant garter snake, California red-legged frog, California tiger salamander), see AMMs 20, 21, 22.

*AMM5: Establish setbacks and buffer zones***.** To the extent practicable, buffer zones dominated by native vegetation will be established between construction activities and covered natural communities, and nest, den or roost sites or covered species. Required buffers proposed by this measure are designed to maintain existing habitat value for covered species, reduce disturbance of species that use habitats protected by buffers, and provide wildlife movement corridors. With regard to streams and wetlands, buffer widths must be compatible with standards and requirements of existing regulatory programs, including the Clean Water Act and State regulations. Avoidance and minimization measures specific to buffers for covered riparian and aquatic communities include the following:

- Establish construction buffers for streams, measured horizontally from the top of the bank and extending the entire length of perennial, intermittent, and ephemeral streams (or linear wetland) within the boundaries of the project site.
- Stream buffer widths will be a function of stream order (e.g. first order), duration of flow, and location (i.e., agricultural, natural, or urban locations). Buffers will be determined in consultation with permitting agencies, and may be reduced with the concurrence of the permitting agencies if the reduction will not result in an adverse impact to the covered species or reduction in the biological values of the riparian or aquatic habitat. No setbacks are required on irrigation ditches, underground stream reaches, or on drainages and swales that lack a defined bed and bank or evidence of scour or sediment transport. The buffer must be marked throughout construction with stakes, fencing or other materials that will be visible to construction workers.

- Require appropriate erosion control measures (e.g. hay bales, filter fences, vegetative buffer strips or other equivalents) to reduce siltation and contaminated runoff from project sites. Brush, loose soils, or other debris materials will not be stockpiled within stream channels or on adjacent banks.
- Silt fencing or other sediment trapping method will be installed downgradient from construction activities to minimize the transport of sediment off site.
- Temporary stream diversions, if required, will use sand bags or other approved methods that minimize instream impacts and effects on wildlife.
- Limit removal of native vegetation as much as possible.
- Locate roadways and other facilities perpendicular to waterways wherever practical to reduce the total riparian area disturbed.
- Locate bridge and road footings outside of high water zones and riparian habitats where practical.
- Construction monitoring will be conducted throughout the construction period to ensure that buffers, BMPs, and other restrictions are implemented properly.

3.4.5.2 Avoidance and Minimization Measures for Covered Natural Communities

*AMM6: Avoid and minimize impacts on vernal pool complex and alkali seasonal wetland complex***.** Natural community goals and objectives of the BDCP Conservation Strategy include the protection of vernal pool complex and alkali seasonal wetland complex and managed wetlands in and adjacent to the Plan Area that support habitat for associated native species. BDCP projects should avoid and minimize the fill of seasonal wetlands, vernal pools, and associated uplands, in particular the high value sites identified through implementation of Conservation Measure CM3 *Natural Communities Protection*. If planning surveys indicate that these communities are present in areas where fill is proposed, areas specified for avoidance will be protected with vegetated buffers that protect the wetland community and provide habitat for covered species and other native species. General buffer criteria are outlined in AMM5. Additional avoidance and minimization measures specific to vernal pool, vernal swale, alkali meadow, and alkali sink habitats, including their watersheds, and managed wetlands are as follows:

- Establish buffers measured horizontally from the edge of hydrophytic vegetation associated with the vernal pool;
- Vegetated buffers will consist of valley floor grassland and/or other natural vegetation communities (i.e, oak savanna/woodland, coastal marsh or riparian habitats);
- Buffer width will be sufficient to prevent significant adverse changes in water quality due to adjacent upland sources, or the inflow of water that could change the timing and duration of inundation of the wetland;

- Buffer width must be adequate to provide upland habitat for pollinators, amphibian species and terrestrial species;
- Buffer width must be adequate to provide connectivity between individual aggregations of vernal pools within a larger complex; and
- Buffer width must be adequate to protect the wetland and associated upland habitat from edge effects associated with surrounding land uses.

Buffer widths of 500 feet or greater will be presumed to meet these criteria. If avoidance is not practicable, the BDCP Implementation Office will provide documentation to USFWS and DFG explaining why avoidance is not practicable and/or would not contribute to the conservation goals and objectives of the BDCP. Smaller proposed buffer distances must be supported by assessments of the project's compliance with water quality/quantity criteria and assessments of habitat-related criteria.

*AMM7: Avoid and minimize impacts on riparian communities***.** Natural community goals and objectives of the BDCP Conservation Strategy include increasing the extent and spatial distribution of riparian forest and scrub within the Planning Area to support habitat and food production for associated native species and increase connectivity among native habitats within and adjacent to the Plan Area. If planning surveys indicate that riparian communities are present in areas affected by BDCP projects, areas specified for enhancement, restoration or other actions under BDCP conservation measures will be protected by avoidance or minimization measures. General avoidance and minimization measures for riparian communities include establishing buffer zones (AMM5), construction period best management practices (AMM4), and construction period monitoring (AMM3). Additional avoidance and minimization measures specific to riparian communities include the following:

- Design project elements including roadways and other facilities perpendicular, rather than parallel to riparian zones and waterways whenever possible; and
- Locate bridge and road footings outside of high water zones and riparian habitats.

Except as noted below for covered wildlife species that inhabit riparian communities, riparian buffer widths will extend at a minimum to the outer dripline of riparian vegetation.

*AMM8: Implement Construction Best Management Practices for Fish Species***.** Construction of the proposed intake facilities in the North Delta have the potential to affect fish species, including covered species, by creating noise levels above ambient conditions during construction activities such as mobilization and demobilization of equipment, development of staging/storage areas and construction zones, creation of temporary detour roads, earthwork, deep excavation, shoring and bracing, levee construction, slurry cut-off walls, and coffer-damming, trenching, and other construction activities. In addition to increased noise, fish species could be affected by increased suspended sediments from pile installation, levee breaching, and dredging by decreasing visibility for foraging activities or impairing oxygen exchange due to clogged gills

(USEPA 1993). Moreover, the greatest effects from suspended sediments are to fish eggs, larvae, and juveniles (USACE 1992).

Best management practices (BMPs) will be used to avoid and minimize these impacts during construction. Although most fishes would likely move out of disturbed areas during construction and could return after these activities are completed, a number of protection measures would be used to further reduce affects to fish species, including:

- Preparing, maintaining, and implementing a Stormwater Pollution Prevention Plan (SWPPP) that contains all of the BMPs that would apply to all aspects of project construction.
- Placing and maintaining silt fences, coir logs, straw bale dikes, silt fences, and other siltation barriers so that silt or other deleterious materials does not enter the river.
- Settling, filtering, or otherwise treating construction-related water before discharge to minimize turbidity and siltation.
- Preventing raw cement and concrete, concrete wash water, bentonite, petroleum products, or other products that could be hazardous to aquatic life from contaminating soils, and/or entering streams, sloughs, or the river.
- Setting work windows during which the most sensitive lifestages of covered fish species are not generally found in the vicinity of the construction area.
- Dredging in front of the intake structure should be performed during a low river flow period, if possible, and a temporary silt screen should be provided to minimize suspended sediment movement into the river. This should coincide with the work windows set in the previous bullet.
- Vegetate or otherwise protect all disturbed surfaces to prevent erosion.

3.4.5.3 Species-Specific Avoidance and Minimization Measures

This section provides descriptions of avoidance and minimization measures for specific covered species. Several covered species are designated as fully protected by the California Fish and Game Code (§3511 and §4700), as DFG cannot issue permits for take of these species. Fully protected species in the Plan Area are: salt marsh harvest mouse, greater sandhill crane, California black rail, California clapper rail, and white-tailed kite.

Many of the avoidance and minimization measures described in this section are designed to provide opportunities for individual wildlife to avoid or escape construction areas.

AMM9: Avoid and minimize impacts on and mortality of San Joaquin kit fox. The BDCP Implementation Office will implement the 1999 USFWS Standardized Recommendations for Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance (see Appendix I) to avoid and minimize impacts on occupied kit fox sites. If preconstruction surveys (AMM2) identify a kit fox den in the proposed development footprint of a BDCP project site, the den will be monitored for 3 days by an agency-approved biologist using a tracking medium or an infrared beam camera to determine if the den is currently being used. Unoccupied dens should be destroyed to prevent subsequent use. If kit fox activity is observed at a den during the initial monitoring period, the den will be monitored for an additional 5 consecutive days from the time of the first observation. If an active natal or pupping den is found, USFWS and DFG will be notified immediately. The den will be excavated after the pups and adults have vacated and then only after further consultation with USFWS and DFG. For dens other than natal or pupping dens, use of the den can be discouraged by partially plugging the entrance with soil such that any resident animals can easily escape. Once the den is determined to be unoccupied it may be excavated under the direction of the biologist. Alternatively, if the animal is still present after 5 or more consecutive days of plugging and monitoring, the den may have to be excavated when, in the opinion of the biologist, it is temporary vacant (i.e. during the animal's normal foraging activities.).

If dens are identified outside the proposed disturbance footprint of a BDCP project site, exclusion zones around each den entrance or cluster of entrances will be demarcated. No construction-related activities will be allowed within the exclusion zone. Exclusion zone radius for potential or atypical kit fox dens will be at least 50 feet and 250 feet for all known occupied dens. The exclusion zone will be marked with flagged stakes.

*AMM10: Avoid and minimize impacts on and mortality of riparian woodrat and riparian brush rabbit***.** If preconstruction protocol surveys (AMM2) identify occupied riparian woodrat or riparian brush rabbit habitat along BDCP project construction corridors, avoid mortality by 1) reducing the corridor width to avoid occupied habitat, 2) if feasible, consider tunneling beneath the occupied riparian corridor, and 3) if appropriate, coordinate with the USFWS and DFG to develop a trapping and relocation program. All trapped animals will be relocated to approved sites prior to construction activities. If occupied habitat is present within proposed habitat restoration sites, avoid mortality and minimize impacts on individuals by 1) selecting alternative unoccupied restoration sites; or 2) designing the habitat restoration to avoid direct impacts on individuals, minimize impacts on habitat, and include riparian woodrat and riparian brush rabbit habitat in the restoration project design.

Implementation of avoidance and minimization measures for riparian habitat (see AMM7) will be considered sufficient to avoid take of these species in unoccupied potential habitat. Limited take of up to 3 acres of potential habitat (i.e. habitat conversion) for these species may occur under the HCP/NCCP for covered projects under the following conditions: 1) no individuals are encountered in preconstruction surveys, 2) the impact is less than 0.25 acres of habitat on a per-project basis, and 3) actions result in no harm, injury, or harassment of individuals.

*AMM11: Avoid and minimize impacts on Townsend's Big-eared Bat***.** If initial planning surveys, CNDDB search and habitat models (Appendix A, *Covered Species Accounts*) indicate suitable breeding or roosting sites for Townsend's big-eared bat are present on BDCP project sites, an agency-approved wildlife biologist will conduct preconstruction surveys to determine if they are occupied by the species. If the site is occupied, the BDCP permit applicant will avoid impacts to the extent practicable by relocating impacts at least 500 feet away from the occupied breeding or roosting site, and postponing construction activities that could disturb active roost sites while sites are occupied. Construction is allowed either prior to or after the hibernation season (November to March) for hibernation sites and prior to or after the breeding season (April to August 15) for nursery colonies. Avoidance and minimization measures will be incorporated into the project design.

If the project design cannot fully avoid impacts to roost sites, sealing the sites while they are unoccupied will allow bats to reestablish elsewhere. In this case, monitoring surveys will be conducted immediately prior to construction to determine if the sites are occupied or whether they show signs of recent previous occupation. If bats are discovered or if evidence of recent prior occupation is established in these surveys, construction will be scheduled such that it minimizes impacts on the bats. Unoccupied hibernation sites with evidence of prior occupation will be sealed before the hibernation season, and nursery sites will be sealed before the breeding season.

*AMM12: Avoid mortality of salt marsh harvest mouse***.** The salt marsh harvest mouse is a fully protected species under the California Fish and Game Code and direct mortality must be avoided. All construction activities will be done between May 1 and October 15, and locations of activities, such as levee breaches, will be sited to avoid potential salt marsh harvest mouse habitat. Salt marsh harvest mouse surveys using approved protocols will be conducted at the breach locations prior to excavation according the protocol specified by the USFWS. Surveys will be conducted for 7 consecutive days. If salt marsh harvest mouse is present at specific breach locations the captured animals will be relocated to a suitable alternate location on the property and surveys will continue until no mice are captured for 5 consecutive days. Vegetation will then be hand-removed, followed by another trapping sequence. To avoid the loss of individual salt marsh harvest mice from construction activities in suitable habitat, vegetation removal will be limited to the minimum extent necessary to permit the construction activity to occur. A sufficient extent of habitat, as determined by a DFG and USFWS approved biologist, will be allowed to remain adjacent to the construction area to provide refugia for displaced salt marsh harvest mice. Construction can commence after salt marsh harvest mice are not detected for 5 consecutive days following vegetation removal. If salt marsh harvest mice are not present, vegetation will be removed (by hand) from breach locations immediately following surveys. A qualified (with necessary permits from USFWS) biologist will walk in front of the excavator as it moves down the levee towards the breach location to flush any salt marsh harvest mice that may be in the vegetation on the levee crown and shoulders. No pets will be allowed on the work site and all persons will stay within the boundaries of the work site, which is the top of the levees and the water side levee slopes.

*AMM13: Avoid and minimize impacts on and mortality of Suisun shrew***.** Conduct preconstruction surveys to identify occupied habitat for the Suisun shrew within the area that could be impacted by BDCP actions in the Suisun Marsh Restoration Opportunity Area and potentially occupied habitats in the West Delta Restoration Opportunity Area. If Suisun shrews are present on project sites, avoid mortality and minimize impacts on individuals by 1) designing the habitat restoration to avoid the potential for mortality or 2) remove Suisun shrews from locations that could be affected by habitat restoration activities using DFG-approved methods and relocating them to DFG-approved sites. Direct mortality will be avoided by establishing a 200 foot buffer adjacent to suitable tidal marsh habitats, in which no construction activity or disturbance is permitted.

*AMM14: Avoid and minimize impacts on tricolored blackbird***.** Conduct preconstruction surveys within known or suitable nesting habitat no more than 30 days prior to scheduled construction to identify active tricolored blackbird colonies within a BDCP project site. Avoid mortality and minimize impacts by creating a 500-foot no-disturbance buffer around each active colony and allow no entry of any kind into the buffer while the colony site is occupied during the breeding season (approximately mid-March through mid-August). Entry into the buffer may be granted if a qualified biologist, with concurrence from USFWS and DFG, determines through monitoring surveys that healthy young have fledged and nest sites are no longer active, or nesting birds do not exhibit significant adverse reaction to construction activities.

AMM15: Avoid and minimize impacts on Suisun song sparrow and California least tern. Conduct preconstruction surveys of potential breeding habitat for the Suisun song sparrow and California least tern within 0.25 miles from the project footprint limit of habitat restoration projects in the Suisun Marsh Restoration Opportunity Area and potentially occupied habitats in the West Delta Restoration Opportunity Area. Preconstruction surveys will be conducted during the breeding season prior to project activity. If an active Suisun song sparrow nest is present, avoid mortality and minimize impacts by creating a minimum 500-foot no-disturbance buffer around the nest site and allow no entry of any kind into the buffer while the site is occupied during the breeding season (approximately early April through late August). Entry into the buffer may be granted if a qualified biologist, with concurrence from USFWS and DFG, determines through monitoring surveys that healthy young have fledged and nest sites are no longer active, or nesting birds do not exhibit significant adverse reaction to construction activities.

*AMM16: Avoid and minimize impacts on yellow-breasted chat, least Bell's vireo, and western yellow-billed cuckoo***.** Conduct preconstruction surveys of potential breeding habitat for the yellow-breasted chat, least Bell's vireo, and western yellow-billed cuckoo within 0.25 miles from the project footprint limit of habitat restoration. Preconstruction surveys will be conducted during the breeding season prior to project activity. If an active yellow-breasted chat nest site is present, avoid mortality and minimize impacts by creating a 1,300-foot no-disturbance buffer around the nest site and allow no entry of any kind into the buffer while the site is occupied during the breeding season (approximately early April through late-August). Entry into the buffer may be granted if a qualified biologist, with concurrence from USFWS and DFG, determines that healthy young have fledged and nest sites are no longer active, or nesting birds do not exhibit significant adverse reaction to construction activities.

*AMM17: Avoid and minimize impacts on nesting and wintering burrowing owls***.** If preconstruction surveys identify occupied breeding burrows within a BDCP project site, establish a 250-foot no-disturbance buffer around each occupied breeding burrow and allow no entry of any kind into the buffer while the site is occupied during the breeding season (approximately February 1 through August 31). The buffer may be reduced through consultation with a qualified biologist and with concurrence from USFWS and DFG based on line-of-sight, topography, land uses, type of disturbance, and other relevant factors. Entry into the buffer is granted when a qualified biologist, with concurrence from USFWS and DFG, determines that healthy young have fledged, are capable of independent survival, and nest sites are no longer active.

Avoid disturbance to winter burrows by creating a 160-foot no-disturbance buffer around each occupied wintering burrow and allow no entry of any kind into the buffer while the site is occupied during the winter season (approximately September 1 through January 31). The buffer can be reduced through consultation with a qualified biologist and with concurrence from USFWS and DFG based on line-of-sight, topography, land uses, type of disturbance, monitoring of the site to evaluate reaction to disturbances, and other issues. If direct impacts to active winter burrows cannot be avoided and the site is also used for breeding, implement standard DFG guidelines for passive relocation by installing one-way doors on active winter burrows (see Appendix I).

*AMM18: Avoid and minimize impacts on and avoid mortality of greater sandhill cranes***.** The greater sandhill crane is fully protected under the California Fish and Game Code and direct mortality must be avoided. If preconstruction surveys determine that a greater sandhill crane roost site is located within or adjacent to a BDCP project site, a 0.5 mile no-disturbance buffer will be established around each identified roost area. Construction and other work activity in the buffer will be restricted based on crane use patterns of the roost while the site is occupied during the winter season (approximately October 1 through February 28). During the roosting season, construction equipment greater than 50 feet in height will avoid locations that could lead to strikes by greater sandhill crane. When locating permanent facilities that could pose a bird strike hazard for greater sandhill crane, specific site locations will be chosen that minimize bird strike hazard to greater sandhill crane. Bird strike risk to greater sandhill crane will be considered when locating transmission, sub-transmission, and distribution power lines and conductor and ground lines will be fitted with flight diverters in compliance with the best available practices such as those specified in the USFWS Avian Protection Guidelines.

*AMM19: Avoid and minimize impacts on and avoid mortality of California black rail and California clapper rail***.** The California black rail and the California clapper rail are fully protected species under the California Fish and Game Code and direct mortality must be avoided. In areas with habitat for California black rail or the California clapper rail, as determined by planning surveys, work will be conducted outside of the breeding season during the period from September 1 to January 31, and no buffers will be required. To avoid the loss of individual rails, construction or other work activities within or adjacent to rail habitat will not be allowed in the time period within two hours before or two hours after local mean higher high tide to allow fleeing rails to reach cover. This restriction may be modified in consultation with DFG and USFWS if mean higher high tides during work periods are not sufficient to increase the likelihood for affecting individual birds. Activities conducted during the breeding season will implement the specific avoidance and minimization measures. If preconstruction surveys, using agency accepted protocols, determine that California black rail or California clapper rail are nesting within or adjacent to BDCP project sites, a 500-foot buffer will be established within which no activities will be allowed that could disturb the nesting pair or their young. The size of the no-disturbance buffer zone may be reduced if a qualified biologist determines, in consultation with DFG and USFWS, that the birds would be unaffected by project-related activities. An example in which a buffer distance would be reduced is in instances in which a major slough channel or other substantial physical barrier exists between the rail nest site and the activity. Buffers will be maintained until the young have fledged and are capable of flight (typically prior to September 15).

*AMM20: Avoid and minimize impacts on white-tailed kite and Swainson's hawk and avoid mortality of white-tailed kites***.** The white-tailed kite is a fully protected species under the California Fish and Game Code and direct mortality must be avoided. Preconstruction surveys will be conducted for active raptor nest sites (i.e. trees) within and adjacent to (within 0.5 miles) BDCP project sites. For construction scheduled during the breeding season of white-tailed kite and Swainson's hawk (March 15-September 15), surveys will take place no more than 30 days prior to the start of construction. A 1,000-foot radius no-disturbance buffer will be established around each active white-tailed kite nest site and at 0.25 mile radius around each Swainson's hawk nest site. No entry of any kind related to the BDCP construction activity will be allowed in the buffer while a nest site is occupied by white-tailed kite or Swainson's hawk during the breeding season. The buffer size may be reduced on the determination of a qualified biologist and with concurrence from USFWS and DFG based on line-of-sight, topography, land use, type of disturbance, existing ambient noise and disturbance levels, and other relevant factors. Entry into the buffer will be granted when a qualified biologist, with concurrence from USFWS and DFG, determines that the young have fledged and are capable of independent survival and the nest site is no longer active. If nest tree removal is necessary, tree removal will occur only during the non-breeding season (September through February).

*AMM21: Avoid and minimize impacts on giant garter snake***.** To the extent practicable, implement BDCP project site-specific measures approved by USFWS and DFG to avoid and minimize impacts on giant garter snake, as follows: Limit habitat disturbance to the period May 1 to September 30 (the active period for snakes) to minimize direct mortality, and dewater irrigation ditches, canals or other aquatic habitat, if needed, between April 15 and September 30. Dewatered areas must remain dry for at least 15 consecutive days prior to excavation or filling the habitat. If a site cannot be completely dewatered, netting and salvage of prey items may be necessary to discourage use by giant garter snakes.

Impacts to giant garter snakes may be minimized by the following measures: (1) From October to April, construction should be limited to in-channel work below OHWM and channel banks should not be disturbed. (2) During the dormant period, dredged or excavated material should be hauled off-site to discourage use by overwintering snakes. (3) Clearing of vegetation in aquatic habitats and channel banks should be limited to the minimum necessary to facilitate construction. (4) Movement of heavy equipment should be confined to existing roads and tops of channel banks. (5) No erosion control material containing nylon mesh or monofilament may be used within 200 feet of suitable giant garter snake aquatic habitat.

AMM22: Avoid and minimize impacts to western pond turtle and California red-legged frog. Conduct preconstruction USFWS and DFG-approved surveys to determine if suitable aquatic habitat is present for California red-legged frog and western pond turtle within one mile of BDCP project sites. The survey period for red-legged frogs extends from January to September, and surveys should be conducted two weeks prior to the beginning of construction activities during this period. The survey period for western pond turtle will be determined in consultation with the agencies. Guidelines for sampling habitats and site occupancy of western pond turtles are in preparation (Bury 2009, pers. comm.), and may be implemented with agency approval.

If occupied sites consist of isolated pools or ponds, avoid disturbance to these sites within or near the project footprint to the extent feasible and minimize the loss of occupied and potentially occupied aquatic habitat and grassland vegetation through adjustments in project design, as practicable. If occupied sites are along streams or other channels, install temporary aquatic barriers and relocate and exclude animals from the work area. A 500 foot buffer will be established on both sides of creeks and wetlands occupied by red-legged frogs or western pond turtles, and entry will be restricted during the construction period. Buffers may be reduced if a qualified biologist determines, in consultation with DFG and USFWS, that 1) the reduction would not affect habitat (e.g., a stream crossing project is directionally bored under the occupied habitat), or 2) the reduction will not result in an adverse impact to the species or reduction in the biological values of the habitat.

Direct mortality for California red-legged frogs and western pond turtles in irrigation ditches and canals can be minimized by implementing de-watering measures described for giant garter snake (AMM20), screening water intakes, and removing predators such as crayfish, bullfrogs and warm-water fish from aquatic habitats in the project site. Construction activities should avoid creation of perennial ponds in occupied sites that could result in the expansion of predator populations. Permit applicants will coordinate with the USFWS and DFG to develop a trapping and relocation program and to develop appropriate seasonal restrictions to minimize mortality. Individuals found within the construction footprint will be captured and relocated to designated relocation habitat approved by USFWS and DFG.

*AMM23: Avoid and minimize impacts on western spadefoot toad and California tiger salamander***.** Conduct preconstruction USFWS approved surveys to determine if California tiger salamanders or western spadefoot toads are present in suitable aquatic and upland habitat within

1.24 miles of BDCP project sites. Aquatic larval sampling for California tiger salamanders is conducted in March, April, and May; upland sampling of adults is conducted from October through March. The survey period for western spadefoot toads will be determined in consultation with the agencies.

Avoid disturbance to occupied sites within or near the project footprint to the extent feasible and minimize the loss of occupied and potentially occupied seasonal pool and grassland vegetation through adjustments in project design, as practicable. As needed, permit applicants will coordinate with the USFWS and DFG to develop appropriate seasonal restrictions to minimize mortality. Dewatering of aquatic habitats will take place outside of the breeding season (December to June). Construction activities should avoid creation of perennial ponds in occupied sites that could result in the expansion of predator populations. Permit applicants will coordinate with the USFWS and DFG to develop a trapping and relocation program. Individuals found within the construction footprint will be captured and relocated to designated relocation habitat approved by USFWS and DFG. .

AMM24: Avoid and minimize impacts on valley elderberry longhorn beetle. Avoid disturbance to elderberry shrubs large enough to support beetle habitat within or near the project footprint to the extent practicable through adjustments in project design. For ground-disturbing activities within 100 ft around elderberry shrubs with stems > 1 inch, establish a 20 ft buffer from the dripline of each plant. No harmful chemicals will be applied within 100 ft of the buffer. Protected elderberry bushes may be trimmed during the dormant period (November to mid-February), and grasses may be mowed within the buffer from July to April.

AMM25: Avoid impacts on covered plant species associated with tidal mudflats, tidal emergent wetlands, and valley/foothill riparian communities. If occurrences of side-flowering skullcap slough thistle, Suisun thistle, soft bird's-beak, Delta tule pea, Mason's lilaeopsis, Delta mudwort, or Suisun marsh aster could be affected by BDCP actions, to the extent practicable, implement the proposed BDCP actions to avoid the direct loss of plants. Establish a 100 foot buffer around known populations of covered plants, and place temporary fences around plants to be avoided during construction. Minimization of impacts to side-flowering skullcap, where side-flowering skullcap is present on stumps or other substrate, may occur through the movement and transplantation of the substrate and plants to appropriate sites in the immediate vicinity.

AMM26: Avoid and minimize impacts on covered plant species associated with alkali seasonal wetland complex, vernal pool complex, other natural seasonal wetlands, and grassland habitats. If occurrences of alkali milk-vetch, heartscale, brittlescale, San Joaquin spearscale, slough thistle, Delta button-celery, Boggs Lake hedge-hyssop, Carquinez goldenbush, Legenere, Heckard'pepper-grass, or caper-fruited tropidocarpum are detected within BDCP project sites, design and implement proposed BDCP actions to avoid the direct loss of any of these covered plants. To the extent practicable, implement project site-specific measures approved by the USFWS and DFG to avoid and minimize impacts on these species. Avoidance of impacts may require case-by-case review with DFG and/or USFWS. Impacts to plants that occur in vernal pool habitat may be avoided or minimized by implementing measures provided in AMM6. For plants occurring in other covered communities, establish a 250 foot buffer around covered plant populations, and avoid disturbance to adjacent areas that support the hydrological regime of the plants.

*AMM27: Avoid and minimize impacts on soft bird's-beak and Suisun thistle***.** If occurrences of soft bird's-beak and Suisun thistle are detected within BDCP project sites, design and implement proposed BDCP actions to avoid the direct loss of any of these covered plants. Implement project site-specific measures approved by the USFWS and DFG to avoid and minimize impacts on these species. Avoidance of impacts may require case-by-case review with DFG and/or USFWS. Establish site appropriate buffers with approval of USFWS and DFG around covered plant populations.

3.5 POTENTIAL CONSERVATION MEASURES TO ADDRESS OTHER STRESSORS

*[**Note to Reviewers:** As the BDCP Conservation Strategy is refined over the next several months, the Potential Conservation Measures described in this section will be further evaluated to determine whether they should be included as conservation measures in the initial BDCP or remain as potential actions that may be adopted as conservation measures at a later date, pursuant to the adaptive management program. The Steering Committee believes that the concepts reflected in these potential conservation measures may effectively address a number of other stressors, but that they require further development before they can serve as conservation measures. As such, Potential Conservation Measures will not be used by the fish and wildlife agencies to provide the basis for the issuance of regulatory authorizations for the BDCP.]*

3.5.1 Introduction

The BDCP Conservation Strategy includes a number of conservation measures that address environmental stressors not related to water operations or physical habitat restoration, preservation, or management. Such measures, which are referred to as "other stressor conservation measures," have the potential to improve the quality of Delta's ecological conditions to the benefit of covered fish species. Some other stressor conservation measures are described in Section 3.4.4, *Species Level Other Stressor Conservation Measures*. The Steering Committee indentified additional actions that address other stressors, referred to as "important related actions" (IRAs) that could potentially become conservation measures.

Because of these potential conservation measures could reduce other stressors to benefit ecological conditions in the Delta, the BDCP establishes the requirement that the BDCP Program Manager take the steps necessary, through the adaptive management process, to determine whether these potential conservation measures identified in this section should ultimately be adopted as new conservation measures. The following are potential conservation measures to address other stressors:

- Ammonia Load Reduction;
- Endocrine Disrupting Compounds Load Reduction;
- Agricultural Pesticides and Herbicides Runoff Reduction;
- Stormwater and Urban Runoff Toxic Contaminants Reduction;
- Nonnative Aquatic Organisms Introduction Risk Reduction;
- Nonnative Species Introduction Detection and Response Improvement;
- Nonnative Predatory Fish Harvest Increase;
- Mark-Selective Fishery Implementation; and
- Non-Project Diversions Entrainment Reduction.

The approach to the implementation of these potential conservation measures under the BDCP is described in Section 3.5.2, *Implementation of Potential Conservation Measures to Address Other Stressors*. Descriptions of these additional other stressor conservation measures are provided in Section 3.5.3, *Descriptions of Potential Conservation Measures to Address Other Stressors*.

3.5.2 Implementation of Potential Conservation Measures to Address Other Stressors

The potential conservation measures described in Section 3.5.3, below, may be enacted during the course of Plan implementation through the BDCP adaptive management program (Section 3.7 *Adaptive Management Program*). As monitoring and research improve scientific knowledge about the effects of other stressors on covered fish species, the level of uncertainty will diminish regarding the importance of such stressors for the fish and the effectiveness of actions to reduce such stressors. Through the adaptive management process, measures to address other stressors that are proven to be effective in the conservation of covered fish species will be more fully developed and implemented by the BDCP Program Manager or the Program Manager will seek to have the measures implemented by other entities that has the authority to do so.

In certain instances, the Program Manager may identify mechanisms to create intergovernmental partnerships between BDCP authorized entities and the agencies that have jurisdiction over the environmental effects that the other stressor measures would address. These interagency partnerships may be used to advance studies, actions, and enforcement to reduce the adverse effects of the stressors on fish. The Program Manager, through the BDCP Science Manager, may work with the Delta Independent Science Board, Delta Science Program, State Water Resources Control Board, Regional Water Quality Control Boards, and others to support research necessary to clarify the science and assure implementation of corrective actions related to other stressors.

The Program Manager, BDCP Implementation Board, and BDCP Stakeholder Committee members will work to encourage all state and federal agencies, boards, and commissions that have regulatory authority in the Plan Area to exercise that authority to reduce the impact of other stressors on the covered species and will encourage those entities to provide funding to support those activities in their annual budgets. The Program Manager, Implementation Board, and Stakeholder Committee members will encourage state and federal agencies to seek opportunities to take or support actions that implement BDCP conservation measures that address other stressors. The Program Manager and Implementation Board may consider incorporating new other stressors measures into the BDCP, through the adaptive management process, as they are identified by the state and federal agencies.

The Program Manager, through the Science Manager, will advocate and pursue research to continue evaluation of other stressors and engage the regulatory agencies to take actions based upon improved scientific understanding to reduce the effects of these stressors on the health of at risk fish species in the Delta. The Program Manager will initially focus on ammonia effects on covered fish species and regulatory actions to eliminate those effects.

3.5.3 Descriptions of Potential Conservation Measures to address Other Stressors

*[**Note to Reviewers:** This section will include descriptions of potential conservation measures to address other stressors, i.e., all the Important Related Actions (IRAs).]*

3.5.3.1 Ammonia Load Reduction

3.5.3.2 Endocrine Disrupting Compounds Load Reduction

3.5.3.3 Agricultural Pesticides and Herbicides Runoff Reduction

3.5.3.4 Stormwater and Urban Runoff Toxic Contaminants Reduction

3.5.3.5 Nonnative Aquatic Organisms Introduction Risk Reduction

3.5.3.7 Nonnative Species Introduction Detection and Response Improvement

3.5.3.8 Nonnative Predatory Fish Harvest Increase

3.5.3.9 Mark-Selective Fishery Implementation

3.5.3.11 Non-Project Diversions Entrainment Reduction

3.6 MONITORING AND RESEARCH PROGRAM

*[**Note to Reviewers:** This draft of the Monitoring and Research Program is revised from the July 27, 2009 draft. The two large monitoring actions tables included in this section are initial drafts that will be revised and refined, as described in the Note to Reviewers in Section 3.3. It is expected that a section will be added in future drafts, specifying in more detail the issues to be addressed by the research program and focus for additional research needs.]*

The BDCP Conservation Strategy provides flexibility for adjustments to be made over time as additional information becomes available about the ecological systems and processes of the Delta and the effect of the BDCP conservation measures on those systems and processes. Monitoring and research are critical elements of adaptive management, providing the data and analysis needed to inform decision-making. Information gained through monitoring and research also provides the basis for determining the effectiveness of the Conservation Strategy over time. A well-designed monitoring and research program is essential for the success of BDCP.

Monitoring will play four crucial roles in the implementation of the BDCP. First, it will provide basic information necessary to track Plan commitments and compliance with the terms and conditions of regulatory authorizations. Second, it will provide information about the current state of the system against which change can be assessed. Third, it will provide information about the changing state of the system as conservation actions are implemented that can be used to assess system response and progress toward achieving the Plan's goals and objectives over time. Finally, monitoring provides important information about implementation of conservation measures that can be used to increase their effectiveness.

Program evaluation involves compiling and synthesizing monitoring data to evaluate program success and support adjustments over time, including revising program objectives and actions. Program evaluation will also be used to support the Implementation Office's efforts to communicate information to the public about the status of the BDCP (Section 3.7, *Adaptive Management Program*, discusses the program evaluation).

Information derived from research efforts will provide the basis for addressing key uncertainties and testing hypotheses that underpin various conservation measures. Research supports learning, a better understanding of the processes driving the system, and an improved knowledge base upon which informed decisions can be made regarding management interventions. Given the complexities of the Delta ecosystem, and the uncertainties regarding the outcomes that will result from the implementation of certain conservation measures, research and other information-gathering efforts will help ensure the success of the Plan.

This section describes key elements of the BDCP monitoring and research program, including: the parties responsible for implementing the monitoring program; the framework for integrating monitoring data to support program evaluation and reporting; the manner in which the BDCP monitoring program will interface with other monitoring programs; the types of monitoring that will be conducted; the process that will be used to develop site-specific monitoring plans; and the process that will be used to develop a research program. For more information on the Adaptive Management Program, including the role of monitoring and research in the adaptive management process, see Section 3.7, *Adaptive Management Program*.

Site-specific monitoring plans for each conservation measure, as well as a specific research agenda, will be prepared as part of the BDCP implementation process. These plans will be reviewed on a regular basis and adjustments made in response to new information and/or identified research needs. Plan implementation, monitoring, analysis and research, are all part of an overall adaptive management process. This process is not intended to be a stand-alone process, but rather one that integrates information to facilitate decision making, including decisions to adjust the design and implementation of conservation measures, and the type and extent of monitoring associated with those measures, as the Plan is implemented.

Because the Delta reflects a highly altered ecosystem, with limited reference sites for historical conditions, the monitoring program and the evaluation framework will rely heavily on Before/After and Control/Impact (BACI) design approaches to assess ecosystem change (Green 1979, Underwood 1992, Underwood 1994). Although the BACI approach is typically presented as a means for testing whether an impact to the system has occurred, it is technically a model that tests for changes in conditions. The model may also be used to evaluate conservation and restoration projects (Michener 1997 and Lincoln-Smith et al 2006) and test if conditions are improving. These types of monitoring approaches are commonly used in restoration ecology, particularly where numerous natural and anthropogenic disturbances represent unplanned, uncontrollable events that cannot be replicated or studied using traditional experimental approaches and statistical analyses. Ultimately, experience in restoration ecology suggests using a broad mix of appropriate research approaches (e.g., long-term studies, large-scale comparative studies, space-for-time substitution, modeling, manipulative experiments, and focused experimentation) and analytical tools (e.g., observational, spatial, and temporal statistics) (Michener 1997).

Evaluating discernable changes in environmental conditions is often difficult, due to the multitude of interacting factors. It is often not clear which environmental component will be affected by a stressor reduction and what type of change will result. A changing environment is natural and variation due to natural effects may be great (Smith 2002). To account for this, BDCP monitoring designs will be informed by the location and timing of effects expected to occur (both spatially and temporally), what organisms are expected to be affected (fish, wildlife, plants, aquatic invertebrates, etc.), what the expected benefits are (magnitude, duration), potential mitigating factors (including distribution and exposure), and how various factors may alter exposure and effect.

The BDCP monitoring program will be conducting sufficient baseline monitoring to establish the "before" condition against which change can be compared. This will entail both assessing existing data bases and determining what new measurements will be useful prior to the implementation of a conservation measure.

The monitoring program outlined in this chapter is consistent with the guidance provided by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service in the "Five-Point Policy" for Habitat Conservation Plans (HCP)[38] and provisions of the Natural Community Conservation Planning Act (NCCPA)[39] . As described in the Five-Point Policy, the monitoring

[38] 65 FR 106, June 1, 2000

[39] Fish and Game Code Sections 2810(a)(7)

program of a conservation plan should generate information sufficient to guide plan implementation, particularly with respect to the following matters:

> *"(1) assess the implementation and effectiveness of the HCP terms and conditions (e.g., financial responsibilities and obligations, management responsibilities, and other aspects of the incidental take permit, HCP, and the IA, if applicable); (2) determine the level of incidental take of the covered species; (3) determine the biological conditions resulting from the operating conservation program (e.g., change in the species' status or a change in the habitat conditions); and (4) provide any information needed to implement an adaptive management strategy, if utilized. An effective monitoring program is flexible enough to allow modifications, if necessary, to obtain the appropriate information."*[40]

The BDCP research program will be implemented to address specific scientific questions regarding: (1) covered species; (2) natural communities; and (3) ecosystem processes to increase the base of knowledge about these resources such that conservation measures can be adaptively implemented to advance biological goals and objectives. Specifically, the BDCP monitoring and research program will be conducted primarily to:

- Document compliance with terms and conditions of BDCP regulatory authorizations, including limits established for the incidental take of covered species;
- Increase and refine scientific understanding of the effects of the covered activities (Chapter 4, *Description of Covered Activities*) on covered species and natural communities;
- Collect data necessary to effectively implement conservation measures;
- Document and evaluate the effectiveness of conservation measures in achieving BDCP biological goals and objectives;
- Test the scientific hypotheses on which the assessment of effects and effectiveness are based; and
- Assess progress towards achieving the biological goals and objectives both specific to conservation actions and Delta-wide.

3.6.1 Responsibility for the Monitoring and Research Program

The Implementation Office (IO) Science Manager, under the direction of the BDCP Program Manager, will be responsible for the overall management and oversight of the BDCP monitoring and research programs, including the implementation of monitoring-related activities (see Section 7.3.4, *Management of Biological Monitoring, Scientific Research, and Reporting Programs*). The Science Manager, with the support of the Interagency Ecological Program (IEP), will be responsible for developing and overseeing the implementation of the monitoring

[40] 65 FR 106, June 1, 2000; 35254

and research program activities. The Science Manager may further utilize the Delta Science Program and Independent Science Board to review and provide input on aspects of the monitoring and research program. The IO may look to the Authorized Entities and Supporting Entities (see Chapter 7, *Implementation Structure*) to conduct monitoring activities on specific conservation actions, as appropriate.

The BDCP Science Manager will be responsible for ensuring that the BDCP science activities, reporting, and reviews are coordinated with other science activities being conducted in the Delta. The Science Manager will seek the assistance of the Lead Scientist of the IEP and the Chief Scientist for the Delta Science Program to ensure that BDCP science activities, reporting, and reviews are coordinated with other science activities being conducted in the Delta.

3.6.2 Monitoring Framework

The following outlines a framework for integrating monitoring data to support program evaluation and reporting. The BDCP Evaluation Framework is described in Section 3.7, *Adaptive Management Program*. Specific types of monitoring (baseline, compliance, effectiveness, and system-wide) that will feed the evaluation framework (as well as other plan reporting requirements) are described in more detail in Section 3.6.4, *Types of Monitoring*.

The BDCP monitoring framework as presented herein is modeled after the successful Ecosystem Health Monitoring Program used as part of the Healthy Waterways Initiative in South East Queensland, Australia (South East Queensland Healthy Waterways Partnership 2007). The framework tracks indicators for five basic ecological conditions that collectively reflect the overall health of the ecosystem. For the BDCP, the monitoring and evaluation framework is divided into five ecological categories: (1) ecological processes; (2) physical and chemical conditions (including nutrients); (3) food webs; (4) natural communities; and (5) fish, wildlife, and plants. A select set of key indicators for these five characteristics will be measured for the appropriate geographic area to assess status and trends. Specific indicators, metrics and sampling designs will vary depending on the regional area.

Table 3-18 illustrates how the BDCP monitoring and evaluation framework could be structured. An example of all likely possible monitoring elements was developed for the implementation of a project at Suisun Marsh under the CM4, *Tidal Habitat Restoration*. It is expected that frameworks for other conservation measures will be developed and refined during plan implementation using this as an example of the types of elements that could be included.

Table 3-18. Example Framework For Southern Suisun Marsh Monitoring and Metrics

*[**Note to Reviewers:** Table in development. To come]*

3.6.3 Integration of Monitoring and Research with Other Programs

Monitoring of covered species and many ecosystem conditions that are relevant to BDCP implementation is currently undertaken by a number of entities, including IEP, Delta Science Program, California State University Endangered Species Recovery Program, USGS, DFG, DWR, USFWS, Reclamation, NOAA Fisheries Science Center, and UC Davis. As an example of the types of monitoring data that are currently being collected, Table 3-19 lists some of the fisheries monitoring data that is coordinated by the IEP.[41]

In addition to fish monitoring, there is a considerable amount of water quality monitoring that is currently being conducted in the Delta. The Environmental Monitoring Program (which also monitors lower trophic levels) is part of the IEP, while programs tracking environmental contaminants currently are not. The new Delta Regional Monitoring Program is intended to coordinate these programs.[42] [43]

Most of the existing Delta monitoring efforts are being implemented as conditions of existing regulatory authorizations and many are coordinated under the IEP umbrella. The IEP has been instrumental in coordinating Delta monitoring and research activities conducted by State and federal agencies and other science partners for 40 years. IEP monitoring activities are generally carried out in compliance with Water Right Decision and Endangered Species Act permit conditions. Most of the existing IEP-coordinated monitoring focuses on open water areas and the major Delta waterways conveying water to the SWP and CVP facilities in the south Delta. A new regional monitoring program intended to coordinate Delta water quality monitoring in compliance with Clean Water Act permit conditions is currently under development by the Central Valley Regional Water Quality Control Board. A similar regional monitoring program already exists for San Francisco Bay and is carried out by the San Francisco Estuary Institute, a non-profit research organization.

Due to their permit-driven nature, none of the existing long-term monitoring programs focus explicitly on monitoring ecological processes and habitats. Perhaps as a result, there has never been an integrative "Ecosystem Health" assessment similar to the Australian example mentioned in Section 3.6.2, Monitoring Framework. The "Are Our Aquatic Ecosystems Healthy?" portal[44] currently under development by the California Water Quality Monitoring Council (WQMC) may provide an opportunity to better organize, integrate, evaluate, and communicate data and information about the health of the Delta relative to other aquatic ecosystems in California and changes in Delta ecosystem health associated with the BDCP and other programs. The WQMC is based on an interagency MOU mandated by California Senate Bill 1070 (Kehoe, 2006) and

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[41] A more complete summary of the IEP fish monitoring programs can be found at: http://www.water.ca.gov/iep/docs/IEP_FishMonitoring_final.pdf.

[42] For information on this new Delta Regional Monitoring Program see http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/comprehensive_monitoring_program/index.shtml).

[43] A recent summary of existing water quality monitoring programs can be found at http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/comprehensive_monitoring_program/draftfinal_deltamon_25nov09.pdf

[44] See the portal at http://www.waterboards.ca.gov/mywaterquality/

requires the boards, departments and offices within the California Environmental Protection Agency (Cal/EPA) and the California Natural Resources Agency to integrate and coordinate their water quality and related ecosystem monitoring, assessment, and reporting.

The Science Manager will coordinate with the IEP and other entities involved in monitoring programs and will use data collected through these programs, as appropriate, to support evaluation of the effectiveness of the BDCP Conservation Strategy in achieving biological goals and objectives and to assess the long-term status and trends of covered species populations and ecosystem conditions.

Table 3-19. Sample Listing of Existing Bay-Delta Fish Monitoring Programs Coordinated through the Interagency Ecological Program (IEP)

Monitoring Program	*Agency*	*Primary Purpose*	*Available Data for BDCP*
Spring Kodiak trawl	DFG	Monitors spawning adult delta smelt distribution, relative abundance, and reproductive status, January-May, 2002-present	Spawning abundance index, distribution, sex ratios, reproductive status (e.g., pre-spawn, mature, or spent)
20 mm tow net survey	DFG	Monitors post larval-juvenile delta smelt distribution and relative abundance, March-June, 1995-present	Post larval and juvenile abundance index, distribution, length frequency
Summer tow net survey	DFG	Monitors striped bass and delta smelt abundance indices, July-August, 1959-present	Delta smelt: juvenile delta smelt abundance index, distribution, and length frequency. Longfin smelt: post larval juvenile longfin smelt abundance index, distribution, and length frequency. Sacramento splittail: YOY splittail, distribution, and length frequency
Fall midwinter trawl	DFG	Monitors striped bass and delta smelt abundance indices, September-December, 1967-present	Delta smelt: Pre-adult delta smelt abundance index. Longfin smelt: Pre-adult longfin smelt abundance index. Sacramento splittail: Abundance of all size classes
Smelt larval study	DFG	Monitors longfin smelt larvae distribution and relative abundance, January 2009-present	Larval abundance index and distribution
Bay Study	DFG	Monitors abundance indices for a variety of species in South San Francisco and Suisun Bays, Year-round, 1980-present	Delta smelt: Juveniles-adult delta smelt abundance index. Longfin smelt: Juveniles-adult longfin smelt abundance index. Sacramento splittail: Young of year and older splittail abundance.
Suisun Marsh fisheries monitoring program	UC Davis	Monitors abundance of all fish species in Suisun Marsh, Year-round, 1979-present	Delta smelt: Juveniles-adult delta smelt abundance, distribution within Suisun Marsh. Longfin smelt: Juveniles-adult longfin smelt abundance, distribution within Suisun Marsh. Sacramento splittail: Abundance of all size classes, distribution within Suisun Marsh.
Fish salvage monitoring	DWR, DFG, USBR	Monitors entrainment and salvage of all fish species, Year-round, 1979-present	Delta and longfin smelt: 20 mm post larvae-adult smelt abundance. Sacramento splittail: Abundance of all size classes >20 mm and length frequency. Almonds: >20 mm larvae-adults abundance. Sturgeon: >20 mm juvenile sturgeon abundance.

Table 3-19. Sample Listing of Existing Bay-Delta Fish Monitoring Programs Coordinated through the Interagency Ecological Program (IEP) (continued)

Monitoring Program	*Agency*	*Primary Purpose*	*Available Data for BDCP*
Chips Island, Mossdale, and Sacramento trawls	USFWS	Monitors fish abundance and distribution in mid-channel at surface at Chips Island, Moss dale (RM 54), and Sacramento (RM 55), and survival through the Delta, targets Chinook salmon, Year-round, 1976-present	Almonds: juvenile abundance, distribution, length frequency, survival indices (of hatchery tagged fish) to Chips Island Delta smelt: >25 mm abundance, distribution, and length frequency. Longfin smelt: >25 mm abundance and distribution, and length frequency. Sacramento splittail: >25 mm abundance and distribution, and length frequency.
Beach seines	USFWS	Monitors fish abundance and distribution throughout the Delta, upstream Sacramento River, northern San Francisco and San Pablo Bays, targets Chinook salmon, Year-round, 1976-present	Sacramento splittail: >25 mm young of year splittail abundance, distribution, and size frequency. Almonds: juvenile almonds, abundance, distribution, and size frequency.
Chinook salmon escapement estimates (Grand tab database)	DFG, DWR	Grand tab collects all races of Chinook salmon escapement	Almonds: adult returns to spawning grounds by race and location
Suisun March otter trawl	UC Davis	Monitors abundance of all fish species in Suisun Marsh, Year-round, 1979-present	Chinook salmon: juvenile abundance and distribution within Suisun Marsh
Adult sturgeon tagging study	DFG	Tag-recapture (via creel surveys) of green (prior to being listed) and white sturgeon for abundance and population dynamics	White and green sturgeon: abundance, distribution, population dynamics, length frequency, annual harvest rates, and migration rates.

3.6.4 Types of Monitoring

The Implementation Office will conduct and/or coordinate several types of monitoring to ensure the success of the Conservation Strategy. The general types of monitoring required are described in this section.

3.6.4.1 Preconstruction Surveys

As specified in Section 3.4.5, *Avoidance and Minimization Measures*, preconstruction surveys are required for specifically identified covered species, prior to the implementation of certain covered activities and conservation measures (e.g., water facilities construction or tidal habitat restoration actions that would remove existing terrestrial habitat) that may affect covered species or their habitats.

The potentially affected area will be surveyed to determine if covered species are present and likely to be affected by the activity. Survey results will be used by the Implementation Office to determine the need to implement measures described in Section 3.4.5 to avoid and minimize impacts on covered species and natural communities related to the covered activity or conservation measure. Preconstruction surveys may also be used in measure and record the level of take for a specific action as part of compliance monitoring, discussed below.

Preconstruction surveys may be coupled with baseline surveys, discussed below, as appropriate.

3.6.4.2 Construction Monitoring

Monitoring of construction activities will be conducted during the construction of various proposed facilities (both covered activities and conservation measures), including habitat restoration projects. Construction monitoring is required to ensure that avoidance and minimization measures are properly carried out where specific sensitive occurrences of covered species (e.g., an active nesting site for a covered bird species or a population of a highly restricted covered plant species) have been identified at or adjacent to a construction site. The Implementation Office will: (1) monitor implementation of covered activities to ensure that any applicable avoidance and/or minimization measure is properly and effectively implemented, and (2) ensure that conservation measures are implemented in accordance with specifications and plans.

3.6.4.3 Compliance Monitoring

The purpose of compliance monitoring is to: (1) track progress of BDCP implementation in accordance with established timetables, and (2) ensure compliance with terms and conditions of the BDCP and its associated permits. Compliance monitoring will be undertaken for all conservation measures, whether implemented directly by the BDCP Implementation Office or by other supporting entities through contracts, memoranda of agreement, or other agreements with the BDCP Implementation Office. Compliance monitoring will be conducted to ensure that conservation measures are meeting specified permit terms.

3.6.4.4 Baseline Surveys

Surveys to establish existing baseline conditions are critical to conducting a “before” and “after” comparison of biological and physical conditions related to the implementation of conservation actions and to the evaluation of the effectiveness of those conservation actions (refer to Section 3.6.4.5, *Effectiveness Monitoring*, below). Appropriate statistical designs for baseline surveys and effectiveness monitoring will be established as part of development of action-specific monitoring plans (Section 3.6.6, *Development of Specific Monitoring Plans*). Baseline surveys will be performed prior to implementation of conservation actions with sufficient lead time to allow future detection of changes in trajectories for the expected outcomes after implementation. For example, zooplankton sampling would be conducted in channels adjacent to tidal restoration sites in all seasons for multiple years prior to levee breaching to set the baseline condition. Monitoring sampling of zooplankton would be conducted at the same channel locations immediately following the levee breaching and throughout the natural development period of the restored tidal habitat, to quantify changes in the zooplankton community related to increased food availability.

Baseline and monitoring survey results will be used as the basis for BACI designs intended to evaluate program effectiveness. In some cases baseline monitoring may involve monitoring at reference (control) sites inside or outside the BDCP area (e.g., habitat use in unaffected habitat areas). BACI design approaches may be used where reference sites are limited.

3.6.4.5 Effectiveness Monitoring

Effectiveness monitoring assesses ecosystem, natural community, and covered species responses to the implementation of conservation measures and monitors progress made toward achieving biological goals and objectives. Effectiveness monitoring will occur at two scales: (1) a local scale focused on evaluating the effectiveness of specific individual conservation measures; and (2) a system-wide scale focused on the status and trends in species populations, natural communities, and ecosystem processes within the Plan Area. Each of these effectiveness monitoring scales are described in more detail below.

Effectiveness monitoring will be closely coordinated with baseline monitoring and the BDCP research program to support adaptive management. It is anticipated that the extent of effectiveness monitoring will be reduced over time as causal relationships between the implementation of conservation measures and the responses of covered species and ecosystems to those measures are better understood (as a result of knowledge gained under the BDCP monitoring and research program and other research programs). For example, if relationships between restoration of tidal marsh and zooplankton production are established through monitoring and research on initially restored tidal marshes, then effectiveness monitoring for assessing the production of zooplankton associated with subsequent restoration of tidal marsh may be reduced or no longer required. Effectiveness monitoring will also be spatially stratified to establish the effectiveness of the conservation measures in each Conservation Zone or ecologically relevant portions of the Plan Area.

Conservation Measure Monitoring. Monitoring focused on specific conservation measures will be undertaken for water operations, physical habitat restoration and enhancement, and other stressors conservation measures implemented by the BDCP Implementation Office and Supporting Entities. BDCP covered species will be monitored to assess individual, population, and community responses directly associated with specific conservation measures. Specific attributes of the aquatic ecosystem that are necessary for the survival and recovery of covered fish species will also be monitored as they relate to specific conservation measures. Monitoring at the local scale will also be used to determine whether any desirable or undesirable consequences are occurring in association with the implementation of specific conservation measures.

System-Wide Monitoring. Together with the BDCP research program, system-wide monitoring is intended to complement conservation measure monitoring by evaluating the status of ecological processes, natural communities, and covered species across the Plan Area, and in some cases outside of the Plan Area. Information within the scope of system-wide monitoring includes overall status, distribution of organisms, and trends related to covered species populations. Together with the conservation measure monitoring, system-wide monitoring is intended to help determine causality when examining a potential biological response, or lack thereof, to BDCP actions. System-wide monitoring allows for the evaluation of the collective effects of multiple conservation measures through time and provides information specific to the measuring metrics and the achievement of biological goals.

Consistent with the BDCP goals and objectives, system-wide monitoring will focus on three levels of ecological scale: (1) ecosystem processes (ecological processes, physical and chemical conditions, and food webs), (2) natural communities (including the ecological functions they provide for covered species), and (3) covered species. Each of these is described below.

Ecosystem Processes. Within the BDCP conservation lands and the Plan Area, the Implementation Office will monitor the structure and function of the aquatic ecosystems and the processes that influence these attributes at appropriate time intervals and at appropriate locations, over the term of the BDCP. Monitoring of aquatic ecosystem processes and conditions will provide the BDCP Implementation Office with information necessary to track long-term changes affecting the aquatic ecosystem (e.g., covered activities, climate viability and change, activities of others) and to document the contribution of the BDCP toward maintaining and improving aquatic ecosystem attributes in support of the covered fish species.

The BDCP Implementation Office will use the best available scientific understanding and datasets associated with the Delta aquatic ecosystem to establish markers from which to assess future changes in ecosystem processes, structure and function. Depending on the type and extent of data gaps, the BDCP Implementation Office will at the outset of Plan implementation collect necessary additional information to better understand existing conditions. If strong relationships between the response of specific ecosystem functions and conservation measures are established, the frequency of system monitoring for those monitoring elements of the Plan may be modified by the BDCP Implementation Office.

Natural Communities. The BDCP Implementation Office will monitor the extent and distribution of natural communities within the BDCP conservation lands and within the Plan Area at appropriate intervals over the term of the BDCP, depending on the type of community. Monitoring of covered natural communities will provide the BDCP Implementation Office with information sufficient to track long-term changes in the distribution and extent of covered natural communities attributable to any of a number of factors that may affect the communities (e.g., covered activities, climate variability and change, and activities of others). The results of these monitoring efforts will also provide documentation of the contribution of the BDCP towards maintaining and improving the extent, distribution, and continuity of natural communities. The baseline conditions from which changes in the range and distribution of natural communities will be assessed are the conditions described in Chapter 2, *Existing Ecological Conditions* and Appendix A, *Covered Species Accounts* and in baseline data collected by the Implementation Office early in the implementation period.

Covered Species. The status, distribution, and trends in populations of covered fish, wildlife, and plant species will be monitored within the BDCP Plan Area over the term of the BDCP. This level of monitoring will provide the BDCP Implementation Office with information sufficient to track long-term changes attributable to factors such as covered activities, physical and chemical changes, and climate variability and change that may affect covered species. The results of these monitoring efforts will document the contribution of the BDCP toward the conservation of covered species and inform system-level assessments of status, trends, and distribution. The baseline conditions from which changes in the range and distribution of covered species will be assessed are the conditions described in Chapter 2, *Existing Ecological Conditions* and Appendix A, *Covered Species Accounts* and in baseline data collected by the Implementation Office early in the implementation period.

As part of the covered species monitoring, the BDCP Implementation Office will also review relevant scientific data collected for covered species whose range and life stage distribution extends beyond the BDCP Plan Area as this information becomes available. Review of information gathered outside of the BDCP Plan Area will be sought to further inform assessments of the status and trends relating to covered species within the BDCP Plan Area and for making adjustments to BDCP implementation through the adaptive management process.

Species monitoring will be particularly important for covered fish and wildlife species that are migratory, nomadic, or otherwise highly mobile (i.e., dispersing readily in and out of the Plan Area). For these species, factors external to the Plan Area can readily obscure the type and extent of response to the implementation of the BDCP. For example, it may be that a conservation measure intended to restore habitat for a covered species is not followed by use of that habitat. The apparent lack of response, however, may be due to a population decline of the covered species caused by increased mortality outside the Plan Area. To establish causality, a number of monitoring metrics are needed, making use of cross-system comparisons.

3.6.5 Potential BDCP Monitoring Actions and Metrics

Potential monitoring actions and metrics to be implemented by the BDCP Implementation Office are divided into the same ecological hierarchy as the biological goals and objectives and conservation measures. Potential effectiveness monitoring actions and metrics for conservation measures are presented in Table 3-20 and potential monitoring actions and metrics for system-wide monitoring are presented in Table 3-21. Each potential monitoring action includes a description of existing programs that are currently implementing a portion or all of the monitoring action and how the monitoring information is expected to inform adaptive management decision making. All types of monitoring identified in Section 3.6.4, *Types of Monitoring*, are addressed in these tables. Tables 3-20 and 3-21 illustrate the types of monitoring actions and metrics that could be implemented, however, the Implementation Office will have the flexibility to determine the specific methods for gathering monitoring information and to change monitoring actions and metrics through the adaptive management process (see Section 3.6.6, *Development of Specific Monitoring Plans*, and Section 3.7, *Adaptive Management Program*).

3.6.6 Development of Specific Monitoring Plans

The BDCP Implementation Office will prepare detailed monitoring plans tailored to specific conservation measures and to system-wide monitoring needs based on the monitoring actions and metrics in Tables 3-20 and 3-21. These monitoring plans will be developed prior to implementation of the applicable conservation measures and the plans will include specific experimental and statistical designs to allow analysis of the status and trends of the selected metrics using approaches such as BACI analyses (see the discussion of target research in Section 3.7.5, *Adaptive Management Experiments)*. The monitoring plans will include survey protocols for efforts related to preconstruction, construction, compliance, effectiveness, and system-wide monitoring. In most instances, existing and generally accepted monitoring protocols (e.g., USFWS survey protocols for listed species, and protocols for monitoring status and trends in abundance and distribution of covered fish species) will be adopted by the BDCP Implementation Office, as appropriate. In some cases, however, the Implementation Office will need to develop specific monitoring protocols to assess a conservation measure.

The specific contents of each specific monitoring plan may vary depending on its purpose. The monitoring plans, however, will generally include the following types of information:

- Description of the purpose and objectives of the monitoring (e.g., assessing progress towards achieving a biological objective);
- Description of monitoring protocols, including sampling design and justification supporting the validity of monitoring methods and sampling design;
- Analytical methods for assessing monitoring results;
- Procedures for validating monitoring data and methods;
- Monitoring schedule, duration, and rationale;
- Spatial sampling scheme;
- Content requirements and submission schedule for monitoring reports;
- Monitoring data storage and management procedures;
- Analytical methods for the assessment of data and presentation of results;
- References, including printed references and personal communications;
- Provisions for documenting subsequent revisions to the monitoring plan; and
- Other information pertinent to specific monitoring plans.

Monitoring provides the necessary information to make adjustments in the implementation of the Plan and to measure progress toward achieving the BDCP biological goals and objectives; therefore, monitoring plans must be based on the best available information and subject to rigorous standards, including statistically sound sampling designs. To ensure defensibility of the

BDCP monitoring plans, protocols, and sampling designs, the Implementation Office will provide for internal science-based review of these monitoring elements as a routine matter and the overall plans will be examined by external science review as necessary and appropriate.

3.6.7 Research Program

While habitat conservation plans and natural community conservation plans are not specifically required to include research programs, the ecological complexity of the Delta and the level of uncertainty regarding the level of anticipated beneficial outcomes for covered species resulting from some of the conservation measures highlight the need for targeted research to better inform BDCP implementation and monitoring and adaptive management decision making. Existing research programs (particularly those funded under the IEP and Delta Science Program) have produced a broad range of valuable information. The BDCP Science Manager will identify research priorities to address specific uncertainties and provide funding for research to support more effective implementation of the Conservation Strategy. The Science Manager will coordinate with other entities, including IEP and the Delta Science Program to identify research needs and priorities. Many of the uncertainties and research needs are stated within the BDCP conservation measures in Section 3.4, *Conservation Measures*.

The following provides a preliminary description of how the BDCP will approach its research program. Additional details regarding the research program will be developed as proposed conservation measures are further refined and site-specific designs are developed, including the development of experimental designs to be incorporated with program implementation to support the adaptive management process.

BDCP Implementation Office may undertake or contract focused research to develop information necessary to better inform BDCP implementation. The types of research that may be conducted include those related to resolving BDCP-specific questions and needs related to:

- Key ecological processes and controls on these processes;
- Technologies and methods for effectively implementing and measuring the outcome of conservation measures;
- Development of new and more sensitive indicators and metrics;
- Improving understanding of the ecological requirements of covered species as they relate to effective implementation of conservation measures;
- Modeling and assessing responses of covered species to conservation measures;
- Determining causal relationships between ecological stressors and drivers and changes in natural communities and covered species; and
- Identify and evaluate tradeoffs among conservation measures.

Each conservation measure in Section 3.4, *Conservation Measures,* include discussions of hypothesized benefits of the measures that are testable under the either the monitoring program or the research program. Results of research would also be used to help direct and prioritize subsequent implementation of conservation measures through the adaptive management process.

The BDCP Implementation Office will use and maintain existing analytical tools (e.g., the DRERIP conceptual models and hydrologic models such as CALSIM, DSM2, and RMA), as appropriate, may also develop or participate in the development of models and other analytical tools to help inform BDCP implementation and support the adaptive management process. These analytical tools include current models and development or improvement of relevant deterministic, statistical, and conceptual models and exploring correlations and the cause and effect relationships between various components of the Delta ecosystem. To develop these modeling and analytical tools, the BDCP Implementation Office may conduct studies to collect information necessary for development of the tools. Additionally, it is anticipated that the BDCP Implementation Office will also participate in revising and improving existing tools (e.g., hydrologic and hydrodynamic models, DRERIP conceptual models) as new capabilities become available over the term of the BDCP.

3.6.8 Database Development and Maintenance

The BDCP Implementation Office will develop and maintain a comprehensive spatially-linked database to track implementation of all aspects of the BDCP. The database would be structured to be “user friendly” and to allow for future expansion and integration with external databases (e.g., linkage to databases of the Delta Science Program, and California Water Quality Monitoring Council). The database would look to other well recognized database management examples such as the Consortium of Universities for the Advancement of Hydrologic Science and the U.S. Long Term Ecological Research Network, which are leaders in multiple facets of data management in the environmental sciences. Functions that the BDCP database would be expected to support include:

- Data documentation such that future users can determine why, how, and where data were collected (i.e., metadata);
- Quality assurance and control of the data and data entry;
- Access to and use of the most current information for analysis and decision making; and
- Evaluation of data by all users, as appropriate, and incorporation of corrections and improvements in the data.

Major types of information expected to be maintained within the database include:

- Monitoring, research, and adaptive management experiment data and results;
- Modeling inputs, outputs, and results;

- Status of covered activities, including implementation and impacts;
- Implementation status of conservation measures;
- Implementation status of research and adaptive management experiments;
- Adopted changes to BDCP implementation through the adaptive management process; and
- All reports and documents generated by the Implementation Office and relevant data and reports generated by other entities.

The BDCP Implementation Office may choose to develop a web-linked database to facilitate controlled transference of information into and out of the database by other entities. If the BDCP Implementation Office chooses to allow access to the database by others, the database will incorporate strict controls and monitoring to ensure the integrity of the database is maintained.

The BDCP Implementation Office will ensure quality control of all monitoring data and will adopt procedures to maintain high standards of quality. Steps will be instituted to maintain the accuracy and functionality of gages, meters, and other devices, and protocols will be established to govern the collection, transcription, and storage of data. All monitoring data will be entered into database software and will be made readily available online once quality control analyses have been conducted.

The BDCP Implementation Office will use standard analytical procedures where such procedures exist. Particular analyses would be specific to individual monitoring parameters and would consist of classical parametric or non-parametric hypothesis testing and statistical models (e.g., t-tests, ANOVAs, correlations, regressions, etc.) to the extent practicable. If advanced statistical methods are necessary (e.g., multivariate ANOVAs, principal components analysis, Bayesian statistics, etc.), the BDCP Implementation Office would consult with experts to ensure proper analyses are being conducted. For many parameters, due to high environmental variability, time series analyses will be necessary to assess with confidence whether a trend in a parameter depicts a change that has occurred as a result of a BDCP action. Results of the analysis of monitoring data will feed back into the BDCP adaptive management process to modify and refine conservation measures to maximize benefits to and minimize unanticipated adverse effects on covered species and other components of the aquatic community.

3.6.9 Monitoring and Research Schedule

Following the signing of the Implementing Agreement and authorization of the BDCP, the Implementation Office will develop detailed monitoring plans and schedules for compliance and effectiveness monitoring. In addition, site-specific monitoring schedules will be developed for each BDCP conservation area as they are protected, enhanced, and restored.

3.6.10 Reporting and Science Communication

Requirements for the Reporting of monitoring results are provided in Chapter 6, *Plan Implementation.* The BDCP Implementation Office will regularly prepare implementation reports that describe survey, monitoring, research, and experimental activities and results over the term of the BDCP. Regular reporting requirements are described in Section 6.2, *Compliance and Progress Reporting*. The Implementation Office will also support peer-reviewed publications, seminars, and conferences like the Delta Science Conference and State of the Estuary Conference as additional mechanisms for communicating information and results. These approaches tend to foster the level of synthesis and integration needed to support an adaptive management approach.

*[**Note to Reviewers:** This table presents in-progress draft potential effectiveness monitoring actions for each BDCP conservation measure. This table will continue to be refined and populated to ensure that all of the effectiveness monitoring, including incorporation of metrics from the logic chain, are addressed.]*

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Ecosystem-Level Conservation Measures				
CM1: Water Facilities and Operation				
Monitoring Action CM1-1. Document the operation of the new water diversion facility in the north Delta with multiple intakes and fish screens and an isolated conveyance facility while maintaining sufficient bypass flows for covered fish species.				
Base condition: As-built construction drawings. **Approach**: Record amounts and timing of water diversion and conveyance, record bypass flows at automated monitoring stations downstream of the last intake. **Schedule:** real-time data compiled for daily summaries.	**Existing Programs:** 1. Continuous Multi-parameter Monitoring, Discrete Physical /Chemical Water Quality Sampling (Environmental Monitoring program; IEP) 2.Continuous Recorder Sites (DWR, USBR) 3. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program (Central Valley Water Board) 4. Delta Flows Network and National Water Quality Assessment Program (USGS) 5. other (DWR, SRCSD, SWAMP, Central Valley Water Board, State Water Board, SFEI, etc) **Potential Program Additions:** add automatic water monitoring stations at each intake as needed.	1. Hourly Intake (cfs) 2. Bypass flow (cfs) downstream of last intake	This monitoring action will provide real-time data on the amount of water diverted by the north Delta diversion facility, and the amount of water that bypasses the facility. This information will be used by the Implementing Office to determine of water operations adhere to existing target levels. The monitoring schedule may be adjusted to better estimate diversion and bypass flows.	ECSY2.1 ECSY2.2 ECSY2.3 ECSY2.4 ECSY2.5 CHSA1.5 GRST1.1 RILA1.4 PALA1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 1-2: Record and quantify the number of fish impinged at intakes of the new water diversion facility in the north Delta.				
Base condition: As-built construction drawings. **Approach**: Time stratified sampling; record number, size, species and life stage, reproductive status of impinged fish at intake screens; Install underwater monitoring cameras at fish screens to examine fish behavior at intake screens **Schedule:** Daily	**Existing Programs:** Protocols, equipment and skilled personnel working at CVP and SWP facilities (south Delta) **Potential Program Additions:** Equipment and staff to monitor north Delta diversion facility using identical protocols; protocols for analyzing video sequences of underwater cameras	1.Number of fish 2. Species 3. Life stage 4. Reproductive status	This monitoring action will provide data on impingement of covered fish species at the North Delta facilities. This information will be used by the Implementing Office to determine if the existing fish screens perform to meet target thresholds. It will also provide insights in fish behavior at intakes and will be used to evaluate and redesign fish screens if necessary. The monitoring schedule may be intensified if large numbers of fish are impinged at any given time/season.	CHSA1.6 STEE1.5 SASP1.4 GRST1.4 WHST1.4
Monitoring Action CM 1-3: Record and quantify the number of fish entrained at the south Delta SWP and CVP pumping facilities.				
Base Condition: Current levels of entrainment **Approach:** Use existing protocols and sampling procedures, continue to collect entrainment and salvage data at CVP and SWM pumping stations. **Schedule:** ongoing, daily	**Existing Programs:** Ongoing fish sampling at pumping facilities, IEP Monitoring (Fishery Improvements) coordinated with DWR, DFG, USBR, UCD, and other federal, state, and local agencies. **Potential Program Additions:** None	1. Monthly salvage density (fish/cubic foot per second [cfs] 2. Estimated entrainment (numbers) 3. Estimated impingement (numbers) 4. Species composition 5. Size distribution of individual species	This monitoring provides information about the seasonal distribution and amount of fish losses due to entrainment at pumping facilities The Implementation Office will use this information as input in population and life-cycle models of covered fish, and to determine if fish salvage and screening perform at expected target levels. This monitoring activity is already adaptively scheduled by adjusting sampling according to the number of fish entrained and by flow. Modification of this sampling is not expected.	CHSA1.6 GRST1.4 SASP1.4 STEE1.5 WHST1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM1-4: Document diversion operations to ensure target flows in Old and Middle Rivers.				
Base Condition: Pre-implementation flows of Old and Middle Rivers. **Approach:** Use existing network of fixed-site sampling stations to collect time-histories of water quality variables. Derive flux between regions in the Delta through these key channels. **Schedule:** Within 1 year of initiation of the South Delta Diversion Operational Limits, operate monitoring sites and track flow on a daily basis.	**Existing Programs:** 1. Continuous Multi-parameter Monitoring, Discrete Physical /Chemical Water Quality Sampling (Environmental Monitoring program; IEP) 2.Continuous Recorder Sites (DWR, USBR) 3. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program (Central Valley Water Board) 4. Delta Flows Network and National Water Quality Assessment Program (USGS) 5. other (DWR, SRCSD, SWAMP, Central Valley Water Board, State Water Board, SFEI, etc) **Potential Program Additions:** **1.** If needed, add complementary stations to track water flows within Old and Middle River. see also Monitoring Action CM4-4 and Monitoring Action CM4-6.	1. Flow dynamics (velocity and volume of flows, direction) in Old and Middle River	This monitoring action will provide information regarding the effectiveness of adaptive operational changes of Old and Middle River flows (by modifications in export rates and reverse flows). The Implementing Office will use this information to determine if flow rates are within adaptive range limits. The schedule for monitoring may be changed if flow dynamics are found not to be within not adaptive range limits.	ECSY2.1 ECSY2.2 ECSY2.3 ECSY2.4 ECSY2.5 CHSA1.5 STEE1.3 PALA1.4 RILA1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM1-5: Document fish migration and hydrodynamics (including hydraulic residence time) resulting from Delta Cross Channel operations (increasing the duration of Delta Cross Channel closure).				
Baseline Condition: Current knowledge of migration routes of covered fish species; if necessary determine proportion of covered juvenile fish (salmonids and sturgeon) migrating through the interior Delta and the mainstem of the Sacramento River. **Approach**: Conduct tracking (e.g., radio-telemetry, acoustic tracking, or other appropriate methods) of juvenile winter-run Chinook salmon, green and white sturgeon, and other species as appropriate to determine the proportion of fish migrating through the mainstem Sacramento River and tributaries and the interior of the delta and their survival. Compare water quality and organic food indices among migration routes and under different flow regimes and Cross Channel gate operation. **Schedule**: During migration track marked fish daily. Aggregate data by month and derive mortality estimates for fish in each migration route (mainstem vs interior).	**Existing Programs:** 1. Previous salmon survival and migration studies (e.g., USFWS, Perry et al. 2010), ultrasonic recorder stations (USGS & California Bay-Delta Authority). 2. Water quality monitoring sites within the Delta (see CM1-1). **Potential Program Additions:** Implement a routine juvenile fish migration and survival tracking program by experimentally releasing tagged fish to determine the effects of Cross Channel Closure on survival.	1. Migration routes (% individuals moving through the mainstem) by juvenile salmon and sturgeon 2. route- and species-specific survival estimates 3. Hydraulic residence time 4. Flows and downstream transport of fish eggs, larvae, juveniles, organic material, phytoplankton, and zooplankton, within the Sacramento River into the Delta.	This monitoring will provide information on the effectiveness of Delta Cross Channel closure to increase covered fish survival and by improving downstream transport of fish eggs, larvae, juveniles and organic food resources. Results of this monitoring will be used within the BDCP adaptive management framework to refine and modify seasonal operations of Delta Cross Channel gates. The schedule of monitoring may be adaptively altered if data resolution requirements are not met or when a clear relationship between Delta Cross channel operation, covered species survival and transport, and tidal flows is established and can be predicted robustly and with low uncertainty.	CHSA1.5 STEE1.3 RILA1.4 PALA1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM1-6: Document achievement of minimum flow requirements at Rio Vista to support fishery and aquatic habitat in the reach of the Sacramento River between Sacramento and Rio Vista.				
Base Condition: Existing data and modeling results for flow statistics of the Sacramento river between Sacramento and Rio Vista **Approach:** Using the existing network of fixed-site sampling stations, collect time-histories of water quality variables. Derive flow rates. **Schedule:** Operate monitoring sites and track flow on a continuous basis for at least 5 years or until a robust predictive model can be derived from the monitoring data that allows forecasting of flow rates as a product of operational and other variables.	**Existing Programs:** 1. Continuous Multi-parameter Monitoring, Discrete Physical /Chemical Water Quality Sampling (Environmental Monitoring program; IEP) 2.Continuous Recorder Sites (DWR, USBR) 3. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program (Central Valley Water Board) 4. Delta Flows Network and National Water Quality Assessment Program (USGS) 5. other (DWR, SRCSD, SWAMP, Central Valley Water Board, State Water Board, SFEI, etc) **Potential Program Additions:** 1. If needed, add complementary stations to track water flows within The Sacramento River between Sacramento and Rio Vista. see also Monitoring Action CM4-4 and Monitoring Action CM4-6.	1. Flow dynamics (cfs) of the Sacramento River reach between Sacramento and Rio Vista.	This monitoring action will provide information regarding the effectiveness of adaptive operational changes to ensure minimum flows at Rio Vista to support fishery and aquatic habitat in the reach of the Sacramento River between Sacramento and Rio Vista. The Implementing Office will use this information to determine if flow rates are within adaptive range limits. The schedule for monitoring may be changed if flow dynamics are found not to be within not adaptive range limits.	ECSY2.1 ECSY2.2 ECSY2.3 ECSY2.4 ECSY2.5 CHSA1.5 STEE1.3 GRST1.1 RILA1.4 PALA1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM1-7: Monitor Delta outflows during the near-term implementation period for environmental benefits.				
Base Condition: Current Delta Outflows; seasonal position of 350 µS/cm EC isohaline (X2). **Approach**: Continue monitoring salinity via the fixed water quality stations throughout the Delta. Obtain Daily and seasonal dynamics to determine if and when Delta outflows are below target levels. **Schedule**: Daily monitoring via fixed station network.	**Existing Programs:** 1. IEP Monitoring Data– daily average surface salinity at fixed stations along the Sacramento River interpolated to determine the location of 350 µS/cm EC isohaline. 2. DSM2 Simulations – daily average, depth-averaged salinity at fixed locations (every DSM2 node) along the Sacramento River is interpolated to determine the location of 350 µS/cm EC isohaline. **Potential Program Additions:** none	1. Daily average surface salinity at fixed stations. 2. Interpolated position of the isohaline (X2), expressed in miles from the Golden Gate Bridge. 3. Net Delta Outflow Index	This monitoring action will provide information on the magnitude of Delta outflow and related parameters (salinity intrusion). It will track the position of the isohaline Based on results and analysis of monitoring data, adaptive modifications to management of Delta outflow under the BDCP adaptive management framework could occur by modifying operational criteria by season or water-year type (hydrology). The schedule of monitoring actions may be altered to improve precision and accuracy of estimating the position of the isohyaline.	ECSY2.1 ECSY2.2 ECSY2.3 ECSY2.4 ECSY2.5 CHSA1.5 STEE1.3 GRST1.1 RILA1.4 PALA1.4
Monitoring Action CM1-8: Record in-Delta agricultural, municipal, and industrial water quality.				
Base condition: Current water quality monitoring **Approach**: Continue current water quality monitoring as mandated by existing D-1641 North and Western Delta agricultural and municipal and industrial (M&I) standards and all water quality requirements contained in the North Delta Water Agency/DWR Contract and other DWR contractual obligations. **Schedule:** as currently implemented.	**Existing Programs:** 1. Continuous Multi-parameter Monitoring, Discrete Physical /Chemical Water Quality Sampling (Environmental Monitoring program; IEP) 2.Continuous Recorder Sites (DWR, USBR) 3. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program (Central Valley Water Board) 4. Delta Flows Network and National Water Quality Assessment Program (USGS) 5. other (DWR, SRCSD, SWAMP, Central Valley Water Board, State Water Board, SFEI, etc)	1. EC (salinity) 2. Water temperature (^{o}C) 3. mg/L dissolved oxygen 4. Turbidity (NTUs) 5. Concentration (µg/L) of ammonia, pyrethroids, copper, organophosphates 6. pH 7. mg methylmercury/L	This monitoring action is intended to collect data necessary to determine if salinity conditions are meeting contractual and legal requirements. This information will be used to address deviations from salinity target conditions, and design modifications and/ research studies to address uncertainty in salinity control. The monitoring schedule may be adjusted in response to monitoring results to better understand causal relationships between water management and salinity.	CHSA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 1-9: Document and quantify effects of modified/reduced operations the Montezuma Slough Salinity Control Gate for covered fish species passage and salinity				
Base Condition: current operation and flows (local current patterns and tidal hydrodynamics). **Approach**: continue to monitor and calculate water quality and flow parameters through Suisun March and at Chipps Island (Delta Net outflow index), continue IEP Suisun Marsh fish monitoring (otter trawls and beach seines) **Schedule**: instantaneous automatic 15 min interval recording of salinity data, Seasonal fish abundance as currently conducted by IEP.	**Existing Programs:** IEP coordinated programs: 1. Suisun Marsh Water Quality Monitoring and Compliance (five compliance stations); 2. Aquatic Monitoring by University of California Davis (UCD) and DFG in Suisun Marsh (otter trawls and beach seine) **Potential Program Additions:** none	1. Catch per unit effort (CPUE) and % change (over baseline conditions) of outmigrating juvenile salmonids and sturgeon in Suisun Marsh; 2. Catch per unit effort (CPUE) and % change (over baseline conditions) of splittail, salmonids, and sturgeon in existing and future restored intertidal marsh habitats in Suisun Marsh (see also CM 4-5). 3. Salinity levels within Suisun marsh and in adjacent Delta channels 4. Flow (cfs) in Montezuma Slough	This monitoring action provides information on the effects of changing or eliminating salinity control gate operations in Montezuma Slough on covered fish species and salinity levels within the Delta. In the event that the control structure remains in place and the gates are opened, results of monitoring could be used in the future to adaptively manage the control gates (resume gate operations) if unexpected undesirable consequences are detected. If the control structure is removed, adaptive management of salinity regimes will require modifications of Delta outflow to manage salinity within the marsh. The monitoring schedule may be adjusted to better inform management decisions if deemed necessary.	CHSA1.1 STEE1.1 STEE1.3 RILA1.4 PALA1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM2: Yolo Bypass Fisheries Enhancements				
Monitoring Action CM2-1: Document the operation of the modified Fremont Weir (i.e., elevation reduction)				
Base Condition: As-built construction drawings. **Approach**: Document flow over the weir. Document the operation of inundation gates and deep channel fish passage gates. **Schedule:** real-time recording, during flooding of the weir.	**Existing Programs:** CA Dept of Water Resources/NCRO river stage monitoring gages **Potential Program Additions:** real-time recording of gate operations (open/closed)	1. River stage at Fremont weir 2. Flow (cfs) 3. Gate status (open/closed)	This monitoring action will provide information on the operation of the modified Fremont weir, particularly on the number of days and the amount of water that flows over the weir into Yolo bypass and the operation of the fish passage gates at below flood stage of the Sacramento River (11.5 – 17.5 ft) This information will be used by the Implementing Office to refine operation of the gates to provide for the inundation of the Yolo bypass according to target levels. The monitoring schedule may be adjusted if deemed necessary to provide higher resolution information for gate operations.	ECSY2.2 ECSY5.1 CHSA1.1 CHSA1.5 STEE1.1 STEE1.2 STEE1.3 SASP1.1 SASP1.2 GRST1.3 WHST1.3 RILA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM2-2: Document the effects of the fish passage gates at Fremont Weir (replacing fish ladder)				
Base conditions: As-built construction drawings. **Approach:** Install and operate underwater high resolution cameras and or automatic fish counters (using resistivity, infrared scanning technology or other appropriate methods) to characterize and quantify covered fish species passing through fish passage gates within the inundation channel during flooding of the Yolo Bypass. Compile and analyze fish passage data daily during operation of the passage gates. **Schedule:** real-time instantaneous fish counting when fish passage gates are open.	**Existing Programs:** none **Potential Program Additions:** Automated fish counting technology (automatic counter sensors, computer system and software to scan, recognize and measure fish); skilled personnel to manage and analyze fish counter data; See Monitoring Action CM2-7, CM2-10, CM2-11	1. Number of fish passing through the gates 2. Species 3. Size class 4. Origin (wild or hatchery for fin-clipped fish)	This monitoring action will provide information to quantify adult fish passage from the up- and downstream between the Sacramento River and the Yolo Bypass. This information will be used by the Implementing Office to estimate the population size of adult covered fish species using the Yolo bypass during inundation. The monitoring schedule will be adjusted during inundation events and status of fish passage gates.	CHSA1.1 CHSA1.5 STEE1.1 STEE1.2 STEE1.3 SASP1.1 SASP1.2 GRST1.3 WHST1.3 RILA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM2-3: Document the effects of the Yolo Bypass modifications to improve distribution (e.g., wetted area) and hydrodynamic characteristics (e.g., residence times, flow ramping, and recession) of water moving through the Yolo Bypass.				
Base conditions: as-built construction drawings; current extent of Yolo bypass inundation and hydroperiod **Approach:** Document and quantify grading, removal of existing berms, levees, and water control structures, construction of berms or levees, re-working of agricultural delivery channels, and earthwork or structures by remote sensing data and field observations entered into GIS. Record and quantify the hydrodynamic characteristics of the Yolo basin by flood and spill gages and satellite imagery LANDSAT or similar to estimate extent of wetted area). Develop correlation between the extent wetted, hydrodynamic indicators and flood gage measurements. Update GIS database if lands are acquired in fee-title or through conservation or flood easements. **Schedule:** Daily monitoring of flood gauges, weekly acquisition of remote sensing data, until a correlation can be established between stage at various flood gauges and hydrodynamic measures.	**Existing Programs:** Yolo bypass inundation gauging stations at Fremont weir (USGS), Sacramento Weir (USGS) and Lisbon (DWR). Potential GIS capability with DWR IISS section within DWR-DES **Potential Program Additions:** Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab)	1. Yolo bypass wetted area 2. Residence times 3. Flow ramping rate (change of water flow cmps/hr hour) 4. Recession timelines	This monitoring action will provide information on the relationships between the hydrological conditions within the Yolo bypass as they pertain to fish habitat, and flood gage information provided throughout the basin. This information will be used to determine the operational constraints and effectiveness of gate and spill operations of the Fremont weir and flow obstruction removals within the floodplain. It will also be used to assess if additional floodplain modifications are necessary to reduce flow and inundation impediments, and to address erosion and other issues. The monitoring schedule may modified once robust, statistically significant and precise correlations have been verified.	ECSY5.1 CHSA1.1 CHSA1.5 STEE1.1 STEE1.2 STEE1.3 SASP1.1 SASP1.2 GRST1.3 WHST1.3 RILA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM2-4: Document and quantify the effectiveness of Experimental Sturgeon Ramps for the upstream migration of sturgeon from the Yolo bypass to the Sacramento River.				
Base condition: as-built construction drawings **Approach**: Install and operate underwater high resolution cameras and automatic fish counters (using infrared scanning technology, resistivity sensors or other appropriate methods) to characterize and quantify covered fish species passing through sturgeon ramps when weir spills exceed 2 feet. **Schedule**: instantaneously count and record fish using ramps. Compile counts daily.	**Existing Programs:** none **Potential Program Additions:** Automated fish counting technology (automatic counter sensors, computer system and software to scan, recognize and measure fish); skilled personnel to manage and analyze fish counter data; live video feed to web-based application See CM 2-2	1. Number of fish passing 2. Species 3. Size class	This monitoring action will provide information on the effectiveness of experimental Sturgeon Ramps at the Fremont Weir to allow passage of adult sturgeon and lamprey from the Yolo Bypass over the Fremont Weir and into the Sacramento River. This information will be used by the Implementing Office within the adaptive management experiment framework to estimate passage rates, refine design features or formulate alternative designs. The monitoring schedule may be adjusted to data needs or may be reduced when effectiveness of the sturgeon rams has been documented with low uncertainty.	GRST1.3 WHST1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM2-5: Document Stilling Basin Modification and assess risk of covered fish stranding.				
Base conditions: As-built construction drawings **Approach**: Document the physical changes in stilling basin topography. Estimate the number of fish stranding in the stilling basin as flows are receding by electro-fishing, beach seining or other appropriate method. **Schedule:** Sample if standing water remains within the basin after weir spills have ceased and floodplain drainage has begun.	**Existing Programs:** Intermittent and historical IEP and USFWS beach seine and trawling methods within the Yolo and Sutter bypasses **Potential Program Additions:** Fish sampling of stilling basin to verify stranding. See CM5-2	Number of fish Size species	This monitoring action will provide information to assess if the basin drains sufficiently into the deep fish passage channel and thus will prevent stranding of juvenile and adult fish. Information from this monitoring action will be used by the Implementing Office to assess the risk of stranding at the stilling basin, and to guide the redesign if necessary, if significant numbers of fish are found to be stranded in the basin after re-contouring. The monitoring schedule will be reduced to annual visits at the end of the inundation period once fish escape of from the basin has been verified with low uncertainty.	CHSA1.1 CHSA1.5 STEE1.1 STEE1.2 STEE1.3 SASP1.1 SASP1.2 GRST1.3 WHST1.3 RILA1.3 PALA1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM2-6: Document and evaluate Sacramento Weir improvements for fish passage and minimization of standing risk.				
Base condition: As-built construction drawings. **Approach:** Document modifications to the weir. Using fish sampling (seining, electro-fishing, traps), determine the number and species of juvenile and adult fish using the stilling basin and (if implemented) fish ladders. Install automatic fish scanners and underwater high-resolution cameras to assess passage of adult fish over the weir into the Sacramento River. **Schedule**: Weekly sampling of fish until a minimal stranding risk has been estimated and verified precisely. Instantaneous video monitoring of fish passing through fish ladder.	**Existing Programs:** none **Potential Program Additions:** Intermittent fish sampling during and after weir spills in Sacramento weir stilling basin; automated fish counting technology (computer system and software to scan, recognize and measure fish); skilled personnel to manage and analyze fish counter data; See Monitoring Action CM2-2	Number, size and species of fish passing over fish ladder Number, species and life stage of juvenile fish sampled in the stilling basin	This monitoring action will provide information on the effectiveness of modifications of the Sacramento weir and its stilling basin to allow passage of adult and juvenile fish from the Yolo Bypass into the Sacramento River or downstream the Tule Canal/Toe Drain to escape stranding. This information will be used by the Implementing Office within the adaptive management experiment framework to estimate passage rates, refine design features or formulate alternative designs. The monitoring schedule may be adjusted to data needs or may be reduced when effectiveness of the implemented modifications has been documented with low uncertainty.	CHSA1.3 CHSA1.1 CHSA1.5 STEE1.1 STEE1.2 STEE1.3 SASP1.1 SASP1.2 GRST1.3 WHST1.3 RILA1.3 PALA1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM2-7: Document the Tule Canal/Toe Drain Improvements to increase hydrologic connectivity.				
Base condition: As-built construction drawings. **Approach:** Document modifications to the Tule Canal /Toe drain. Measure flow within the channel with automatic gages. **Schedule**: Real-time continuous automatic flow measurements.	**Existing Programs:** none **Potential Program Additions:** Install automatic flow gage within the Tule Canal /Toe drain	1. flow (cfs)	This monitoring action will provide information on the effectiveness of modifications of the Tule Canal /Toe drain to allow passage of adult and juvenile fish downstream the Tule Canal/Toe Drain to escape stranding. This information will be used by the Implementing Office within the adaptive management experiment framework refine design features or formulate alternative designs. The monitoring schedule may be adjusted to data needs or may be reduced when effectiveness of the implemented modifications has been documented with low uncertainty.	CHSA1.5 STEE1.3 GRST1.1 GRST1.3 WHST1.3 RILA1.3 RILA1.4 PALA1.4

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-8: Determine the effectiveness of Lower Putah Creek realignments to improve upstream and downstream passage of Chinook salmon and steelhead in Putah Creek and floodplain habitat restoration.				
Base condition: As-built construction drawings. **Approach:** Document modifications to Lower Putah Creek. Using automatic resistivity-based fish counters to detect and enumerate adult fish returning. **Schedule**: Continuous operation of the fish counter during spawning season.	**Existing Programs:** none **Potential Program Additions:** Install automatic fish counter within Lower Putah Creek. See Monitoring Action CM2-7	1. Number of fish returning 2. Species	This monitoring action will provide information on the effectiveness of modifications of Lower Putah Creek to allow passage of adult and juvenile covered fish along Lower Putah Creek. This information will be used by the Implementing Office within the adaptive management experiment framework refine design features or formulate alternative designs. The monitoring schedule may be adjusted to data needs or may be reduced when effectiveness of the implemented modifications has been documented with low uncertainty.	CHSA1.3 STEE1.3 GRST1.3 WHST1.3 RILA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-9: Determine upstream migration success of salmonids, sturgeon, and lamprey through the Yolo Bypass.				
Base condition: existing knowledge of upstream migration and its correlation with flow (DFG data) Approach: Using a combination of mark-recapture and automatic resistivity-based fish counters and high-resolution underwater camera systems at Fremont weir, detect and enumerate adult fish returning (see Monitoring Action CM2-7). Schedule: Continuous operation of the fish monitoring system during migration season	**Existing Programs:** DFG fish tagging program **Potential Program Additions:** automated fish counting technology (computer system and software to scan, recognize and measure fish); skilled personnel to manage and analyze fish counter data; See Monitoring Action CM2-2, CM2-6, CM2-10.	1. Number of fish passing 2. Species 3. Size class	This monitoring action will provide information on the effectiveness of adult covered fish species migrating from the Yolo Bypass over the Fremont Weir and into the Sacramento River. This information will be used by the Implementing Office within the adaptive management experiment framework to estimate passage rates, refine design features or formulate alternative designs. The monitoring schedule may be adjusted to data needs or may be reduced when effectiveness of permeability of the Yolo Bypass for upstream migration of adult fish has been documented with low uncertainty.	CHSA1.3 STEE1.3 GRST1.3 WHST1.3 RILA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-10: Determine passage rates of covered salmonids, sturgeon, Sacramento splittail, and lamprey from the Sacramento River into the Yolo Bypass during periods of Fremont Weir operation.				
Base condition: As-built construction drawings. **Approach:** Using a mark-recapture approach, determine the number and species of juvenile and fish out migrating over the Fremont weir. Install automatic fish scanners and underwater high-resolution cameras to assess passage of adult fish over the weir into the Sacramento River. **Schedule**: Weekly sampling of fish for the period of inundation. Instantaneous video monitoring of fish passing through fish ladder.	**Existing Programs:** none **Potential Program Additions:** Intermittent fish sampling during and after weir spills; automated fish counting technology (computer system and software to scan, recognize and measure fish); skilled personnel to manage and analyze fish counter data; See Monitoring Action CM2-2, CM2-7, CM2-10	Number, size and species of fish passing over fish ladder Number, species and life stage of juvenile fish sampled in the stilling basin	This monitoring action will provide information on the effectiveness of modifications of the Sacramento weir and its stilling basin to allow passage of adult and juvenile fish from the Yolo Bypass into the Sacramento River or downstream the Tule Canal/Toe Drain to escape stranding. This information will be used by the Implementing Office within the adaptive management experiment framework to estimate passage rates, refine design features or formulate alternative designs. The monitoring schedule may be adjusted to data needs or may be reduced when effectiveness of the implemented modifications has been documented with low uncertainty.	ECSY5.1 CHSA1.2 STEE1.2 SASP1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-11: Determine zooplankton and invertebrate production rates during periods the Fremont Weir is operated.				
Base Condition: existing data on Yolo Bypass zooplankton productivity **Approach:** Establish monitoring stations at inflow and outflow locations and within the inundated floodplain of the Yolo bypass. Take weekly grab samples and measurements of chlorophyll a and zooplankton. **Schedule:** Conduct sampling for the first 5 years following reestablishment of tidal flow and every 5 years thereafter.	**Existing Programs:** Environmental Monitoring Program (EMP, under IEP) **Potential Program Additions:** **1.** Additional sampling stations in the Yolo Bypass floodplains t reflect the before-after-control-impact design. Locations of some added stations will be fixed during the duration of the plan (systemwide monitoring to detect increase on food availability in delta waterways), others are added to account for different flow rates and inundation depth in dry vs wet years to track how food production develops over time. Sampling stations will also provide water quality data (e.g., temperature, turbidity, pH for ammonia conversion, amount of organic carbon) Invertebrate sampling should be adaptively adjusted to changes in fish diets – see also: Monitoring Action CM4-4, CM4-6, and CM16-5	1. Phytoplankton species composition/relative abundance 2. Phytoplankton density (mg/L chlorophyll a) 3. Zooplankton species composition/relative abundance 4. Zooplankton density (number/1,000 m^3)	This monitoring action is intended to collect data necessary to determine and quantify the degree to which the Yolo bypass is producing and exporting phytoplankton and zooplankton into the Delta. This information, in combination with evaluation of other foodweb-related monitoring and research data, will provide the basis for : 1. Identifying sources of uncertainty and the design of management experiments and/ research studies, to address uncertainty. 2. evaluating underlying conceptual models and hypotheses (source-sink dynamics, variability and uncertainty in primary production response) 3. evaluating restoration design options to increase the production and export of primary production inundated floodplains 4. Implementing additional management actions to improve production and export of primary production from the floodplain. The monitoring schedule will be modified if uncertainty or variances do not support a clear causal relationship between floodplain inundation and food production and - exports.	ECSY5.1 ECSY5.2 CHSA1.2 STEE1.2 SASP1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-12: Determine growth rates of juvenile salmonids entering the Yolo Bypass during periods of Fremont Weir operation.				
Base condition: Current studies and knowledge about salmon growth and survival in the Delta and the Yolo bypass. **Approach**: Conduct routine mark-recapture and radio-telemetry tagging experiments by marking juvenile salmon within the Yolo bypass and measuring survival and growth rates at Chipps Island **Schedule**: annually mark and radio-tag individual Chinook for at least 5 years. Repeat mark-recapture monitoring every 5th year	**Existing Programs:** IEP mid-water trawl at Chipps Island, previous salmon survival studies (Perry et al 2009) **Potential Program Additions:** 1. routine radio-tracking and mark recapture program	1. survival rates 2. growth rates (mm/d)	This monitoring action provides information on the effectiveness of modifying the Fremont weir to benefit survival and growth rates of juvenile outmigrating Chinook salmon. The implementing Office will use this information to determine if operation of the Fremont weir is achieving target levels of survival and growth. The information will also ser as a basis to determine f additional research should be conducted, and if initial models and hypotheses are supported by monitoring data. The monitoring schedule may be extended if survival and growth data are inconclusive to determine that survival and growth has achieved target levels or of substantial environmental variability has increased the level of uncertainty associated with predicted outcomes.	CHSA1.2 STEE1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-13: Determine escapement success of juvenile covered salmonids, sturgeon, Sacramento splittail, and lamprey from the Yolo Bypass during periods of Fremont Weir operation.				
Base condition: Current studies and knowledge about survival of juvenile covered fish in the Delta and the Yolo bypass. **Approach**: Conduct routine mark-recapture and/ or radio-telemetry tagging experiments by marking juvenile covered species near the Fremont Weir within the Yolo bypass and measuring survival and growth rates at Chipps Island **Schedule**: annually mark and radio-tag individual covered species for at least 5 years. Repeat mark-recapture monitoring every 5th year	**Existing Programs:** IEP mid-water trawl at Chipps Island, previous salmon survival studies (Perry et al 2009) **Potential Program Additions:** 1. routine radio-tracking and/or mark recapture program	1. Survival rates 2. Species	This monitoring action provides information on the effectiveness of modifying the operations of Fremont weir to benefit survival and growth rates of juvenile outmigrating covered species. The implementing Office will use this information to determine if operation of the Fremont weir is achieving target levels of survival and growth. The information will also serve as a basis to determine if additional research should be conducted, and if initial models and hypotheses are supported by monitoring data. The monitoring schedule may be extended if survival and growth data are inconclusive to determine that survival and growth has achieved target levels or of substantial environmental variability has increased the level of uncertainty associated with predicted outcomes.	CHSA1.1 STEE1.1 GRST1.1 PALA1.2
Monitoring Action CM 2-15: Document Sacramento splittail spawning and spawning success in the Yolo Bypass during periods of Fremont Weir operation.				
	[Text to come.]	[Text to come.]	[Text to come.]	SASP1.1 SASP1.2 SASP1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 2-16: Determine the distribution and abundance of giant garter snake in the Yolo Bypass.				
Base Condition: none **Approach**: Using accepted survey protocols, conduct randomized, stratified surveys to detect presence of GGS in the Yolo Bypass, especially using known or historical locations as starting points and radiating outwards from there. **Schedule**: Annual surveys during periods of GGS activity. Continue for at least 5 inundation years. Repeat every 5 years, focusing on verifying presence in previously established occurrences.	**Existing Programs:** historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. Standardized surveys for Giants Garter Snake 3. Establishment of new sampling points/grids/stations as habitat patches are restored and populations expand See Monitoring Action CM4-8 , 4-14	1. Presence and sex/age distribution of Giant Garter Snake 2. Estimated population trend Giant Garter Snakes in restored habitats (source or sink?)	This monitoring action is intended to collect data on the distribution and population trend of giant garter snake in the Yolo Bypass. Monitoring results will be used to determine if habitat restoration has a source or sink effect on the abundance of giant garter snake in the Yolo Bypass This information is necessary to determine if adaptive changes to the implementation schedule or additional measures may be necessary to increase the abundance and viability of giant garter snake populations in the Yolo Bypass	TANC1.1 FMNC1.1 FMNC2.1 NANC2.1 NWNC2.1 ALNC1.2 ALNC1.5 ALNC1.7 ALNC1.8 GGSN1.1 GGSN2.1
Monitoring Action CM 2-17: Determine abundance of wintering waterfowl and shorebirds in the Yolo Bypass during years the Fremont Weir is operated.				
Base Condition: Current waterfowl monitoring as conducted by USFWS, CDFG and CWA **Approach**: Continue USFWS and CDFG special fall and midwinter aerial surveys. The midwinter survey, the longest running population assessment, focuses on all ducks, geese, swans, and coots. **Schedule**: Annual mid-winter surveys as currently implemented by USFWS.	**Existing Programs:** USFWS midwinter waterfowl surveys **Potential Program Additions:** none	1. Number 2. Species 3. sex/age composition (if possible)	This monitoring action provides information on the abundance of wintering waterfowl. The Implementation office will use this information to determine the effectiveness of inundation of the Yolo bypass ion providing wintering habitat for waterfowl. The Monitoring schedule may be changed if necessary to improve accuracy and/or precision of waterfowl estimates.	MWNC1.1 MWNC1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM3: Protect Natural Communities				
Action CM3-1 Record the acquisition or protection of parcels by conservation zone, natural community, and covered species habitat.				
Base Condition: Pre-acquisition parcel information. **Approach**: Document and record in a suitable database the characteristics of protected land as they are added to the conservation lands system **Schedule:** Update maps and database of conservation lands annually to reflect status of each parcel as they are added to the conservation land system.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab)	Acres of land protected by Conservation Zone / ROA and natural community Linear miles of edge within tidal mudflat habitats as habitat for tidal-mudflat associated species (e.g., Delta tule pea, Suisun marsh aster)	This monitoring action will provide the means to track how the Implementing Office is adding conservation lands in each Conservation Acquisition zone. This information will be used to assess progress and determine if conservation targets in each CAZ and natural community have been met.	ECSY1.1 ECSY1.2 GRNC1.1 VPNC1.1 ALNC1.1-1.6
Monitoring Action CM 3-2: Record, quantify and delineate occurrences of covered plant species.				
Base Condition: Pre-acquisition parcel information. Baseline survey of parcels at acquisition **Approach**: Document and record in a suitable database the characteristics of rare species occurrences on BDCP protected lands **Schedule**: Survey once every 5 years to document presence and condition/abundance of special status plants	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Special status surveys and species verifications by a qualified botanist	Species occurrences: 1. Location 2. Species 3. Habitat 4. Number of individuals 5. Land use 6. Threats	This monitoring action will provide information on the presence and status of special-status plants on conservation lands within the BDCP Plan Area. This information will be used in the development of specific management plans for each parcel to ensure that management and protection activities are compatible with special-status plants and these plants are protected and maintained. The monitoring schedule will be altered for species that are dependent on specific climatic events or conditions (i.e. vernal pool plans require "wet" years to emerge)	ALMV1.1 AWNC1.1 CAGB1.1 CFTR1.1 DEBC1.1 HART/ BRIT1.1 HEPE1.1 SOBB1.1 SUTH1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 3-3: Document habitat connectivity among the various BDCP conservation land units in the conservation land system.				
Base Condition: Pre-acquisition parcel information. Baseline documentation **Approach**: Document and record in a suitable database evidence of connectivity and movement of animals and plants across conservation land habitats. **Schedule**: Update maps and database of conservation lands annually to reflect the conservation status of adjacent lands and the location of newly arriving species of interest.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab)	Land status and changes in natural communities on adjacent parcels Species occurrence of newly arriving species Observed shifts in species distribution and use of the parcel.	This monitoring action will identify how well the protected lands are connected with adjacent habitats to enable species to move across the landscape. This information will be used to determine where uncertainties and knowledge gaps exists regarding the connectivity of habitats within the BDCP Plan Area, and where corridors for covered and invasive species exist. This information will be used to determine appropriate management strategies to support covered species and reduce the likelihood of dispersal of non-native invasive species. The monitoring schedule may be reduced to every 5 or even 10 years once conservation targets have been met within a Conservation Zone.	ECSY3.1 ECSY7.1 ALNC1.7 VRNC2.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Natural Community-Level Conservation Measures				
CM4: Tidal Habitat Restoration				
Monitoring Action CM4-1. Document the extent of tidal habitat restored.				
Base Condition: As-built construction drawings. **Approach:** Delineate the extent of subtidal aquatic, unvegetated mudflat, vegetated marsh plain by vegetation type, and transitional upland by vegetation type. **Schedule:** Annually delineate habitat components for the first 5 years following reestablishment of tidal flow and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (aquatic botanist) See Monitoring Action CM4-2, CM16-1	1. Extent, distribution, and channel order of tidal perennial aquatic natural community on restoration sites. 2. Percentage of subtidal aquatic habitat in areas of subsidence 3. Extent, distribution and persistence of high-functioning tidal mudflat community	This monitoring action provides information regarding the development of restored habitat components over time. Results will be used to evaluate if targets and objectives have been met, parameterize and evaluate conceptual models and other analytical tools, and to prioritize potential actions according to certainty, magnitude and timeliness of benefit. This information will also provide the basis for determining if there is a need to modify subsequent restoration designs to improve their ecosystem and habitat functions, or if it is necessary to alter management actions to support the development of desired habitat functions (e.g., control of non-native vegetation, planting of native emergent vegetation to improve development of marsh functions). The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	TANC1.1 BMNC1.1 FMNC1.1 MFNC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-2. Document the progress of vegetation community establishment and the extent of covered species habitat provided by restored tidal habitats.				
Base Condition: As-built construction drawings. **Approach:** For the first 5 years following completion of tidal marsh restoration projects, annually conduct aerial and/or field surveys in October to map the extent of tidal vegetation establishment. Evaluate and quantify the extent of each covered species habitat based on evaluation of data collected under Monitoring Action CM4-1. **Schedule:** Annually quantify the extent of restored covered, species habitats for the first 5 years following reestablishment of tidal flow and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (aquatic botanist/ field personnel; see Monitoring Action CM4-1, CM16-1)	1. Extent, distribution and persistence of high-functioning tidal mudflat community 2. Linear extent of restored or created tidal mudflat substrate as part of the restored brackish and freshwater tidal habitat and channel margin enhancement. 3. Acres of covered species habitat 4. presence of key habitat correlates and requisites/attributes for covered species 5. Percent absolute and relative cover 6. Extent, distribution, cover, and species composition of non-native invasive species within establishing tidal mudflats on restoration sites	This monitoring action is intended to provide information regarding the development of habitat covered species in restored tidal habitats over time. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	BMNC1.1 FMNC1.1 MFNC1.1 SOBB1.1 SUTH1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-3. Quantify the primary production exported from restored tidal marsh plain into adjacent restored subtidal aquatic habitat areas.				
Base Condition: Seasonal abundances of phytoplankton and zooplankton in channels adjacent to restoration sites. Sample restored subtidal prior to breaching of levees, measured for at least one year prior to restoring tidal habitat. **Approach:** Establish monitoring stations at inflow and outflow locations and within restored subtidal habitat. Take weekly grab samples and measurements of chlorophyll a and zooplankton. **Schedule:** Conduct sampling for the first 5 years following reestablishment of tidal flow and every 5 years thereafter.	**Existing Programs:** Environmental Monitoring Program (EMP, under IEP) **Potential Program Additions:** **1.** Additional sampling stations in connection with restored tidal marsh plains to reflect the before-after-control-impact design. Locations of some added stations will be fixed during the duration of the plan (systemwide monitoring to detect increase on food availability in delta waterways), others are added as levees are breached and sites are flooded to track how food production in individual wetlands develops over time (i.e., flux from wetland restoration sites) Sampling stations will also provide water quality data (e.g., temperature, turbidity, pH for ammonia conversion, amount of organic carbon) Invertebrate sampling should be adaptively adjusted to changes in fish diets – see also: Monitoring Action CM4-4, CM4-6, and CM16-5	1. Phytoplankton species composition/relative abundance 2. Phytoplankton density (mg/L chlorophyll a) 3. Zooplankton species composition/relative abundance 4. Zooplankton density (number/1,000 m^3)	This monitoring action is intended to collect data necessary to determine and quantify the degree to which restored tidal habitats are producing and exporting phytoplankton and zooplankton into restored subtidal habitats. This information, in combination with evaluation of other foodweb-related monitoring and research data, will provide the basis for : 1. Identifying sources of uncertainty and the design of management experiments and/ research studies, to address uncertainty. 2. evaluating underlying conceptual models and hypotheses (source-sink dynamics, variability and uncertainty in primary production response) 3. evaluating restoration design options to increase the production and export of primary production from restored tidal marsh plains 4. Implementing additional management actions to improve production and export of primary production from restored tidal marsh plains The monitoring schedule will be modified if uncertainty or variances do not support a clear causal relationship between tidal marsh restoration and food production and exports. The intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	ECSY5.1 ECSY5.2 TANC1.1 BMNC1.1 FMNC1.1 SASP1.2 CHIN1.1 STEE1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-4. Document the export of organic carbon produced in restored tidal marsh plain into existing Plan Area channels.				
Base Condition: Not applicable. **Approach:** Determine the extent of organic carbon produced in restored tidal marsh plains that is exported from restored tidal habitats to downstream locations either through modeling (e.g., particle tracking modeling) or direct observation (e.g., isotope marking). **Schedule:** To be determined based on an assessment of the sufficiency of phytoplankton and zooplankton production levels determined under CM4-3. Conduct once to establish the extent of organic carbon that is exported and repeat as needed if hydrodynamic conditions change sufficiently in the future such that export rates might be affected.	**Existing Programs:** Environmental Monitoring program (EMP, under IEP) **Potential Program Additions:** See Monitoring Action CM4-3. 1.Possible adaptive expansion of the monitoring program to include isotope particle marking and tracking to determine organic carbon exports downstream locations	1. Amount of organic carbon produced in restored tidal marsh 2. Proportion of total organic carbon produced in restored tidal marsh plain that is exported to specified downstream locations.	This monitoring action is intended to collect complimentary and additional data necessary to determine if and how much restored tidal habitats are producing and exporting phytoplankton and zooplankton to downstream locations. This monitoring is an adaptive contingency monitoring action in case actions under CM-4 suggest a high degree of uncertainty or suggest inadequacy of conceptual models. This monitoring action will be implemented as targeted research project to address uncertainty in food production pathways and the magnitude and dynamics of exports into Delta water ways. It will be adaptively applied to sites, seasons and identified portions of the Delta.	ECSY5.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-5. Determine the extent of covered fish species habitat restored by life stage.				
Base Condition: Not applicable. **Approach:** Based on the current understanding of life stage requirements of each covered fish species and key environmental correlates, delineate the extent of habitat restored for each covered species life stage based on bathymetry (determined from as-build drawings), substrate (assessed before levee breaching), and water quality parameters determined through CM-11. **Schedule:** Annually for the first 10 years and every 5 years thereafter.	**Existing Programs:** Current knowledge on life history and biology of covered fishes in the Delta, life history models. **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab)	1. Extent of restored habitat 2. extent of spawning habitat 3. extent of rearing habitat 4. portion of restored habitat within migration routes/corridors	This monitoring action will provide information on the amount of habitat that is being restored through BDCP conservation measures and how it pertains to requirements for stage-specific life history events of covered species. The implementing Office will use this information to determine if restored habitat effectively addresses habitat limitations. The monitoring action will be intensified of modeling or field observations suggest that certain habitats are in short supply and that restoration and protection targets should be modified through the adaptive decision making process.	CHSA1.1 STEE1.1 SASP1.1 GRST1.2 WHST1.1 RILA1.1 PALA1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-6. Determine covered fish species use of restored subtidal aquatic habitat.				
Base Condition: Estimated existing seasonal abundances of relevant life stages of covered fish species in channels adjacent to restoration sites based on existing information (IEP fish sampling). **Approach:** Conduct surveys for each covered fish species using standardized existing or improved methods. **Schedule:** Conduct sampling for the first 5 years following reestablishment of tidal flow and at least every 5 years thereafter.	**Existing Programs:** IEP –coordinated fish surveys: 1. CDFG 20 mm Survey 2. CDFG Delta smelt larva study 3. USFWS Spring Kodiak Trawl and "Supplemental Surveys", Mossdale trawl 4. USFWS Midwater trawl 5. USFWS beach seine 6. CDFG Summer townet survey 7. UCD/IEP Suisun Marsh otter trawl **Potential Program Additions:** 1. Expanded sampling location array to reflect changed food availability, diversion and flow regimes (e.g., North delta and Ship Channel); additional sampling areas should be located near restored subtidal habitat to determine fish response to restored habitats. Stratify sampling by project and systemwide variables.	1. Seasonal distribution of covered fish species 2. Type of use (e.g., rearing, spawning) 3. Duration of use 4. species, age composition and sizes of covered fish species 5. CPUE	This monitoring action will provide information to determine and quantify use of restored subtidal aquatic habitat by covered fish species. This information in combination with evaluation of other covered fish species-related monitoring and research data, will be used to evaluate underlying models and hypotheses about the predicted benefits of restored subtidal aquatic habitat to covered fish species. This information will aid in identifying sources of uncertainty and will guide the design of further management experiments and/ research studies to address uncertainty. The Implementing Office will use this information to evaluate restoration design options and additional management actions to increase the benefits of restored tidal marsh plains to covered species. The monitoring schedule and methods may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	CHSA1.1 STEE1.1 SASP1.1 GRST1.2 WHST1.1 RILA1.1 PALA1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-7. Determine nonnative fish species use of restored subtidal aquatic habitat.				
Base Condition: Estimated existing seasonal abundances of relevant life stages of nonnative fish species in channels adjacent to restoration sites based on existing information (IEP fish sampling). **Approach:** Conduct surveys for nonnative fish species using standardized existing or improved methods. **Schedule:** Conduct sampling for the first 5 years following reestablishment of tidal flow and at least every 5 years thereafter.	**Existing Programs:** IEP –coordinated fish surveys: 1. CDFG 20 mm Survey 2. CDFG Delta smelt larva study 3. USFWS Spring Kodiak Trawl and “Supplemental Surveys”, Mossdale trawl 4. USFWS Midwater trawl 5. USFWS beach seine 6. CDFG Summer townet survey 7. UCD/IEP Suisun Marsh otter trawl **Potential Program Additions:** 1. Expanded sampling location array to reflect changed food availability, diversion and flow regimes (e.g., North delta and Ship Channel); additional sampling areas should be located near restored subtidal habitat to determine fish response to restored habitats. Stratify sampling by project and systemwide variables.	1. Seasonal distribution of covered fish species 2. Type of use (e.g., rearing, spawning) 3. Duration of use 4. species, age composition and sizes of covered fish species 5. CPUE	This monitoring action will provide information to determine and quantify use of restored subtidal aquatic habitat by nonnative fish species. This information in combination with evaluation of other non-native fish species-related monitoring and research data, will be used to evaluate underlying models and hypotheses about the predicted use of restored subtidal aquatic habitat by nonnative fish species. This information will aid in identifying sources of uncertainty and will guide the design of further management experiments and/ research studies to address uncertainty. The Implementing Office will use this information to evaluate restoration design options and additional management actions to minimize the use of restored tidal marsh plains to nonnative species. The monitoring schedule and methods may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	ECSY6.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-8. Determine the extent of nonnative submerged (SAV) and floating aquatic vegetation (FAV) in subtidal aquatic habitats.				
Implemented through Monitoring Action CM13-1. *Also see Monitoring Action SY 5-2. Determine the abundance and species composition of non-native, submerged and floating aquatic vegetation (Table 3-20)*				ECSY6.1
Monitoring Action CM4-9. Determine the extent and patterns of establishment of nonnative clams in restored subtidal aquatic habitats.				
Base conditions: ongoing benthic monitoring by IEP throughout the Estuary. **Approach**: Benthic monitoring will be conducted at up to 20 sites within the estuary, with four benthic samples and one sediment sample taken at each site. Samples are analyzed by a contracting lab. Samples will be collected using a hydraulic winch and Ponar dredge or other appropriate grab sampler. **Schedule**: Quarterly	**Existing Programs:** Benthic monitoring component of IEP's Environmental Monitoring Program (EMP) **Potential Program Additions:** Increase the number of benthic sampling stations to up to 20 sites as a representatively sample of the entire BDCP plan area. Database to track observation and incidental records of non-native bivalves to estimate their habitat use and range expansion in the Delta	1. Species of non-native bivalves 2. Total number of individuals counted 3. Size distribution of clams	This monitoring activity provides information on the non-native clams of the estuary, changes in their presence, abundance and distribution. Data collected from the benthic monitoring program is also used to detect newly introduced species in the estuary. The Implementing Office will use this information to determine the status and change of benthic communities over the term of the BDCP and to evaluate possible causal relationships between physical factors and benthic invertebrate communities. This information will also provide important indicators of invasive species progress, impacts of toxics and water operations, and other changes within the Delta. The monitoring schedule may be adjusted to provide data at a higher temporal or spatial resolution of deemed necessary.	ECSY6.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-10. Determine the extent and patterns of establishment of Microcystis in restored subtidal aquatic habitats				
Base Condition: existing data on Delta microcystis abundance, productivity and correlations with water quality parameters **Approach:** Establish additional fixed monitoring stations as needed in areas where microcystis blooms are observed or likely to occur given water conditions. Take weekly grab samples and measurements of chlorophyll a. **Schedule:** Conduct sampling for the first 5 years following first detection and every 5 years thereafter.	**Existing Programs:** Environmental Monitoring Program (EMP, under IEP) **Potential Program Additions:** **1.** Locations of added stations will be fixed during the duration of the plan to detect increase on microcystis abundance and blooming activity in delta waterways Sampling stations will also provide water quality data (e.g., temperature, turbidity, pH for ammonia conversion, amount of organic carbon) *See Monitoring Actions CM 4-3, CM4-4 , CM4-6, and CM16-5* *See Monitoring Actions SY5-3 (Table 3-21)*	1. Phytoplankton species composition/relative abundance 2. Phytoplankton density (mg/L chlorophyll a) 3. microcystis colony structure 4. Water temperature 5. $NH4^+$ concentration 6. EC 7. presence of non-native clams (see SY5-3)	This monitoring action is intended to collect data necessary to determine and quantify the degree of microcystis spread and toxic blooms in the Delta. This information, in combination with evaluation of other foodweb-related monitoring and research data, will provide the basis for : 1. Identifying sources of uncertainty and the design of management experiments and/ research studies, to address uncertainty. 2. evaluating underlying conceptual models and hypotheses (e.g., excessive N loading . grazing effects by clams, salinity and temperature limiting factors) 3. evaluating restoration design options to increase the production and export of primary production inundated floodplains 4. Implementing additional management actions to improve production and export of primary production from the floodplain.	ECSY6.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-11. Determine water quality conditions for covered fish species in restored subtidal aquatic habitats.				
Base Condition: Existing seasonal water quality conditions in channels adjacent to restoration sites based on existing information (see Applicable IEP and other Resources). Upon breaching, establish base conditions by paired sampling within restored habitat and at outflow channel locations. **Approach:** Establish water quality sampling stations in restored subtidal habitat area. Monthly, collect and analyze water grab samples at representative depths for: 1) water temperature, 2) dissolved oxygen, 3) turbidity, 4) salinity, 5) ammonia and 6) methylmercury. **Schedule:** Sample monthly for 1) the first 2 years following reestablishment of tidal flow, 2) quarterly for the following 10 years, 3) and quarterly every 5 years thereafter.	**Existing Programs:** 1. Continuous Multiparameter Monitoring, Discrete Physical /Chemical Water Quality Sampling (Environmental Monitoring program; IEP) 2.Continuous Recorder Sites (DWR, USBR) 3. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program (Central Valley Water Board) 4. Delta Flows Network and National Water Quality Assessment Program (USGS) 5. other (DWR, SRCSD, SWAMP, Central Valley Water Board, State Water Board, SFEI, etc) **Potential Program Additions:** **1.** There are over 100 water quality sampling sites within the Delta providing a baseline of water quality data. If needed, additional localized sampling stations may be added to reflect the before-after-control-impact design (grab samples in project locations). Locations of some stations will be added as levees are breached and sites are flooded to track water quality changes at restoration sites.	1. Water temperature (^{o}C) 2. mg/L dissolved oxygen 3. Turbidity (NTUs) 4. Salinity (EC) 5. pH 6. mg methylmercury/L	This monitoring action is intended to collect data necessary to determine if water quality conditions in restored tidal marshes are suitable for supporting covered fish species. It will also be used to determine the possible impact on water quality in adjacent channels and habitats. This information will be used to evaluate underlying models and hypotheses of water quality responses to tidal marsh restoration. This information will aid in identifying sources of uncertainty and will guide the design of further management experiments, design modifications and/ research studies to address uncertainty. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	CHSA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-12. Determine the response and status of salt marsh harvest mouse, Suisun shrew, Suisun song sparrow, and California clapper rail, California black rail to loss of existing Suisun Marsh habitats that are restored as tidal habitat.				
Base Condition: The existing distribution and abundance of Suisun Marsh covered mammal and bird species based on existing information and additional surveys if needed. **Approach:** Conduct surveys, transects, mark-recapture or other methods to evaluate the response and status of Suisun Marsh populations of covered mammal and bird species following the conversion of existing species habitat areas to tidal habitat. Map upland refugia during high tide events, survey for presence/use of salt marsh harvest mouse during high tide **Schedule:** Conduct at least annual sampling of covered species distribution and abundance for 5 years following each tidal habitat restoration project until use of restored tidal habitats by covered mammal and bird species is established.	**Existing Programs:** IEP's Suisun marsh program (triennial vegetation surveys, GIS map identifying 103 vegetation classifications, change detection analysis, Salt Marsh Harvest Mouse Monitoring program on Conservation Areas), Point Reyes Bird Observatory (PRBO) San Francisco Bay Tidal Marsh Project, some historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. Regular mark-recapture program for SMHM and Suisun shrew (trapping grids) in Suisun marsh 2. Standardized surveys for Clapper rail, Suisun song sparrow and black rail (using PRBO San Francisco Bay Tidal Marsh Project protocols as appropriate) 3. Establishment of new sampling points/grids/stations as habitat patches are restored See Monitoring Action CM4-9	1. Abundance (N) of each species in Suisun Marsh 2. Population trend (λ) of each species in Suisun Marsh 3. Distribution and range of each species in Suisun Marsh 4. Extent and distribution of upland refugia for salt marsh harvest mouse during high tide.	This monitoring action is intended to test the hypothesis that restoring tidal marshes will have no effect on the status and population size of covered species in Suisun Marsh. Monitoring results will be used to determine how much habitat restoration has affected the distribution and abundance of Suisun Marsh covered mammal and bird species. This information is necessary to determine if adaptive changes to the implementation schedule (i.e., timing and extent of tidal habitat restoration projects in Suisun Marsh) are necessary to maintain viability of covered species populations in Suisun Marsh. Monitoring frequency and intensity may be adjusted to provide monitoring that addresses uncertainties effectively.	TANC1.1 BMNC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-13. Determine covered wildlife species use of restored tidal habitats in Suisun Marsh.				
Base Condition: The existing distribution and abundance of covered marsh-associated wildlife species in Suisun Marsh based on existing information and additional surveys if needed. Not applicable to restoration sites in the Delta. **Approach:** Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, nesting) of marsh plain and transitional upland habitats by covered wildlife species. Conduct standard vegetation transects and monitoring of incidental reports of newly established clones of covered plants, tracking of growth, survival and cover of covered plant species. **Schedule:** Conduct surveys for each species during each species' active period for 5 years following the development of habitat functions for each species as determined through data collected under CM4-2 and every 5 years thereafter.	**Existing Programs:** IEP's Suisun marsh program, some historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. Intensive mark-recapture program for SMHM and Suisun shrew in Suisun marsh 2. Standardized surveys (breeding, winter) for Clapper rail, Suisun song sparrow and black rail 3. standard surveys of covered plant species 3. Establishment of new sampling points/grids/stations as habitat patches are restored and populations expand See Monitoring Action CM4-8	1. Estimated abundance of each species in using restored habitat 2. estimated populations trend in restored habitats (source or sink?) 3. Presence and population size of covered plant species (e.g., bird's beak, Mason's lilaeopsis, Delta mudwort, Delta tule pea Slough thistle,and Suisun Marsh aster)	This monitoring action is intended to collect data on the distribution and population trend of covered species in Suisun Marsh restored habitats. Monitoring results will be used to determine if habitat restoration has a source or sink effect on the abundance of Suisun Marsh covered mammal and bird species This information is necessary to determine if adaptive changes to the implementation schedule (i.e., timing and extent of tidal habitat restoration projects in Suisun Marsh) are necessary to maintain populations of these covered species in Suisun Marsh and to increase the utility of restored habitats to covered species	ECSY1.5 TANC1.1 MFNC1.1 MFNC1.2 BMNC1.1 BMNC2.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM4-14. Determine covered wildlife species use of restored tidal habitats in the Delta.				
Base Condition: The existing distribution and abundance of covered marsh-associated wildlife species, specifically giant garter snake (Conservation Zone 4 and 5), western pond turtles, and California least tern foraging sites. **Approach:** Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, nesting) of marsh plain and transitional upland habitats by covered wildlife species. Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, nesting) of Giant Garter snake (Conservation Zone 4 and 5), western pond turtles, and California least tern sites. **Schedule:** Conduct surveys for each species during each species' active period for 5 years following the development of habitat functions for each species as determined through data collected under CM4-2 and every 5 years thereafter.	**Existing Programs:** historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. Standardized surveys for Giants Garter Snake, western pond turtles and California least tern 3. Establishment of new sampling points/grids/stations as habitat patches are restored and populations expand See Monitoring Action CM4-8	1. Presence and sex/age distribution of Giant Garter Snake 2. Presence and sex/age distribution of western pond turtles 3. Estimated populations trend of covered species in restored habitats (source or sink?)	This monitoring action is intended to collect data on the distribution and population trend of covered species in restored habitats. Monitoring results will be used to determine if habitat restoration has a source or sink effect on the abundance of covered mammal and bird species. This information is necessary to determine if adaptive changes to the implementation schedule (i.e., timing and extent of tidal habitat restoration projects) are necessary to maintain populations of these covered species and to increase the utility of restored habitats to covered species.	ECSY1.5 TANC1.1 MFNC1.1 MFNC1.2 BMNC1.1 BMNC2.1 FMNC1.1 FMNC2.1 GGSN1.1 GGSN2.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM5: Seasonally Inundated Floodplain Restoration				
Monitoring Action CM 5-1: Develop inundation rating curves to quantify the relationship between discharge and inundation dynamics of floodplain habitat for covered species.				
Base condition: As-built restored habitat elevations and river stage elevations**.** **Approach:** The Implementing Office will develop inundation rating curves for inundation depth and extent of restored inundated floodplain habitat area and will record floodplain inundation events and period of inundation by automatic water depth monitoring gages and other appropriate methods. **Schedule**: monitoring of inundation depth and extent of inundated area will continue until a sufficient inundation rating curve can be established with reasonable uncertainty.	**Existing Programs:** California Bay Delta Authority Science Program - Integrated Regional Wetlands Monitoring (historical pilot program) **Potential Program Additions:** 1. Installation and monitoring of automated monitoring devices or other appropriate measures to determine inundation depth, stage and frequency.	1. Inundation frequency 2. Inundation duration	This monitoring element will provide information on the relationship between inundation depth and inundation period and extent to guide the design of floodplain projects and/or operation of flood control structures. This information will be used to guide and if necessary, change the design of floodplain restoration projects and if applicable, the operation of flood control structures to effectively control the period of inundation in seasonal floodplains under an variable flow regimes. The monitoring schedule may be adjusted in response to uncertainty of the established ratings curve.	CHSA1.1 STEE1.1 SASP1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM5-2: Record and quantify incidences and locations of stranded covered fish species at the end of the inundation period in restored floodplains.				
Base Condition: none **Approach**: Visual and other surveys (e.g., beach seining) immediately following inundation periods in restored floodplain habitats as flows are receding from the floodplain to document stranding locations and magnitude. **Schedule**: Annual surveys for the first five years after restoration. Once documented, monitoring will be discontinued and a more limited monitoring effort to be determined by the Implementing Office would be conducted every 5th year that restored floodplains are inundated to document any changes in stranding location and magnitude that may result from changes in floodplain topography (e.g., formation of scour holes or sedimentation that create isolated pools).	**Existing Programs:** Intermittent and historical IEP and USFWS beach seine and trawling methods within the Yolo and Sutter bypasses **Potential Program Additions:** **1.** Weekly surveys of restored floodplains to identify areas suddenly dewatered by lower river conditions which may contain stranded fish. 2. Follow-up on the ground, dip netting, beach seining or electro-shocking of remnant puddles to verify stranding. On-the-ground mapping of standing locations to guide re-contouring.	1. locations of covered fish species stranding 2. number, species, length, and age/sex distribution of stranded fish 3. type of stranding pool (i.e., erosion, topography, man-made, etc.)	This monitoring action will provide information on the extent and magnitude of fish strandings at the end of the inundation period in restored floodplains. This information will be used to determine the severity of fish stranding and their locations within the restored floodplain. Results of monitoring will be used to determine if modifications to floodplain surfaces are needed to reduce stranding risk (e.g., grading). The schedule of the monitoring action may be adjusted to reflect changes in management. In locations where floodplain topography was altered to reduce fish stranding, monitoring will continue for at least 3 years to document reduction in stranding incidences.	CHIN1.1 STEE1.1 SASP1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM5-3. Quantify presence and abundance of juvenile salmonids in restored floodplain habitats during inundation periods.				
Base Condition: Concurrent presence and abundance of juvenile salmonids in adjacent Delta waterways **Approach**: Visual and non-lethal fish sampling (e.g., beach seining, electrofishing) of representative, randomly selected sections of restored floodplain habitats during the inundation period and in adjacent Delta waterways. **Schedule**: During the first 5 floodplain inundation events that coincide with rearing/outmigration periods of juvenile salmonids, conduct biweekly sampling of the inundated floodplain as long as the floodplain is inundated. Subsequently monitor every fifth flood event over the term of the BDCP.	**Existing Programs:** Historical sampling, USFWS weekly beach seining survey of juvenile salmonids (49 permanent locations Delta wide) **Potential Program Additions:** 1. Add sampling locations to include restored floodplain and adjacent channel habitats to ensure statistical representative sampling effort	1. Abundance, size, and race of salmonid species in the inundated restored floodplain habitat and in adjacent Delta waterways.	This monitoring action will provide information on the presence and abundance and relative use of restored floodplains compared to adjacent delta waterways. Results of monitoring will be assessed to determine if floodplain habitats attract more salmonids than adjacent waterways and if fish abundance, age and size distributions differ among restored floodplains and adjacent waterways of the Delta. Results will be used to determine if subsequent design or locations of restored floodplains need to be adjusted to improve their function as juvenile salmonid habitat. The schedule of the monitoring action may be adjusted to reflect changes in management or research results on fish presence in inundated floodplains.	CHSA1.1 CHSA1.2 STEE1.1 STEE1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM5-4: Delineate and quantify Sacramento splittail spawning and rearing in relationship to restored seasonally inundated floodplain habitat.				
Base condition: Conduct surveys of splittail adults, larvae, and eggs in slow-moving sections of rivers and sloughs and dead-end sloughs adjacent to projected floodplains to determine the abundance of splittail larvae and early juveniles present during the reproductive period. **Approach:** Conduct fish sampling surveys in restored floodplain habitats and adjacent slow-moving sections of rivers and sloughs and dead-end sloughs during inundation periods to determine the change in densities of larvae and juveniles relative to base conditions and in-channel spawning. **Schedule:** Weekly fish sampling will be conducted in spawning habitat within restored habitats and in adjacent channel habitats during the first 5 floodplain inundation periods during the splittail spawning season. Subsequently monitor every fifth flood event over the term of the BDCP.	**Existing Programs:** USFWS rotary screw traps USFWS beach seine **Potential Program Additions:** 1. Add sampling locations to include restored floodplain and adjacent channel habitats to ensure statistical representative sampling effort	1. Production of Sacramento splittail (number of larval and early juvenile splittail/10,000 m^3) during floodplain inundation periods	This monitoring action will provide information on productivity of Sacramento splittail populations and the contribution of inundated restored floodplains on spawning and rearing of splittail. This information will be used by the Implementing Office to decide if the production of splittail during floodplain inundation periods has increased significantly from base conditions. If monitoring results do not support conceptual models and hypotheses predicting increasing splittail spawning, the Implementing Office will conduct additional studies to determine 1. uncertainties and competing hypotheses 2. other factors/stressors that affect splittail spawning and rearing in restored habitats, and 3. restoration design modifications to increase splittail productivity. If causes are related to inundation duration, experimental management of flood control structures and floodplain topography may used to address uncertainties. The monitoring schedule may be extended or intensified if uncertainties of causal relationships persist.	SASP1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM5-5: Quantify abundance of nonnative fish species in restored floodplain habitats during inundation periods.				
Base Condition: Concurrent abundance of nonnative fish species in adjacent Delta waterways **Approach**: Visual and non-lethal fish sampling (e.g., beach seining, electrofishing) of representative, randomly selected sections of restored floodplain habitats during the inundation period and in adjacent Delta waterways. **Schedule**: During the first 5 floodplain inundation events that coincide with rearing/outmigration periods of juvenile salmonids, conduct biweekly sampling of the inundated floodplain as long as the floodplain is inundated. Subsequently monitor every fifth flood event over the term of the BDCP.	**Existing Programs:** Historical sampling, USFWS weekly beach seining (49 locations Delta wide) **Potential Program Additions:** 1. Add sampling locations to include restored floodplain and adjacent channel habitats to ensure statistical representative sampling effort	1. Abundance, size, and race of salmonid species in the inundated restored floodplain habitat and in adjacent Delta waterways.	This monitoring action will provide information on the presence, abundance, and relative use of restored floodplains compared to adjacent delta waterways. Results of monitoring will be assessed to determine if floodplain habitats attract more salmonids than adjacent waterways and if fish abundance, age and size distributions differ among restored floodplains and adjacent waterways of the Delta. Results will be used to determine if subsequent design or locations of restored floodplains need to be adjusted to improve their function as juvenile salmonid habitat. The schedule of the monitoring action may be adjusted to reflect changes in management or research results on fish presence in inundated floodplains.	ECSY6.1 CHSA1.8 STEE1.7 SASP1.5

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM5-6: Identify types and quantities of aquatic food production for covered fish species.				
Base Condition: Aquatic food production in adjacent channel habitat prior to restoration activities. Take weekly samples and measurements during inundation period for zooplankton and pelagic macroinvertebrates in Delta waterways adjacent to floodplain restoration sites for a least one year before habitat is restored to establish base conditions. **Approach:** Sample and measure zooplankton and pelagic macroinvertebrates abundance weekly at inflow, outflow and interior sampling points/transects within restored floodplains during inundation periods, and compare these with in-channel samples of zooplankton and pelagic macroinvertebrates taken in adjacent waterways. Assess measurements of zooplankton and pelagic macroinvertebrates to establish relationships between restored floodplain habitat during inundation periods and production of zooplankton and and pelagic macroinvertebrate forage species for covered fish. **Schedule** : Once these relationships have been established, annual monitoring of aquatic food production may be discontinued and a more limited monitoring effort to be determined by the Implementing Office may be conducted every 5th year to document any changes in zooplankton and macroinvertebrates production during floodplain inundation periods over the term of the BDCP.	**Existing Programs:** Zooplankton monitoring conducted by Environmental Monitoring Program (EMP under IEP umbrella) also includes monitoring of water quality, benthos, phytoplankton and exotic species **Potential Program Additions:** 1. Additional sampling stations to reflect the before-after-control-impact design. Locations of some added stations will be fixed during the duration of the plan (systemwide monitoring to detect increase on food availability in delta waterways), others are added as levees are breached and sites are flooded to track how food production in individual wetlands develops over time (i.e., flux from wetland restoration sites) Sampling stations will also provide water quality data (e.g., temperature, turbidity, pH for ammonia conversion, amount of organic carbon) Invertebrate sampling should be adaptively adjusted to changes in fish diets – see also Monitoring Action CM4-4 and Monitoring Action CM4-6.	1. Zooplankton species composition/relative abundance 2. Zooplankton density (number/1,000 m^3) 3. Pelagic macroinvertebrate species composition / relative abundance 4. Pelagic macroinvertebrate density (number/1,000 m^3)	The monitoring action will provide information to test hypotheses on the role that the restored floodplain plays in providing additional aquatic food resources for covered fish in and outside the restoration areas. The monitoring will provide quantitative assessments to determine how much of this food enters the aquatic system through outflows from the floodplain. This information will be used by the Implementing Office to determine if and how much restored floodplains contribute to increased food availability for covered fish species. This information will be used to guide the development of alternative models, hypotheses, management strategies and additional research studies to resolve uncertainties about hypotheses or models. For example, if production of zooplankton and macroinvertebrates does not exceed production relative to base conditions or is not trending towards achieving those production levels, the Implementing Office may conduct investigations to determine causes for insufficient production of zooplankton and macroinvertebrates. Depending on the causes, potential actions could include the experimental modification of floodplain surfaces to increase inundation duration or vegetation structure, or installing water control structures at inflow and outflow locations.	ECSY5.1 ECSY5.2 CHSA1.2 STEE1.2 SASP1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM5-7: Document occurrences and abundances of delta button-celery and slough thistle.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	MFNC1.1 MFNC1.2
CM6: Channel Margin Habitat Restoration				
Monitoring Action CM6-1 Extent of channel margin enhanced to provide habitat for covered fish species.				
Base Condition: As-built restoration designs. Baseline documentation for acquired parcels **Approach:** Extent of enhanced habitat following restoration actions will be delineated, including habitat type (e.g., submerged bench, channel margin emergent vegetation, overhead shaded riverine cover) and vegetation communities. **Schedule**: Annually delineate habitat components for the first 5 years following restoration actions.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (aquatic botanist/ field personnel) See Monitoring Action CM4-1, CM4-2, CM6-2)	1. Linear feet of enhanced habitat by habitat type	This monitoring action will provide information about the progress and spatial extent of channel habitat enhancement. This information will be used to determine if subsequent restoration designs can or should be modified to improve habitat conditions for covered fish species. It will also serve to guide and design management actions to increase or maintain enhancement results (see Monitoring Action CM16-2). The monitoring schedule may be adjusted for a particular project in response to monitoring results. The intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	MFNC1.1 MFNC1.2 CHSA1.1 STEE1.1 SASP1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM6-2: Quantify the extent and dynamics of establishment of emergent vegetation .				
Base Condition: As-built restoration designs. Targets for the establishment of emergent vegetation as identified in habitat enhancement design specifications for each channel margin enhancement site. Baseline documentation for acquired parcels. **Approach:** Percent absolute vegetative cover and extent of vegetated channel will be determined in years 1, 2, and 5 following enhancement. Enhancement sites will be monitored at least every 5 years to assess the extent of established non-native invasive vegetation.	**Existing Programs:** DWR IISS section within DWR-DES **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (aquatic botanist/ field personnel) See Monitoring Action CM4-1, CM4-2, CM6-1)	1. Percent absolute vegetation cover over time 2. Linear extent of vegetated channel margin 3. Presence and extent of non-native invasive vegetation	This monitoring action is intended to provide information regarding the development of habitat structure and vegetation community structure in enhanced channel margin habitats over time. This information will provide the basis for determining if there is a need to modify subsequent enhancement designs to improve the development of emergent vegetation over time. It also may guide development of management actions to improve the establishment of emergent plant communities in enhanced channel margin habitats, including additional studies to identify such actions. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	FMNC1.1 FMNC2.1 MFNC1.1 MFNC1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM6-3: Quantify the presence and abundance of covered and nonnative fish species using enhanced channel margin habitats.				
Base condition: If sufficient existing information is not available, conduct monthly fish sampling surveys along existing channel margin habitats to be enhanced for a least one year before enhancement is implemented using appropriate survey methods to be determined by the Implementing Office to establish base conditions. **Approach:** Following enhancement, initiate comparable surveys within enhanced channel margin habitats and continue surveys **Schedule**: Continue surveys until a relationship between the abundance of each covered fish species/non-native predatory fish species and the extent and function of enhanced habitat is established (at least 5 years). Subsequently, surveys will be conducted at least every 5 years to document any changes that may occur in use of enhanced channel margin habitats over the term of the BDCP.	**Existing Programs:** fish surveys 1. CDFG 20 mm Survey 2. CDFG delta smelt larva study 3. USFWS Spring Kodiak Trawl and 'Supplemental Surveys", Mossdale trawl 4. USFWS Midwater trawl 5. USFWS beach seine 6. CDFG Summer townet survey 7. UCD/IEP Suisun Marsh otter trawl **Potential Program Additions:** Expanded sampling location array to sampling locations along channel margin and within channel margin habitats. Beach seining to reflect micro-habitats and shallow areas not sampled by trawls. Trawl or townet surveys if channel margin extends too deep for beach seine sampling.	1. Presence of covered fish species by life stage in enhanced channel margin habitats 2. Abundance and length of covered fish species per unit area of habitat 3. Abundance of nonnative fish per unit area of habitat 4. Ratio of nonnative predatory fish to native fish	This monitoring action will provide quantitative information about the effectiveness of the enhanced channel margins to provide habitat for different life stages of covered fish species and their spatial response (presence and density) to these enhancements. Monitoring results will be used to evaluate if targets and objectives have been met, parameterize and evaluate conceptual models and other analytical tools, and to prioritize potential actions according to certainty, magnitude and timeliness of benefit. The information provided will also support decisions on potential modification of enhancement design and techniques. It will guide management actions to maintain enhanced habitats. It will also be used to determine if additional research activities or special survey technology should be developed. The monitoring schedule may be adjusted if the relationship between the abundance of each covered fish species/non-native predatory fish species and the extent and function of enhanced habitat cannot be established with acceptable certainty over the first 5 years, especially in cases where designs and enhancement techniques are changed through the adaptive management process. In these cases, annual monitoring will continue for 10 years post enhancement, and then be repeated every 5 years.	ECSY6.1 CHSA1.8 STEE1.7 SASP1.5 CHSA1.1 STEE1.1 SASP1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM6-4: Document occurrences and abundances of intertidal covered plant species.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	FMNC1.1 FMNC2.1 MFNC1.1 MFNC1.2 SOBB1.1 SOBB1.2 SUTH1.1 SUTH1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM7: Riparian Habitat Restoration				
Monitoring Action CM7-1. Document the extent of riparian natural communities restored.				
Base Condition: As-built construction drawings. **Approach:** Delineate the extent of restored riparian habitat by vegetation community type, vegetation structure type, and seral stage; to characterize vegetation structure, measure vegetation attributes such as canopy height, canopy closure, and percent midstory cover. Also measure percent native trees and percent native shrubs **Schedule:** Annually delineate habitat components for the first 5 years following the implementation of individual riparian restoration projects and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) including terrestrial data 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (terrestrial botanist/ field personnel) See also Monitoring Action CM4-1, CM4-2, CM16-1, CM16-2)	1. Acres of each component of restored riparian habitat. 2. patch length, width 3. % absolute vegetation cover. 4. % relative cover of native plant species. 5. Canopy height 6. Canopy closure 7. % midstory cover 8. % native trees 9. % native shrubs	This monitoring action is intended to provide information regarding the development of restored riparian habitat components over time. This information will provide the basis for determining if there is a need to: Modify subsequent restoration designs to improve their ecosystem and habitat functions, Undertake management actions to improve development of desired habitat functions (e.g., control of non-native vegetation, planting of native vegetation, improve local hydrology to enhance development of riparian functions and diversify native vegetation types, habitat structure, and seral stage). The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	VRNC1.1 VRNC2.3 RIBR1.1 RIWR1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM7-2. Document the extent of covered species habitat supported by restored riparian natural communities.				
Base Condition: As-built construction drawings. **Approach:** Evaluate and quantify the extent of each covered species habitat based on evaluation of data collected under Monitoring Action CM7-1. **Schedule:** Annually quantify the extent of restored, covered species habitats for the first 5 years following the implementation of every riparian restoration project and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) including terrestrial data 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (terrestrial botanist/ field personnel) See also Monitoring Action CM4-1, CM4-2, CM16-1, CM16-2)	1. Acres of each covered species habitat restored.	This monitoring action is intended to provide information regarding the development of habitat functions for covered species in restored riparian habitats over time. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	VRNC1.1
Monitoring Action CM7-3. Document the extent of restored riparian brush rabbit and riparian woodrat habitat.				
Base Condition: As built construction drawings. **Approach**: Annual stratified randomized surveys of Riparian brush rabbit for 10 consecutive days **Schedule**: Every 5 years in suitable riparian habitat followed by surveys every 5 years	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) including terrestrial data **2.** field survey crews for riparian wildlife surveys	1. Acreage and net gain or loss (%) of suitable habitat with adjacent upland flood refugia 2. Number and size of largest patches of suitable riparian habitat with upland refugia 3. Connectivity between suitable riparian habitat in the Plan Area and occupied habitat outside the Plan Area 5. Presence/abundance of riparian woodrats in Conservation Zone 7		RIBR1.1 RIWR1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM7-4. Document the self-sustainability of restored riparian habitats and their functioning over time.				
Base Condition: As-built construction drawings. **Approach:** Evaluate and quantify the extent of restored riparian habitat exhibiting ecological succession, characteristic attributes and regeneration based on evaluation of data collected under Monitoring Action CM7-1. **Schedule:** Quantify the extent of restored riparian habitat exhibiting regeneration and/or ecological succession by spatially tracking changes in seral stage every 5 years beginning with the implementation of every riparian restoration project.	**Existing Programs:** None **Potential Program Additions:** 1. Habitat structural monitoring/inventory using standard forestry and/or botanical protocols 2. randomized sampling of riparian habitat structure	1. Percent relative cover of restored riparian habitat exhibiting succession 2. Percent relative cover of restored riparian habitat exhibiting regeneration. 3. Connectivity with existing riparian corridors	This monitoring action is intended to provide information regarding the self-sustainability of restored riparian habitats and their functioning over time. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	ECSY1.5 VRNC2.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM7-5. Determine covered wildlife species use of restored riparian habitats.				
Base Condition: The existing distribution and abundance of covered wildlife species in restored riparian patches based on existing information and additional surveys if/where needed. **Approach:** Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, nesting) of riparian habitats by covered wildlife species. **Schedule:** Conduct surveys for each species during each species' active period for 5 years following the implementation of each restoration project as determined through data collected under CM4-2 and every 5 years thereafter.	**Existing Programs:** 1. Breeding bird survey routes (partial) 2. historical and intermittent research results (e.g., Point Reyes Bird Observatory bird monitoring database from over 250 sites in riparian habitats throughout California, much of it in the Central Valley) 3. CALFED science program bird monitoring element of project plans **Potential Program Additions:** 1. Breeding bird surveys (USGS protocol) at additional locations in restored riparian habitats, surveys should be consistent with the Riparian Habitat Joint Venture's "Riparian Bird Conservation Plan" 2. Randomized amphibian an reptile surveys during peak activity times in restored riparian habitats and adjacent remnant riparian habitats (control sites).	1. Estimated abundance of each species using restored riparian habitat 2. Estimated extent of occupied covered species habitat	This monitoring action is intended to provide information regarding the type and extent of use of restored habitats by riparian-associated covered wildlife species. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	VRNC1.1 VRNC2.1 RIBR1.1 RIWR1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM8: Grassland Community Restoration				
Monitoring Action CM8-1. Document the extent of grassland habitat restored.				
Base Condition: As-built construction drawings. **Approach:** Delineate the extent of grassland habitat by vegetation type, vegetation structure, and dominant species composition. **Schedule:** Annually delineate habitat components for the first 5 years following the implementation of individual grassland restoration projects.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) including terrestrial data 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (terrestrial botanist/ field personnel) See also Monitoring Action CM4-1, CM4-2, CM16-1, CM16-2)	1. Acres of each component of restored grassland habitat. 2. Percent absolute vegetation cover. 3. Percent relative cover of native plant species.	This monitoring action is intended to provide information about the development of grassland attributes in restored grassland habitat parcels over time. Monitoring results will be used to determine if subsequent restoration designs should be modified to improve their ecosystem and habitat functions. It will also guide adaptive management actions to improve development of desired habitat attributes (e.g., re-seeding, planting of native vegetation, control of non-native vegetation). The monitoring schedule may be adjusted for a particular project in response to monitoring results, especial the rangeland health assessment. The intensity of monitoring for subsequent projects may be decreased if strong causal relationships between restoration actions and grassland community responses are established.	ECSY1.3 ECSY1.5 ECSY3.2 GRNC1.2 GRNC2.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM8-2. Document the ecosystem functions of restored grassland habitat in comparison with site potential.				
Base Condition: Post-restoration conditions determined under CM8-1). Reference sheet for ecological site(s) – to be developed if necessary. **Approach:** Apply the "Interpreting Indicators of Rangeland Health" protocol to conduct rapid, qualitative assessment of soil/site stability, hydrologic function, and biotic integrity of restored grassland sites against a reference condition (ecological site; see Appendix I-xx, "Interpreting Indicators of Rangeland Health- version 3.0"). **Schedule:** Conduct rangeland health assessment in year 5 and every 10 years thereafter	**Existing Programs:** 1. NRCS National Grazing Lands Team, 2. County RCDs 3. NRCS local and regional offices **Potential Program Additions:** 1. ESD reference sheets for all restored grassland sites 2. Rangeland health assessment capabilities (terrestrial botanist, collaboration with NRCS soil specialists)	Rangeland health indicators: 1. Rills 2. Water Flow Patterns 3. Pedestals and/or Terracettes 4. Bare Ground 5. Gullies 6. Wind Scour or deposition 7. Litter Movement 8. Soil Surface Resistance to Erosion 9. Soil Surface Loss & Degradation 10. Plant Community Composition and Distribution Relative to Infiltration and Runoff 11. Compaction 12. Functional/Structural Groups 13. Plant Mortality and Decadence 14. Litter Amount 15. Annual Production 16. Invasive Plants 17. Reproductive Capability of Perennial Plants	This monitoring action is intended to provide information about the development of ecosystem functions in restored grassland habitat components over time. This information will provide the basis for addressing whether subsequent restoration designs should be modified to improve their ecosystem and habitat functions. It also will establish if adaptive management actions or interventions are required to halt deteriorative processes (erosion, invasive weeds). Furthermore, the information may provide reasons for additional research studies to address and resolve uncertainties in understanding ecosystem processes in restored grassland habitats. The monitoring schedule may be adjusted for a particular project in response to monitoring results. The intensity of monitoring for subsequent projects may be decreased if strong causal relationships between restoration actions and grassland community responses are established.	GRNC1.2 GRNC2.1 GRNC2.2 GRNC2.3 GRNC2.4 GRNC2.5

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM8-3. Document the extent of covered species habitat supported by restored grassland natural communities.				
Base Condition: Post-restoration conditions determined under CM8-1). **Approach:** Evaluate and quantify the extent of each covered species habitat based on evaluation of data collected under Monitoring Action CM8-1. **Schedule:** Annually quantify the extent of restored, covered species habitats for the first 5 years following the implementation of every grassland restoration project and every 5 years thereafter.	**Existing Programs:** 1. USGS Breeding bird survey routes (partial) 2. historical and intermittent research studies **Potential Program Additions:** 1. Breeding bird surveys (USGS protocol) at additional locations in restored grassland habitats 2. randomized camera trap, track, scat or spotlight surveys for mammals 3. Randomized amphibian an reptile surveys during peak activity times in restored habitats and adjacent remnant riparian habitats (control sites).	1. Acres of each covered species habitat restored.	This monitoring action is intended to provide information regarding the development of habitat functions for covered species in restored grassland habitats over time. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The information will also be used to determine what management actions (e.g., prescribed burning, controlled livestock grazing, weed control) are appropriate and indicated to advance progress towards achieving conservation targets. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if strong causal relationships between restoration actions and outcomes are established.	GRNC1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM8-4: Determine covered wildlife and plant covered species use of restored grassland.				
Base Condition: Post-restoration conditions determined under CM8-1). **Approach:** Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, breeding) of vernal pool complex by covered wildlife species. **Schedule:** Conduct surveys during each species' active period for 5 years following implementation of each restoration project as determined through data collected under CM8-3 and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** See CM 8-3	1. Estimated abundance of each species using restored grassland 2. Estimated extent of grassland habitat occupied by each covered species (or number of occurrences for covered plant species) 3. Occurrence of breeding activity	This monitoring action is intended to provide information regarding the degree of apparent response by covered species to grassland restoration and the habitat functions provided. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established	GRNC1.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM9: Vernal Pool Complex Restoration				
Monitoring Action CM9-1. Document the extent of vernal pool complex restored.				
Base Condition: As-built construction drawings. **Approach:** Delineate the extent of restored vernal pool complex by type (e.g., vernal pools, vernal pool margins, and swales) and in relation to the local moisture gradient and dominant, associated plant communities. **Schedule:** Annually delineate habitat components for the first 5 years following the implementation of individual vernal pool complex restoration projects and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) Various vernal pool monitoring and sampling plans (e.g., **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (terrestrial botanist)	1. Acres of each component of restored vernal pool complex habitat. 2. Percent absolute vegetation cover. 3. Percent relative cover of native plant species.	This monitoring action is intended to provide information regarding the development of restored habitat components over time. This information will provide the basis for determining if restoration targets (acres) are met, if existing restoration designs and methods are adequate in providing the desired results, and if uncertainties exist that may require additional experimentation or research. Monitoring information will also provide information necessary to determine if habitat management actions are necessary to improve habitat functions (e.g., the need to implementing nonnative species control actions). The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	VPNC2.1 VPNC2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM9-2. Quantify the extent of covered species habitat and functions supported by restored vernal pool complex.				
Base Condition: As-built construction drawings. **Approach:** Evaluate and quantify the extent of each covered species habitat based on evaluation of data collected under Monitoring Action CM9-1 and based on inventory of key environmental correlates or habitat requisites of covered species. **Schedule:** Annually quantify the extent of restored, covered species habitats for the first 5 years with sufficient hydrology following the implementation of every vernal pool complex restoration project and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy 3. Delineation and mapping of species occurrences and special habitat features (key ecological correlates) that are pre-requisite for covered species using the site (e.g., small mammal burrows for burrowing owls) 4. Hydrological monitoring program (remote or on the ground tracking of inundation of vernal pool habitats 5. Survey team for vernal pool species (botanist, aquatic ecologist)	1. Acres of each covered species habitat restored. 2. Presence and abundance of habitat elements required by covered species for breeding, resting, foraging etc. Source of water feeding the restored vernal pool complex 3. Seasonal timing and duration of the inundation and water-logged soil phase 4. Estimated species diversity 5. Presence/abundance of non-native species 6. Presence/abundance of non-native predators	This monitoring action is intended to provide information regarding the development of habitat functions for covered species in restored vernal pool complex habitats over time. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	VPNC2.1 VPNC2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM9-3: Determine covered wildlife and plant covered species use of restored vernal pool complex.				
Base Condition: The existing distribution and abundance of covered wildlife species in restored vernal pool complex patches based on existing information and additional surveys if/where needed. **Approach:** Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, breeding) of vernal pool complex by covered wildlife species. **Schedule:** Conduct surveys for each species during each species' active period for 5 years for which sufficient hydrology is present following the implementation of each restoration project as determined through data collected under CM9-2 and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** See CM 9-2	1. Estimated abundance of each species using restored vernal pool complex 2. Estimated extent of vernal pool complex habitat occupied by each covered species (or number of occurrences for covered plant species 3. Occurrence of breeding or regeneration at restored vernal pool complex	This monitoring action is intended to provide information regarding the degree of apparent response by covered species to vernal pool complex restoration and the habitat functions provided. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established	VPNC2.1 VPNC2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM10: Nontidal Freshwater Marsh Restoration				
Monitoring Action CM10-1. Document the extent of nontidal marsh habitat restored.				
Base Condition: As-built construction drawings, comprehensive ecological baseline documentation. **Approach:** Delineate the extent of nontidal freshwater marsh by vegetation type, vegetation structure, and plant species composition. **Schedule:** Annually delineate habitat components for the first 5 years following the implementation of individual non-tidal marsh restoration projects and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (aquatic botanist/ field personnel) See Monitoring Action CM4-2, CM16-1	1. Acres of each component of restored nontidal marsh habitat. 2. Acres restored or created in Conservation Zones, 1,2,4,5, and 7, respectively) 2. Percent absolute upland, emergent and floating vegetation cover. 3. Percent relative cover of native plant species.	This monitoring action is intended to provide information regarding the progress of development of restored habitat components over time. This information will provide the basis for determining if future nontidal freshwater marsh restoration projects should be modified to improve ecosystem and habitat functions. It will also identify potential needs for management actions, such as hydroperiod modifications, non-native species control and vegetation management (controlled livestock grazing, prescribed burning). The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	NANC2.1 NWNC2.1 GGSN1.1 GGSN2.1 GGSN2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM10-2. Document the extent, attributes and functions of giant garter snake and other covered species habitat supported by restored non-tidal marsh communities.				
Base Condition: Baseline documentation, as-build construction drawings and maps **Approach:** Evaluate and quantify the extent of giant garter snake and other covered species habitats based on evaluation of data collected under Monitoring Action CM10-1 and from field surveys of specific key environmental correlates and habitat requisites for covered species. **Schedule:** Annually quantify the extent of restored, covered species habitats for the first 5 years following the implementation of every riparian restoration project and every 5 years thereafter.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 1. Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. Vegetation sampling (on-the ground) for field verification to increase mapping accuracy (aquatic botanist/ field personnel; see Monitoring Action CM4-1, CM16-1)	1. Acres of each covered species habitat restored. 2. Extent and dispersion/ connectivity of upland refugia for target covered species such as giant garter snake in areas prone to flooding 3. habitat attributes and habitat function (e.g., foraging, breeding, resting, etc) for Giant garter snake and western pond turtle.	This monitoring action is intended to provide information regarding the development of habitat functions for giant garter snake and other covered species over time. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for giant garter snake. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	NANC2.1 NWNC2.1 GGSN1.1 GGSN2.1 GGSN2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM 10-3. Document the functionality and condition of restored nontidal marsh habitats over time.				
Base Condition: As-built construction drawings. Comprehensive ecological baseline documentation **Approach:** Conduct a California Rapid Assessment Method for Wetlands (CRAM, Appendix I-X "California Rapid Assessment Method for Wetlands version 5.0.2") to (a) evaluate wetland conditions and stressors and determine the need for intensive monitoring; (2) evaluate performance of restored nontidal marsh; and (3) assess progress of restoration relative to ambient conditions, reference conditions, and expected ecological trajectories. **Schedule:** Conduct a CRAM assessment 5 years after project implementation and every 5 years thereafter.	**Existing Programs:** none **Potential Program Additions:** **1.** develop CRAM capability either per contract with consultant or by training botanical staff.	1. Buffer and Connectivity Metrics 2. Water Source, Hydroperiod, Hydrologic Connectivity 3. Physical Patch Richness 4. Topographic Complexity 5. Organic Matter Accumulation 6. Biotic Patch Richness 7. Vertical Structure 8. Interspersion and zonation 9. Percent Invasive Plant Species 10. Native Plant Species Richness	This monitoring action is intended to provide information regarding the functionality, condition and self-sustainability of restored non-tidal marsh habitats and their ecological dynamics over time. The use of CRAM for ambient monitoring will, over time, help the Implementing Office to quantify the relative influence of anthropogenic stress, management actions, and natural disturbance on the spatial and temporal variability in reference conditions. This information can then be used in the design, management, and assessment of similar wetland projects. The monitoring schedule may be adjusted for a particular project in response to monitoring results and the intensity of monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established. If the causes are not readily apparent, then research might be recommended to determine the causes and to what extent they can be managed. If the causes are deemed natural, then management actions may not be warranted.	NANC2.1 NANC2.2 NWNC2.1 NWNC2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM10-4. Determine covered wildlife species use of restored non-tidal marsh habitats.				
Base Condition: The existing distribution and abundance of covered wildlife species, especially giant garter snake, in restored and existing nontidal marsh habitats patches based on existing information and additional surveys if/where needed. **Approach:** Conduct standardized surveys using established methods to determine the abundance and type of use (e.g., foraging, resting) of giant garter snake; reconnaissance level surveys and incidental records of other covered species (primarily tricolored blackbird, western pond turtle) and non-native predators or competitors **Schedule:** Conduct surveys for each species during each species' active period for 5 years following the implementation of each restoration project as determined through data collected under CM4-2 and every 5 years thereafter.	**Existing Programs:** USGS studies of Giant Garter Snakes at four sites in the Sacramento Valley (1996–2006), USGS Natomas HCP Monitoring. **Potential Program Additions:** 1. Add the USGS Giant Garter Snake monitoring team under the IEP program for routine GGS effectiveness monitoring. Conduct, possibly localized mark-recapture /and radio-telemetry studies to determine habitat use patterns within proposed 1,000-acre giant garter snake conservation lands designed to enhance the Caldoni Marsh/White Slough and the Yolo Basin/Willow Slough giant garter snake populations. 2. Annual wildlife surveys for covered species.	1. Estimated abundance of each covered target species in created non-tidal, freshwater perennial emergent wetlands 2. Estimated extent of occupied covered species habitat in each created non-tidal, freshwater perennial emergent wetland 3. Acreage of created nontidal marsh that functions as habitat for the giant garter snake within or adjacent to habitat occupied by the Caldoni Marsh/White Slough and Yolo/Willow Slough giant garter snake subpopulations in Conservation Zones 2 and 4 3. Connectivity of water conveyance and habitat for giant garter snake 4. Acreage of created nontidal marsh that functions as habitat for the tricolored blackbird 4 5. Acreage of created nontidal marsh that functions as habitat for the western pond turtle 6. Abundance of feral pigs, cats and other non-native predators (non-native centrarchid fish and bullfrog) or competitors (non-native turtles), abundance of nest predators and parasites (brown-headed cowbirds)	This monitoring action is intended to provide information regarding the use and functionality of restored habitats for covered species, particularly the giant garter snake. This information will provide the basis for determining if there is a need to modify subsequent restoration designs to improve the development of habitat functions for target covered species. It will also determine if additional research studies are needed to assess the contribution of restored non-tidal marsh habitats to the viability of covered species. The monitoring schedule may be adjusted annually for a particular project in response to variable water levels and habitat conditions, marsh maintenance and enhancement activities, grazing or other circumstances that necessitate changes in the sampling schedule and/or protocol. Sampling intensity may take into account garter snake activity (and therefore detectability), unfavorable habitat conditions (i.e., lack of water), maintenance activities, trap theft and/or tampering, or other circumstances. Monitoring for subsequent projects may be decreased if causal relationships between restoration actions and outcomes are established.	NANC2.1 NANC2.2 NWNC2.1 NWNC2.2

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM11 Enhance and Manage Preserved Natural Communities				
Monitoring Action CM11-1. Document the planning and implementing progress for the development of Site-Specific Management Plans				
Base Condition: N/A **Approach**: Document completion of site-specific management plans for conservation lands in annual plans **Schedule**: Within 1 year of each conservation land acquisition.	**Existing Programs:** None **Potential Program Additions:** Project management database	Management plans	This monitoring action is intended to provide information to assess the progress the Implementing Office is making towards developing long-term guidance for site-specific management of each acquired BDCP conservation lands. The information in each management plan will provide the menu of actions to be undertaken and related implementation schedules.	

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM11-2 Quantify covered species habitat availability, function, and suitability of conservation lands				
Base Condition: Baseline condition reports, existing conditions (see Chapter 2, *Existing Ecological Conditions* and Appendix A, *Covered Species Accounts*). **Approach**: Inventory key habitat correlates and requisites for each covered species associated with natural communities to determine the extent and suitability of covered species habitat on conservation lands over time (e.g., percent of riparian with suitable structure and vegetation associations to support riparian brush rabbit; percent of agricultural habitat suitable for Swainson's hawk or greater sandhill crane foraging). Conduct comprehensive field surveys, map extent, and document conditions. **Schedule**: Conduct complete baseline survey the first year following implementation of Site-Specific Management Plan, then repeat biannually for 10 years, followed by 5-year interval surveys.	**Existing Programs:** DWR IISS section within DWR-DES (potentially) **Potential Program Additions:** 2. Vegetation and habitat sampling (on-the ground) for field verification to increase mapping accuracy (botanist) 3. Capabilities to determine habitat quality and presence of key habitat correlates for covered species (terrestrial ecologist) See also CM 7-1, CM 8-1, CM 10-1	1. Extent, distribution, age structure, size structure, canopy structure, vegetation associations, and species composition of each natural community on restoration sites 2. Presence of species-specific requisites (e.g., basking sites, roost and nest trees, foraging sites, burrows, cover) 3. Estimated abundance of suitable habitat for each targeted covered species. 4. occurrences of Suisun Thistle 5. proximity of non-rice agricultural lands to occupied Swainson's hawk nesting habitat 6. relative cover of native grasses and forbs in Alkali seasonal wetlands and grasslands 5. acres of greater sandhill foraging habitat within its winter use area and within 2 miles of known roosting sites in CZ 3,4,5, and/or 6 6. Prey abundance for grassland foraging species, especially insects, small mammals 7. Extent and severity of detrimental agricultural practices and disturbance from adjacent sites 7. extent of seasonal buffers around riparian habitats	This action is intended to provide information on the abundance of suitable habitat and habitat functions that addresses any or all life requisites for each covered species on all BDCP protected lands. The information will provide the basis of tracking specific habitat elements and habitat function throughout the Plan Area that is essential for Covered Species occurrence, including riparian structure and composition, functionality of water conveyance canals and associated wetlands, woodlots, tree and hedge rows, vegetation and winter water depth of created managed wetland, and the proportion of agricultural lands with suitable cover types that meet foraging habitat objectives for agriculture-associated covered species. . This monitoring is subject to modification if acquisition proceeds more slowly than expected and the periodicity can be extended.	ALNC1.2 ALNC1.4 AWNC2.1 FMNC1.1 FMNC2.1 TANC 2.1 GRNC1.1 GRNC2.2 GRNC2.1 IDSC1.1 NANC2.1 VRNC2.1 VRNC2.2 VRNC2.3 VPNC2.1 MWNC1.2 BMNC1.1 ONSW1.1 SUTH1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM11-3. Quantify abundance, locations and distribution of Invasive Plants on conservation lands				
Base Condition: Percent cover at the time of acquisition. **Approach**: Develop survey and control protocols and include in Site-Specific Management Plans. Implement periodic inventory of invasive plant populations on conservation lands. Establish thresholds for control actions and implement before thresholds are reached. **Schedule**: Conduct complete baseline survey the first year following implementation of the Site-Specific Management Plan; continue in 5-year intervals. Implement control actions as needed based on management thresholds.	**Existing Programs:** previous landowner's knowledge, agricultural agency (RCD, NRCS) weed abatement records **Potential Program Additions:** 1. Non-native invasive species survey protocols and identification skills 2. Weed control team (trained staff, equipment, GPS, etc).	1. Estimated percent cover of invasive species 2. Location 3. Species 4. Previous control measures	This Monitoring Action is intended to provide information on the extent of invasive plant infestations on BDCP protected lands, and to establish and implement a process of control of invasive species populations. This information will provide the basis for determining the extent of infestation, control triggers, and longterm monitoring to estimate the success of control actions. This monitoring action is subject to modification based on the response of nonnative invasive species to control measures.	ALNC1.1 AWNC2.1 BMNC2.1 CAGB1.1 CAGB1.2 CALT1.1 CCWF/ADEP1.1 CFTR1.1 CFTR1.2 CFTR1.3 DEBC1.1 DEBC1.2 ECSY1.5 ECSY4.1 ECSY3.1 GGNS2.2 GGSN1.1 GGSN2.1 GSHC1.1 GRNC2.1 GRNC2.2 HART/BRIT1.1 HART/BRIT1.2 HART/BRIT1.3 HART/BRIT1.4 HEPE1.1 HEPE1.2 IDSC1.1 MFNC1.2 MWNC2.1 NANC2.1 NWNC2.1 ONSW1.1 SOBB1.1 SOBB1.2 RIBR1.1 RIWR1.1 CRLF1.1 SUTH1.1 SUTH1.2 TANC1.1 TANC2.1 TCBB1.1 VPNC2.1 VRNC2.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM11-4. Fund Research				
Base Condition: N/A **Approach**: Provide funding to support the USFWS captive breeding and reintroduction program for Lange's metalmark butterfly and for implementation of the propagation and out-planting program for Contra Costa wallflower and Antioch Dunes evening primrose; and **Schedule**: As requested.	Existing Programs: Program Additions	Receipt of funds.	This Monitoring Action is intended to assist with established and ongoing research programs to benefit target species. This monitoring action is subject to modification based on continuing research activities and the need for additional funding.	IDSC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM11-5. Increase habitat function for covered species				
Base Condition: Pre-acquisition condition. **Approach**: Each Site-Specific Management Plan will include specific enhancement objectives to increase habitat function by supporting or increasing specific key environmental correlates and habitat requisites for covered species depending on the location, existing habitat function, and opportunities for enhancement. For example, in grassland habitats where burrowing animals are determined to be limited based on results from implementation of Monitoring Action CM11.3, actions will be undertaken (e.g., manipulation of topography, reduction in rodent control programs, non-native predator control, etc.) to increase ground squirrel and small mammal populations. Another example is postponing tilling of harvested corn fields to increase available forage for wintering greater sandhill cranes. **Schedule**: Variable and ongoing.	**Existing Programs:** None **Potential Program Additions:** 1. Survey methodology to inventory habitat functions and stressors for individual covered species on conservation land 2. Database on non-native predator records on conservation lands (observations, surveys, control measures)	1. Burrowing owl occupancy of artificial burrows. 2. Swainson's hawk and white-tailed occupancy of planted trees. 3. Ground squirrel and rodent activity (burrows per acre). 4. Greater sandhill crane occupancy of created roosts. 5. Activity and reproductive performance of tricolored blackbird colonies. 6. Estimated abundance of California red-legged frogs in enhanced stockponds. 7. Extent of grazing activity in vernal pools 8. Condition of rangeland (cover and composition). 9. Percent cover of native grasses 10. Number of created riparian brush rabbit "bunny mounds" 11. Activity , reproductive success and percent of parasitized nests of tricolored blackbird and yellow-breasted chat breeding colonies, and least Bell's vireo and yellow-billed cuckoo nests. 12. Extent of upland refugia in restored marshes. 13. Documented predation events at nesting colonies. 14. Trend in predator populations. 15. Estimated abundance of feral pigs in Suisun Marsh and other conservation lands. 16. presence /abundance of black rats in suitable riparian woodrat habitat in Conservation Zone 7 17. Acres of each agricultural cover type. 18. Forage value of greater sandhill crane winter foraging habitat (lbs per acre). 19. Covered aquatic invertebrate occupancy of vernal pools. 20. Estimated abundance of giant garter snake	This action is intended to enhance the function of BDCP protected lands to meet specific covered species requirements. This information will provide the basis for determining the functioning of conservation lands with respect to meeting covered species objectives. Management actions are undertaken based on the guidance in the Site-Specific Monitoring Plan, which is subject to modification based on site-specific conditions, opportunities unforeseen at the onset of implementation, or to adjust to the progress of other site specific management plans and the need to meet overall Plan Area-wide goals.	ALNC1.1 ALNC1.1 AWNC2.1 BMNC2.1 CAGB1.1 CAGB1.2 CALT1.1 CCWF/ADEP1.1 CFTR1.1 CFTR1.2 CFTR1.3 DEBC1.1 DEBC1.2 ECSY1.5 ECSY4.1 ECSY3.1 GGNS2.2 GGSN1.1 GGSN2.1 GSHC1.1 GRNC2.1 GRNC2.2 HART/BRIT1.1 HART/BRIT1.2 HART/BRIT1.3 HART/BRIT1.4 HEPE1.1 HEPE1.2 IDSC1.1 MFNC1.2 MWNC2.1 NANC2.1 NWNC2.1 ONSW1.1 SOBB1.1 SOBB1.2 RIBR1.1 RIWR1.1 CRLF1.1 SUTH1.1 SUTH1.2 TANC1.1 TANC2.1 TCBB1.1 VPNC2.1 VRNC2.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM12: Methylmercury Management				
Monitoring Action CM12-1: Determine the trend in load of methylmercury or precursors discharged from treated sources				
Base conditions: Mercury concentrations in soils to be restored as tidal habitat before levees are breached based on survey information collected under Conservation Measure *CM4, Tidal Habitat Restoration*. **Approach**: Testing of monthly water and sediment samples in restored subtidal habitat areas for methylmercury concentrations. **Schedule**: Monitor monthly for five years or until relationships between restoration of tidal habitats at different locations in the Plan Area and methylmercury concentrations are understood. After the initial five year monitoring period, every 10 years monitor methylmercury concentrations bimonthly for one year.	**Existing**: 1. Environmental Monitoring program (IEP) 2. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program 3.Continuous Recorder Sites (USBR) 4. Delta Flows network and National Water Quality Assessment Program (USGS) 5. other (DWR, SFEI, etc) 6. UC Davis Biosentinel Hg Monitoring Program **Potential Program Additions:** 1. Establishment and monitoring of methylmercury monitoring stations in restored subtidal habitat areas. See also Monitoring Action CM4-4 and Monitoring Action CM4-6. 2. Expand UC Davis Biosentinel Hg Monitoring Program to include entire Delta and restored floodplain and tidal habitats.	Concentration of methylmercury and precursors	This monitoring is designed to determine the effectiveness of tidal habitat restoration designs in avoiding or reducing methylmercury concentrations in restored subtidal habitats. This information will be used by the Implementing Office to determine if adjustments in tidal habitat restoration designs are necessary to further reduce methylation of mercury. The monitoring schedule may be adjusted based on assessments of initial monitoring results at each restoration site.	TANC1.1 BMNC1.1 FMNC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM12-2: Determine the extent of methylmercury exported into Delta channels.				
Base conditions: 1) Methylmercury concentrations in the water column and sediments in channels adjacent tidal marsh restoration sites before levees are breach based on existing data or survey data collected for this purpose. 2) Methylmercury concentrations in restored subtidal habitats from data collected under CM12-2. **Approach**: Testing of monthly water and sediment samples in channels adjacent to restored subtidal habitat areas for methylmercury concentrations in conjunction with sampling implemented under CM12-1. **Schedule**: Monitor monthly for five years or until relationships between restoration of tidal habitats at different locations in the Plan Area and export of methylmercury into adjacent channels are understood. After the initial five year monitoring period, every 10 years monitor methylmercury concentrations bimonthly for one year.	**Existing**: 1. Environmental Monitoring program (IEP) 2. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program 3. Continuous Recorder Sites (USBR) 4. Delta Flows network and National Water Quality Assessment Program (USGS) 5. Other (DWR, SFEI, etc) 6. UC Davis Biosentinel Hg Monitoring Program **Potential Program Additions:** 1. Establishment and monitoring of sampling stations in channels adjacent to restored subtidal habitats	Concentration of methylmercury and precursors	This monitoring is designed to determine the effectiveness of tidal habitat restoration designs in avoiding or reducing export of methylmercury into existing Plan Area tidal aquatic habitats. This information will be used by the Implementing Office to determine if adjustments in tidal habitat restoration designs are necessary to further reduce methylation of mercury. The monitoring schedule may be adjusted based on assessments of initial monitoring results.	TANC1.1 BMNC1.1 FMNC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM13: Nonnative Aquatic Vegetation Control				
Monitoring Action CM13-1: Detect and document the establishment of non-native submerged (SAV) and floating aquatic vegetation (FAV) in subtidal aquatic habitats in restored tidal habitat areas.				
Base Condition: The current extent of SAV and FAV present in channels adjacent to tidal habitat restoration sites before breaching of levees based on existing information or field surveys. **Approach**: Monthly monitoring to detect and delineate the extent of SAV and FAV in newly restored tidal habitat areas to detect SAV and FAV establishment, conditions under which it establishes, and patterns of establishment. Monitoring data will be evaluated relative to water quality, hydrodynamic, and other physical parameters collected under other monitoring actions or by others to establish relationships between SAV/FAV establishment and restoration design and site conditions. **Schedule:** Monitoring will occur for five years at each site until relationships between tidal habitat restoration designs and SAV/FAV establishment are well understood.	**Existing Programs:** Department of Boating and Waterways is the lead agency for controlling aquatic weeds in the Delta **Potential Program Additions:** 1. SAV/FAV surveys of restored subtidal habitats	Temporal progress of SAV/FAV establishment Spatial extent of SAV/FAV within a restored subtidal habitat project area	This monitoring is designed to determine the SAV/FAV establishment process relative restoration design and parameters related to Plan Area location (e.g., water quality constituents, hydrodynamic conditions, wind patterns). This information will be used to determine if subsequent restoration designs should be adjusted to reduce the likelihood of establishment and extent of SAV/FAV in restored subtidal habitats and to help guide development of more effective SAV/FAV control methods. The duration of monitoring may be increased or decreased as indicated from evaluation of monitoring results.	ECSY6.1 TANC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM13-2: Determine the need for implementation of SAV/FAV control actions and the effectiveness of SAV/FAV control actions.				
Base condition: the extent and distribution of SAV/FAV in restored subtidal habitat areas before implementation of control actions. **Approach**: Monthly surveys of restored subtidal habitats from [month] to [month] to assess the extent of SAV/FAV for use in determining need to implement control actions. Weekly surveys to document changes in extent and distribution of SAV/FAV relative to base conditions following implementation of control actions. **Schedule:** Monthly surveys to determine the need to implement control actions over the term of BDCP. Monitoring following control actions continues until monitoring indicates that the response of SAV/FAV has stabilized or SAV/FAV is determined to be spreading.	**Existing Programs:** Department of Boating and Waterways is the lead agency for controlling aquatic weeds in the Delta **Potential Program Additions:** 1. SAV/FAV surveys of restored subtidal habitats in conjunction with control actions	Areal extent of SAV/FAV or other appropriate measure (e.g., biovolume) Distribution of SAV/FAV in restored habitat	This monitoring action is designed to provide the information necessary to determine the need to implement control actions, the effectiveness of SAV/FAV control techniques over time, and to help determine the frequency with which control actions will need to be implemented in future years. Monitoring frequency and duration to determine the need to implement control actions may be adjusted if relationships between SAV/FAV establishment and need for control actions is established.	ECSY6.1 TANC1.1

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM13-3: Determine the effectiveness of SAV/FAV control actions in reducing the risk for nonnative predatory fish predation on covered fish species.				
Base condition: Nonnative predatory fish abundance before implementation of control actions as determined through CM15 or surveys conducted specifically for this purpose. **Approach:** Bimonthly surveys of control areas following control actions to determine the abundance and distribution of non-native predatory fish. **Schedule:** Monitoring following control actions continues until monitoring indicates that the response of nonnative predatory fish has stabilized or there abundance and distribution increases.	**Existing Programs:** DFG, USFWS, and NMFS fish monitoring programs **Potential Program Additions:** 1. Non-predatory surveys of restored subtidal habitats	Number of nonnative predatory fish per unit area	This monitoring action is designed to provide the information necessary to determine the need to implement control actions, the effectiveness of SAV/FAV control techniques over time, and to help determine the frequency with which control actions will need to be implemented in future years.	ECSY6.1 TANC1.1 CHSA1.8 SASP1.5 STEE1.7
Monitoring Action CM13-4: Determine if non-native SAV/FAV control results in measurable increase in turbidity.				
Base condition: Turbidity of the water column at sampling locations within restored subtidal habitat areas before implementation of SAV/FAV control actions. **Approach**: Weekly turbidity measurements at sampling sites within restored subtidal habitat areas following implementation of control actions. Conducted in conjunction with monitoring under CM2 **Schedule**: see Monitoring Action CM13-1	**Existing:** 1. Environmental Monitoring program (IEP) 2. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program 3.Continuous Recorder Sites (USBR) 4. Delta Flows network and National Water Quality Assessment Program (USGS) 5. other (DWR, SFEI, etc) **Potential Program Additions:** **1.** Establishment sampling stations and monitoring of turbidity in restored subtidal habitat areas	Turbidity (NTU, TSS)	This monitoring approach will provide information necessary to determine if removal of nonnative aquatic vegetation will increase turbidity of the water column to improve habitat conditions for delta smelt.	ECSY6.1 TANC1.1 CHSA1.8 SASP1.5 STEE1.7

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Species-Level Measures				
CM14: Stockton Deep Water Ship Channel Dissolved Oxygen Levels				
Monitoring Action CM14-1 Operate and maintain an oxygen aeration facility in the Stockton Deep Water Ship Channel (DWSC) to increase dissolved oxygen concentrations between Turner Cut and Stockton to meet Total Maximum Daily Load (TMDL) objectives(above 6.0 mg/L from September 1 through November 30 and above 5.0 mg/L at all times).				
Base condition: Existing aeration operations **Approach:** Keep daily operational and maintenance records for the oxygen aeration facility, tracking hours of operation, amount of Oxygen (lbs) injected, sensor operations and system failures or shutdowns. **Schedule:** Daily operational logs and maintenance records, DWSC Demonstration Dissolved Oxygen Aeration Facility monthly reports.	**Existing Programs:** DWR's Stockton DWSC Demonstration Dissolved Oxygen Project, Bay-Delta Office. **Potential Program Additions:** None	Operational statistics 1. hours of operation 2. lbs of dissolved oxygen 3. failures & shutdowns 4. operational costs 5. maintenance and repair records	This monitoring activity ensures that the operation of the DWSC dissolved Oxygen aeration facility is recorded accurately and operational data are publicly available. The Implementing Office will use this information to determine if system modifications need to be implemented based on system performance and cost/benefit ratios. The monitoring schedule may be adjusted if the existing aeration facility will be modified or additional aerators and associated infrastructure are added to optimize DO delivery to the river.	CHSA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM14-2 Measure levels of dissolved oxygen (DO) delivered to the river within the 7.5 mile low dissolved oxygen area of the ship channel				
Base condition: As built construction drawings **Approach:** measure dissolved oxygen levels at various distances from the diffuser(s) and depths via remote monitoring stations. Current DO sensors are placed at a depth of about 10 ft (at low tide) and record 15-minute data. Additional sensors will be installed concurrent with addition of diffuser facilities. **Schedule:** Measure minimum DO levels per 15 min interval at each DO sensor station over a 25 hr tidal cycle. Compile Monthly Dissolved Oxygen Data Reports.	Existing Programs: **1.** Demonstration Dissolved Oxygen (DO) Aeration Facility remote monitoring stations (NA 40, 42, 43 and 48), handheld instrument data, California Data Exchange Center (CDEC) Rough and Ready Island (RRI) station data, and CDEC San Joaquin River at Garwood Bridge (SJG) station data Potential Program Additions: Possibly additional remote monitoring stations Possible additional diffusers	1. diffused oxygen (mg/L)	Results from this monitoring will be used to assess the performance of the facilities operations at achieving the water quality objective. The BDCP Implementing Office will use this information to determine whether aeration facility operations result in measurable benefits to water quality of the DWSC. Based on review of performance and effectiveness monitoring results, the BDCP Implementing Office will adjust funding levels, oxygen diffuser methods, or other related aspects that will improve the performance and/or biological effectiveness of the project through the BDCP adaptive management process as appropriate. Such changes will be effected through the BDCP adaptive management process and would be included in the subsequent annual work plans.	CHSA1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM14-3 Determine if aeration increases the use of the Stockton DWSC as a migration route for covered fish species.				
Baseline Condition: existing knowledge and study results on fish migration routes and channel-specific survival rates **Approach**: Through tracking of marked fish (e.g., acoustic tags, radiotelemetry or other suitable method), determine the proportion of tagged fish that successfully migrate through the DWSC. Determine the residence time within DWSC. **Schedule**: Implement covered fish species tracking until a precise (+- 5%) estimate of permeability can be established by species, location and season. Once permeability rates have been estimated, fish tracking can be discontinued for 5 years. Every 5 years thereafter, the Implementing Office will estimate permeation rates and residence times for covered fish species for at least 2 months.	**Existing Programs:** USFWS Delta Juvenile Fish monitoring program (DJFMP), various DFG fish survival and migration tracking studies. Potential Program Additions: Coordinate DJFMP with juvenile fish mortality tracking projects in coordination with operation of DWSC aeration facilities. Separate tracking of tagged adults	Permeation rates (% of tracked fish) Residence time of tracked fish within the DWSC Survival of tagged fish (see also CM 16-3)	This monitoring action is designed to provide information on the effects of DO aeration of the DWSC in enhancing migration of covered species through the DWSC. The Implementing Office will use this information to determine if oxygen diffusion is effective in the re-routing of migrating covered fish species. The monitoring action may be reduced if permeation rates are found to have minimal seasonal and location-dependent variance and are highly precise (+-5%). Results from tracking studies every 5 years will determine if increasing monitoring activities are necessary (i.e., if permeation rates fall below the initially determine value).	CHSA1.3 STEE1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM15: Predator Control				
Monitoring Action CM15-1: Document the extent and locations of fish predator hotspots within the Delta.				
Base Condition: Estimated existing locations and types of predator hotspots such as abandoned structures, boats, deep holes , etc. where predators have an above-average effect on sensitive life stages of covered fish species, based on existing information. **Approach:** Using a combination of existing knowledge (e.g., survey of fishermen about striped bass catch locations), aerial surveys (e.g., during mapping of nonnative FAV/SAV), and direct observations (IEP and agency staff on boats within the Delta waterways), inventory and map all known and suspected predator hotspots within Delta waterways where sensitive lifestages of covered fish species are present. **Schedule:** Within 3 years and prior to implementing any predator control measures at hotspots, conduct complete mapping of all major fish-rearing habitats within each waterway to identify and rank potential hotspots of predators. Continue adding new hotspots as they become known.	**Existing Programs:** Extant knowledge of hotspots by fishery biologists, game wardens and agency staff.: DWR IISS section within DWR-DES (potential data warehouse and GIS repository) **Potential Program Additions:** **1.** Development of spatial databases and mapping capabilities including photo-interpretation (GIS lab) 2. tracking of incidental information of predator hotpots from agency staff	1.Location 2. Size 3. Type 4. Structural elements 5. Abundance and type of predatory fish present and relative threat to covered fish species	This monitoring action is designed to provide information on the location and extent of predator hotspots within Delta waterways. The Implementing Office will use this information to schedule removal/amelioration of structures and channel geometry to reduce favorable spots for predatory fish. It also will allow the Implementing Office to estimate costs and technical constraints in removing certain hotspots and adaptively prioritize these for removal. This information will be updated annually and the scheduling of removal/amelioration activities will be adjusted adaptively based on this information The schedule may be adjusted in response to unscheduled events that add significant hiding cover into the channel (floods, windthrow, etc), and to the removal and decelerating need of removals as the channels are being cleared.	ECSY6.1 CHSA1.8 SASP1.5 STEE1.7

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM15-2: Document the extent of predator hotspot removals/ameliorations.				
Base condition: Completed predator hotspot inventory and map (see CM15-1). **Approach**: Annually update the database by identifying removed hotspots. Track costs and disposal of removed materials. **Schedule**: Annual.	**Existing Programs:** none **Potential Program Additions:** **1.** Responsibility to track progress as predator hotspots are removed or ameliorated	Change in number of hotspots Type of hotspots removed/ ameliorated (abandoned structure, boat, etc.)	See CM 15-1	ECSY6.1 CHSA1.8 SASP1.5 STEE1.7
Monitoring Action CM15-3: Document the extent of predator removal activities within Delta hotspots				
Base condition: Existing knowledge of agency staff and experts pertaining to predator hotspots (see CM 15-1). Prior to predator control measures, the relative abundance (species, size and age composition) of predatory fish species must be sampled (non-lethally) at least twice per hotspot to establish baseline conditions. **Approach**: Implement localized predator control actions (e.g., electro-shocking, seining, gill netting or other appropriate methods) to remove targeted predators of covered fish species **Schedule**: Upon establishing baseline conditions and after implementing control measures, continue localized control measures each year at various locations throughout the Delta. Each hotspot will be treated several times (not more than 10 days apart) until predator numbers removed have declined and show a significant asymptotic trend (leveling off). Resample and retreat hotspots every 3-5 years.	**Existing Programs:** IEP fish predator control studies **Potential Program Additions:** Predatory fish control program to reduce localized predator densities and thus reduce covered fish mortality	Predators removed: Species number Size, age Location Diet (gut content)	This monitoring action will provide a estimate of the magnitude of the predator control efforts (Treatment size). This information will be used by the Implementing Office to estimate the effectiveness of controlling predators on sensitive lifestages of covered fish species in open systems (waterways of the delta). It will also provide insight in the life history of predatory fish and will allow addressing potential efficiency issues in an adaptive manner. The Implementing Office will also use these data to address cost effectiveness and to guide additional research, This schedule may be changed upon careful review of results to better encapsulate the response time of predator populations to control measures.	ECSY6.1 CHSA1.8 SASP1.5 STEE1.7

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM15-4: Determine the survival of covered fish species in response to predator control actions.				
Base condition: Baseline studies of predatory fish abundance and mortality levels of covered species due to predation prior to predator control measure implementation. **Approach**: Implement an adaptive experimental management program using a BACI approach to determine the existence and importance of compensatory predation mortality in sensitive lifestages of covered fish species. Specifically, this program investigates under which environmental conditions mortality of covered fish is additive and hence can be affected by localized predator control. Using a combination of fish tagging, sampling and radio- or acoustic telemetry tracking approaches, the Implementing Office will determine mortality rates due to predators at local predation hotspots in comparison to earlier (unmanaged) circumstances (before) and adjacent, randomly selected non-hotspot sites (control sites) **Schedule**: Annually, until uncertainty regarding predator management effectiveness (and density dependence) can be reduced and robust correlations between environmental conditions and predator control effectiveness can be established.	**Existing Programs:** USFWS Delta Juvenile Fish monitoring program (DJFMP), Delta smelt mortality monitoring, DFG hatchery fish radio tracking and acoustic tagging studies. **Potential Program Additions:** Coordinate DJFMP with fish mortality tracking projects in coordination with predator removal projects.	1. Survival rates of sensitive lifestages of covered fish species	This monitoring action is designed to provide information on the effects of predator removals on juvenile fish of covered species. The Implementing Office will use this information to determine if predator removal is effective in increasing the survival of juvenile covered fish species (i.e., mortality is not compensatory / juvenile fish are not regulated by density-dependent factors). To remove uncertainty regarding the role of varying habitat quality and spawning success, the Implementing Office will determine if targeted research or management experiments are needed to determine the conditions under which predator removal an effective management tool to support survival of sensitive lifestages of covered fish species.	ECSY6.1 CHSA1.8 SASP1.5 STEE1.7

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM16: Non-Physical Fish Barriers				
Monitoring Action CM16-1 Document the installation of non-physical fish barriers.				
Baseline Condition: As-built construction drawings. **Approach**: Document the installation and seasonal operation of non-physical fish barriers. **Schedule**: ongoing as barriers are installed.	**Existing Programs:** 2009 pilot study (Bowen et al. 2009), various research data. **Potential Program Additions:** 1. Fish barrier database that tracks seasonal operation, cost and incidental observations	Location Hours and dates of operations Performance/Failures and operational statistics of the three components (light, sound, bubbles) Other incidental observations Cost of operations	This monitoring action will provide information on the operation of non-physical fish barriers. This information will be used by the Implementing Office to schedule operations, redesign failing or faulty equipment, or implement other corrective measures as needed to ensure the continuous operation. The monitoring schedule will be adjusted to reflect additional data needs	CHSA1.5 STEE1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM16-2: Determine the permeability of non-physical barriers for outmigrating juvenile salmonids.				
Baseline Condition: existing knowledge and study results on fish migration routes and channel-specific survival artes **Approach**: Through tracking of marked fish (e.g., acoustic tags, radiotelemetry or other suitable method), determine the proportion of tagged fish that penetrate non-physical fish barriers. Determine the residence time at or near barriers. **Schedule**: Implement juvenile salmonid tracking prior or at least simultaneously with the initiation of operation of each physical barrier. Continue tracking fish until a precise (+- 5%) estimate of permeability can be established by species, location and season. Use occasional failures as "experiments" to determine "control" values. Once permeability rates have been estimated, fish tracking can be discontinued for 5 years. Every 5 years thereafter, the Implementing Office will randomly select 3 non-physical fish barriers and estimate permeation rates and residence times for outmigrating juvenile salmonids for at least 2 months.	**Existing Programs:** USFWS Delta Juvenile Fish monitoring program (DJFMP), DFG hatchery fish radio tracking and acoustic tagging studies. **Potential Program Additions:** Coordinate DJFMP with fish mortality tracking projects in coordination with operation of non-physical fish barriers.	Permeation rates (% of tracked fish) Residence time of tracked fish within 500 ft of the barriers Lifestage of tracked fish Survival of tagged fish (see also CM16-3)	This monitoring action is designed to provide information on the effects of non-physical fish barriers in deterring juvenile fish of covered species to enter "low survival" channels. The Implementing Office will use this information to determine if non-physical fish barriers are effective in the re-routing of migrating juvenile covered fish species. This information will also be used to determine if outmigrating juvenile salmonids "pool" at the barriers. Intermittent replications of fish tracking will ensure that non-physical fish barriers are still functional and effective. The monitoring action may be reduced if permeation rates are found to have minimal seasonal and location-dependent variance and are highly precise (+-5%). Results from tracking studies at 3 randomly selected barriers every 5 years will determine if increasing monitoring activities are necessary (i.e., if permeation rates fall below the initially determined value).	CHSA1.5 STEE1.3

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM16-3 Determine the abundance of predators and their effect on the survival of outmigrating juvenile salmonids at non-physical fish barriers.				
Base condition: Baseline studies of predatory fish abundance and mortality levels of covered species due to predation.. **Approach**: Using a combination of fish tagging, sampling and radio- or acoustic telemetry tracking approaches, or visual sampling (underwater cameras) the Implementing Office will determine the abundance and composition of predator guilds at non-physical fish barriers in comparison to earlier (unmanaged) circumstances (before) and adjacent, randomly selected non-hotspots sites (control sites). In conjunction with CM16-3, estimate predation mortality to juvenile salmonids. Also, investigate if there are correlations between residence time of marked juvenile salmonids and predation risk and survival at barriers. **Schedule**: Annually, until uncertainty regarding predation rates can be reduced and robust correlations between residence time and survival of marked juvenile salmonids can be established	**Existing Programs:** USFWS Delta Juvenile Fish Monitoring Program (DJFMP), DFG hatchery fish radio tracking and acoustic tagging studies. **Potential Program Additions:** Coordinate DJFMP with fish mortality tracking projects in coordination with operation of non-physical fish barriers.	Survival of tracked juvenile salmonids (a) within 500 feet of non-physical fish barriers, and (b) for the entire migration (by migration route)	This monitoring action is designed to provide information on the effects of non-physical fish barriers in increasing total survival of outmigrating juvenile fish of covered species. The Implementing Office will use this information to determine to what degree survival of migrating juvenile covered fish species increases as a function of non-physical fish barriers. It will also use these data to determine if predation in the immediate vicinity of barriers increases due to juvenile fish aggregations at the barriers, and to what extent predation at the barriers alters survival during the entire outmigration This information will also be used to determine if predator control activities (see CM15) may be indicated. Results from intermittent replications of fish tracking will determine if non-physical fish barriers are still functional and effective. The monitoring action may be reduced if predation rates are found to have estimable, minimal seasonal and location-dependent variance and are highly precise (+-5%). Results from tracking studies at 3 randomly selected barriers every 5 years will determine if increasing monitoring activities are necessary (i.e., if predation rates increase above the initially determined value).	CHSA1.5 CHSA1.8 STEE1.3 STEE1.7 SASP1.5

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM16-4: Determine change in survivorship of outmigrating juvenile salmonids redirected by non-physical barriers.				
Baseline Condition: existing survivorship of outmigrating salmonids using existing migration pathways **Approach**: Through tracking of marked fish (e.g., acoustic tags, radiotelemetry or other suitable method), determine change in outmigration success relative to existing conditions **Schedule**: Annually during peak outmigration periods of affected runs until relationships between barrier operations and outmigration success are understood	**Existing Programs:** USFWS Delta Juvenile Fish monitoring program (DJFMP), DFG hatchery fish radio tracking and acoustic tagging studies. **Potential Program Additions:** Implementation of targeted studies to assess change in survivorship relative to barrier operations.	Change in proportion of outmigrating salmonids passing Chipps Island	This action is designed to provide the Implementing Office with information necessary to determine the effectiveness of non-physical barriers and barrier operations in improving juvenile salmonid survival by directing migration pathways.	CHSA1.5 CHSA1.8 STEE1.3 STEE1.7 SASP1.5
CM17: Hatchery and Genetic Management Plans				
Monitoring Action CM17-1 Document development and implementation of hatchery and genetic management plans for salmonid stocks.				
Base condition: Existing HGMPs and hatchery operations **Approach:** BDCP will evaluate progress towards HGMPs for each hatchery through annual accomplishment reports plans, fiscal accounting reports and interagency agreements and work plans. **Schedule:** within the first 5 years BDCP will have funded and achieved the development of HGMPs for each hatchery within the BDCP area. Updates of HGMPs are conducted every 10 years for the duration of the BDCP.	**Existing Programs:** Existing HGMPs and drafts (Nimbus Hatchery , Feather River Hatchery, Mokelumne River Hatchery) and Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery 2001 Biological Assessment **Potential Program Additions:** none	Annual fiscal /accounting reports Interagency workplans HGMPs as they are developed	This monitoring action will provide information on the progress the BDCP Implementing Office is making towards the implementation of HGMPs for all salmonid hatcheries affected by BDCP. This information will be used by the Implementing Office to determine if modifications to targets or schedules are necessary, and how modifications will be implemented. Such changes will be effected through the BDCP adaptive management process and will be included in the subsequent annual work plans.	CHSA1.9 STEE1.8

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM17-2 Determine if HGMP development and implementation substantially and cost-effectively benefit covered salmonid stocks.				
Base condition: HGMPs as developed and implemented, research hypotheses and models. **Approach**: With funding from BDCP, the Implementing Office will collaborate in the Design and Evaluation of targeted studies, conducted by collaborating agencies that explicitly test the hypothesis that implemented HGMPs are reducing negative effects on wild Chinook salmon and steelhead. **Schedule:** 10 years after implementation of the BDCP, the Implementing Office will have completed a comprehensive meta-analysis and evaluation of the HGMP program.	**Existing Programs:** DFG and USFWS expert staff, UCD genetics lab, hatchery personnel and facilities **Potential Program Additions:** review and analysis capability (either in house or under contract) to comprehensively and rigorously evaluate studies and data on the impacts of hatchery fish on wild salmonid stocks.	Population viability of wild salmonid stocks Competition indices and models Genetic integrity of hatchery and wild stocks	This monitoring action will provide information on the cost-benefit relationship of implementing HGMPs to benefit wild salmonids. If results of review indicate that HGMP development and implementation does not substantially and cost-effectively benefit covered fish species, the BDCP Management Entity in coordination with Fishery Agencies may terminate this conservation measure. If terminated, remaining funding will be deobligated from this conservation measure and reallocated to augment funding for other more effective conservation measures identified in coordination with the Fishery Agencies through the BDCP adaptive management process. The monitoring schedule may be extended for up to 5 years if longer time series are needed to determine conclusively the effects of HGMPs on wild salmonid stocks.	CHSA1.10 STEE1.9

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM18: Illegal Harvest				
Monitoring Action CM18-1: Determine if hiring target of 17 additional game wardens for the BDCP Plan Area has been met				
Base Condition: Current staffing levels of CDFG enforcement officers within the BDCP Plan Area. **Approach:** Review annual employment reports provided by DFG to determine success in filling vacant game warden positions and to determined why positions were not filled (if applicable) **Schedule:** Annual monitoring until the 5-year deadline has been met	**Existing Programs:** none Potential Program Additions: 1. Collaborative data exchange with DFG enforcement and Human Resources	1. Hiring of 17 additional game wardens for the BDCP Plan Area	This monitoring action is intended to provide information regarding achieving enhanced enforcement of fishery regulations for covered species. This information will provide the basis for determining if there is a need to modify the hiring process. The monitoring schedule may be extended beyond the initial 5 year period if necessary.	CHSA1.7 STEE1.6 SASP1.3 GRST1.5 WHST1.5
Monitoring Action CM18-2: Determine the game warden's contact rate with the public				
Base Condition: Current 5-year average contact rate for Game wardens in the BDCP Plan Area **Approach:** The Implementing Office will review annual reports of enforcement statistics for the BDCP plan area, which details the number of contacts, warnings and citations issued per game warden **Schedule:** Annual monitoring of game warden contact rates	**Existing Programs:** Existing analytical methods for assessing effectiveness of contact rates **Potential Program Additions:** 1. Collaborative data exchange with DFG enforcement	1. Rates of contacts, warnings and citations by game warden	This monitoring action is intended to provide information regarding the achievement of enhanced enforcement of fishery regulations for covered species. This information will provide the basis for determining if there is a need provide additional training of game wardens. The monitoring schedule may be altered if necessary.	CHSA1.7 STEE1.6 SASP1.3 GRST1.5 WHST1.5

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
Monitoring Action CM18-3: Determine compliance ratios in routine enforcement activities				
Base Condition: 5-year average compliance ratios for Game wardens in the Bay Delta and similar areas **Approach:** The total number of contacts with the public and the total number of warnings and citations issued per year will be recorded annually, consistent with current game warden practices. **Schedule:** Annual monitoring of compliance ratios	**Existing Programs:** Existing analytical methods for assessing compliance effectiveness **Potential Program Additions:** 1. Collaborative data exchange with DFG enforcement	1. % change in compliance ratios (trend) 2. Annual deviation from the 5 year running average compliance ratio.	This monitoring action will provide an assessment of routine enforcement activity and effectiveness of enforcement to reduce illegal harvest This monitoring action will provide the basis for determining if enforcement actions and staffing levels are sufficient to reduce illegal harvest of covered fish in the BDCP Plan Area. The monitoring schedule may be reduced once compliance ratios have declined and are at satisfactory levels	
Monitoring Action CM18-4: Determine success of undercover and non-routine operations				
Base Condition: Current 5-year average arrest ratios for undercover and special enforcement actions in the BDCP Plan Area. **Approach:** The total number of contacts with the public and the total number of warnings and citations issued per year will be recorded annually, consistent with current game warden practices. **Schedule:** Annual monitoring of compliance ratios	**Existing Programs:** Existing analytical methods for assessing success of special enforcement operations **Potential Program Additions:** 1. Collaborative data exchange with DFG enforcement	1. Number of arrests in special undercover enforcement operations 2. Annual deviation (% change) from the 3 year running average of number of arrests per person-hour	This monitoring action will provide an assessment of undercover and non-routine enforcement activity and effectiveness of enforcement to reduce illegal harvest. This monitoring action will provide the basis for determining if undercover and special enforcement actions are sufficient to reduce illegal harvest of covered fish in the BDCP Plan Area. The monitoring schedule may be reduced once arrests/person-hour ratios have declined and are at satisfactory levels.	CHSA1.7 STEE1.6 SASP1.3 GRST1.5 WHST1.5

Table 3-20. Potential Effectiveness Monitoring Actions for Conservation Measures (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Objectives addressed*
CM19: Conservation Hatcheries				
Monitoring Action CM19-1: Support the development of a delta and longfin smelt conservation hatchery by USFWS to house a delta smelt refugial population and provide a source of delta and longfin smelt for supplementation or reintroduction, if deemed necessary by Fishery Agencies.				
Base condition: MOU **Approach**: IEP will 1) document the establishment of functional hatchery facilities and 2) track the funds expended towards implementing a collaborative development of conservation hatcheries by USFWS through its annual reports, financial and operational records. **Schedule**: Annually	**Resources:** 1. USFWS proposals **Potential Program Additions:** 1. Conservation hatchery program budget, 2. Conservation hatchery administration staff	1. Annual progress reports	This monitoring action will provide a detailed accounting of expenses and other support provided to USFWS to develop and operate Conservation hatcheries. This information will be used by the Implementing Office to determine if funding levels and expected benefits are within target levels. The annual reporting schedule is maintained for the duration of the conservation hatchery program.	
Monitoring Action CM19-2: Support the expansion of the refugial population of delta smelt and establishment of a refugial population of longfin smelt at the University of California, Davis Fish Conservation and Culture Laboratory to serve as a population safeguard in case of a catastrophic event in the wild.				
Base condition: MOU. **Approach**: IEP will 1) review annual reports to determine if hatchery operations are successful in establishing and maintaining sufficient refugial populations to meet BDCP objectives and 2) track the funds expended towards expanding refugial population of Delta smelt and longfin smelt at the University of California, Davis Fish Conservation and Culture Laboratory through its annual reports, financial and operational records. **Schedule**: Annually	Resources: 1. University of California, Davis Fish Conservation and Culture Laboratory Potential Program Additions: 1. Conservation hatchery program budget 2. Conservation hatchery administration staff	1. Annual progress reports	This monitoring action will provide a detailed accounting of expenses and other support provided to expanding refugial populations of Delta smelt and longfin smelt at the University of California, Davis Fish Conservation and Culture Laboratory. This information will be used by the Implementing Office to determine if funding levels and expected benefits are within target levels. The annual reporting schedule is maintained for the duration of the conservation hatchery program.	

*[**Note to Reviewers:** This table presents in-progress draft potential system-wide monitoring actions based on the five ecological characteristics described in Section 3.6.2, Monitoring Framework. This table will continue to be refined and populated to ensure that all of the system-wide monitoring actions, including incorporation of metrics from the logic chain, are addressed.]*

Table 3-21. Potential System-Wide Monitoring Actions

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Ecosystem Monitoring Element: Foodweb				
Element 1: Primary and Secondary Production				
Monitoring Action SY1-1: Determine the seasonal abundance, distribution, and composition of phytoplankton and zooplankton in Delta and Suisun Marsh/Bay waterways.				
Condition: Seasonal abundances of phytoplankton and zooplankton in Delta and Suisun Marsh channels and waterways as currently sampled. **Approach:** Establish monitoring stations that are representative of different reaches of the Delta and Suisun marsh Take monthly grab samples and measurements of chlorophyll a and zooplankton. Invertebrate sampling should be adaptively adjusted to changes in fish diets. Plankton monitoring tracks changes in phyto- and zooplankton diversity, abundance, and distribution associated with physical and other biological factors in the Delta. Salinity and other water quality variables are monitored at all plankton sites. **Schedule:** Conduct sampling monthly every year for the first 10 years, then randomly sample 30% of all sampling stations annually for the duration of the BDCP.	**Existing Programs:** Ongoing discrete sampling through Environmental Monitoring Program (EMP, under IEP) **Potential Program Additions:** **1.** Additional sampling stations to represent the entire system by individual reach or major channel system. Locations of added stations will be fixed during the duration of the plan to detect increase on food availability in delta waterways. Note that additional stations are added under Monitoring Actions CM 4-3, CM4-4 , CM4-6, and CM16-5 as levees are breached and sites are flooded to track how food production in individual wetlands develops over time (i.e., flux from wetland restoration sites) Sampling stations will also provide water quality data (e.g., temperature, turbidity, pH for ammonia conversion, amount of organic carbon.	1. Phytoplankton: -mg/L chlorophyll a - species composition - relative abundance 2. Zooplankton: - number/1,000 m^3 - species composition - relative abundance 3. variations in oxygen concentration 4. organic carbon-14 content 5. Stable isotopes of Oxygen (16O, 18O and 17O	This monitoring action is intended to collect data necessary to determine and quantify the overall production and export of phytoplankton and zooplankton throughout the Delta This information, in combination with evaluation of other project-specific foodweb-related monitoring and research data, will provide the basis for : 1. Identifying sources of uncertainty and the design of management experiments and/ research studies, to address uncertainty. 2. evaluating underlying conceptual models and hypotheses (source-sink dynamics, variability and uncertainty in primary production response) 3. evaluating restoration design options to increase the production and export of primary production from restored tidal marsh plains 4. Implementing additional management actions to improve production and export of primary production within the Delta. The monitoring schedule will be modified if uncertainty or variances do not support current conceptual models and hypotheses	ECSY5.1 CHSA1.2 STEE1.2 SASP1.2 GRST1.2 WHST12

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY1-2: Determine the seasonal abundance, distribution, and composition of benthic invertebrates in Delta and Suisun Marsh/Bay waterways.				
Base conditions: ongoing benthic monitoring by IEP throughout the Estuary. **Approach**: Benthic monitoring will be conducted at up to 20 sites within the estuary, with four benthic samples and one sediment sample taken at each site. Samples are analyzed by a contracting lab. Samples will be collected using a hydraulic winch and Ponar dredge or other appropriate grab sampler. **Schedule**: Quarterly	**Existing Programs:** Benthic monitoring component of IEP's Environmental Monitoring Program (EMP) **Potential Program Additions:** Increase the number of benthic sampling stations to up to 20 sites as a representatively sample of the entire BDCP plan area.	1. Species of macro-benthic organisms identified 2. Total number of individuals counted	This monitoring activity provides information on the benthic communities of the estuary, changes in benthic fauna presence, and abundance and distribution associated physical factors in the estuary. Data collected from the benthic monitoring program is also used to detect newly introduced species in the estuary. The Implementing Office will use this information to determine the status and change of benthic communities over the term of the BDCP and to evaluate possible causal relationships between physical factors and benthic invertebrate communities. This information will also provide important indicators of invasive species progress, impacts of toxics and water operations, and other changes within the Delta. The implementing office will use this information to address changes and modifications to conservation measures through the adaptive decision making process. The monitoring schedule may be adjusted to provide data at a higher temporal or spatial resolution of deemed necessary.	ECSY5.1 ECSY5.2 CHSA1.2 STEE1.2 SASP1.2 GRST1.2 WHST12

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Ecosystem Monitoring Element: Physical/Chemical/Nutrient Processes				
Element 2: Water Quality				
Monitoring Action SY2-1: Determine the seasonal and spatial variability of water quality within the Plan Area.				
Condition: Existing seasonal water quality conditions based on existing information (see Applicable IEP and other Resources **Approach:** Continue current water quality monitoring as mandated by existing D-1641 North and Western Delta agricultural and municipal and industrial (M&I) standards and all water quality requirements contained in the North Delta Water Agency/DWR Contract and other DWR contractual obligations. **Schedule:** as currently implemented.	**Existing Programs:** 1. Continuous Multiparameter Monitoring, Discrete Physical /Chemical Water Quality Sampling (Environmental Monitoring program; IEP) 2.Continuous Recorder Sites (DWR, USBR) 3. National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program (Central Valley Water Board) 4. Delta Flows Network and USGS)National Water Quality Assessment Program (, Toxic Substances Hydrology Program 5.. other (DWR, SRCSD, SWAMP, Central Valley Water Board, State Water Board, SFEI, etc) **Potential Program Additions:** **1.** There are over 100 water quality sampling sites within the Delta providing a baseline of water quality data. If needed, additional sampling stations may be added to reflect system-wide representative sampling efforts. Additional water quality sampling stations will be added as levees are breached and sites are flooded to track water quality changes at restoration sites. 2. Expand UC Davis Biosentinel Hg Monitoring Program to include entire Delta. see also Monitoring Action CM4-4 and Monitoring Action CM4-6.	1. Water temperature (^{o}C) 2. mg/L dissolved oxygen 3. NTUs 4. EC 5. pH 6. mg methylmercury/L 7. other nutrients and/or toxicants (e.g., Ammonia, Major Cations (Na, K, Ca, Mg), Metals (Cd, Co, Cu, Fe, Mn, Pb, Zn), inorganic Nitrate, pyrethrins,) 8. Derived location of X2 (isohyaline)	This monitoring action is intended to collect data necessary to determine if salinity conditions are meeting contractual and legal requirements. It also provides data necessary to determine if water quality conditions in the different portions of the Delta remain suitable or improve for supporting covered fish species. This information will also used as a reference condition to determine the possible impact of restoration activities on water quality. This information will be used to address deviations from salinity target conditions, and design modifications and/ research studies to address uncertainty in salinity control. This information will be used to evaluate underlying models and hypotheses of water quality responses conservation measures. This information will aid in identifying sources of uncertainty and will guide the design of further management experiments, design modifications and/ research studies to address uncertainty. The monitoring schedule may be adjusted in response to monitoring results to better understand causal relationships between water management and water quality.	CHSA1.1 GRST1.2 PALA1.1 RILA1.1 SASP1.1 STEE1.1 WHST1.1

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Ecosystem Element 3: Hydrodynamics				
Monitoring action SY 3-1: Determine daily flow characteristics throughout the BDCP Plan area.				
Base Condition: Temporal and spatial patterns of flow throughout the Delta region; DAYFLOW, SI3D predictions. **Approach**: Continue monitoring Delta flow and hydrological dynamics through IEP's EMP,. Continue to monitor and calculate flow parameters through Suisun March and at Chipps Island (Delta Net outflow index), **Schedule**: as currently implemented	**Existing Programs:** 1. Delta Flows network (USGS) (21 continuously operating flow stations) 2. IEP EMP sampling station network (15 sites sampled monthly) 3. Flow models (e.g., DAYFLOW, SI3D) **Potential Program Additions:** Expand the USGS network to 29 stations as planned	1. Flow (CFS) 2. Salinity (EC) 3. Water temperature (C^o)	This monitoring action will provide data that will be used by water project operators to assess compliance with target flow levels. They provide a framework for understanding how the tidal currents, river inflows, water project exports, temporary barriers, and DCC gate operations impact transport within the upper estuary. These data are also used routinely for numerical model calibration and validation and are regularly leveraged into large interdisciplinary process-based studies.	ECSY2.1 ECSY2.2 ECSY2.3 ECSY2.4 ECSY2.5, ECSY0.1 CHSA1.5 GRST1.1, RILA1.4, PALA1.4
Ecosystem Element 4: Climate Change				
Monitoring action SY 4-1 Determine the long term dynamics of hydrological characteristics (water level, temperature, salinity) throughout the BDCP Plan area.				
Base Condition: Current monitoring conducted by the interagency network of recorder stations. **Approach**: Continue existing continuous USGS and other agency monitoring programs of Bay Delta water levels, salinity and water temperature; continue modeling of **Schedule**: as currently implemented	**Existing Programs:** Delta Flows network (USGS) comprised of 21 continuously operating flow stations **Potential Program Additions:** Expand the network to 29 stations as planned; See Monitoring Action SY4-1	1. Water level (m) 2. Salinity (EC) 3. Water temperature (C^o)	This monitoring action will provide the Implementing Office with information to determine the magnitude and direction of climate-driven environmental change within the Delta. This information will be used to (a) calibrate models and modify hypotheses as necessary, (b) determine if goals, objectives, or conservation measures are no longer linked with underlying models or hypotheses and thus should be adjusted, modified or eliminated, and (c) if and where changes to planned restoration activities should be considered and managed through the adaptive decision making framework.	ECSY2.1 ECSY2.2 ECSY2.3 ECSY2.4 ECSY2.5, ECSY0.1 CHSA1.5 GRST1.1, RILA1.4, PALA1.4

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
		Ecosystem Monitoring Element: Ecological Processes		
		Element 5: Nonnative Species		
Monitoring Action SY 5-1: Determine the seasonal abundance, distribution, and composition of established nonnative fish predators and competitors with native fishes.				
Base condition: Existing fish surveys and harvest statistics for non-native fish predators/competitors. **Approach:** Annual surveys of non-native fish populations to detect long-term trends. Continue representative sampling of non-native predators in trawls and fish surveys. Estimate harvest rate, population size (CPUE) and age distribution of non-native predatory fish caught in sport fisheries (mark-recapture). **Schedule**: annual	**Existing Programs:** fish surveys 1. CDFG 20 mm Survey 2. CDFG Delta smelt larva study 3. USFWS Spring Kodiak Trawl and 'Supplemental Surveys", (e.g., Mossdale trawl) 4. USFWS Midwater trawl 5. USFWS beach seine 6. CDFG Summer townet survey 7. UCD/IEP Suisun Marsh otter trawl 8. DFG striped bass mark-recapture program 9. IEP fish predator control studies **Potential Program Additions:** Expanded sampling location array to create representative systemwide monitoring network of fish populations. Beach seining to reflect micro-habitats and shallow areas not sampled by trawls. Creel surveys or mandatory harvest reporting for non-native sport fish	1.Abundance, density and diet of non-native predatory centrarchids species (e.g., largemouth bass and sunfishes) in size classes that prey on covered fish species in Delta channels 2. Abundance of non-native predatory fish per unit area of habitat 4. Ratio of non-native fish to native fish 5. Change in harvest success and size of non-native fish caught in sport fisheries	This monitoring action will provide quantitative information about the effectiveness of the conservation measures to reduce predator and competitor populations for different life stages of covered fish species and their spatial response (presence and density) to these enhancements. Monitoring results will be used to evaluate if targets and objectives have been met, parameterize and evaluate conceptual models and other analytical tools, and to prioritize potential actions according to certainty, magnitude and timeliness of benefit. The information provided will also support decisions on potential modification to conservation measures, goals and objectives. It will also be used to determine if additional research activities or special survey technology should be developed.	ECSY6.1 TANC1.2 CHSA1.8 STEE1.7 SASP1.5

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY 5-2. Determine the abundance and species composition of non-native, submerged and floating aquatic vegetation.				
Base Condition: Existing knowledge/surveys/data by resource managers (DBW) will be used to delineate and estimate nonnative SAV and FAV extent in the Delta. **Approach**: This monitoring is implemented as a two-stage sampling: 1. determine the extent and locations of SAV/FAV by remote sensing or other appropriate methods; 2. Randomized stratified water column sampling. Once a close correlation has been established between actual vegetation samples and remote sensing, physical vegetation samples can be eliminated from the sampling protocol. **Schedule:** Every 3 years delineate areas of nonnative invasive aquatic vegetation and conduct Delta wide paired sampling.	**Existing Programs:** Department of Boating and Waterways (DBW) Aquatic Pest Control Program (DBW is the lead agency for controlling Water Hyacinth and Egeria in the Delta) **Potential Program Additions:** 1. Collaboration with DBW on delineation and inventory of aquatic weed extent 2. Remote sensing or aerial imagery acquisition multiple times throughout the growing season (additional delineation via GPS/GIS from vessels etc.) 3. Vessel-based subsampling to estimate composition of aquatic species See also Monitoring Actions CM 13-1, SY3.3	Extent (acres) of nonnative SAV and FAV Maps of the distribution of nonnative SAV and FAV Species composition of nonnative aquatic vegetation	This monitoring is designed to determine the extent of nonnative SAV and FAV in the waterways and floodplains of the BDCP. The BDCP Implementing Office will use results of plan-area wide monitoring to determine if and where controlling SAV and FAV is achievable and sustainable. This information will be used to determine if non-native aquatic vegetation control measures are sufficient to sustainably reduce their impact in important portions of the Delta. The results will also be used by the Implementing Office to determine if control activities should be adaptively adjusted to changing nonnative SAV/FAV extent. The Implementing Office will also use these results to address uncertainties with research studies and adaptive management experiments. The monitoring schedule may be adjusted to reflect changes in non-native aquatic control efforts.	ECSY6.1 TANC1.2 CHSA1.8, SASP1.5, STEE1.7

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY5-3. Determine the status and distribution of nonnative clams.				
Base conditions: ongoing benthic monitoring by IEP throughout the Estuary. **Approach**: Benthic monitoring will be conducted at up to 20 sites within the estuary, with four benthic samples and one sediment sample taken at each site. Samples are analyzed by a contracting lab. Samples will be collected using a hydraulic winch and Ponar dredge or other appropriate grab sampler. **Schedule**: Quarterly	**Existing Programs:** Benthic monitoring component of IEP's Environmental Monitoring Program (EMP) **Potential Program Additions:** Increase the number of benthic sampling stations to up to 20 sites as a representatively sample of the entire BDCP plan area. Database to track observation and incidental records of non-native bivalves to estimate their habitat use and range expansion in the Delta	1. Species of non-native bivalves 2. Total number of individuals counted	This monitoring activity provides information on the non-native clams of the estuary, changes in their presence, abundance and distribution. Data collected from the benthic monitoring program is also used to detect newly introduced species in the estuary. The Implementing Office will use this information to determine the status and change of benthic communities over the term of the BDCP and to evaluate possible causal relationships between physical factors and benthic invertebrate communities. This information will also provide important indicators of invasive species progress, impacts of toxics and water operations, and other changes within the Delta. The implementing office will use this information to address changes and modifications to conservation measures through the adaptive decision making process. The monitoring schedule may be adjusted to provide data at a higher temporal or spatial resolution of deemed necessary.	ECSY6.1 TANC1.2

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY5-3. Determine the status and distribution of Microcystis blooms.				
Base Condition: existing data on Delta microcystis abundance, productivity and correlations with water quality parameters **Approach:** Establish additional fixed monitoring stations as needed in areas where microcystis blooms are observed or likely to occur given water conditions. Take weekly grab samples and measurements of chlorophyll a. **Schedule:** Conduct sampling for the first 5 years following first detection and every 5 years thereafter.	**Existing Programs:** Environmental Monitoring Program (EMP, under IEP) **Potential Program Additions:** **1.** Locations of added stations will be fixed during the duration of the plan to detect increase on microcystis abundance and blooming activity in delta waterways Sampling stations will also provide water quality data (e.g., temperature, turbidity, pH for ammonia conversion, amount of organic carbon) *See Monitoring Actions CM 4-3, CM4-4 , CM4-6, and CM16-5*	1. Phytoplankton species composition/relative abundance 2. Phytoplankton density (mg/L chlorophyll a) 3. microcystis colony structure 4. Water temperature 5. $NH4^{+}$ concentration 6. EC 7. presence of non-native clams (see SY5-3)	This monitoring action is intended to collect data necessary to determine and quantify the degree of microcystis spread and toxic blooms in the Delta. This information, in combination with evaluation of other foodweb-related monitoring and research data, will provide the basis for : 1. Identifying sources of uncertainty and the design of management experiments and/ research studies, to address uncertainty. 2. evaluating underlying conceptual models and hypotheses (e.g., excessive N loading . grazing effects by clams, salinity and temperature limiting factors) 3. evaluating restoration design options to increase the production and export of primary production inundated floodplains 4. Implementing additional management actions to improve production and export of primary production from the floodplain.	ECSY6.1

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Natural Community Monitoring Element				
Element 6: Landscape change				
Monitoring SY6-1: Determine the long-term changes in the location, extent, distribution and juxtaposition of Natural Communities within the Plan Area.				
Base Condition: Current landscape composition (see Chapter 2, *Existing Ecological Conditions*). **Approach**: GIS coverages of natural communities will be updated by remote sensing or other appropriate methods to provide estimates of the change occurring within natural communities and landscapes of the BDCP Planning Area. Classification will be field-checked using BDCP conservation lands as verification sites. **Schedule**: Every five years	**Existing Programs:** GIS database (BDCP) Agency databases (CASIL) **Potential Program Additions:** GIS and spatial analysis capability	1. Extent (acres) 2. Location (boundaries) 3. Distribution (number of parcels, parcel size) 4. Neighborhood spatial statistics	This monitoring action will provide the Implementing Office with a Planning Area-wide assessment of how landscapes change over time. This provides an important framework for assessing the effectiveness of the conservation lands system and its functionality and role within the overall landscape. It also indicates to what degree landscape change follows anticipated shifts in the distributions of covered species and natural communities in response to climate change. The Implementing Office will use this information to determine if current models and hypotheses on landscape and climate change are supported or need to be modified. It further will use this information to examine the context of conservation measures and to address conservation targets through the adaptive decision making process. For example, if certain natural community types become unexpectedly rare, the Implementing Office can adaptively respond by increasing acquisition of conservation lands of the rarest community type. The monitoring schedule may be adjusted if landscape change accelerates.	ECSY1.1 ECSY1.2

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY6-2: Determine structural connectivity and identify corridors and landscape barriers of the BDCP Plan Area				
Base Condition: Current landscape composition (see Chapter 2, *Existing Ecological Conditions*). **Approach**: Connectivity will be evaluated from Planning Area -wide GIS mapping by calculating structural connectivity measures (e.g., mean inter-patch distance and other connectivity measures) and species specific functional connectivity assessments (e.g., least-cost corridor analyses, circuit theory). Connectivity maps will be produced to identify gaps and breaks in structural and functional connectivity throughout the BDCP Planning Area. **Schedule**: Every 10 years.	**Existing Programs:** GIS databases (BDCP) Agency databases (CASIL) **Potential Program Additions:** 1. GIS and spatial analysis capability 2. Connectivity assessment and analysis (including species modeling)	1. Landscape statistics (e.g., contagion, diversity, elevation, area-perimeter ratios)	This monitoring action will provide the Implementing Office with a Planning Area-wide assessment of structural and functional connectivity of habitats for covered species over time. This provides an important framework for assessing the effectiveness of the conservation lands system and its functionality in connecting habitats and improving covered species movement across the landscape. The Implementing Office will use this information to determine the locations where additional conservation land acquisitions are need to increase landscape connectivity. The monitoring schedule may be adjusted if landscape change accelerates or if major, landscape-altering events occur (floods, fire, seismic events).	ECSY3.1 ECSY3.2

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Element 7: Biodiversity				
Monitoring Action SY7-1: Determine the diversity of native species within the BDCP Area.				
Base Condition: Current species occurrence and predicted habitat (see Appendix 1, Covered Species and Chapter 2, *Existing Ecological Conditions*). **Approach**: Calculate the change in the number of present covered species, based on (a) updated maps of natural communities (see Monitoring Action SY6-1), (b) actual surveys of conservation lands, (c) species occurrence databases (e.g., CNDDB) and other agency records. **Schedule**: Every 10 years.	**Existing Programs:** 1. GIS databases 2. CNDDB	1. Number of species 2. Acres of habitat per species	This monitoring action will provide information to the Implementing Office whether the presence/occurrence and diversity of covered species may have changed for the Planning Area. The Implementing Office will use this information to evaluate if conservation lands acquisition should be redesigned or modified. It will also use this information to initiate targeted research to determine causal relationships for this change. This monitoring schedule may be intensified to a 5-year interval if rapid change in biodiversity is indicated or following a major, planning area – wide disturbance (flood, seismic event, etc).	ECSY1.1

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Fish, Wildlife, and Plant Monitoring Elements				
Element 8: Abundance and distribution of covered fish species.				
Monitoring Action SY8-1: Determine the distribution and abundance of juvenile salmonid abundance for each run.				
Base Condition: Current knowledge of presence and abundance of juvenile salmonids in Delta waterways **Approach**: Visual and non-lethal fish sampling (e.g., beach seining, electrofishing) of representative, randomly selected sections in Delta rearing habitats during the. **Schedule**: Annually during rearing/outmigration periods of juvenile salmonids, conduct biweekly sampling	**Existing Programs:** Historical sampling, USFWS weekly beach seining survey of juvenile salmonids (49 permanent locations Delta wide) **Potential Program Additions:** 1. Add sampling locations to ensure statistical representative sampling effort See also *Monitoring Action CM5-3.*	1. Abundance 2 . size 3. race 4. location	This monitoring action will provide information on the presence and abundance and relative use of delta waterways by juvenile salmonids. Results of monitoring will be assessed to determine if salmonid distribution and abundance is responding to increasing habitat and food availability as restoration progresses. The information will be used test and evaluate numerous models and hypotheses on stressors and limiting factors for salmonids in the Delta. The schedule of the monitoring action may be adjusted to reflect changes in management or research results on fish presence in inundated floodplains.	CHSA1.5 STEE1.3
Monitoring Action SY8-2: Determine the seasonal abundance and distribution of juvenile and adult delta smelt.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Monitoring Action SY8-3: Determine the location of delta smelt spawning habitats.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY8-4: Determine the seasonal abundance and distribution of juvenile and adult Sacramento splittail.				
Base condition: Conduct surveys of splittail adults, larvae, and eggs to determine the abundance of splittail larvae, juveniles and adult present during the reproductive period. **Approach:** Conduct fish sampling surveys to determine the change in densities of larvae and juveniles relative to base conditions and in-channel spawning. **Schedule:** Weekly fish sampling will be conducted in spawning habitat during the first 5 floodplain inundation periods during the splittail spawning season. Subsequently monitor every fifth flood event over the term of the BDCP.	**Existing Programs:** USFWS rotary screw traps USFWS beach seine **Potential Program Additions:** 1. Add sampling locations to include restored floodplain and adjacent channel habitats to ensure statistical representative sampling effort	1. Production of Sacramento splittail (number of larval and early juvenile splittail/10,000 m^3) during floodplain inundation periods	This monitoring action will provide information on productivity of Sacramento splittail populations and the contribution of inundated restored floodplains on spawning and rearing of splittail. This information will be used by the Implementing Office to decide if the production of splittail during floodplain inundation periods has increased significantly from base conditions. If monitoring results do not support conceptual models and hypotheses predicting increasing splittail spawning, the Implementing Office will conduct additional studies to determine 1. uncertainties and competing hypotheses 2. other factors/stressors that affect splittail spawning and rearing in restored habitats, and 3. restoration design modifications to increase splittail productivity. If causes are related to inundation duration, experimental management of flood control structures and floodplain topography may used to address uncertainties. The monitoring schedule may be extended or intensified if uncertainties of causal relationships persist.	SASP1.1 SASP1.3

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY8-5: Determine the seasonal abundance and distribution of juvenile and adult green sturgeon and white sturgeon.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	GRST1.2 WHST1.1
Element 9: Survival of covered fish species.				
Monitoring Action SY9-1: Determine nonnative predatory fish predation rates on each run of juvenile salmonids.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	CHSA1.5 CHSA1.8 STEE1.3 STEE1.7 SASP1.5
Monitoring Action SY8-2: Determine annual outmigration success of juvenile salmonids.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	CHSA1.5 CHSA1.8 STEE1.3 STEE1.7 SASP1.5
Monitoring Action SY8-3: Determine entrainment levels of covered fish species.				
Implemented through Monitoring Actions CM-2 and CM-3.				
Monitoring Action SY8-4: Determine tissue concentrations of selenium, mercury, pyrethroids, and endocrine disrupting compounds in covered fish species.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	[To come.]
Monitoring Action SY8-5: Determine Pacific and river lamprey upstream and downstream migration success.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	[To come.]
Element 10: Growth rates of covered fish species.				
Monitoring Acton SY10-1: Determine the level of co-occurrence of juvenile fall-run Chinook salmon with preferred prey species.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	CHSA1.1
Monitoring Acton SY10-2: Determine the level of co-occurrence of delta smelt with preferred prey species.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Monitoring Acton SY10-3: Determine the extent of delta smelt rearing habitat.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Monitoring Acton SY10-4: Determine the spring abundance of preferred longfin smelt prey species.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Acton SY10-5: Determine the seasonal abundance of preferred Sacramento splittail prey items.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	SASP1.2
Monitoring Acton SY10-6: Determine the size (weight, length) distribution of juvenile salmonids of each run outmigrating from the Delta.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	CHSA1.2 STEE1.2
Monitoring Acton SY10-6: Determine the seasonal size (weight, length) distribution of delta smelt and longfin smelt.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Element 11: Production of covered fish species.				
Monitoring Acton SY11-1: Determine the extent of longfin smelt spawning habitat.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Monitoring Acton SY11-2: Determine the upstream migration success of green and white sturgeon through the Delta .				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Monitoring Acton SY11-3: Determine adult recruitment of delta smelt and longfin smelt .				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	
Element 12: Genetic integrity of wild salmonid stocks.				
Monitoring Action SY12-1: Determine the degree of population genetic variability in each Chinook salmon run and Central Valley steelhead.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	CHSA1.9 STEE1.8

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Element 13: Distribution, status, trends of covered wildlife species populations.				
Monitoring Action SY12-1: Determine the number of occupied Swainson's hawk, least Bell's vireo, and western yellow-billed cuckoo nesting territories.				
Base Condition: Pre-acquisition condition, existing knowledge on presence of covered species habitat requirements. **Approach**: Review of agency records, research results, expert knowledge and other data on locations of observations of nesting Swainson's hawk, least Bell's vireo, and western yellow-billed cuckoo. **Schedule**: Annual.	**Existing Programs:** None **Potential Program Additions:** 1. Database of observation records *See CM 11-5*	1. location 2. species	This action is intended to provide the basis for comparing plan-area-wide species performance to the functioning of conservation lands. Management actions are undertaken based on the guidance in the Site-Specific Monitoring Plan, which is subject to modification based on site-specific conditions, opportunities unforeseen at the onset of implementation, or to adjust to the progress of other site specific management plans and the need to meet overall Plan Area-wide goals.	ALNC1.8 ECSY1.5 VRNC1.1 VRNC2.1
Monitoring Action SY12-2: Determine the abundance and distribution of riparian brush rabbit and riparian woodrat if found in the Plan Area.				
Base Condition: expert knowledge **Approach**: track agency records, studies and incidental observations of riparian brush rabbit and riparian woodrat within the BDCP plan Area. If necessary, conduct 10 day trapping grid sampling to verify suspected occurrences. **Schedule**: Annual compilation of Continue for at least 5 inundation years. Ten repeat every 5 years, focusing on verifying presence in previously established occurrences	**Existing Programs:** historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. database to track annual information on riparian brush rabbit and riparian woodrat distribution and status	1. Presence and sex/age distribution of riparian brush rabbit and riparian woodrat in the BDCP plan area.	This monitoring action is intended to collect data on the distribution and population trend of riparian brush rabbit and riparian woodrat. Monitoring results will be used to determine if habitat restoration has a source or sink effect on the abundance of riparian brush rabbit and riparian woodrat. This information is necessary to determine if adaptive changes to the implementation schedule or additional measures may be necessary to increase the abundance and viability of of riparian brush rabbit and riparian woodrat populations.	RIBR1.1 RIWR1.1 VRNC1.1 VRNC2.1

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Monitoring Action SY12-3: Determine the abundance and distribution of giant garter snake.				
Base Condition: expert knowledge **Approach**: track agency records, studies and incidental observations of Giant Garter Snakes within the BDCP plan Area. If necessary, conduct field trapping/sampling to verify suspected occurrences. **Schedule**: Annual compilation of Continue for at least 5 inundation years. Ten repeat every 5 years, focusing on verifying presence in previously established occurrences	**Existing Programs:** historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. database to track annual information o Garter snake distribution and status *See CM 2-16, CM10-4*	1. Presence and sex/age distribution of Giant Garter Snake	This monitoring action is intended to collect data on the distribution and population trend of giant garter snake. Monitoring results will be used to determine if habitat restoration has a source or sink effect on the abundance of giant garter snakes. This information is necessary to determine if adaptive changes to the implementation schedule or additional measures may be necessary to increase the abundance and viability of giant garter snake populations.	ALNC1.1 ALNC1.2 ALNC1.5 ALNC1.6 TANC1.1 FMNC1.1 FMNC2.1 NANC2.1 NWNC1.1 NWNC2.1 ALNC1.7 ALNC1.8 GGSN1.1 GGSN2.1 GGSN2.2
Monitoring Action SY12-4: Determine the abundance of waterfowl wintering in the Plan Area.				
Base Condition: Current waterfowl monitoring as conducted by USFWS, CDFG and CWA **Approach**: Continue USFWS and CDFG special fall and midwinter aerial surveys. The midwinter survey, the longest running population assessment, focuses on all ducks, geese, swans, and coots. **Schedule**: Annual mid-winter surveys as currently implemented by USFWS.	**Existing Programs:** USFWS midwinter waterfowl surveys **Potential Program Additions:** none	1. Number 2. Species 3. sex/age composition (if possible)	This monitoring action provides information on the abundance of wintering waterfowl. The Implementation office will use this information to determine area-wide trends in waterfowl numbers and to compare these with waterfowl use of restored or created wetland wintering habitat for waterfowl. The Monitoring schedule may be changed if necessary to improve accuracy and/or precision of waterfowl estimates.	MWNC1.1
Monitoring Action SY12-5: Determine the abundance of shorebirds using the Plan Area during spring and fall migration periods.				
[Text to come.]	[Text to come.]	[Text to come.]		MWNC1.2

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Element 14: Reproductive success of covered wildlife species.				
Monitoring Action SY12-1: Determine Swainson's hawk, least Bell's vireo, and western yellow-billed cuckoo the nesting success.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	[To come.]
Monitoring Action SY12-1: Determine the recruitment rate for riparian brush rabbit and riparian woodrat if found in the Plan Area.				
Base Condition: expert knowledge **Approach**: If riparian brush rabbit or riparian woodrat are verified within the BDCP plan Area, conduct 10day capture-recapture (trapping grid) sampling at the beginning, middle and end of the reproductive period **Schedule**: 3 consecutive seasons every 10 years .	**Existing Programs:** historical surveys, research projects, approved sampling protocols. **Potential Program Additions:** 1. trapping survey team, equipment and methodology to conduct capture -recapure	1. sex/age distribution of riparian brush rabbit and riparian woodrat 2. Lactation rates	This monitoring action is intended to provide information on recruitment of juvenile riparian woodrats and brush rabbits into the adult population. This information will be used in parameterizing a population viability model for each species. Model output will predict the probability of population persistence and extinction. Monitoring results will be used to determine if habitat restoration has a source or sink effect on the abundance of riparian brush rabbit and riparian woodrat. This information is necessary to determine if adaptive changes to the implementation schedule or additional measures may be necessary to increase the abundance and viability of of riparian brush rabbit and riparian woodrat populations.	

Table 3-21. Potential System-Wide Monitoring Actions (continued)

Base Conditions, Approach, and Schedule	*Applicable IEP and other Programs and Potential Additions to those Programs*	*Metrics*	*Adaptive Management Considerations*	*Biological Goals and Objectives Addressed*
Element 15: Distribution, status, and abundance of covered plant species.				
Monitoring Action SY12-1: Determine the abundance and distribution of intertidal covered plant species.				
[Text to come.]	[Text to come.]	[Text to come.]	[Text to come.]	MFNC1.2 BMNC1.2 FMNC1.2 SUTH1.1 SUTH1.2 SOBB1.1 SOBB1.2

3.7 ADAPTIVE MANAGEMENT PROGRAM

[***Note to Reviewers****: The text of this section of Chapter 3 on adaptive management was revised based on comments by Steering Committee members following the October 21, 2010 meeting. This section is subject to change and revision based on further input from the BDCP Steering Committee.*]

The BDCP Adaptive management program is premised on the concept that, as new information and insight is gained during the implementation of a conservation plan, adjustments can be made to the conservation actions to further advance the goals and objectives of the plan. The Natural Community Conservation Planning Act (NCCPA) recognizes this function, defining adaptive management as a process whereby "the results of new information gathered through the monitoring program of the plan and from other sources [is applied] to adjust management strategies and practices to assist in providing for the conservation of covered species."[45] Similarly, the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) describe adaptive management as a "method for examining alternative strategies for meeting measurable biological goals and objectives, and then if necessary, adjusting future conservation management actions according to what is learned."[46]

Consistent with these definitions, the BDCP adaptive management program will provide the basis for: (1) key gaps in data and knowledge to be identified and steps to be taken to close such gaps; ; (2) alternative approaches to conservation actions to be developed that would enhance the effectiveness of conservation measures; (3) new information gathered through monitoring and targeted research programs to be evaluated; and (4) analytical processes and feedback loops to be instituted to better inform decisions regarding adaptive changes. Outcomes of the adaptive management decision making process could include changes in conservation measures, biological objectives and targets, monitoring actions and metrics, and analytical tools within the boundaries established by the BDCP.

The Program Manager, through the Science Manager, will be responsible for the administration and implementation of the BDCP adaptive management program. The BDCP Implementation Board will oversee the Implementation Office's implementation of the program. The roles and responsibilities of the Implementation Office, the Implementation Board, the fish and wildlife agencies, and the Authorized Entities in the adaptive management program are summarized in Section 3.7.2 *Adaptive Management Decision Making Process.*

The conservation measures described in Section 3.4, *Conservation Measures*, are based on the best scientific and commercial information and data available and have been designed to address the biological goals and objectives of the Plan. As the BDCP is being implemented, however, new data and information will be developed through the monitoring and research program described in Section 3.6, *Monitoring and Research Program*, as well as through other efforts, that

[45] Fish and Game Code Section 2805(a)
[46] Five-Point Policy for HCPs, 65 FR 106, June 1, 2000

will further inform the Implementation Office on a number of matters affecting plan implementation.

Information gained through monitoring and research will help inform investigations into such matters as: maximizing the efficacy of conservation measures and understanding the factors that may account for poorer than expected ecological responses to the implementation conservation measures; the synergistic and cumulative effects associated with multiple conservation measures; the influence of factors present outside the BDCP Plan Area, including those associated with other conservation planning efforts; and the effects of operational criteria on ecosystem conditions. Additionally, monitoring and research conducted under the BDCP and other programs produce information and data regarding the effects of climate change on Delta conditions (e.g., sea level rise, hydrology in the Delta watershed, and increased water temperatures), seismic events, projected large-scale changes in land use, and other circumstances that fall outside of the scope of the BDCP to address.

As more is understood about the Delta ecosystem, modifications to the BDCP conservation measures may be necessary. Conservation measures may initially prove to be less effective than expected, but as more is learned through the adaptive management process, certain adjustments may be possible to increase the effectiveness of measures. Alternatively, conservation measures may prove initially effective, but changing conditions in the Plan Area may necessitate changes in the manner in which conservation measure are implemented or require a shift to more effective measures. The adaptive management process will afford the Implementation Office, in coordination with the Implementation Board, the flexibility to address the shortcomings of conservation measures in meeting BDCP goals and objectives by making adjustments to these measures. Specifically, adaptive management changes may include modifications to the conservation measures, their elimination altogether, or the addition of new measures. The adaptive management program may also indicate refinements to the biological goals and objectives and targets; changes in the priorities for implementation of conservation measures, including the shifting of funds among measures; and changes to the monitoring program as indicated by new scientific information. Should strong cause and effect relationships be established, the adaptive management program will provide the mechanism to concentrate efforts on the implementation of conservation measures that have been demonstrated to be effective and to de-emphasize or discontinue implementation of conservation measures that have proven to be less effective at achieving desired outcomes.

To address uncertainty regarding Delta ecological processes and species biology, to provide for flexibility in the Conservation Strategy through time as ecological knowledge expands, and to ensure that the BDCP becomes increasingly more effective over time and responsive to changing ecological conditions in the Delta, the BDCP adaptive management program has been developed with the following elements:

- **Process Framework –** the process by which the BDCP adaptive management program will be implemented, including gathering data through monitoring and targeted research, analyzing data, assimilating new knowledge, and making adjustments to the strategy (Section 3.7.1, *Adaptive Management Process Framework*);

- **Decision Making Process –** a decision making process that effectively uses new information in a timely manner to make adaptive management changes and that allows for sufficient input from various participants (Section 3.7.2, *Adaptive Management Decision Making Process*; see also Chapter 7, *Implementation Structure*) under the governance structure of the BDCP;
- **Adaptive Ranges –** specifically established upper and lower boundaries and limits that govern the scope of changes that can be made to conservation measures, including water operations criteria, pursuant to the adaptive management program. These ranges are reflected in the BDCP and its associated regulatory authorizations. (Section 3.7.3, *Concept of a "Defined Adaptive Range" and Water Operations Adaptive Management*);
- **Targeted Research** – experiments and pilot studies specifically designed to test uncertainties and the hypotheses underlying conservation measures, and to rapidly gain knowledge that could improve performance (Section 3.7.5, *Adaptive Management Experiments*);
- **Status Reviews –** required regular reviews of the Conservation Strategy's performance, achievement of goals and objectives, and status of covered species (Section 3.7.7, *Program Status Reviews*; see also Section 6.2, *Compliance and Progress Reporting*).

This adaptive program of knowledge expansion and implementation flexibility is central to the BDCP Conservation Strategy and the achievement of the BDCP biological goals and objectives.

3.7.1 Adaptive Management Process Framework

The process framework for the BDCP adaptive management program is depicted in Figure 3-63.

DRAFT

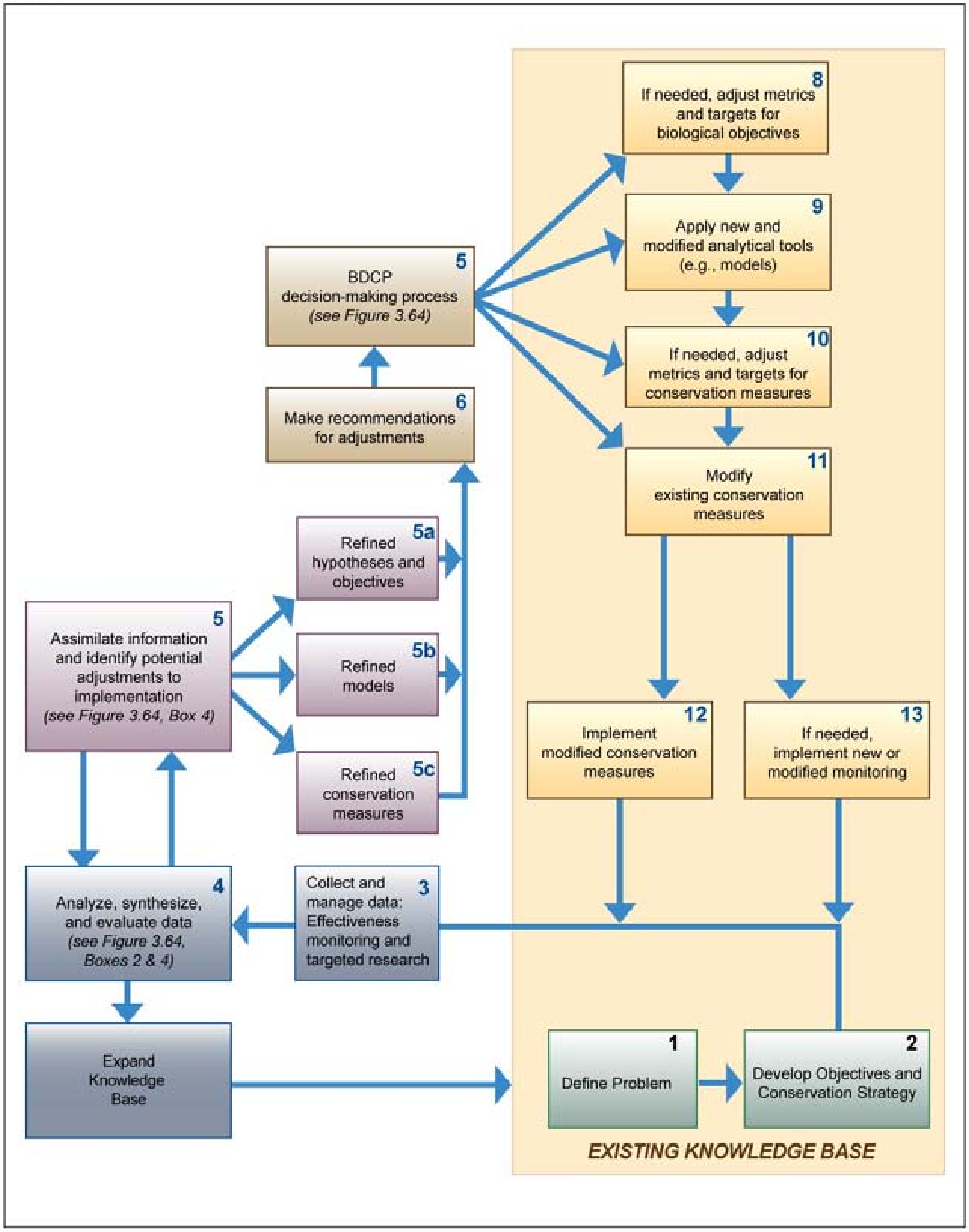

Figure 3-63. BDCP Adaptive Management Process Framework

To ensure development of a scientifically-based BDCP adaptive management program, independent science advisors were engaged to provide expert input on best approaches to adaptive management. The results of the deliberations of these scientists are reflected in the *BDCP Independent Science Advisors Report on Adaptive Management, February 2009* (Appendix G). The report set out the following principles for effective adaptive management:

1. The scope and degree of reversibility of each proposed action (i.e., conservation measure) determines the form of adaptive management that can be applied (e.g., “active” or versus “passive” adaptive management)[47].
2. The knowledge base about the ecosystem is key to decisions about what to do and what to monitor, and includes all relevant information, not just that derived from monitoring and analysis within the context of BDCP.
3. Program goals should relate directly to the problems being addressed and provide the intent behind the conservation measures; objectives should correspond to measurable, predicted outcomes.
4. Models should be used to formalize the knowledge base, develop expectations of future conditions and conservation outcomes that can be tested by monitoring and analysis, assess the likelihood of various outcomes, and identify tradeoffs among conservation measures.
5. Monitoring should be targeted at specific mechanisms thought to underlie the conservation measures, and must be integrated with an explicitly funded program for assessing the resulting data.
6. Prioritization and sequencing of conservation measures should be assessed at multiple steps in the adaptive management cycle.
7. Specifically targeted institutional arrangements are required to establish effective feedback mechanisms to inform decisions about whether to retain, modify, or replace conservation measures.
8. A dedicated, highly skilled agent (person, team, office) is essential to assimilate knowledge from monitoring and technical studies and make recommendations to senior decision makers regarding programmatic changes.

The advisors report included an adaptive management process framework. The BDCP adaptive management process depicted in the flow diagram in Figure 3-64 follows the recommendations provided in the independent science advisors report.

47 Active adaptive management is experimental, involving manipulations intended to achieve conservation goals but also to improve knowledge. Passive adaptive management is not experimental, but is nevertheless approached from a scientific perspective to improve knowledge and adapt strategies during project implementation.

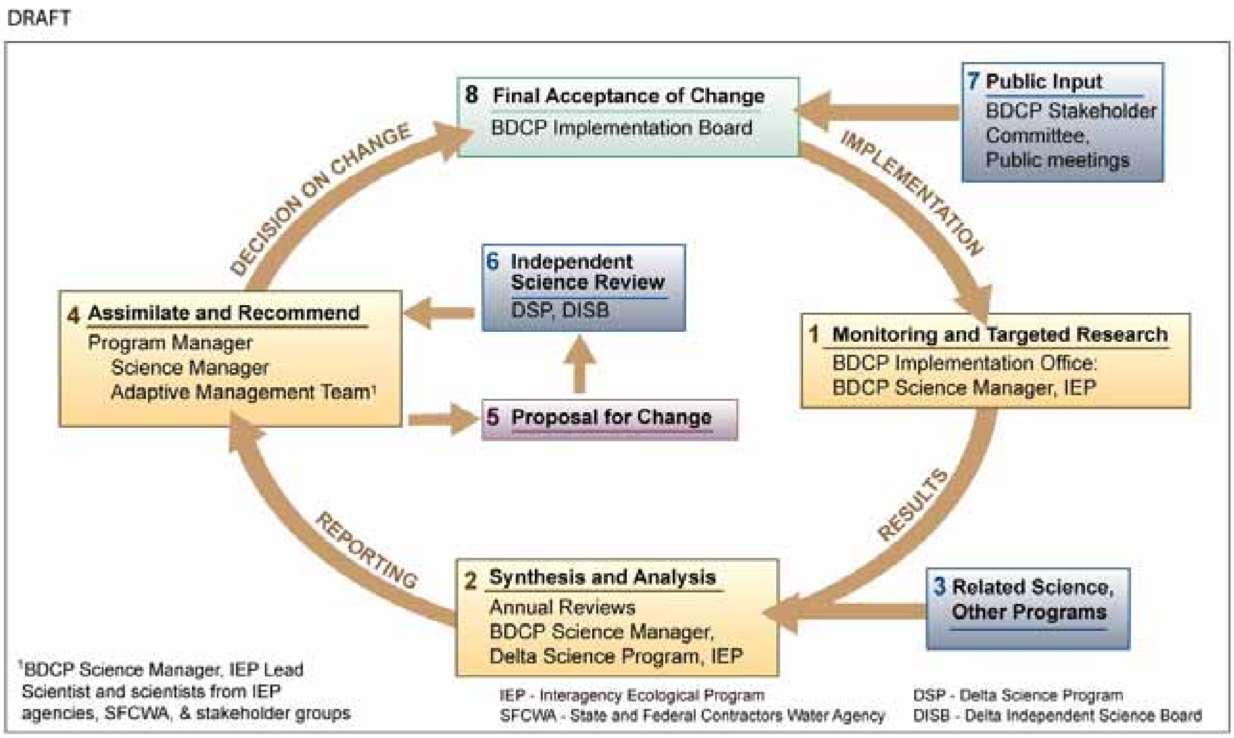

Figure 3-64. BDCP Adaptive Management – Decision-Making Process

3.7.1.1 Plan Objectives and the Knowledge Base

The starting point for the BDCP adaptive management process is with the definition of global problems and the identification of BDCP-specific, measurable and practical biological goals and objectives (see Figure 3-63, Boxes 1 and 2). BDCP objectives are based on the best available information about covered species, natural communities, ecosystem function in the Delta, and about the environmental stressors affecting these biological resources, and anticipated ecological and species responses to the conservation measures. The current information about system function and stressors comprises the existing "knowledge base" (see large shaded box underlying the right side of Figure 3-63). The adaptive management process is designed to use new information (i.e. contributions to the knowledge base) to inform a systematic and integrated critical review, at regular intervals, of the entire Conservation Strategy, including BDCP objectives, conservation measures, hypotheses relating to predicted outcomes and targets. As the knowledge base is expanded, and biological models are revised, changes may be made to the BDCP objectives and associated hypotheses, metrics, targets, and monitoring metrics (Figure 3-63, Box 5; see Section 3.7.1.3). The Science Manager, within the BDCP Implementation Office, is responsible for ensuring that the adaptive management program is focused on the achievement of BDCP biological goals and objectives and that the program draws from be best scientific and commercial information available to support adaptive management decisions.

3.7.1.2 Collect and Manage Data

Critical to the adaptive management process is the collection and management of existing and new data (see Figure 3-63, Box 3) to assess conservation measure performance and the achievement of biological goals and objectives. Monitoring and targeted research data collection and management will be the responsibility of the Science Manager within the BDCP Implementation Office with assistance from the Interagency Ecological Program (IEP), and in coordination with the Delta Science Program and other science and monitoring programs (see Section 3.6, *Monitoring and Research Program*). Monitoring actions and metrics are described in Section 3.6, *Monitoring and Research Program*. In addition, results of targeted research and scientific modeling conducted by programs other than the BDCP will contribute to the knowledge base to support understanding of ecological cause and effect relationships. Monitoring data and research results will provide the BDCP Implementation Office with information to help determine the effectiveness of conservation measures in providing benefits to species and habitats, the effectiveness of adjusting or modifying approaches to the implementation of the measures, and the effectiveness of combinations of measures to achieve desired objectives. Because new data provide the foundation for making effective adjustments to plan implementation over time through the adaptive management process, collected data will undergo quality assurance reviews. Recommendations to modify implementation of conservation measures will be guided by information gathered through the monitoring and research program and other research sources (Figure 3-63, Box 3, see also Figure 3-64, Box 3). The BDCP monitoring and research program is designed to establish cause and effect relationships between implementation of specific conservation measures and the type and magnitude of ecosystem and species responses to those measures, as well as responses to the implementation of combinations of conservation measures.

The Implementation Office will establish processes and procedures to govern the systematic control and management of information obtained through BDCP monitoring and research. Specifically, the Implementation Office will ensure that all information is appropriately classified, stored, secured, and shared. This includes:

- Ensure that records of permanent value are preserved.
- Ensure the security and protection of regulatory, statutory or business importance from unauthorized access and/or modification.
- Ensure that all BDCP data is of the highest quality (accuracy and precision).
- Ensure responsive and transparent sharing of data across the widest-possible spectrum of users, including scientists, government agencies, non-governmental organizations and the public.

3.7.1.3 Analyze Data, Assimilate Information, and Develop and Recommend Adjustments to Implementation.

The science advisors report on adaptive management (Appendix G) pointed out that the weakest aspect of most adaptive management plans is in the sequence of steps required to link the knowledge gained from implementation monitoring and research and other sources to decisions about whether to continue, modify, or stop actions, refine objectives, or alter monitoring (Figure 3-63, Box 5 and Box 6; Figure 3-65). See the discussion of internal and external science review in the 3.7.2, *Adaptive Management Decision Making*.

Collected data will be analyzed and synthesized at appropriate intervals by the Implementation Office, in coordination with Delta Science Program and IEP, and these results will be evaluated by the Adaptive Management Team. The BDCP Science Manager may utilize IEP, the Delta Science Program, and other expertise to support the evaluation of monitoring and research data. Results will include information related to cause and effect relationships between conservation measures and ecological processes, covered species, and natural communities; the status of ecosystem conditions and covered species; and the effectiveness of the conservation measures and the monitoring program (Figure 3-63, Box 5). The results will also clearly identify the inferential reliability of this knowledge (sensu Romesburg 1981), statistical performance measures (e.g. power accuracy, precision) and, if appropriate, alternative hypotheses generated from the results. Information gained through this process may indicate the need to redefine hypotheses underlying biological objectives and conservation measures; refine, discontinue, or expand conservation measures; or develop and implement new conservation measures within limits set by the plan and its associated regulatory authorizations.

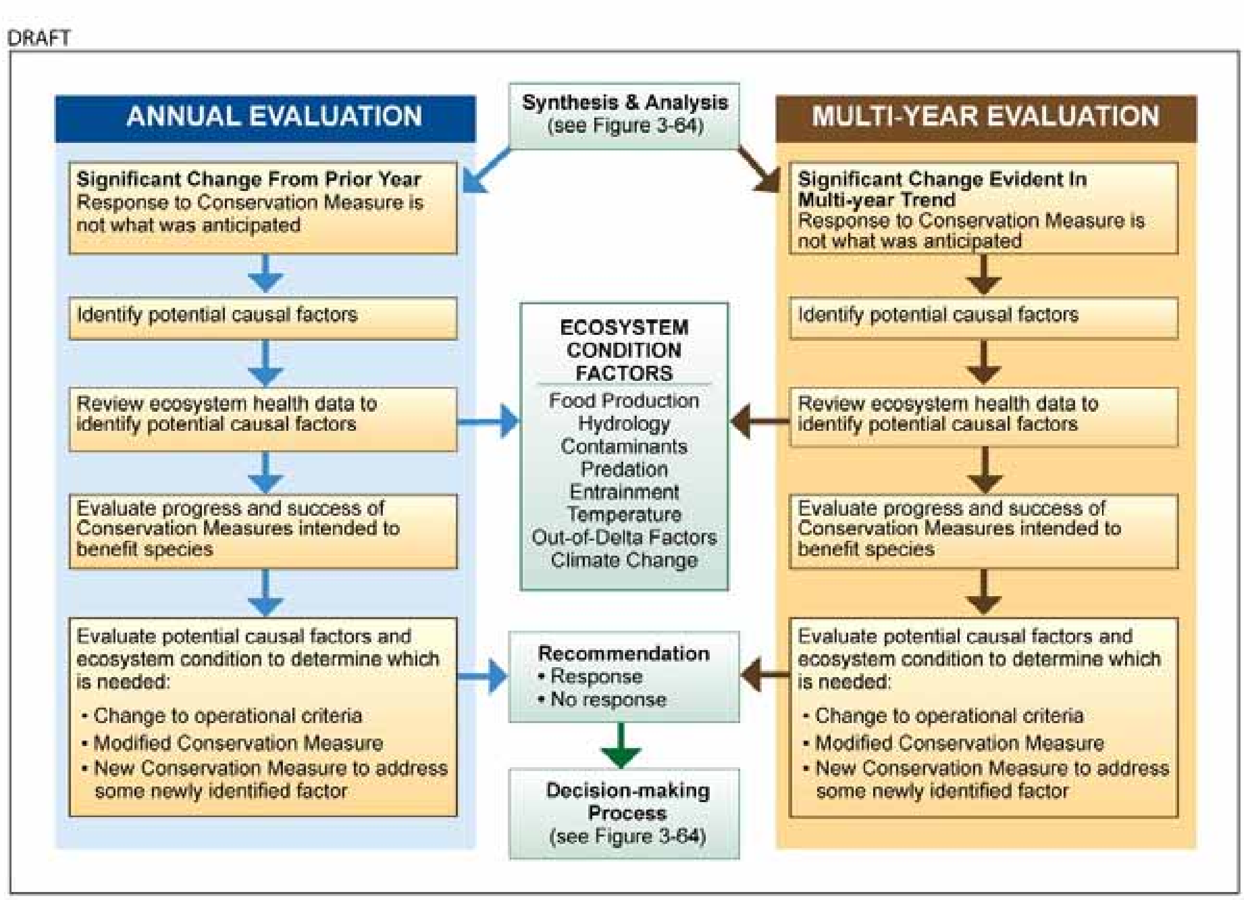

Figure 3-65. BDCP Adaptive Management Process: Response to a Significant Declining Trend in Covered Species

The science advisors also emphasized the need to integrate the evaluation of the efficacy of conservation measures across suites of measures that are inter-related, and to use and expand upon the existing (and new) modeling capabilities to assist in that integrated evaluation. New data will therefore also be used to update models (e.g., conceptual, statistical, and process models) and other analytical tools that are useful in assessing the performance of both individual conservation measures and suites of interrelated measures in helping to achieve the goals and objectives of the plan as the magnitude of stressors are better understood and uncertainties are resolved. New data and modeling work will also help predict the magnitude and trajectory of ecosystem and covered species responses to conservation measures and identify the need for new models and tools (Figure 3-63, Box 5 which corresponds to Box 4 of decision making process illustrated in Figure 3-64). Ecological models (either conceptual or mathematical) are extremely valuable for formalizing the link between objectives and proposed conservation measures to clarify how and why each conservation measure is expected to contribute to objectives and are a key element of adaptive management. Models will be used to formalize knowledge about the system and to predict the outcomes of and design modifications to conservation measures.

Based on assimilation of new information, the Adaptive Management Team (see Section 3.7.2.1, *Roles and Responsibilities*) working with the IEP, Real Time Operations Response Team (see Chapter 7, *Implementation Structure*) and the Implementation Facilitation Team (see Chapter 7, *Implementation Structure*), as appropriate, will formulate recommended new approaches for BDCP implementation intended to increase the effectiveness of conservation measures, the monitoring program, analytical tools, and metrics in meeting the biological goals and objectives of the BDCP (see Figure 3-63, Box 6). The BDCP Program Manager may include such recommendation in the Annual Workplan and Budget (see Section 6.2, *Compliance and Progress Reporting*). Recommended new approaches to conservation actions would be considered, and potentially adopted, through the BDCP adaptive management decision making process (Figure 3-64).

3.7.1.4 Implement Modified Conservation Measures, Tools, Metrics, and Targets

BDCP Implementation Office through the adaptive management program, and within the limits of the adaptive ranges set out in the BDCP and reflected in the associated regulatory authorizations, would implement adaptive changes to the BDCP Conservation Strategy that may include:

- **Adjustments to metrics and targets for biological objectives** (Figure 3-63, Box 8) – Metrics and targets for BDCP biological objectives were developed based on the existing knowledge base. New information developed during the BDCP implementation could result in the need to revise metrics and targets for these objectives (as allowable under the authorizing permits).
- **Development and application of new analytical tools** (Figure 3-63, Box 9) – As knowledge grows over time, new analytical tools are expected to be developed including monitoring technologies and techniques, physical and biological models, statistical

relationships, etc. These new tools would be applied to the monitoring and evaluation of implementation of the BDCP Conservation Strategy as they become available.

- **Adjustments to metrics and targets for conservation measures** (Figure 3-63, Box 10) – Specific metrics and targets have been identified for BDCP conservation measures based on existing knowledge. As understanding of the Delta ecosystem improves, revisions would be made to these metrics and targets to reflect this new knowledge, as appropriate.
- **Modification of conservation measures** (Figure 3-63, Box 11) – The adaptive management program guides the modification of BDCP conservation measures to improve effectiveness in meeting BDCP goals and objectives. The adaptive management program can also modify priorities and timetables for implementing conservation measures based on new knowledge.
- **Discontinuance of ineffective conservation measures** (Figure 3-63, Box 11) – The adaptive management program allows for the elimination of unsuccessful conservation measures. The funds allocated to these measures may be reallocated to expand successful measures.
- **Identification of new conservation measures** (Figure 3-63, Box 11) – As a result of BDCP monitoring and research and new knowledge, new stressors may be identified which are drivers of ecosystem change and species response. The adaptive management program may be used, subject to the limits established in the Plan, to incorporate new conservation measure to address these stressors in the Conservation Strategy. [***Note to Reviewers****: Could refer to Section 3.5, Potential Conservation Measures to Address Other Stressors, depending on the approach decided for those potential conservation measures.]*
- **Implementation of new or modified monitoring methods** (Figure 3-63, Box 13) – The adaptive management program will inform and guide the subjects of monitoring, monitoring metrics, and the duration and scope of monitoring. Monitoring technology and techniques improve through time and as new methods are developed they will be incorporated into the BDCP monitoring program. The adaptive management program would also identify and implement modifications to the research program and adaptive management experiments to address new uncertainties and fill knowledge gaps.

BDCP actions related to SWP and CVP water operations remain under the authority and are the responsibility of DWR and Reclamation, not the Implementation Office. Adjustments to the water operations criteria set out in the BDCP and reflected in its associated authorizations, and within the adaptive range for water operations described in CM1 *Water Facilities and Operations*, may only be conducted through the process identified in Section 3.7.3.2, *Decision Process for Adjusting Water Operations within the Adaptive Range.*

3.7.2 Adaptive Management Decision Making Process

This section describes the process by which adaptive management decisions will be made, including those that result in adjustments to conservation measures, operational criteria, biological objectives, metrics and targets, the monitoring program including monitoring methods, and analytical tools, as warranted by new information. This section describes the relationships among, and coordination between, the entities that comprise the governance structure (Chapter 7, *Implementation Structure*) in the context of the adaptive management decision-making process (Figure 3-64).

3.7.2.1 Roles and Responsibilities

3.7.2.1.1 Science Manager

The BDCP Implementation Office, under the direction of the BDCP Program Manager, is responsible for Plan implementation, including the monitoring, research, and adaptive management programs. The BDCP Science Manager, under the direction of the Program Manager, is the primary Implementation Office staff responsible for ensuring the proper implementation of these programs.

3.7.2.1.2 Adaptive Management Team

The Science Manager may create an "Adaptive Management Team" and will serve as the chair of and recommend membership for the BDCP Adaptive Management Team to the Program Manager. Membership of the Adaptive Management Team will be reviewed and approved by the BDCP Program Manager and the BDCP Implementation Board. The Adaptive Management Team may include:

- BDCP Science Manager (chair);
- IEP Lead Scientist;
- Senior scientists from IEP member agencies[48];
- SFWCA scientists;
- Other scientists; and
- Scientists from the Stakeholder Committee, as appropriate.

Adaptive Management Team members may change as necessary depending on specific the technical issues that need to be addressed (e.g., fisheries, terrestrial wildlife, habitat restoration, water operations).

[48] IEP has ten member agencies: three State (DWR, DFG, and State Water Resources Control Board); six Federal (USFWS, Reclamation, U.S. Geological Survey, USACE, NMFS, and U.S. Environmental Protection Agency), and one non-government organization (The San Francisco Estuarine Institute).

The Science Manager will utilize the Adaptive Management Team to support the conduct of annual and multi-year reviews, in coordination with the Delta Science Program, including efforts to identify issues that may benefit from independent science advice; consider potential adaptive management actions that may be indicated by the results of monitoring and research efforts; and identify research that may be useful to effectively address uncertainties. The Adaptive Management Team will make recommendations to the Program Manager for adaptive management changes to the BDCP Conservation Strategy.

The Science Manager may utilize the Adaptive Management Team to support the synthesis and presentation of current scientific knowledge on relevant Delta resources to the Program Manager and BDCP Implementation Board.

3.7.2.2 Adaptive Management Decisions and Responses (Not Related to Water Operations)

The Program Manager will manage the BDCP adaptive management program through the Science Manager. The Program Manager will facilitate and coordinate discussion and consideration of adaptive management issues among the various participating entities, including the authorized entities, fish and wildlife agencies, and the Implementation Board to facilitate decision-making regarding changes in the implementation of the Plan. Adaptive management decisions to take new actions within the BDCP Plan Area will take into account and be coordinated with changes that may be made to upstream operations, which may result from changes made pursuant to existing or future biological opinions for the CVP/SWP project operations outside the Delta. The decision-making process described in this section does not apply to changes or modifications to water operations that may be made by DWR and USBR. The process for adaptive management decisions affecting water operations is set out in Section 3.7.3.2, *Decision Process for Adjusting Water Operations within the Adaptive Range*. The approach depicted in Figure 3-64 will be used to make adaptive management decisions relating to BDCP actions that are not related to water operations.

1. Monitoring and targeted research (Figure 3-64, box 1) will be conducted under the direction of the Science Manager, with support provided by the IEP.

2. The BDCP Science Manager, in coordination with the IEP, Adaptive Management Team, and the Delta Science Program, will assemble, synthesize, and analyze the results of BDCP monitoring and targeted research (Figure 3-64, box 2) efforts and integrate the results of new and relevant scientific research and studies conducted by other parties (Figure 3-64, box 3).

3. Based on this information and the advice of independent scientists, as appropriate (Figure 3-64, boxes 5 and 6), the Adaptive Management Team, through the Science Manager, will provide recommended program changes to the Program Manager (Figure 3-64, Box 4), either as part of the annual and five year workplan development process or on an *ad hoc* basis, where an adaptive change should occur on a shorter than annual timeframe.

4. The Program Manager will recommend adaptive management changes to the Implementation Board (Figure 3-64, Box 4). The Implementation Board will provide an opportunity for stakeholder input (Figure 3-64, box 7). The Implementation Board will review the Program Manager's recommendation and make final acceptance of the proposed adaptive management changes (Figure 3-64, Box 8).

The BDCP Implementation Board will receive information on the implementation of the BDCP generally, and will review major aspects of the adaptive management program described in the Annual Workplan. Members of the Board will have the right to object to adaptive management proposals made by the Program Manager on the basis that the proposed change, a) will not adequately contribute to achievement of the goals and objectives of the BDCP, or, b) is inconsistent with the requirements of the Plan or the permits/authorizations. If changes are accepted by the Board, they will be implemented by the Implementation Office under the accepted timetable. If the Board cannot come to agreement on an adaptive management change, the dispute resolution process described in Chapter 7, *Implementation Structure,* will be used.

As the BDCP is being implemented, it is expected that some changes in implementation actions and some adaptive management decisions will be considered to be minor. These minor decisions will not be subject to the formal adaptive management decision process as described above. Once such a type or category of change is accepted as minor by the Implementation Board, the Program Manager will be able to undertake such minor adjustments to conservation measures, without the need for extensive coordination with the other entities, thereby encouraging efficiency and timeliness in the implementation process. Such changes to the manner in which actions are implemented under the Plan include, for example, refinements to techniques used to restore habitat or to remove invasive species.

Plan implementation and adaptive management responses that will require full review as part of the adaptive management process include:

- Any change in the water operating criteria within the adaptive range;
- Discontinuation of a conservation measure;
- Expansion of a conservation measure;
- Addition of a new conservation measure;
- Decisions to reallocate available funding or resources away from ineffective conservation measures and toward more promising ones; or
- Any change to BDCP goals and objectives.

The Program Manager will consult with the Implementation Facilitation Team, the Real Time Operations Response Team and Adaptive Management Team regarding ongoing implementation issues which may require changes to broad elements of the Plan or specific actions to determine if such changes should be considered through the adaptive management process. Changes to the

Plan would be subject to the limits, boundaries, parameters and sideboards established for adaptive management actions, including funding caps established to implement the BDCP Conservation Strategy.

In some instances, a significant change in population trends for a covered species may occur, necessitating responsive actions (Figure 3-65). Efforts to respond to such circumstances would be conducted within the framework of the adaptive management program, as appropriate.

3.7.2.3 Internal Scientific Review

The Program Manager will use the Adaptive Management Team to provide internal scientific review (internal to the Implementation Office) on specific technical issues of immediate importance to the success of the adaptive management program and the Conservation Strategy implementation. The Adaptive Management Team will also assess on a regular basis the overall efficacy of the adaptive management program, including the results of effectiveness monitoring, selection of research and adaptive management experiments, and relevance of new scientific information developed by others (e.g., universities, Delta Science Program) to determine whether changes in the implementation of the conservation measures and the monitoring program would improve the effectiveness of the BDCP in achieving its biological goals and objectives

Recommendations made by the Adaptive Management Team and by other scientists and experts will be memorialized in a standardized format and will include a description of the recommended change in implementation; a description of the justification for the recommended change; an assessment of effects the change may have on other elements of BDCP implementation, if any; and any other relevant information in support of the recommendation. The rationale for rejection of adaptive management recommendations made during the internal science review process will also be documented.

3.7.2.4 External Independent Scientific Review

Working in coordination with the Delta Science Program and the Adaptive Management Team, the Program Manager will from time to time seek additional science input on specific implementation and adaptive management-related issues. The Program Manager may convene, at its discretion, experts on selected topics that are not affiliated with the Implementation Office, permit holders, or fish and wildlife agencies. The Program Manager will consult with the Implementation Board regarding the selection of scientists to provide advice on specific matters.

3.7.3 Concept of a "Defined Adaptive Range" and Water Operations Adaptive Management

[***Note to Reviewers**: The process for making adjustments to water operations within the adaptive range needs to be consistent with the process in Section 3.7.2.2, with recognition that these kinds of changes will likely be made more frequently.*]

To allow for flexible and responsive implementation of the BDCP, several conservation measures include a defined "adaptive range" that establishes the parameters within which a conservation measure may be adjusted to improve its effectiveness or respond to changing biological conditions. For example CM6 *Channel Margin Habitat Enhancement* identifies a target of 20 linear miles of enhancement of channel margins in areas important to salmonid outmigration and identifies an adaptive range that allows for an additional 20 miles of margin enhancement through the adaptive management program should this measure prove to be highly effective.

3.7.3.1 Water Operations Adaptive Range

Defined adaptive ranges are included in the BDCP Conservation Strategy for a number of operational criteria established for water operations (see CM1 *Water Facilities and Operations* in Section 3.4 *Conservation Measures*). For example, initial operational criteria (to be implemented once new facilities become operational) are identified in CM1 for Sacramento River bypass flows at the north Delta diversions, along with a defined adaptive range. This adaptive range includes allowance for increasing the bypass flows, through the adaptive management process, should an initial flow criterion prove to be less effective than expected (as defined by the Plan; *e.g.*, objectives established to protect covered fish species). Similarly, a lower limit to the defined adaptive range includes an allowance for narrowing the bypass criteria (allowing increased diversions) should flows or other conservation measures prove more effective in meeting objectives than expected, as defined by a standard or measure set out in the biological objectives and monitoring program.

3.7.3.2 Decision Process for Adjusting Water Operations within the Adaptive Range

SWP and CVP water operations are under the authority and are the responsibility of DWR and Reclamation, not the Implementation Office. Accordingly, DWR and Reclamation will implement the BDCP water operations conservation measures, under CM1 *Water Facilities and Operations*. Adjustments of the water operations criteria within the adaptive range for water operations, established at the time of BDCP authorization and described in CM1 *Water Facilities and Operations,* may only be conducted through the following process.

1. **Proposal to change operating criteria within the adaptive range provided to Program Manager** - Proposals to change the criteria for water operations are likely to come primarily from the IO staff, but may come from an outside body. However, proposed changes may also be requested by member of the Stakeholder Committee. All proposals related to changes in the water operations criteria will be submitted to the Program Manager. A proposal to change the real time operational range within the adaptive range will be identified in the draft Annual Water Operations Strategy and the draft Annual Workplan and Budget. Out-of-cycle proposals for changes may be requested, if necessary, to address biological objectives in situations that are time sensitive.

2. **Review of proposed change** - The Program Manager, through the Science Manager, will solicit independent science input on the proposed change from the Delta Science Program, Independent Science Board, and other appropriate independent scientists with expertise in the resources and operational change proposed.

3. **Submittal of proposal for change by Program Manager to the "Decision Body" –** The Program Manager will submit the proposed change to the "Decision Body" for review as part of the draft Annual Workplan and Budget. Out-of-cycle proposals for changes may be submitted, if necessary to address biological objectives in situations that are time sensitive. [***Note to Reviewers****: The placeholder "Decision Body" is used here until the appropriate entity(ies) is/are identified to serve in the role*.]

4. **Review of proposal for change by "Decision Body" -** The program manager will facilitate a review by the "Decision Body." The "Decision Body" will review the proposed operational change and determine if it is acceptable.

5. **Resolutions of disputes among directors –** If the "Decision Body" cannot reach consensus, then the decision on the proposed change will be elevated to the "Higher Level Decision Body" for joint resolution.

6. **Establish the changed criteria** - Once changes are agreed to by the "Decision Body" or through the dispute resolution process, they will be incorporated into the Annual Water Operations Strategy by DWR and Reclamation and implemented under the accepted timetable. These changed criteria will become the new operational criteria for the conservation measure within which the Real Time Operations Response Team may make real time operational decisions.

The process described above applies only to changes in operational criteria that are within the bounds of the operational adaptive range established at the time of BDCP authorization and described in CM1 *Water Facilities and Operations*. .

3.7.4 Concept of Adaptive Management Triggers

The Program Manager, with Implementation Board concurrence, may elect to develop adaptive management triggers for specific parameters and metrics during Plan implementation as a tool to support the adaptive management program, should the development of such triggers prove valuable to the program. Adaptive management triggers are quantified thresholds established for objectives or conservation measures that, if exceeded, would identify the need for an analysis of cause and effect and development of alternative actions to improve effectiveness of the conservation measure. Adaptive management triggers related to effectiveness identify specific conditions in which targets are not likely to be achieved and therefore adaptive changes should be considered and undertaken.

3.7.5 Adaptive Management Experiments

Because the biological outcome of many management actions is uncertain, the adaptive management program is based on scientific principles that guide continual refinement of conservation efforts in order to achieve the biological goals of the plan. The adaptive management program will develop alternative management strategies and test the effectiveness of these strategies. To that end, there is a continuum of management actions that incorporate scientific principles of adaptive management to varying degrees. The simplest studies involve monitoring effects once a conservation action has been taken, without replication, controls, or comparison of management treatments. At the other end of the spectrum is targeted research that tests a hypothesis in a manner that can be validated through statistical inference.

3.7.5.1 Targeted Research

There are a number of key uncertainties surrounding covered species, ecological processes, and biotic/abiotic interactions, and regarding the effectiveness of the conservation measures (see discussions of hypothesized benefits for individual conservation measures in Section 3.4, *Conservation Measures).* Some of these key uncertainties are expected to be resolved using adaptive management targeted research and others may be resolved by studies outside BDCP.

The Implementation Office may undertake or fund targeted research through the BDCP research program to provide information necessary to adaptively implement the BDCP (see Section 3.6, *Monitoring and Research Program*). This research should answer specific management-related questions that arise based on results of monitoring and to address data gaps to provide information necessary to successfully implement the conservation measures.

Results of research will inform management decisions to and increase the effectiveness of conservation measures. It is expected that most or all targeted research will be conducted by or in partnership with outside scientists from academic institutions, consulting firms, and non-profit organizations. It is anticipated that funding provided by the Implementation Office for targeted research could be matched or supplemented by other entities to increase the level of research and to achieve results that integrate with broader issues in the research community. The amount of targeted research will be limited by funding available to the Implementation Office.

In addition to targeted research undertaken by the Implementation Office, it is also expected that scientists within the Implementation Office will develop partnerships with academic institutions to encourage academic research that could inform and improve management and monitoring techniques.

3.7.5.2 Management-Oriented Conceptual Models

Conceptual models describe our current understanding of a functioning ecosystem. They provide a framework for learning about a system and help formulate hypotheses about cause-and-effect relationships. Conceptual models are useful for management because they can help to identify which factors may be important in a system, which of these factors may be influenced by management, and hence which attribute (component or condition) of the system should be assessed. Conceptual models can inform the research program in several important ways: by providing a basis from which to test assumptions about the relative importance of certain processes, by helping to identify threats or stressors, by identifying species or other attributes that function as ecosystem indicators, and by serving as a repository of our changing understanding of the system as more data become available. Conceptual models can also be used to communicate understanding of the system to other scientists and the public and to facilitate review. For a multi-species, ecosystem-process-based and habitat-based conservation plan such as the BDCP, models provide a useful framework for understanding how individual species react to the same management actions. Therefore, models must be sufficiently complex as to capture the relationships that drive the system and translate these relationships to covered species, but streamlined enough to be useful as management and monitoring tools. Models are only as good as the information used to develop them. Several types of conceptual models have been used in the development of the BDCP Conservation Strategy, and other models may be developed as more data become available, and as more efficient tools are developed.

The Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) Conceptual Models developed by the CALFED Ecosystem Restoration Program are a suite of process, habitat, and species models incorporating the current scientific understanding of the Delta. These conceptual models describe the relationship of life history components to known drivers or stressors, and include categorical evaluations of the relative importance, predictability and level of understanding of the linkages between these drivers/stressors and outcomes. The DRERIP Evaluation Process was used to evaluate the relative magnitude and certainty of effects of proposed BDCP conservation measures on aquatic covered species (i.e., fish and aquatic plants), aquatic and estuarine natural communities, and related ecosystem processes using these DRERIP models and other available data (see Section 10.3.5, *DRERIP Evaluation Process* and Appendix F, *BDCP DRERIP Evaluation Results of Draft Conservation Measures.*). The DRERIP process was also used to explicitly identify key data gaps that should be filled through directed research or other exploratory studies. In most cases these models consist of diagrams that show the hypothesized relationships that characterize the ecosystem and are supplemented by written materials. There is also a need to develop full life history model for all of the covered fish species to facilitate plan implementation and guide adaptive management decision making process. Additional models may be developed as needed during the development and refinement of detailed monitoring plans. As new information becomes available, the DRERIP models will be updated to improve confidence in model parameters.

Species-habitat models have been developed for terrestrial Covered Species and natural communities; (see Appendix A, *Covered Species Accounts*). Species-habitat models, which can also be considered conceptual models, are useful tools that make explicit the assumptions about the relationship between species and habitat type. Species-habitat models were developed for the BDCP to hypothesize a relationship between land cover type and other habitat components and the distribution of covered species. These models have served as the basis for identifying current habitat distribution, predicting habitat distribution after restoration-related conservation measures are implemented, estimating impacts of conservation measure implementation, and prioritizing land acquisition. Information from pre-acquisition surveys and the planning surveys for covered activities will further refine these models such that they can be used to more accurately predict distribution, occupancy, and assess population trends.

3.7.6 Database Development and Reporting

Proper data management, analysis, and reporting are critical to the success of the adaptive management program. Data on monitoring methods, results, and analysis must be managed, stored, and made available to Implementation Office staff, decision-makers, scientific advisors, and other appropriate persons. A database and clear reporting procedure is also required for permit compliance. See Section 3.6.8, *Database Development and Maintenance,* for a discussion of the proposed database structure.

3.7.7 Program Status Reviews

Requirements for annual and five year reports and work plans by the Implementation Office that include discussions of implementation results and adaptive management changes are described in Section 6.2, *Compliance and Progress Reporting*.

3.7.8 Public Involvement

Public involvement is an especially important component of successful adaptive management. The responsibility for public outreach by the Implementation Office is described in Section 7.5, *Public Outreach*.

CHAPTER 4. DESCRIPTION OF COVERED ACTIVITIES AND ASSOCIATED FEDERAL ACTIONS

Table of Contents

List of Tables

List of Figures