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Chapter 3

Conservation Strategy (Section 3.3)

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Acronyms and Abbreviations

BiOp	biological opinion
CESA	California Endangered Species Act
CM	conservation measure
CNDDB	California Natural Diversity Database
CVP	Central Valley Project
DFG	California Department of Fish and Game
DO	dissolved oxygen
DPS	distinct population segment
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
ESA	federal Endangered Species Act
ESU	evolutionarily significant unit
FR	*Federal Register*
NCCP	Natural Community Conservation Plan
NCCPA	Natural Community Conservation Planning Act
NMFS	National Marine Fisheries Service
ppt	parts per thousand
ROA	restoration opportunity area
SAV	submerged aquatic vegetation
SWP	State Water Project
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
YOY	young-of-the-year

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Chapter 3

Conservation Strategy (Section 3.3)

3.3 Biological Goals and Objectives

3.3.1 Framework for the Goals and Objectives

The role of biological goals and objectives within the Bay Delta Conservation Plan (BDCP or Plan) is described in Section 3.1.1, *Biological Goals and Objectives*. The biological goals articulate the broad, intended outcomes of the Plan. Biological objectives are specific, measurable outcomes that are expected to be achieved by the Plan. Conservation measures are designed to achieve the biological objectives and will directly or indirectly contribute to achieving one or more biological goals. The biological goals and objectives were developed consistent with the following 11 guiding principles provided by the California Natural Resources Agency.

1. The BDCP will establish biological goals and objectives for covered species that are intended to be achieved through Plan implementation.
2. Biological objectives may or may not be Endangered Species Act (ESA) permit conditions. Achievement of certain biological objectives may be permit conditions in the context of the adaptive management program for certain conservation measures. Those objectives that may be permit conditions are those that are both achievable by the permittee and are essential for agency findings.
3. Biological goals and objectives for covered fish will be stated as desired outcomes such as targeted increases in growth rates, survival, population size, or habitat extent. Biological goals and objectives for other covered species will be stated as desired outcomes for species habitat amount or condition.
4. Biological goals for covered fish will be expressed as broad biological outcomes associated with population viability criteria such as targeted improvements in population size, productivity, spatial structure or habitat extent.
5. Biological objectives will be expressed as more specific outcomes for species, community, ecosystem, habitat, or stressor attributes that are expected to be achieved by the Plan.
6. Biological objectives for the Plan will be "SMART"—specific, measurable, achievable, relevant, and time-bound—to the maximum extent possible. Where a high level of uncertainty is associated with the measurability, achievability, or relevance of an objective, that uncertainty will be explicitly addressed through planned research, monitoring, and the adaptive management program.
7. Success in achieving the biological goals and objectives will be measured during implementation of the Plan and the adaptive management program through monitoring and targeted research.
8. In developing the BDCP conservation strategy, the effects analysis will evaluate whether the conservation measures proposed to be included in the BDCP are reasonably likely to achieve the objectives where there are data and analytical methods to do so. If the evaluation finds that a conservation measure is unlikely to advance an objective, the conservation measures may be

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modified or alternative measures adopted, or the objective may be reconsidered. Where the data and/or methods do not allow for such an analysis, the Plan will include targeted research to obtain the needed data and develop the needed analytical methods to inform the adaptive management program and address and reduce uncertainty about achieving the objective.

9. During implementation, conservation measures may be adjusted, as necessary, appropriate, and consistent with Plan commitments, through the adaptive management process, to better achieve the biological goals and objectives. The adaptive management process will be designed to distinguish effective (or better) conservation measures from ineffective (or worse) conservation measures.

10. Objectives may also be modified over time, but only if new information indicates that such changes are warranted. The standard for modifying an objective will generally be higher than the standard for modifying a conservation measure. Goals are unlikely to be modified. The process for modifying objectives will be set out in Chapter 3 of the BDCP in the adaptive management and monitoring and research program.

11. Some factors (for example, "other stressors") that are outside the control of the BDCP participants may affect the ability of the BDCP to reach some of its goals and/or objectives. Factors beyond the control of BDCP will be monitored to determine their effect on the ability of BDCP to reach its goals and objectives.

The BDCP biological goals and objectives are organized hierarchically at the landscape, natural community, and species levels, as described in Section 3.1.1, *Biological Goals and Objectives*. Section 3.3.2, *Goal and Objective Statements,* below, lists all of the biological goals and objectives and identifies the conservation measures that will be implemented to achieve these goals and objectives. Section 3.3.3, *Landscape-Scale Biological Goals and Objectives*, lists the landscape-scale goals and objectives and describes the rationale for each. Section 3.3.4, *Natural Community Biological Goals and Objectives*, addresses the conservation strategy for natural communities using a nested approach: for each natural community, the landscape-scale goals and objectives that would benefit that community's conservation strategy are described, followed by the goals and objectives that were developed specifically for that natural community and their associated rationale. Section 3.3.5, *Species Biological Goals and Objectives*, uses the same nested approach for covered species: for each species, the landscape-scale and natural community goals and objectives that would benefit that species are described, followed by goals and objectives developed for that species and the associated rationale. For the most part, the conservation strategies for covered species are addressed through goals and objectives at the landscape and natural community levels. Species-specific goals and objectives were only developed when additional factors, such as specific habitat requirements or population factors, needed to be addressed to conserve the species.

3.3.1.1 Process for Developing Fish Species Biological Goals and Objectives

Preliminary BDCP biological goals and objectives for covered fish species were developed in 2007. These goals and objectives were refined in 2010 in accordance with the Logic Chain approach through extensive Logic Chain workgroup meetings, two independent science review panel reviews and a two-day workshop in October 2010 (Dahm et al. 2010). An incomplete set of revised draft biological goals and objectives reflecting this work was presented in the November 18, 2010, BDCP Working Draft. In April 2011, a group of science advisors was convened to help in completing goals

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and objectives for covered fish species. The advisors produced draft recommendations for three species (Sacramento splittail, winter-run Chinook salmon, and delta smelt) in June 2011 (Anderson et al. 2011). Based on the science advisor's recommendations, refined goals and objectives were then developed for all 11 covered fish species, in a process further informed by discussions with the Science Advisors and a working group meeting in October 2011.

Some of the targets in the biological objectives for covered fish are expressed as a population metric such as species growth or survival. This approach was used because it was recommended by the science advisors, is consistent with the criteria listed above, and addresses important uncertainties related to the efficacy of the conservation measures for the covered fish. Biological objectives with specific population metrics risk being infeasible if the metric cannot be measured accurately, the target cannot be achieved by the Plan, or the target cannot be reached due to factors beyond the control of the Plan. These objectives were developed to minimize these risks and to meet the regulatory requirements of the ESA and NCCPA for each covered fish. See the methods section in Chapter 5, *Effects Analysis*, for a description of the process used to quantatively evaluate whether the Plan will be able to meet each biological objective for covered fish.

*[**Note to reviewers:** further changes are anticipated as a result of forthcoming agency reviews]*

3.3.1.1.1 Conceptual Models and Adaptive Management

Many environmental variables (e.g., temperature, salinity, dissolved oxygen) have the potential to affect a specific species' response (e.g., growth, abundance, distribution). The goals and objectives selected for fish species reflect the best available science for predicting a species' response to a given environmental variable. However, the understanding of species' requirements, life history, and environmental response is in many cases limited and continues to change. In order to provide the flexibility to incorporate new and changing information, a conceptual model reflecting the current state of knowledge is outlined for each species.

The conceptual model reflects a set of scientific theories, principles, and assumptions that describe how a species will likely respond to different environmental variables. For the BDCP, conceptual life-history models developed as part of the DRERIP process are used which provide life stage transition probability diagrams and supporting text that describe the assumptions behind each environmental variable/species response relationship. The conceptual models are used in a number of different ways. They provide the rationale for the species-specific goals and objectives and guide how the biological effects analysis is organized and displayed. They are also useful in determining which environmental and species response variables to monitor in order to track BDCP compliance and effectiveness. Perhaps, most importantly, the conceptual models will be used in the adaptive management process.

The conceptual models are an important part of the adaptive management program, for they are used to interpret monitoring data and make assumptions about the relative success of a BDCP action. If a conceptual model proves incorrect, it can be updated to reflect the best available science and as appropriate management actions can be adjusted to maintain permit compliance. A detailed discussion of the adaptive management approach is provided in Section 3.6, *Adaptive Management and Monitoring Program*.

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3.3.2 Goal and Objective Statements

The biological goals and objectives are listed in Table 3.3-1 at the landscape, natural community, and species levels. Each biological objective will be met through implementation of one or more conservation measures, which are also listed in Table 3.3-1.

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Table 3.3-1. BDCP Conservation Strategy Goals and Objectives with Associated Conservation Measures

Goals and Objectives	Applicable Conservation Measures
Landscape-Scale Goals and Objectives	
Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.	
Objective L1.1: Protect at least 31,000 acres of existing natural communities, focusing on the highest quality natural communities and covered species habitats.	CM3 Natural Communities Protection and Restoration
Objective L1.2: Protect sufficient lands for the restoration of natural communities as described in Objective L1.3.	CM3 Natural Communities Protection and Restoration
Objective L1.3: Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities.	CM2 Yolo Bypass Fishery Enhancement CM3 Natural Communities Protection and Restoration CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM7 Riparian Natural Community Restoration CM8 Grassland Natural Community Restoration CM9 Vernal Pool Complex Restoration CM10 Nontidal Marsh Restoration
Objective L1.4: Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.	CM3 Natural Communities Protection and Restoration
Objective L1.5: Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide upland habitat values and refugia from flooding.	CM3 Natural Communities Protection and Restoration CM5 Seasonally Inundated Floodplain Restoration CM8 Grassland Natural Community Restoration
Objective L1.6: Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.	CM3 Natural Communities Protection and Restoration
Objective L1.7: To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.	CM3 Natural Communities Protection and Restoration CM4 Tidal Natural Communities Restoration
Objective L1.8: To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.	CM4 Tidal Natural Communities Restoration

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Goals and Objectives	Applicable Conservation Measures
Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.	
Objective L2.1: Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances.	CM3 Natural Communities Protection and Restoration CM5 Seasonally Inundated Floodplain Restoration CM11 Natural Communities Enhancement and Management
Objective L2.2: Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).	CM3 Natural Communities Protection and Restoration CM5 Seasonally Inundated Floodplain Restoration
Objective L2.3: Allow lateral river channel migration.	CM3 Natural Communities Protection and Restoration CM5 Seasonally Inundated Floodplain Restoration
Objective L2.4: Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.	CM3 Natural Communities Protection and Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Riparian Natural Community Restoration
Objective L2.5: Promote water quality conditions within the Delta that help restore native fish habitat.	CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement CM7 Riparian Natural Community Restoration CM12 Methylmercury Management CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels
Objective L2.6: Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement
Objective L2.7: Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.	CM11 Natural Communities Enhancement and Management CM20 Recreational Users Invasive Species Program
Objective L2.8: Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.	CM4 Tidal Natural Communities Restoration
Objective L2.9: Provide refuge habitat for migrating and resident covered fish species.	CM4 Tidal Natural Communities Restoration

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Goals and Objectives	Applicable Conservation Measures
Objective L2.10: Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.	CM2 Yolo Bypass Fisheries Enhancements CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Habitat Enhancement CM7 Riparian Natural Community Restoration
Objective L2.11: Restore or create at least 20 linear miles of transitional intertidal areas including tidal mudflat natural community and patches of subtidal and lower marsh.	CM4 Tidal Natural Communities Restoration
Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.	
Objective L3.1: Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.	CM3 Natural Communities Protection and Restoration CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM7 Riparian Natural Community Restoration CM8 Grassland Natural Community Restoration CM11 Natural Communities Enhancement and Management
Objective L3.2: Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic fish species.	CM1 Water Facilities and Operation CM4 Tidal Natural Communities Restoration
Objective L3.3: Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.	CM1 Water Facilities and Operation CM6 Channel Margin Habitat Enhancement
Objective L3.4: Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fishery Enhancement Plan
Goal L4: Reduce mortality of covered species in the Plan Area.	
Objective L4.1: Avoid and minimize adverse effects on covered species resulting from BDCP covered activities.	CM22 Avoidance and Minimization Measures
Objective L4.2: Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species.	CM6 Channel Margin Habitat Enhancement CM13 Invasive Aquatic Vegetation Control CM15 Predator Control
Objective L4.3: 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 Enhancement CM16 Nonphysical Fish Barriers

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Goals and Objectives	Applicable Conservation Measures
Objective L4.4: Reduce entrainment, impingement, and salvage losses of covered fish species.	CM1 Water Facilities and Operation
Natural Community Goals and Objectives	
Tidal Perennial Aquatic	
Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.	
Objective TPANC1.1: Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.	CM3 Natural Communities Protection and Restoration
Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.	
Objective TPANC2.1: Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.	CM13 Invasive Aquatic Vegetation Control
Tidal Mudflat	
No natural community goals and objectives specific to this natural community.	
Tidal Brackish Emergent Wetland	
Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.	
Objective TBEWNC1.1: Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.	CM3 Natural Communities Protection and Restoration CM4 Tidal Natural Communities Restoration
Objective TBEWNC1.2: Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.	CM4 Tidal Natural Communities Restoration
Objective TBEWNC1.3: Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.	CM4 Tidal Natural Communities Restoration
Objective TBEWNC1.4: Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.	CM4 Tidal Natural Communities Restoration

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Goals and Objectives	Applicable Conservation Measures
Tidal Freshwater Emergent Wetland	
Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.	
Objective TFEWNC1.1: Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.	CM4 Tidal Natural Communities Restoration CM6 Channel Margin Enhancement
Objective TFEWNC1.2: Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.	CM4 Tidal Natural Communities Restoration
Goal TFEWNC2: Biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes and functions.	
Objective TFEWNC2.1: Restore and sustain a diversity of marsh vegetation that reflects historical species compositions and high structural complexity.	CM4 Tidal Natural Communities Restoration CM11 Natural Communities Enhancement and Management
Valley/Foothill Riparian	
Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.	
Objective VFRNC1.1: Restore or create 5,000 acres of valley/foothill riparian forest.	CM3 Natural Communities Protection and Restoration CM7 Riparian Natural Community Restoration CM6 Channel Margin Habitat Enhancement
Objective VFRNC1.2: Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period.	CM3 Natural Communities Protection and Restoration
Objective VFRNC1.3: Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.	CM3 Natural Communities Protection and Restoration CM6 Channel Margin Enhancement CM7 Riparian Natural Community Restoration
Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.	
Objective VFRNC2.1: Restore, maintain and enhance structural heterogeneity with adequate vertical and horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands.	CM5 Seasonally Inundated Floodplain Restoration CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management
Objective VFRNC2.2: Maintain at least 1,000 acres of early- to mid-successional vegetation with a well-developed understory of dense shrubs.	CM5 Seasonally Inundated Floodplain Restoration CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management

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Goals and Objectives	Applicable Conservation Measures
Objective VFRNC2.3: Maintain 500 acres of mature riparian forest in large blocks (which must have a minimum patch size of at least 50 acres each) in Conservation Zones 4 and/or 7.	CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management
Goal VFRNC3: Maintain or increase native biodiversity that characterizes the valley/foothill riparian community.	
Objective VFRNC3.1: Maintain or increase abundance and distribution of rare and uncommon shrubs characteristic of riparian communities, especially buttonwillow and elderberry bushes.	CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management
Nontidal Freshwater Perennial Emergent Wetland and Nontidal Perennial Aquatic	
Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.	
Objective NFEW/NPANC1.1: Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle.	CM3 Natural Communities Protection and Restoration CM10 Nontidal Marsh Restoration
Objective NFEW/NPANC1.2: Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.	CM3 Natural Communities Protection and Restoration CM10 Nontidal Marsh Restoration
Alkali Seasonal Wetland Complex	
Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex.	
Objective ASWNC1.1: Protect 150 acres of alkali seasonal wetland in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.	CM3 Natural Communities Protection and Restoration
Goal ASWNC2: Alkali seasonal wetlands that are managed and enhanced to sustain populations of native alkali seasonal wetland species.	
Objective ASWNC2.1: Provide appropriate seasonal flooding characteristics for supporting and sustaining alkali seasonal wetland species.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Vernal Pool Complex	
Goal VPCNC1: Vernal pool complexes comprised of large, interconnected, or contiguous expanses that represent a range of environmental conditions**.**	
Objective VPCNC1.1: Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005).	CM3 Natural Communities Protection and Restoration

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Goals and Objectives	Applicable Conservation Measures
Objective VPCNC1.2: Restore vernal pool complex in Conservation Zones 1, 8, and/or 11 to achieve no net loss of vernal pool acreage.	CM9 Vernal Pool Restoration
Objective VPCNC1.3: Increase the size and connectivity of protected vernal pool complex within the Plan Area and increase connectivity with protected vernal pool complex adjacent to the Plan Area.	CM3 Natural Communities Protection and Restoration
Objective VPCNC1.4: Protect the range of inundation characteristics that are currently represented by vernal pools throughout the Plan Area.	CM3 Natural Communities Protection and Restoration
Goal VPCNC2: Vernal pool complexes that are managed and enhanced to sustain populations of native vernal pool species.	
Objective VPCNC2.1: Maintain or enhance vernal pool complexes to provide the appropriate inundation (ponding) characteristics for supporting and sustaining vernal pool species.	CM11 Natural Communities Enhancement and Management
Objective VPCNC2.2: Maintain and enhance pollination service in the vernal pool complex, especially by native invertebrates including native solitary bees.	CM11 Natural Communities Enhancement and Management
Managed Wetland	
Goal MWNC1: Managed wetland that is managed and enhanced to provide suitable habitat conditions for covered species.	
Objective MWNC1.1: Protect and enhance at least 1,500 acres of managed wetland in the Grizzly Island Marsh Complex consistent with the salt marsh harvest mouse recovery plan.	CM11 Natural Communities Enhancement and Management
Objective MWNC1.2: Create at least 320 acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the greater sandhill crane Winter Use Area in Conservation Zones 3, 4, 5, or 6, with consideration of sea level rise.	CM11 Natural Communities Enhancement and Management
Other Natural Seasonal Wetlands	
[***Note to reviewer:*** *this natural community will be dropped from the public draft of the Plan.*]	
Grassland	
Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.	
Objective GNC1.1: Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.	CM3 Natural Communities Protection and Restoration
Objective GNC1.2: Restore 2,000 acres of grasslands to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia.	CM3 Natural Communities Protection and Restoration CM8 Grassland Natural Community Restoration

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Goals and Objectives	Applicable Conservation Measures
Objective GNC1.3: Protect stock ponds and other aquatic features within protected grasslands to provide aquatic breeding habitat for native amphibians and aquatic reptiles.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.	
Objective GNC2.1: Restore and sustain a mosaic of grassland vegetation alliances, reflecting localized water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states.	CM8 Grassland Natural Community Restoration CM11 Natural Communities Enhancement and Management
Objective GNC2.2: Increase the extent, distribution, and density of native perennial grasses intermingled with other native species, including annual grasses, geophytes, and other forbs.	CM8 Grassland Natural Community Restoration CM11 Natural Communities Enhancement and Management
Objective GNC2.3: Increase burrow availability for burrow-dependent species.	CM11 Natural Communities Enhancement and Management
Objective GNC2.4: Increase prey, especially small mammals and insects, for grassland-foraging species.	CM11 Natural Communities Enhancement and Restoration
Objective GNC2.5: Maintain and enhance aquatic features in grasslands to provide suitable inundation depth and duration and suitable composition of vegetative cover to support breeding for covered amphibian and aquatic reptile species.	CM3 Natural Communities Protection and Restoration
Inland Dune Scrub	
[***Note to reviewer:*** *USFWS and DFG are currently in discussion to decide whether BDCP should include a conservaton strategy for this community, since it isn't affected by covered activities.*]	
Cultivated Lands	
Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.	
Objective CLNC1.1: Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Objective CLNC1.2: Annually maintain 4,600 acres of rice lands or similarly functioning habitat for giant garter snake in Conservation Zone 2.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Objective CLNC1.3: Target cultivated land conservation to provide connectivity between other protected lands.	CM3 Natural Communities Protection and Restoration

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Goals and Objectives	Applicable Conservation Measures
Objective CLNC1.4: Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Species-Specific Goals and Objectives	
Delta Smelt	
Goal DTSM1 (Abundance): Increased spawning success and improve the survival of adult and juvenile delta smelt.	
Objective DTSM1.1 (Growth and Health): Achieve a fall mean body length increase of at least 2 mm longer than existing conditions in December as collected in Fall Midwater Trawl (62 mm vs. 60 mm fork length) within 15 years of BDCP implementation.	CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM12 Methylmercury Management CM13 Invasive Aquatic Vegetation Control CM15 Predator Control CM19 Urban Stormwater Treatment
Objective DTSM1.2 Survival: Limit entrainment mortality associated with project operations to ≤10% of the delta smelt population on average over a 10-year period (across all life stages, not to exceed 20% in any given year) within 15 years of BDCP implementation.[1]	CM1 Water Facilities and Operation
Goal DTSM2 (Spatial Distribution): Increased spatial distribution of juvenile and pre-spawning adult delta smelt in preferred habitat areas.	
Objective DTSM2.1 (Spatial Distribution): Increase the extent of suitable habitat in the Plan Area by 15,000 acres during the near-term, 22,000 acres during early long-term, and 49,000 acres during late long-term, and expand the distribution of juvenile and pre-spawn adult delta smelt into that habitat.	CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM12 Methylmercury Management CM13 Invasive Aquatic Vegetation Control CM15 Predator Control CM19 Urban Stormwater Treatment

[1] Estimated proportions of entrainment vary significantly depending on the method used. The intent of this objective is to maintain or reduce entrainment levels on average, comparable to recent conditions. Additional discussion will be needed to determine the correct percentage, depending on which method is used for calculation.

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Goals and Objectives	Applicable Conservation Measures
Longfin Smelt	
Goal LFSM1 (Abundance): Increase abundance of longfin smelt within 15 years of BDCP implementation.	
Objective LFSM1.1 (Abundance): Achieve an annual average of the abundance indices from 1987to 2000 per year, within 15 years of BDCP implementation.	CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM12 Methylmercury Management CM13 Invasive Aquatic Vegetation Control CM15 Predator Control CM19 Urban Stormwater Treatment
Objective LFSM1.2 (Resilience): During wet years, achieve a Fall Midwater Trawl abundance index ≥ the abundance index predicted based on regression of prior (1987–2000) longfin abundance and outflow.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM12 Methylmercury Management CM13 Invasive Aquatic Vegetation Control CM15 Predator Control CM19 Urban Stormwater Treatment
Objective LFSM1.3 (Survival): Increase survival of longfin smelt larvae immediately following yolk-sac absorption within 15 years of BDCP implementation.	CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM12 Methylmercury Management CM13 Invasive Aquatic Vegetation Control CM15 Predator Control CM19 Urban Stormwater Treatment
Chinook Salmon, Winter-Run	
Goal WRCS1 (Abundance and Life-History Diversity): Improved survival (to contribute to increased abundance) of immigrating and emigrating winter-run salmon through the Plan Area.	
Objective WRCS1.1 (Juvenile Survival): Achieve a through-Delta survival rate of juveniles of at least 30% measured as a 4-year running average within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement

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Goals and Objectives	Applicable Conservation Measures
	CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM15 Predator Control CM16 Nonphysical Fish Barriers CM21 Nonproject Diversions
Objective WRCS1.2 (Adult Passage): Limit passage delays in the Yolo Bypass and other anthropogenic barriers and impediments to no more than 36 hours, within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement
Chinook Salmon, Spring-Run	
Goal SRCS1 (Abundance): Improved survival (to contribute to increased abundance) of emigrating juvenile spring-run salmon through the Plan Area.	
Objective SRCS1.1 (Juvenile Survival): Achieve a 4-year running average through-Delta juvenile survival rate, which will result in stable or expanding population[2] within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM15 Predator Control CM16 Nonphysical Fish Barriers CM21 Nonproject Diversions
Goal SRCS2 (Abundance): Reduce passage delays (to contribute to increased migration and spawning success, and thus abundance) at anthropogenic impediments of adult spring-run migrating through the Delta.	
Objective SRCS2.1 (Migration): Reduce adult passage delays at anthropogenic barriers and impediments that cause median passage times of greater than 36 hours, within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels
Goal SRCS3 (Life-History Diversity and Spatial Distribution): Improved availability of floodplain and channel margin habitat to support spring-run migration and rearing through the Delta.	
Objective SRCS3.1 (Habitat): Increase availability of floodplain habitat by 1,000 acres within 15 years of BDCP implementation, and channel margin habitat by 5 miles within 10 years of BDCP implementation, for spring-run migration and	CM2 Yolo Bypass Fisheries Enhancement CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement

[2] Through-Delta survival targets to be refined using similar analysis used for San Joaquin River flow objectives recommendations to the State Water Resources Control Board (U.S. Department of Interior 2011). Potential to measure: can be measured (e.g., see papers by Perry and Skalksi 2008; MacFarlane and Norton 2001; Brandes 1996; Newman 2008).

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Goals and Objectives	Applicable Conservation Measures
rearing compared to baseline conditions.	
Chinook Salmon, Fall- and Late-Fall- Run	
Goal FRCS1 (Abundance): Improved survival (to contribute to increased abundance) of emigrating juvenile fall-run salmon through the Plan Area.	
Objective FRCS1.1 (Juvenile Survival): Achieve a 4-year running average through-Delta juvenile survival rate, which will result in stable or expanding population[3] within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM15 Predator Control CM16 Nonphysical Fish Barriers CM21 Nonproject Diversions
Goal FRCS2 (Abundance): Reduce passage delays (to contribute to increased migration and spawning success and thus abundance) at anthropogenic impediments of adult fall-run migrating through the Delta.	
Objective FRCS2.1 (Migration): Reduce passage delays at anthropogenic barriers and impediments that cause median passage times of more than 36 hours, within 3 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels
Goal FRCS3 (Life-History Diversity and Spatial Distribution): Improved availability of floodplain and channel margin habitat to support fall-run migration and rearing through the Delta.	
Objective FRCS3.1 (Life-History Diversity and Spatial Distribution): Increase availability of floodplain habitat by 1,000 acres within 15 years of BDCP implementation, and channel margin habitat by 5 miles within 10 years of BDCP implementation, for fall-run migration and rearing compared to baseline conditions.	CM2 Yolo Bypass Fisheries Enhancement CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement
Goal FRCS4 (Life-History Diversity and Spatial Distribution): Reduced illegal take (to contribute to increased abundance and genetic and life-history diversity) of fall-run adults in the Delta.	
Objective FRCS4.1 (Life-History Diversity and Spatial Distribution): Increase enforcement efforts to reduce illegal take in the Plan Area within 5 years of BDCP implementation.	CM17 Illegal Harvest Reduction

[3] Through-Delta survival targets to be refined using similar analysis used for San Joaquin River flow objectives recommendations to the State Water Resources Control Board (U.S. Department of Interior 2011). Potential to measure: can be measured (e.g., see papers by Perry and Skalksi 2008; MacFarlane and Norton 2001; Brandes 1996; Newman 2008).

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Goals and Objectives	Applicable Conservation Measures
Steelhead	
Goal STHD1 (Abundance): Improved survival (to contribute to increased abundance) of juvenile steelhead emigrants form the Sacramento River and San Joaquin River systems through the Plan Area.	
Objective STHD1.1 (Juvenile Survival): Achieve a 4-year running average through-Delta juvenile survival rate, which will result in stable or expanding population[4] within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM15 Predator Control CM16 Nonphysical Fish Barriers CM21 Nonproject Diversions
Goal STHD2 (Life-History Diversity and Spatial Distribution): Improved spatial distribution of juvenile steelhead in the Delta.	
Objective STHD2.1 (Habitat): Increase availability of floodplain habitat by 1,000 acres within 15 years of BDCP implementation, and channel margin habitat by 5 miles within 10 years of BDCP implementation, for steelhead migration and rearing compared to baseline conditions.	CM2 Yolo Bypass Fisheries Enhancement CM5 Seasonally inundated Floodplain Restoration CM6 Channel Margin Restoration
Sacramento Splittail	
Goal SAST1 (Spawning and Rearing Habitat): Improved habitat and restored linkages to enhance survival, reproduction, and distribution of Sacramento splittail in the Plan Area.	
Objective SAST1.1 (Spawning and Rearing Habitat): Maintain 5-year running average of splittail index of abundance in the Plan Area of 150% of baseline conditions by providing access to suitable spawning and rearing habitat in the Plan Area within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Restoration
Green Sturgeon	
Goal GRST1 (Abundance): Increased abundance of green sturgeon in the Plan Area.	
Objective GRST1.1 (Abundance): Increase spawner adult abundance-to-juvenile abundance ratio compared to existing conditions.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration

[4] Through-Delta survival targets to be refined using similar analysis used for San Joaquin River flow objectives recommendations to the State Water Resources Control Board (U.S. Department of Interior 2011). Potential to measure: can be measured (e.g., see papers by Perry and Skalksi 2008; MacFarlane and Norton 2001; Brandes 1996; Newman 2008).

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Goals and Objectives	Applicable Conservation Measures
	CM6 Channel Margin Enhancement CM17 Illegal Harvest Reduction
Goal GRST2 (Stranding): Improved connectivity that facilitates timely passage and reduces stranding of adult green sturgeon.	
Objective GRST2.1 (Stranding): Reduce stranding of adult green sturgeon at Fremont Weir by 75% over baseline conditions within 15 years of BDCP implementation.	CM2 Yolo Bypass Fisheries Enhancement
Goal GRST3 (Spatial Distribution): Increased spatial distribution of YOY and juvenile green sturgeon in the Delta compared to existing conditions.	
Objective GRST3.1 (Distribution): Improve water quality parameters and physical habitat characteristics in the Bay-Delta.	CM12 Methylmercury Management CM19 Urban Stormwater Treatment CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels
White Sturgeon	
Goal WTST1 (Abundance): Increased abundance of white sturgeon in the Plan Area.	
Objective WTST1.1: Increase the spawner-adult-abundance-to-juvenile-abundance ratio compared to existing conditions within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM19 Urban Stormwater Treatment
Goal WTST2 (Life-History and Spatial Distribution): Improved habitat connectivity that facilitates timely passage and reduced stranding of adult white sturgeon.	
Objective WTST2.1 (Passage and Stranding): Reduce stranding of adult white sturgeon at Fremont Weir by 75% over baseline conditions within 15 years of BDCP implementation.	CM2 Yolo Bypass Fisheries Enhancement
Goal WTST3 (Spatial Distribution): Increased spatial distribution of YOY and juvenile white sturgeon in the Bay-Delta compared to existing condition SWP/CVP regulatory requirements.	
Objective WTST3.1 (Distribution): Improve water quality parameters and physical habitat characteristics in the Bay-Delta to increase the spatial distribution of white sturgeon in the Plan Area within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM4 Tidal Natural Communities Restoration CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM12 Methylmercury Management CM13 Invasive Aquatic Vegetation Control

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Goals and Objectives	Applicable Conservation Measures
	CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels CM19 Urban Stormwater Treatment
Pacific and River Lamprey	
Goal PRL1 (Rearing Habitat): Suitable larval rearing habitat for Pacific and River lamprey within the Plan Area.	
Objective PRL1.1: Protect and enhance habitat suitable for larval settlement and development within the Plan Area within 15 years of BDCP implementation.	CM1 Water Facilities and Operation CM2 Yolo Bypass Fisheries Enhancement CM5 Seasonally Inundated Floodplain Restoration CM6 Channel Margin Enhancement CM13 Invasive Aquatic Vegetation Control CM19 Urban Stormwater Treatment
Riparian Brush Rabbit	
Goal RBR1: Suitable habitat available for the future growth and expansion of riparian brush rabbit populations.	
Objective RBR1.1: Of the 750 acres of protected valley/foothill riparian natural community, protect at least 200 acres of suitable riparian brush rabbit habitat (defined in *CM7 Riparian Natural Community Restoration*) that is occupied by the species or contiguous with occupied habitat.	CM3 Natural Communities Protection and Restoration
Objective RBR1.2: Of the 5,000 acres of riparian restoration, restore/create and maintain at least 300 acres of early- to mid-successional riparian habitat that meets the ecological requirements of the riparian brush rabbit and that is within or adjacent to or that facilitates connectivity with existing occupied or potentially occupied habitat.	CM3: Natural Communities Protection and Restoration CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management
Objective RBR1.3: Create and maintain high-water refugia in the 300 acres of restored riparian brush rabbit habitat and additional protected lands occupied or with potential to become occupied by riparian brush rabbit, through the building and/or restoring of high ground habitat on mounds, berms, or levees, so that refugia are no further apart than 20 meters.	CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management
Objective RBR1.4: In protected riparian areas, monitor for and control nonnative predators that impede survival and breeding success of riparian brush rabbits.	CM11 Natural Communities Enhancement and Management CM15 Predator Control
Riparian Woodrat (San Joaquin Valley)	
Goal RW1: A reserve system that includes suitable habitat available for the future growth and expansion of riparian woodrat populations.	
Objective RW1.1: Of the 5,000 acres of riparian restoration, restore/create and maintain at least 300 acres riparian habitat that meets the ecological requirements of the riparian woodrat (e.g., dense willow understory and oak	CM3 Natural Communities Protection and Restoration CM7 Riparian Natural Community Restoration CM11 Natural Communities Enhancement and Management

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Goals and Objectives	Applicable Conservation Measures
overstory) and that is adjacent to or facilitates connectivity with existing occupied or potentially occupied habitat.	
Objective RW1.2: Create high-water refugia in restored sites through the building and/or restoring of high ground habitat on mounds, berms, or levees, so that refugia are no further apart than 20 meters.	CM7 Riparian Natural Community Restoration
Salt Marsh Harvest Mouse	
Goal SMHM1: Suitable habitat and conditions to sustain a population of salt marsh harvest mouse in the reserve system.	
Objective SMHM1.1: Of the 4,800 acres of restored tidal brackish emergent wetland, restore and manage at least 1,000 acres in the Western Suisun/Hill Slough Marsh Complex and 1,000 acres in the Suisun Slough/Cutoff Slough Marsh Complex, in 150-acre or greater patches that provide viable habitat areas for salt marsh harvest mouse habitat consistent with the draft tidal marsh recovery plan (U.S. Fish and Wildlife Service 2010).	CM4 Tidal Natural Communities Restoration
San Joaquin Kit Fox	
No species-specific biological goals or objectives.	
Suisun Shrew	
No species-specific biological goals or objectives.	
Townsend's Big-Eared Bat	
Goal TBEB1: Roosting habitat for Townsend's big-eared bat to protect and promote its distribution in the Plan Area.	
Objective TBEB1.1 Offset any unavoidable loss of a maternal roost or hibernaculum resulting from BDCP activities with a functionally equivalent roost or hibernaculum within 10 miles.	CM11 Natural Communities Enhancement and Management
Objective TBEB1.2 Protect maternity roosts or hibernacula that occur on reserve lands and prohibit recreational or other potentially disruptive activities during periods of seasonal use.	CM11 Natural Communities Enhancement and Management
California Black Rail	
No species-specific biological goals or objectives.	
California Clapper Rail	
No species-specific biological goals or objectives.	
California Least Tern	
No species-specific biological goals or objectives.	

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Goals and Objectives	Applicable Conservation Measures
Greater Sandhill Crane	
Goal GSHC1: Protection and expansion of greater sandhill crane winter range.	
Objective GSHC1.1: Within the at least 20,000 acres of conserved cultivated lands, protect 5,800–7,100 acres of high [0.75 HSU] to very high [1.0 HSU] value habitat for the greater sandhill crane, with at least 30% maintained in very high [1.0] value types in any given year, as defined by this Plan. This protected area will be within the Winter Use Area, will consider sea level rise, and will be within 2 miles of known roosting sites in Conservation Zones 3, 4, and/or 5. Patch size of cultivated lands will be at least 160 acres.	CM3 Natural Communities Protection and Restoration
Objective GSHC1.2: To create additional high value greater sandhill crane winter foraging habitat, 10% of the habitat protected under Objective GSHC1.1 will involve acquiring low value habitat and converting it to high or very high value habitat.	CM3 Natural Communities Protection and Restoration
Objective GSHC1.3: If greater sandhill crane habitat is removed from within 2 miles of a roost site, of the total protected acres under Objective GSHC1.1, create 1 acre or protect 2 acres of foraging habitat for every acre removed within 2 miles of that roost site.	CM3 Natural Communities Protection and Restoration
Objective GSHC1.4: Within the 320 acres of created managed wetland (Objective MWNC1.2), create at least 40 acres of roosting habitat within 2 miles of Winter Use Areas on the Stone Lakes National Wildlife Refuge, and all other roosts within 2 miles of existing traditional roost sites.	CM3 Natural Communities Protection and Restoration
Objective GSHC1.5: If monitoring results indicate that greater sandhill cranes abandon known roost sites as a result of covered activities, create a new roost site of equal size (in addition to the acreage prescribed under Objective MWNC1.1) in the Winter Use Area in Conservation Zones 3, 4, 5, or 6. Create the roost within 2 miles of the affected roost and adjacent to other protected crane foraging habitat.	CM3 Natural Communities Protection and Restoration
Least Bell's Vireo	
No species-specific biological goals or objectives.	
Suisun Song Sparrow	
No species-specific biological goals or objectives.	

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Goals and Objectives	Applicable Conservation Measures
Swainson's Hawk	
Goal SH1: Contribute to the sustainability of the Swainson's hawk population by protecting cultivated lands suitable for Swainson's hawk foraging.	
Objective SH1.1: Within the at least 20,000 acres of conserved cultivated lands, protect 19,800 to 33,700 acres as a matrix of moderate quality [0.5 HSU] Swainson's hawk foraging habitat, at least 30% of which will be managed as very high [1.0 HSU] quality habitat.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Goal SH2: Cultivated lands that provide conditions suitable for supporting Swainson's hawk.	
Objective SH2.1: Increase distribution and abundance of potential Swainson's hawk nest trees in the Plan Area by planting and maintaining native trees along roadsides and field borders within protected cultivated lands at a rate of 1 tree per 10 acres.	CM11 Natural Communities Enhancement and Management
Objective SH2.2: Support the establishment and sustainability of Swainson's hawk prey populations by establishing 20-foot-wide hedgerows along field borders and roadsides within protected cultivated lands at a minimum rate of 400 feet per 100 acres.	CM11 Natural Communities Enhancement and Management
Tricolored Blackbird	
Goal TRBL1: Improved nesting, nesting-adjacent foraging, and wintering habitat for tricolored blackbirds in the Plan Area.	
Objective TRBL1.1: Protect 50 acres of occupied or recently occupied (within the last 15 years) tricolored blackbird nesting habitat located within 5 miles of high quality foraging habitat in Conservation Zones 1, 2, 8, or 11.	CM3 Natural Communities Protection and Restoration
Objective TRBL1.2: Manage protected tricolored blackbird nesting habitat to provide young, lush stands of bulrush/cattail emergent vegetation and prevent vegetation senescence.	CM11 Natural Communities Enhancement and Management
Objective TRBL1.3: Of the cultivated lands protected as covered species habitat, protect 11,400 to 19,000 acres of moderate or higher quality cultivated lands as nonbreeding foraging habitat, 50% of which is of high or very high value.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Objective TRBL1.4: Of the cultivated lands protected as covered species habitat, protect 5,100 to 7,600 acres of high to very high quality breeding-foraging habitat within 5 miles of occupied or recently occupied (within the last 15 years) tricolored blackbird nesting habitat in Conservation Zones 1, 2, 3, 4, 7, 8, or 11.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Western Burrowing Owl	
Goal WBO1: Contribute to the sustainability of the burrowing owl population by protecting cultivated lands suitable for burrowing owl foraging.	
Objective WBO1.1: Of the cultivated lands protected under Objective CLNC1.1, protect at least 1,000 acres in Conservation Zones 1 and 11 that support moderate	CM3 Natural Communities Protection and Restoration

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Goals and Objectives	Applicable Conservation Measures
value burrowing owl habitat and are within 1 mile of high value grassland habitat or occupied moderate value habitat.	
Western Yellow-Billed Cuckoo	
No species-specific biological goals or objectives.	
White-Tailed Kite	
No species-specific biological goals or objectives.	
Yellow-Breasted Chat	
No species-specific biological goals or objectives.	
Giant Garter Snake	
Goal GGS1: High quality upland and aquatic giant garter snake habitat with buffers from disturbance.	
Objective GGS1.1: Restore or protect existing grasslands adjacent to the 400 acres of restored nontidal marsh to provide sufficient upland refugia and overwintering habitat for giant garter snakes.	CM 3 Natural Communities Protection and Restoration CM 10 Nontidal Marsh Restoration
Objective GGS1.2: Protect giant garter snakes on preserve lands from incidental injury or mortality by establishing 200-foot buffers between protected giant garter snake habitat and roads, and establishing giant garter snake preserves at least 2,500 feet from urban areas or areas zoned for urban development.	CM 3 Natural Communities Protection and Restoration CM 10 Nontidal Marsh Restoration
Goal GGS2: Expanded range and protected corridors facilitating giant garter snake movement and population connectivity.	
Objective GGS2.1: Of the at least 20,000 acres of cultivated lands to be protected, prioritize protection of lands that establish connectivity between the giant garter snake Coldani Marsh/White Slough and Yolo Basin/Willow Slough subpopulations and the Stones Lakes National Wildlife Refuge.	CM3 Natural Communities Protection and Restoration
Objective GGS2.2: Of the 13,900 acres of tidal freshwater emergent wetland restoration, restore at least 1,500 acres in Conservation Zone 4 to facilitate connectivity, dispersal, and movement of giant garter snakes and contribute to a north-south corridor that includes protected cultivated lands and restored tidal and nontidal wetlands between Coldani Marsh/White Slough and the Stones Lakes National Wildlife Refuge.	CM3 Natural Communities Protection and Restoration
Objective GGS2.3: In cultivated lands protected for giant garter snake, maintain a water conveyance system that is compatible with giant garter snake foraging, cover, and movement.	CM11 Natural Communities Enhancement and Management
Western Pond Turtle	
No species-specific biological goals or objectives.	

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Goals and Objectives	Applicable Conservation Measures
California Red-Legged Frog	
No species-specific biological goals or objectives.	
California Tiger Salamander	
No species-specific biological goals or objectives.	
Western Spadefoot	
No species-specific biological goals or objectives.	
Valley Elderberry Longhorn Beetle	
Goal VELB1: Promote dispersal and expansion of the valley elderberry longhorn beetle where there are known source populations within the American River and Sacramento River systems.	
Objective VELB1.1: Mitigate for impacts on elderberry shrubs by creating valley elderberry longhorn beetle habitat consistent with the U.S. Fish and Wildlife Service (1999) valley elderberry longhorn beetle conservation guidelines and planting elderberry shrubs in high-density clusters.	CM3 Natural Communities Protection and Restoration CM7 Riparian Natural Community Restoration
Objective VELB1.2: Site valley elderberry longhorn beetle habitat restoration within drainages immediately adjacent to or in the vicinity of sites known to be occupied by valley elderberry longhorn beetle.	CM3 Natural Communities Protection and Restoration CM7 Riparian Natural Community Restoration
Vernal Pool Crustaceans	
Goal VPC1: Protected occurrences of the rarest covered vernal pool crustacean species.	
Objective VPC1.1: Protect at least one currently unprotected occurrence of conservancy fairy shrimp.	CM3 Natural Communities Protection and Restoration
Brittlescale and Heartscale	
Goal BRIT/HART1: A reserve system that includes habitat and occurrences for brittlescale and heartscale.	
Objective BRIT/HART1.1: Of the protected alkali seasonal wetland complex, vernal pool complex, and grassland natural community, protect 150 acres of suitable brittlescale and heartscale habitat in Conservation Zones 1, 8, or 11.	CM3 Natural Communities Protection and Restoration
Caper-Fruited Tropidocarpum	
Goal CFT1: A reserve system that includes suitable habitat for the caper-fruited tropidocarpum.	
Objective CFT1.1: Of the grassland acres to be protected in Conservation Zones 7 and 8, include at least 250 acres in moderately alkaline soils with suitable habitat for the caper-fruited tropidocarpum.	CM3 Natural Communities Protection and Restoration

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Goals and Objectives	Applicable Conservation Measures
Carquinez Goldenbush	
Goal CGB1: A reserve system that includes Carquinez goldenbush occurrences and sustains suitable habitat for this species.	
Objective CGB1.1: Protect at least three unprotected occurrences of the Carquinez goldenbush in Conservation Zones 1 and/or 11. **Objective CGB1.2**: Maintain and enhance occupied Carquinez goldenbush habitat to slow erosion and reverse degradation from livestock grazing.	CM3 Natural Communities Protection and Restoration CM11 Natural Communities Enhancement and Management
Delta Button Celery	
Goal DBC1: Expand the distribution and increase the abundance of delta button celery populations.	
Objective DBC1.1: Establish two occurrences of delta button celery within the restored floodplain habitat on the mainstem of the San Joaquin River in Conservation Zone 7 between Mossdale and Vernalis.	CM11 Natural Communities Enhancement and Management
Delta Mudwort and Mason's Lilaeopsis	
Goal DMW/ML1: A reserve system that supports Mason's lilaeopsis and delta mudwort.	
Objective DMW/ML1.1: No net loss of Mason's lilaeopsis and delta mudwort occurrences within the footprint, or the area of affected tidal range, of BDCP restoration projects.	CM4 Tidal Natural Communities Restoration
Delta Tule Pea and Suisun Marsh Aster	
Goal DTP/SMA1: A reserve system that supports the Delta tule pea and Suisun Marsh aster.	
Objective DTP/SMA1.1: No net loss of Delta tule pea and Suisun Marsh aster occurrences within restoration sites.	CM4 Tidal Natural Communities Restoration CM11 Natural Communities Enhancement and Management
Side-Flowering Skullcap	
No species-specific biological goals or objectives.	
Slough Thistle	
Goal ST1: Expand the distribution and increase the abundance of slough thistle populations.	
Objective ST1.1: Establish two occurrences of slough thistle within the restored floodplain habitat on the main stem of the San Joaquin River in Conservation Zone 7 between Mossdale and Vernalis.	CM11 Natural Communities Enhancement and Management
Soft Bird's-Beak and Suisun Thistle	
Goal SBB/ST1: Protected and expanded Suisun thistle and soft bird's-beak populations.	
Objective SBB/ST1.1: Restore tidal inundation to wetlands in the Hill Slough Ecological Reserve and to the ponded area at Rush Ranch.	CM4 Tidal Natural Communities Restoration

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Goals and Objectives	Applicable Conservation Measures
Objective SBB/ST1.2: Complete seed banking of all existing Suisun Marsh populations and the representative genetic diversity using accepted seed banking protocols.	CM11 Natural Communities Enhancement and Management
Vernal Pool Plant Species	
Goal VPP1: A reserve system that protects vernal pool plant populations.	
Objective VPP1.1: Protect at least two currently unprotected occurrences of alkali milk-vetch in the Altamont Hills or Jepson Prairie Core Recovery Areas (Conservation Zones 1, 8, or 11).	CM3 Natural Communities Protection and Restoration
Objective VPP1.2: Protect and/or establish at least two currently unprotected occurrences of Heckard's peppergrass in Conservation Zones 1, 8, or 11.	CM3 Natural Communities Protection and Restoration CM9 Vernal Pool Complex Restoration
Objective VPP1.3: Protect at least two currently unprotected occurrences of San Joaquin spearscale in Conservation Zones 1, 8, or 11.	CM3 Natural Communities Protection and Restoration

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

3.3.3 Landscape-Scale Biological Goals and Objectives

The following landscape-scale goals and objectives were developed to follow the principles of conservation biology and the requirements of the Natural Community Conservation Planning Act (NCCPA). For the covered fish species, the landscape-scale goals and objectives are designed to address major stressors of the 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 terrestrial and wetland natural communities and species, these goals and objectives address biodiversity, ecosystem function, and the desired extent, distribution, connectivity, and ecological function of the landscape for supporting the habitats and life requirements of covered species within the BDCP Plan Area.

The landscape-scale goals and objectives address conditions in the reserve system, ecological processes and conditions, and landscape-scale factors that affect fish and wildlife movement and fish mortality.

3.3.3.1 Reserve System

Goal L1 and its associated objectives address the quantity and characteristics of land that will be protected within the BDCP reserve system.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.

- **Objective L1.1:** Protect at least 31,000 acres of existing natural communities, focusing on the highest quality natural communities and covered species habitats.
- **Objective L1.2:** Protect sufficient lands for the restoration of natural communities as described in Objective L1.3.
- **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities.
- **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.
- **Objective L1.5:** Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide upland habitat values and refugia from flooding.
- **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.
- **Objective L1.7:** To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.
- **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.

Objective L1.1 Rationale*:* Achieving this objective will protect the highest quality natural communities and covered species habitat in the Plan Area to optimize the ecological value of the reserve system for conserving covered species and native biodiversity. The target for total protected

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acreage is based on the sum of all natural community acreage targets. Achieving this objective will protect natural communities, species habitat, and species diversity on a landscape basis consistent with Section 2830(a)(3) of the NCCPA. Achieving this objective will also conserve representative natural and semi-natural landscapes to maintain the ecological integrity of large habitat blocks, ecosystem function, and biological diversity, consistent with Section 2820(a)(4)(A) of the NCCPA. The acreage to be conserved for each natural community, and rationale for that acreage, is provided in Section 3.3.4, *Natural Community Goals and Objectives. CM3 Natural Communities Protection and Restoration* describes the site selection criteria that will be used to identify lands for protection to meet this objective.

Objective L1.2 Rationale: Achieving this objective will protect sufficient lands to restore natural communities. *CM3 Natural Communities Protection and Restoration* describes how the Implementation Office will identify, prioritize, and secure lands for restoration to meet Objective L1.2.

Objective L1.3 Rationale: Achieving this objective will restore at least 65,000 acres of tidally influenced natural communities, including tidal perennial aquatic, tidal brackish emergent wetland, tidal freshwater emergent wetland, and tidal mudflats. Achieving this objective will also contribute to the conservation and restoration of representative natural and semi-natural landscapes to maintain the ecological integrity of large habitat blocks, ecosystem function, and biological diversity, consistent with Section 2820(a)(4)(A) of the NCCPA. The rationale for restoring tidally influenced natural communities follows, and additional rationale specific to each of these natural communities is provided in Section 3.3.4, *Natural Community Goals and Objectives.*

The majority of tidal marsh and associated tidal mudflat in Suisun Marsh and the Delta has been lost. This loss 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 tidal marsh and mudflat has also greatly reduced the extent and quality of habitat for native wildlife and plants adapted to this environment, including many of the covered species. Restored shallow subtidal aquatic habitat is expected to support, depending on location, delta smelt, longfin smelt, juvenile salmonid rearing, sturgeon, and lamprey habitat. Terrestrial covered species specific to each community are described in Section 3.3.4, *Natural Community Goals and Objectives.*

Restoration of tidal wetlands will 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 contribute to the long-term conservation of marsh-associated covered species. Tidal natural communities restoration 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. Upland transition zones will be protected adjacent to restored tidal marshes to ensure that tidal emergent wetlands are sustainable in the event of predicted future rises in sea level.

Tidal restoration will aid in the recovery of natural tidal fluctuation that is essential to improve the function of the tidal emergent wetlands. Restoration of tidal influence affects water accessibility, soil oxygen status, and soil salinity, all of which are critical factors for the emergent wetland vegetation. Effective tidal exchange is expected to enhance the following functions.

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- Export of productivity from the marsh plain into adjacent Delta waterways in support of aquatic foodweb processes.
- Production and export of phytoplankton and zooplankton from tidal channels into adjacent Delta waterways in support of the aquatic foodweb.
- Maintenance of cooler localized water temperatures preferred by covered fish species through nocturnal thermal exchange on marsh plains.
- An additional 8,529 acres of nontidal natural communities, consisting of vernal pool complex[5], grasslands, valley/foothill riparian, nontidal perennial aquatic/nontidal freshwater emergent wetland, and managed wetland natural communities will also be restored. The rationale for restoration related objectives specific to each of these natural communities is provided in Section 3.3.4, *Natural Community Goals and Objectives.*

Objective L1.4 Rationale: Achieving this objective will include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) in the reserve system to provide a range of habitat characteristics, food resources, and complexity for native species, including covered species. A variety of environmental gradients will allow shifting species distributions in response to environmental changes, and will facilitate species' responses to catastrophic events such as fire or extreme environmental fluctuations such as flood or drought. Achieving this objective will meet requirements under Section 2820(a)(4)(D) of the NCCPA to protect a range of environmental gradients and provide for shifting distributions of species due to changed circumstances.

Protection of a variety of environmental gradients in the reserve system is necessary to accommodate climate change. Changes in temperature range and precipitation patterns resulting from climate change may cause some areas of suitable habitat to become unsuitable for some species, while other areas of currently unsuitable habitat may become suitable for other species. Many habitats and species will be affected by climate change and their temporal dynamics and spatial distributions will change in unpredictable ways. Faced with large, uncertain, and dynamic responses, it is important that a broad range of elevation and other habitat characteristics be provided within an interconnected reserve system to ensure that, while some current habitat may be lost as a result of global climate change, sufficient suitable habitat will remain available to sustain both covered and noncovered species.

Objective L1.5 Rationale: Achieving this objective will protect the uplands adjacent to the riparian habitat required by many riparian wildlife species. Although periodic flooding may enhance riparian habitat conditions, species such as riparian brush rabbit and riparian woodrat need adjacent upland areas such as grasslands to provide upland refugia during high flood events. Riparian birds and other wildlife also use adjacent uplands for supplemental foraging. These adjacent uplands also provide a buffer between the valley/foothill riparian natural community and urban and agricultural lands, reducing the adverse effects of noise, lighting, pesticides, urban and agricultural runoff, and other potential factors related to urban and agricultural uses.

Objective L1.6 Rationale: Achieving this objective will protect and restore large swaths of connected habitat to enhance ecosystem processes and connectivity and help increase the abundance, distribution, and diversity of covered and other native species. Achieving this objective will also contribute toward the maintenance of habitat areas that are large enough to support

[5] Assuming 89 acres of vernal pool complex restoration

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sustainable populations of covered species, consistent with Section 2820(a)(4)(C) of the NCCPA. Habitat loss, fragmentation, and degradation in 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.

Objective L1.7 Rationale*:* Achieving this objective will protect the upland transitional areas adjacent to restored tidal natural communities in order to permit future upslope establishment of tidal emergent wetlands with sea level rise. The effects of climate change on the Plan Area are expected to have far-reaching and potentially dramatic effects 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 as a result of global climate change, sufficient suitable habitat will remain available to sustain both covered and noncovered species. Achievement of this goal will benefit all covered and other native species in the Plan Area.

The Implementation Office will provide upland refugia habitat for native species adjacent to restored tidal marsh, in addition to the transitional uplands protected to accommodate sea level rise. A variety of native species, including covered species such as saltmarsh harvest mouse, Suisun shrew, Suisun song sparrow, black rail, and California clapper rail rely on uplands adjacent to tidal emergent wetlands to provide refugia and foraging habitat during high tide events. Upland transitional lands will be conserved as described in *CM3 Natural Communities Protection and Restoration*. Cultivated lands and managed wetlands within this upland transitional area will be converted to grasslands as described in *CM8 Grassland Natural Community Restoration*.

Objective L1.8 Rationale: Achieving this objective will restore tidal marsh within the anticipated future eastward position of the low salinity zone (generally identified as X2), which is positively correlated with the abundance of life stages of a number of fish species, including some covered fish species (e.g., longfin smelt) in the estuary (Baxter et al. 1999; Kimmerer 2004). Suisun Bay and the western Delta represent important low salinity habitat areas in the estuary. Open water habitat in this region serves as larval and juvenile rearing, adult holding, and foraging habitat for resident and anadramous species such as salmon, steelhead, and lamprey. A combined outflow from the Plan Area during the dry season and a rising sea level resulting from climate change is expected to 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 (U.S. Fish and Wildlife Service 2004).

3.3.3.2 Ecological Processes and Conditions

Goal L2 and its associated objectives address the ecological processes and conditions that will be protected within the BDCP reserve system.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances.
- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.3:** Allow lateral river channel migration.
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat.
- **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.
- **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.
- **Objective L2.8:** Produce sinuous, high-density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
- **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
- **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.
- **Objective L2.11:** Restore or create at least 20 linear miles of transitional intertidal areas including tidal mudflat natural community and patches of subtidal and lower marsh.

Objective L2.1 Rationale: Achieving this objective will restore floodplains to promote natural seasonal inundation (*CM5 Seasonally Inundated Floodplain Restoration*). Prior to channel straightening, dredging, and levee construction in the Delta, rivers and tributaries flowed through wide floodplains. Many native species are adapted to periodically flooded riparian habitat. The process and pattern of seasonal inundation drives plant succession and vegetation structure in the floodplain, and are especially important in maintaining early seral stage vegetation. Further description of the benefits of this objective is provided in Section 3.3.4.5, *Valley Foothill/Riparian*.

Objective L2.2 Rationale: Achieving this objective will promote fluvial processes, thereby causing deposition of fresh sediments and making bare mineral soils available for natural colonization by vegetation (*CM5 Seasonally Inundated Floodplain Restoration*). Fluvial processes such as erosion, deposition, and overland scour create the topography of river channels and floodplains and deposit sediment that forms soil for riparian plant growth. Historically, riparian areas around the margins of the Delta and in the lower Yolo Bypass Basin were subject to strong fluvial control from adjacent rivers—notably the Sacramento, Cosumnes, Mokelumne, and the San Joaquin. However, channelization and levee construction in the Delta have greatly altered the timing, distribution and magnitude of the natural fluvial processes upon which healthy riparian natural communities depend.

Objective L2.3 Rationale: Achieving this objective will allow lateral channel migration, which occurs when a river channel moves across or within its valley bottom. It is a characteristic process of natural, seasonally inundated floodplains, and it promotes and is a component of the fluvial processes addressed under Objective L2.2. Lateral channel migration results from erosion of

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floodplain material along one bank concurrent with deposition of sediment along the other bank. Bank erosion is the primary channel process necessary for channel migration to occur (Leopold et al. 1964).

Channels that actively migrate have a high diversity of aquatic habitats. A migrating channel may include side channels and/or multiple channels, both of which increase channel complexity, thus contributing to diversity, richness, and sustainability of the aquatic ecosystem, and benefiting salmonid spawning and rearing habitat. Side channels provide refugia for fish, and while the mainstem river channel is not likely to experience significant cooling as a result of shading from overhanging vegetation, as provided through *CM6 Channel Margin Enhancement*, small pools that form in side channels can benefit from this shading and resultant cooling effect. Oxbow lakes that form from meandering channels provide aquatic habitat for western pond turtle. Bank erosion from channel migration recruits spawning gravel for salmonids from alluvial riverbanks. Additionally, channels that are allowed to freely migrate are better able to accommodate flood flows without excessive erosional events or other flood related damage. *CM5 Seasonally Inundated Floodplain Restoration,* describes how floodplains will be restored to provide lateral channel migration.

Objective L2.4 Rationale: Achieving this objective will connect rivers to their floodplains, providing a host of ecological benefits. Floodplains provide important habitat for rearing, migrating, and adult fish; migratory waterfowl; and terrestrial amphibians, reptiles, and mammals native to the Delta. Seasonally inundated floodplains provide an export of phytoplankton and other organic matter to other regions of the Delta. Also, because these floodplains are shallower, have longer residence times, and are generally warmer than the mainstem river, they have greater rates of phytoplankton production than do the channels of the rivers (Sommer et al. 2001). Levee construction, dredging, channel straightening, bank hardening, and water removals for agriculture and export have disconnected river channels from their historical floodplains and resulted in a substantial reduction in the historical extent of active floodplains in the Delta. This has resulted in substantial loss of high-value spawning and rearing habitat for splittail, a decrease in rearing and foraging habitat for salmonids, a decrease in primary productivity and therefore food availability to planktivorous fishes, and a decline in the abundance and distribution of floodplain-associated species, including Sacramento splittail, Chinook salmon, and slough thistle. Restoring natural fluvial processes will improve habitat conditions for covered fish species by providing suitable habitat conditions such as floodplain inundation, settling of sediments, refugia from high flows, and refugia from potential predators.

Several species of plants have also experienced a reduction in abundance and distribution related to the loss of the historic floodplain. Slough thistle is generally found in the portions of channels that flood at high water and on the banks of floodwater conveyance canals and drains (Griggs pers. comm.; Hansen pers. comm.). The reduction in slough thistle occurrence in the Plan Area is likely related to the loss of scour habitat found in and along floodplains. The loss of woody debris and stumps that are typically associated with well-connected floodplain habitat are partially to blame for the limited distribution and abundance of side-flowering skullcap, as this species grows on decaying wood along channel banks.

Large floodplains with long water retention times can be important groundwater recharge areas, depending on substrate permeability (Osmond et al. 1995). Water storage and groundwater recharge in turn sustains the riparian and other natural communities within the floodplain, thereby benefitting covered and other native species that depend on these natural communities.

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Objective L2.5 Rationale: Achieving this objective will address the primary water quality issues of dissolved oxygen (DO) and methylmercury. These two factors affect covered fish species and other aquatic organisms in the Delta.

As much as 60% of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses, and depleted flows have contributed to higher water temperatures and lower DO levels. Levels of DO below 5 milligrams per liter have been reported to delay or block migratory movements by fall-run Chinook salmon (Hallock et al. 1970). Low DO levels can cause physiological stress and mortality of fish, including Chinook salmon and steelhead (Jassby and Van Nieuwenhuyse 2005) and other aquatic organisms (Central Valley Regional Water Quality Control Board 2007).

Adult fish, including covered fish species migrating upstream in the fall and early winter, encounter low DO in the Stockton Deep Water Ship Channel (DWSC) resulting from low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. The DWSC is important for covered fish species such as Chinook salmon and white sturgeon because it is the safest (in terms of predation and entrainment hazard) and most direct route to spawning habitat upstream of Stockton and rearing habitat downstream in the Delta. As described in *CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels*, aeration facilities in the DWSC will improve DO conditions, thus reducing passage delays of Chinook salmon and white sturgeon, and promoting suitable water quality conditions for covered fish species and other native aquatic wildlife.

Mercury is present in sediments and soils throughout the Delta, having been deposited by tributaries and rivers that drain former mining areas in the mountains. While mercury in its elemental form does not pose a risk to aquatic organisms, exposing soils to periodic wet and drying-out periods results in a process called methylation, which converts mercury to a more toxic form, methylmercury. Restoration actions proposed in *CM4 Tidal Natural Communities Restoration* will increase the acreage of intermittently wetted areas in the Plan Area by converting cultivated lands and other upland areas to tidal, open water, and floodplain habitats, potentially increasing methylmercury production in the Plan Area. Some of this increased production is likely to be taken up by organisms, and to bioaccumulate through the foodweb. The risk that mercury and methylmercury pose to covered species is discussed in Appendix 5.D, *Toxics*. To meet objective L2.6, the Implementation Office will monitor and minimize restoration-related mobilization of methylmercury as described in *CM12 Methylmercury Management.*

Objective L2.6 Rationale: Achieving this objective will provide a diversity of habitats to support life-history diversity. For native fish, life-history diversity is an important component of population resiliency (i.e., the ability to recover from disturbance). Life-history diversity refers to diversity in behaviors between individuals in a population with respect to different life stages (e.g., timing of migration, spawning, and rearing). For example, Chinook salmon often express a diversity of life stages including variations in freshwater and estuarine residency, timing of seaward migration, and timing and aging of spawning (Bottom et al. 2009). Each life-history variant is an alternate pathway by which individuals can complete their life cycles. This life-history diversity, in which all individuals do not behave similarly or occupy the same habitats over time, has been described as an evolutionary strategy for Chinook salmon to spread risk and avoid brood failure in the presence of unpredictable environmental conditions (Bottom et al. 2009). A variety of habitat opportunities are necessary for fish populations to express this life-history diversity. Providing a diversity of habitats increases the likelihood that suitable habitat will be available to different life stages at times that

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they are important. Fish habitat diversity will be provided through a number of different conservation measures as listed on Table 3.3-1.

Objective L2.7 Rationale: Achieving this objective will increase native species diversity to promote natural community resilience and resistance to disturbances such as drought and flooding. Additionally, vegetation biodiversity in riparian and other natural communities provides the structural diversity necessary to provide suitable habitat for many wildlife species. Increasing the relative cover of native plant species also reduces potential negative effects of nonnative plants. The importance of native species diversity is further discussed for natural communities in Section 3.3.4, *Natural Communities Biological Goals and Objectives*. This objective will achieve restoration of natural communities with native vegetation as described in *CM3 Natural Communities Protection and Restoration*, and through nonnative plant monitoring and management as described in *CM11 Natural Communities Enhancement and Management*. It will also minimize the introduction and spread of invasive nonnative species as described in *CM13 Invasive Aquatic Vegetation Control* and *CM20 Recreational Users Invasive Species Program*.

Objective L2.8 Rationale: Achieving this objective will restore a dense network of sinuous channels in tidal brackish and freshwater marsh to approximate natural, historical conditions, and will promote effective tidal exchange throughout the marsh plain, transporting important food resources (plankton, invertebrates, and other organic material) to tidal perennial aquatic fish habitat. This will be implemented through marsh restoration as described in *CM4 Tidal Natural Communities Restoration.*

Objective L2.9 Rationale: Achieving this objective will provide refuge habitats for migrating and resident fish species, including floodplains and localized microhabitats or zones within a channel that provide favorable conditions (e.g., water temperature, depth, or velocity) or cover to escape or hide from predators. Natural channel processes and conditions such as lateral channel migration, connection to the floodplain, groundwater recharge, and presence of riparian natural community to contribute organic matter promote the formation of a variety of fish refugia in river systems (Sedell et al. 1990). This objective will be met primarily through *CM5 Seasonally Inundated Floodplain Restoration, CM6 Channel Margin Enhancement,* and *CM7 Riparian Natural Community Restoration*.

Objective L2.10 Rationale: Achieving this objective will enhance the production and export of phytoplankton and zooplankton from tidal channels into adjacent Delta waterways in support of the aquatic foodweb. Loss of tidal communities and riparian vegetation in the Delta has greatly reduced the input of food resources for fish into adjoining sloughs and channels and the downstream bay and estuary. Habitat restoration and effective tidal exchange (*CM4 Tidal Natural Communities Restoration*) is expected to enhance food production. Restoration of riparian vegetation along channel margins and in floodplains (*CM6 Channel Margin Enhancement* and *CM5 Seasonally Inundated Floodplain Restoration*) and seasonal inundation in the Yolo Bypass (*CM2 Yolo Bypass Fisheries Enhancement*) are expected to provide organic carbon in support of the foodweb and macroinvertebrates (e.g., insects) that provide food for covered fish species.

Objective L2.11 Rationale: This objective will ensure that tidal restoration includes at least 20 linear miles of transitional intertidal areas including tidal mudflat natural community and patches of subtidal and lower marsh. This transitional tidal area typically occurs as a linear fringe and is where tidal marsh is most subject to the influence of marine or estuarine conditions, as it is flooded daily. This is, therefore, where fish and other aquatic organisms will most frequently interface with the

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marsh edge and have access to organic material associated with marsh vegetation. This intertidal zone is also where sediment deposition is mostly likely to occur and result in formation of tidal mudflats (See Section 3.3.4.2 *Tidal Mudflat* for a description of the ecological benefits of the tidal mudflat natural community.) Lower marsh supports a unique assemblage of plant species adapted to highly saline conditions.

3.3.3.3 Fish and Wildlife Movement

Goal L3 and its associated objectives address the fish and wildlife movement that will be protected within the BDCP reserve system.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area. • **Objective L3.2:** Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for covered fish species. • **Objective L3.3:** Support the movement of larval and juvenile life stages of covered fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.1 Rationale: Achieving this objective will protect the large, interconnected blocks of habitat required by relatively wide-ranging species such as San Joaquin kit fox. Such species are negatively affected by movement barriers such as chainlink fences or other impenetrable fences or busy roads. The dispersal and local movements of California tiger salamander and other amphibians can be impeded by dense grasses and lack of burrows, soil cracks, or other refugia. Achieving this objective will contribute to the establishment of linkages between reserves within and adjacent to the Plan Area, consistent with Section 2820(a)(4)(B) of the NCCPA. It will also sustain effective movement and interchange of organisms between habitat areas to maintain ecological integrity of habitat within the Plan Area, consistent with Section 2820(a)(4)(E) of the NCCPA. Habitat linkages for covered wildlife species will be protected as described in *CM3 Natural Communities Protection and Restoration*, and linkages will be improved and maintained through management measures as described in *CM11 Natural Communities Enhancement and Management.*

Objective L3.2 Rationale: Achieving this objective will increase the connectivity between low salinity zone habitat and upstream freshwater spawning habitat to benefit covered fish species in several ways. Delta and longfin smelt will benefit from improved access to spawning habitat and a range of suitable spawning conditions through a variety of habitat conditions. Anadromous salmonid juveniles will benefit from having a large area of connected habitat along an extended salinity gradient within which to forage and find refuge while undergoing smoltification (adaptation to the saltwater environment). To a lesser degree, sturgeons and lampreys will also benefit from habitat connectivity within the estuarine environment, and an extended salinity gradient within which to adapt to transitions between oceanic and freshwater salinity environments. Achieving this objective will sustain effective movement and interchange of organisms between habitat areas to maintain ecological integrity of habitat within the Plan Area, consistent with Section 2820(a)(4)(E) of the NCCPA. Habitat connectivity in these areas is supported by *CM4 Tidal Natural Communities Restoration, CM5 Seasonally Inundated Floodplain Restoration, CM6 Channel Margin Enhancement,*

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and *CM7 Riparian Natural Community Restoration*, while salinity gradients are subject to modification through *CM1 Water Facilities and Operations.*

Objective L3.3 Rationale: Achieving this objective will support the movement of larval and juvenile fish life stages to suitable downstream foraging areas, and thus increase survival. Once delta smelt larvae hatch they have 12 days before their yolk sac is absorbed and they must start foraging and capturing prey. Juvenile salmonids, and to a lesser degree juvenile sturgeons, also benefit from access to a variety of habitats suitable for refuge and foraging during their downriver migration and estuarine rearing periods. Achieving this objective will sustain effective movement and interchange of organisms between habitat areas to maintain ecological integrity of habitat within the Plan Area, consistent with Section 2820(a)(4)(E) of the NCCPA. Movement of juvenile salmonids to downstream rearing habitats will be enhanced through *CM1 Water Facilities and Operations,* while habitats along the migration route will be protected or restored through *CM3 Natural Communities Protection and Restoration, CM4 Tidal Natural Communities Restoration, CM5 Seasonally Inundated Floodplain Restoration, CM6 Channel Margin Enhancement,* and *CM7 Riparian Natural Community Restoration.*

Objective L3.4 Rationale: Achieving this objective will support the movement of adult fish to their spawning habitats. Achieving this objective will also sustain effective movement and interchange of organisms between habitat areas to maintain ecological integrity of habitat within the Plan Area, consistent with Section 2820(a)(4)(E) of the NCCPA. A number of 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 rivers and channels are thought to contribute to false attraction to migration cues, and longer migration routes that may expose fish to sources of mortality such as predation. South Delta diversions (*CM1 Water Facilities and Operation)* will reduce the need to export water at the south Delta diversions, thereby reducing reverse flows in Old and Middle Rivers.

3.3.3.4 Fish Mortality

Goal L4 and its associated objectives address reduction of fish mortality within the BDCP reserve system.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4. 3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 Rationale: Achieving this objective will provide the measures to avoid and minimize effects on covered species necessary to meet regulatory requirements and to ensure that covered species are adequately conserved in the Plan Area. The ESA (Section 10[a][2][A][ii]) requires that a habtat conservation plan (HCP) applicant minimize the impact of take of covered species to the maximum extent practicable. Additionally, Fish & Game Code Section 2801(g) describes the NCCPA

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as providing a planning framework to avoid and minimize impacts on wildlife. Although all conservation measures are intended to minimize the risk of incidental take of covered species, the subject is most directly addressed by *CM22 Avoidance and Minimization Measures*.

Objectives L4.2 and L4.3 Rationale: Achieving this objective will address predation by nonnative species to reduce effects on covered species. Although a natural part of the estuarine ecosystem, predation in the Delta has been identified as a stressor to BDCP covered fish species (Essex Partnership 2009). 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 on covered fish.

Nonnative predation is an important threat to Central Valley steelhead and Chinook salmon in areas with high densities of nonnative fish (e.g., smallmouth, largemouth and striped bass, and catfish) where they are thought to prey on out-migrating juveniles (Lindley and Mohr 2003) (Appendix 2.A, *Covered Species Accounts*). Predation by nonnative fish species has also been identified as a stressor on delta smelt populations, although the importance of predation on populations of this species is believed to be low (Hanson pers. comm.) (Appendix 2.A, *Covered Species Accounts*). Although effects of nonnative predators on longfin smelt are largely unknown, predators such as inland silversides, largemouth bass, and striped bass may be an important factor influencing longfin smelt population levels (Bennett and Moyle 1996; Moyle 2002). Sacramento splittail have persisted in the delta for over a century with the presence of striped and largemouth bass, but reduced turbidity in the Delta combined with increased habitat for nonnative predators provided by Brazilian waterweed and water hyacinth have increased largemouth bass abundance and their ability to visually forage, thereby increasing predation risk to splittail (Toft et al. 2003; Brown and Michniuk 2007).

Fish predators tend to be attracted to instream structures (Gingras 1997), and new diversion structures in the Sacramento River potentially attract predators (Essex Partnership 2009). Striped bass, for example, have been shown to aggregate around instream structures in the Sacramento River from Red Bluff to the Delta. New intake structures in the Sacramento River will also create a local hydraulic discontinuity that may provide ambush sites for striped bass. Thus, predation rates on Chinook salmon, steelhead, white sturgeon, and Sacramento splittail will potentially increase as a result of installing intake structures and other instream structures (Essex Partnership 2009). To offset these effects and contribute to native biodiversity and covered species recovery, localized predator control will be implemented at predator "hot spots" in the Delta, as described in *CM15 Predator Control*. This 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), delta smelt (Stevens 1966; Thomas 1967; Moyle 2002), and possibly longfin smelt (Nowak et al. 2004), green sturgeon, and white sturgeon. This distribution of covered fish species will also be managed to minimize fish movement into high predation risk areas (*CM1 Water Facilities and Operation*, *CM2 Yolo Bypass Fisheries Enhancement*, and *CM16 Nonphysical Fish Barriers*).

Objective L4.4 Rationale: Achieving this objective will reduce fish mortality caused by entrainment and impingement, and will increase survival and salvage rates for larvae and small juveniles. Water diverted directly from the south Delta through the Central Valley Project (CVP)/State Water Project (SWP) facilities creates an artificial north-to-south water flow through the Delta, compared to the natural general east-to-west flow pattern. This has resulted in reverse flows in major Delta channels,

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which has in turn resulted in fish entrainment. Although existing diversion facilities are equipped with louvers that guide juvenile and larger fish into salvage facilities and salvaged fish are subsequently released in the lower Sacramento and San Joaquin Rivers, planktonic eggs, larvae, and small juveniles are not effectively salvaged and do not survive when transported to conveyance facilities. Fish mortality as a result of these factors will be reduced as described in *CM1 Water Facilities and Operation.*

3.3.4 Natural Community Biological Goals and Objectives

Natural community goals and objectives are outlined below. Applicable landscape-scale goals and objectives are listed, followed by a description of the benefits to the natural community that would result from achieving each objective. Natural community goals and objectives are then listed, with a description of the approach and rationale used to establish each natural community objective. Conservation measures designed to meet all objectives are found in Section 3.4, *Conservation Measures*. The extent of conserved natural communities expected with full implementation of the BDCP is shown in Table 3.3-2.

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Table 3.3-2. Expected Extent of Conserved Natural Communities in Conservation Zones 1 through 11 with BDCP Implementation

Natural Communities	Existing Conditions			With BDCP Implementation			Total Extent with BDCP Implementation		
	Total Extent (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent of Existing Acres Protected	Protected by BDCP (acres)	Minimum Restored by BDCP (acres)	Total Conserved with BDCP (BDCP protected + restored) (acres)	Total Conserved (Existing Protected + BDCP Conserved)	Percent of Total Extent Conserved with BDCP Implementation
Tidal Perennial Aquatic	86,236	18,085	68,151	21%	0	10,000[2]	10,000	28,085[2]	33%
Tidal Mudflat[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A2[2]	N/A
Tidal Brackish Emergent Wetland	8,351	5,102	3,249	61%	0	4,800[2]	4,800	9,902[2]	119%
Tidal Freshwater Emergent Wetland	8,947	4,991	3,956	56%	0	13,900[2]	13,900	18,891[2]	211%
Valley/Foothill Riparian	17,930	5,424	12,505	30%	750	5,000	5,750	11,175	62%
Nontidal Perennial Aquatic	5,421	1,250	4,171	23%	0	400	400	2,057	31%
Nontidal Freshwater Perennial Emergent Wetland	1,135	407	728	36%	0				
Alkali Seasonal Wetland Complex	3,722	2,769	953	74%	150	0	150	2,919	78%
Vernal Pool Complex	7,908	4,536	3,372	57%	600	89	689	5,225	66%
Managed wetlands	64,861	52,689	12,172	81%	1,500	320	1,820	54,509	84%
Other Natural Seasonal Wetland[3]	322	245	77	76%	0	0	0	245	76%
Grassland	77,495	18,263	59,232	24%	8,000	2,000	10,000	28,263	36%
Inland Dune Scrub[4]	19	17	2	89%				17	89%
Cultivated Lands	503,779	57,165	446,614	11%	20,000	0	20,000	77,165	15%
Total	**786,125**	**170,944**	**615,181**	**22%**	**31,000**	**36,509**	**67,509**	**238,453**	**30%**

[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] These acres are minimum restoration commitments for each natural community. Tidal restoration will total 65,000 acres, including adjacent upland areas that could be inundated with sea level rise. In order to meet the 65,000 acre commitment, acreage in excess of these minimums will be restored.

[3] **Note to reviewers:** This natural community is minor in extent, has limited habitat values, and impacts can be avoided. At the recommendation of DFG and USFWS, a conservation strategy is not included for other natural seasonal wetlands. This section will be deleted from the public review draft.

[4] **Note to reviewer: US**FWS and DFG are currently in discussion to decide whether the BDCP should include a conservation strategy for this community, since it isn't affected by covered activities.

N/A = no specific acreage associated with this category or subcategory at this time.

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3.3.4.1 Tidal Perennial Aquatic

Tidal perennial aquatic natural community includes both deep and shallow tidal aquatic environments (as measured from the mean lower low tide [lowest of the low tide in a day], deep aquatic is more than 10 feet deep; shallow is up to 10 feet deep) (CALFED Bay-Delta Program 2000). 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. 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 tidal perennial aquatic community occurs throughout the Plan Area in all conservation zones (Figure 3.2-3). In the historical Delta, prior to anthropogenic modification, tidal processes played an important role in forming and maintaining an expansive, complex mosaic of marshes with tidal channels, sloughs, and lakes (Whipple 2010). Most tidal perennial aquatic natural community in the Plan Area currently exists in the form of channelized waterways connected to other tidal natural communities (e.g., tidal mudflat, tidal freshwater emergent wetland). Under current water operation conditions in the Plan Area, the tidal perennial aquatic natural community is predominantly freshwater, with brackish conditions occurring in Suisun Bay at times of high tides and low river flows. The natural community occurs as large open water bodies such as the Suisun Bay, flooded Delta Islands such as Franks Tract and Liberty Island, reservoirs such as Clifton Court Forebay, perennial water courses such as the Sacramento, San Joaquin, and Mokelumne Rivers, and also as smaller open water areas in the many distributaries, sloughs, and channels of the Plan Area.

The tidal perennial aquatic natural community in the Delta has been substantially reduced through channelization and levee construction, which has reduced tidal flows and tidal influence throughout the Delta. Most of this resulted from the construction of a system of levees built to reclaim wetlands for agricultural uses beginning with the passage of the Swamp Land Act of 1850. Introduction of nonnative aquatic predators and invasive aquatic plant species, such as Brazilian waterweed and Eurasian watermilfoil that provide habitat for nonnative predators, have reduced this community's function as habitat for native fish. Contaminants have also reduced the water quality function of the tidal aquatic natural community in the Delta. For example, pyrethroid insecticides in the Delta may be associated with tissue abnormalities found in delta smelt and striped bass (U.S. Environmental Protection Agency 2011). Additionally, mercury from historical gold mining activities in the Sierra Nevada foothills has been transported via streams and rivers to the Delta, where it occurs in the sediment and becomes toxic when periodic drying and flooding activate a process that converts the mercury to methylmercury.

The tidal perennial aquatic natural community supports a diverse community of invertebrates and microorganisms (e.g., phytoplankton and zooplankton), which supports the aquatic foodweb. This foodweb supports a diverse fish community of over 50 species of fish, approximately 50% 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, DO, flow rates, and water temperature. 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 wildlife. The tidal perennial aquatic

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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. Also, the community borders tidal marsh communities and contains structural elements such as woody debris that serve as basking sites for giant garter snakes and western pond turtles.

The conservation approach for tidal perennial aquatic is to restore this community in the Plan Area, and manage through invasive species control to benefit native aquatic vertebrates and maintain or increase native biodiversity. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.1.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the tidal perennial aquatic natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objective L1.4 Benefits: Achieving this objective will provide elevation gradients within the reserve system, thus providing the opportunity for the tidal perennial aquatic natural community to expand as sea level rises with climate change. This objective will be achieved through land protection as described in *CM3 Natural Communities Protection and Restoration.*

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.7:** Increase native species diversity and relative cover of native plant species and reduce the introduction and proliferation of nonnative species. • **Objective L2.8:** Produce sinuous, high density, dendritic networks through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objective L2.5 Benefits: Achieving this objective will address the primary water quality issues of DO and methylmercury. These two factors affect covered fish species and other aquatic organisms in the Delta. The rationale provided in Section 3.3.3, *Landscape-Scale Biological Goals and Objectives*, includes additional detail regarding the benefits of this objective to the tidal perennial aquatic natural community.

Objective L2.7 Benefits: Achieving this objective will promote species diversity and thus contribute to natural community resilience and resistance to disturbances. This objective will also minimize the introduction and spread of invasive nonnative aquatic species as described in *CM13 Invasive Aquatic Vegetation Control* and *CM20 Recreational Users Invasive Species Program.* The rationale provided in

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Section 3.3.3, *Landscape-Scale Biological Goals and Objectives*, includes additional detail regarding the benefits of this objective to the tidal perennial aquatic natural community.

Objective L2.8 Benefits: Achieving this objective will result in a dense network of sinuous channels in tidal brackish and freshwater marsh, which will promote effective tidal exchange throughout the marsh plain, transporting important food resources (plankton, invertebrates, and other organic material) to the tidal perennial aquatic natural community. This will be implemented through marsh restoration as described in *CM4 Tidal Natural Communities Restoration.*

Objective L2.10 Benefits: Achieving this objective will enhance the aquatic habitat functions of tidal perennial aquatic natural community by increasing food abundance and productivity for aquatic species. This objective will be achieved through promoting effective tidal exchange (*CM4 Tidal Natural Community Restoration*), restoring vegetation adjacent to waterways for organic input (*CM6 Channel Margin Enhancement* and *CM7 Riparian Natural Community Restoration*) and promoting fluvial conditions that flush organic matter into tidal aquatic areas (*CM5 Seasonally Inundated Floodplain Restoration* and *CM2 Yolo Bypass Fisheries Enhancement*).

3.3.4.1.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the tidal perennial aquatic natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Rationale: Achieving this objective will provide aquatic species habitat conducive to primary productivity, which is essential to maintaining a robust food base for covered fish species. Restoring or creating at least 10,000 acres of tidal perennial aquatic habitat in Conservation Zones 1, 2, 4, 5, 7, and 11 will be a substantial increase in the amount of habitat contributing to primary productivity and food resources important to covered fish species. This substantial increase in tidal perennial aquatic habitat will help to offset the historic loss of such habitat within the Plan Area.

Of the Delta habitats, the tidal marsh sloughs have the highest particulate organic matter and phytoplankton concentrations and support the greatest zooplankton growth rates (Müller-Solger et al. 2002; Sobczak et al. 2002).

Tidal perennial aquatic restoration in the Cache Slough Complex at the southern end of the Yolo Bypass, in combination with floodplain enhancement, is expected to provide tidal freshwater wetland structure and functions adjacent to open water habitat. Tidal wetlands also have the capacity to export food resources to adjacent channels and to downstream systems (Cloern et al. 2007; Lehman et al. 2008). The export of food may include movement of phytoplankton and zooplankton by advection and tidal exchanges as well as the export of productivity in the form of macroinvertebrates, small fishes, and other larger organisms (Kneib 1997, 2003).

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Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Rationale: This objective will address the nonnative plant species that limit turbidity in the Delta, which has decreased over time (Jassby et al. 2002 in Nobriga and Herbold 2009). It is hypothesized that one of the primary causes of the decrease in turbidity is biological filtration by submerged aquatic vegetation (SAV) (Brown and Michniuk 2007 in Nobriga and Herbold 2009). Controlling invasive plants, especially SAV, is anticipated to result in some degree of increased turbidity. Some covered fish species, such as delta and longfin smelt have evolved in turbid waters and have adapted to life in turbid waters to avoid predators and to successful forage on prey organisms, so increases in turbidity would be expected to improve survival and growth for these species.

3.3.4.2 Tidal Mudflat

The tidal mudflat natural community generally consists of bare, unvegetated areas of mud substrate and typically occupies a narrow transition zone in the intertidal zone of various natural communities in the Plan Area. Tidal mudflats typically consist of exposed mud during low tide and shallow aquatic areas during high tide. Tidal mudflat occurs 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. To a lesser degree, it also occupies microhabitats in areas of sediment deposition along natural and artificial levees in the valley/foothill riparian natural community, and seasonal floodplain and channel margin natural communities. Tidal mudflat often shifts in distribution over time and is sustained through disturbances to other nearby communities or through the deposition of mineral soil within the intertidal zone.

The extent of tidal mudflat has been substantially reduced in the Plan Area with the construction of levees and dikes, the channelization of waterways, and the conversion of tidal marshes to cultivation and other land uses. As of 1998, tidal mudflats in the Bay-Delta area had declined to approximately 58% of the historical extent present in 1800 (Ecoatlas Goals Project 1999). 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 substrate 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.

While mudflats are no longer being filled for diking or development, their extent is likely to continue shrinking due to the absence of sediment influx from upstream and continued shoreline erosion from wave action, primarily during storms. Most major rivers upstream have been dammed, trapping sediment behind upstream reservoirs (The Bay Institute 2004). Sea level rise resulting from climate change is also likely to diminish tidal mudflats (The Bay Institute 2004).

When exposed at low tide, lower elevation tidal mudflats serve as important foraging habitat for a wide variety shorebirds, both resident and migratory, which consume the crustaceans, bivalves, gastropods, aquatic insects, and polychaetes. When covered at high tide, these same areas serve as shallow open water habitat for several covered pelagic fish species, including splittail, salmonids,

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delta smelt, and sturgeon. These species use the area as a shallow water refuge from predators and also to forage on benthic invertebrates. Tidal mudflats also provide an important source of sediment for restoration of subsided tidal marshes (The Bay Institute 2004). At the microhabitat level, mudflats along river channels provide important habitat for covered plant species, including Mason's lilaeopsis, delta mudwort, Delta tule pea, and Suisun Marsh aster.

The conservation approach for this natural community relies primarily on landscape-scale objectives related to tidal restoration, floodplain restoration, and channel margin enhancement. The establishment of tidal communities along an elevation gradient and tidal and fluvial processes that result in sediment transport and deposition, in addition to invasive plant control, are expected to promote and maintain this natural community in the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.2.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the tidal mudflat natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objectives L1.3 and L1.4 Benefits: Tidal restoration along an elevation gradient consistent with these objectives will result in a range of intertidal zones, within which tidal mudflat is expected to develop between shallow subtidal aquatic areas and emergent marsh plains. This is further described under Objective L2.11, below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species. • **Objective L2.11:** Restore or create at least 20 linear miles of transitional intertidal areas including tidal mudflat natural community and patches of subtidal and lower marsh.

Objective L2.2 Benefits: Achieving this objective as described in *CM5 Seasonally Inundated Floodplain Restoration* and *CM6 Channel Margin Enhancement* is expected to promote development of the types of mudflats that occur adjacent to riparian natural communities along channel margins. These mudflats develop as a result of fluvial processes and sediment deposition, and provide substrate that supports covered plant species including delta mudwort, Delta tule pea, Mason's

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lilaeopsis and Suisun Marsh aster. Furthermore, fluvial processes are instrumental in the production of tidal mudflat through sediment transport to intertidal areas.

Objective L2.7 Benefits: Nonnative invasive plants can encroach into tidal mudflats and thereby diminish the extent of this natural community. Invasive plants will be managed as needed to protect tidal mudflats, as described in *CM11 Natural Communities Enhancement and Management.*

Objective L2.11 Benefits: 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. Consistent with this objective and as described in *CM4 Tidal Natural Communities Restoration*, tidal restoration will include the restoration of at least 20 miles of transitional intertidal area, or which tidal mudflat will be a component.

3.3.4.2.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to conserve the tidal mudflat natural community within the reserve system. Additional goals and objectives are not necessary for this natural community.

3.3.4.3 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 is located in Suisun Marsh and along the shore and on islands in the saltwater/freshwater mixing zone that extends from near Collinsville westward to the Carquinez Strait (Figure 3.2-4). 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 north 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,* for more detail on the current state of this natural community.

The tidal brackish emergent wetland community is characterized by three transition zones: high, middle, and low marsh. The high marsh has been defined as the area from approximately mean higher high water to extreme high water (Josselyn 1983), and is dominated by saline-tolerant pickleweed and saltgrass. Fat hen and alkali heath are important community components. The middle marsh has been defined as the region from approximately mean high water to mean higher high water (Josselyn 1983). Here, pickleweed and saltgrass codominate with American bulrush, and there is an increase in other species of rushes as well. Because of daily tidal flushing, soil salinity is not as high in this zone as in the high marsh. The low marsh occurs from approximately the mean lower high water to mean high water (Josselyn 1983). Low, brackish tidal marsh vegetation typically is dominated by emergent plants tolerant of extended periods of tidal submergence, such as native cordgrass, hardstem bulrush, and California bulrush. These plants tend to occur in large, monospecific stands.

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 this natural community for associated covered and other native species. Prior to extensive anthropogenic modifications of Suisun Marsh that included dike building and drainage, the tidal

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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%) remain; of this, 5,102 acres (61%) are currently under protected status. The biodiversity in the tidal brackish emergent wetland community is high because it represents a convergence of salt- and freshwater-tolerant species, and Suisun Marsh is the largest brackish marsh in the San Francisco Bay estuary. Several species of plants and wildlife are endemic to this community, including the salt marsh harvest mouse, Suisun shrew, Suisun song sparrow, and Mason's lilaeopsis. The long-term survival of these species may depend on restoring this natural community.

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 breaching dikes around unsubsided areas of the marsh and through site-specific contouring to speed the establishment of natural tidal channels. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.3.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the tidal brackish emergent wetland natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities. • **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.

Objective L1.4 Benefits: Providing elevation and hydrologic gradients in restored tidal brackish emergent wetland consistent with this objective will contribute to the range of habitat requisites for the five covered wildlife species associated with tidal brackish marsh. Tidal brackish emergent wetland is a complex of high, mid, and low marsh, each of which provides some form of habitat function for the tidal brackish marsh covered species. The distribution of these habitat features is driven by differences in tidal inundation, which is a function of elevation gradients. Restoration measures will incorporate an elevation gradient to achieve a range of high, mid, and low marsh conditions, including 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.

Objective L1.8 Benefits: Achieving this objective will protect upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetland to permit the future migration of tidal

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emergent wetland communities in response to sea level rise. As sea level rises, and existing tidal lands are flooded more frequently and with longer duration, there will be a need for freshwater and brackish tidal communities to also shift upwards in mean elevation. Without the ability of these habitat types to migrate upward, the existing tidal wetland community will become intertidal and subtidal communities without being replaced in other, more upland locations.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species. • **Objective L2.8**: Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.

Objective L2.7 Benefits: Achieving this objective will increase species diversity in the tidal brackish emergent wetland natural community which will, in turn, contribute to community stability and resilience. Reducing invasive plants such peppergrass and smooth cordgrass will promote diversity of native plant species. Additionally, reducing the introduction and proliferation of nonnative wildlife will benefit native wildlife using the tidal brackish emergent wetland natural community. Nonnative predators of concern in tidal brackish emergent wetlands include red fox and Norway rat, which have been identified as potential threats to nesting rails and song sparrows. These species will be monitored and controlled if they pose a threat to covered species populations or native plant diversity, as described in *CM11 Natural Communities Enhancement and Management.*

Objective L2.8 Benefits: Producing a network of channels in the tidal brackish emergent wetland will provide important foraging habitat for several covered wildlife species in Suisun Marsh, especially those species that remain close to protective cover along channel banks when foraging. Tidal channels also convey marine nutrients into the marsh, and allow organic material produced in the marsh to be transported to the tidal perennial aquatic natural community and support the aquatic foodweb.

3.3.4.3.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the tidal brackish emergent wetland natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objective TBEWNC1.1 Rationale: Restoring at least 4,800 acres of tidal brackish emergent wetland in Suisun Marsh (Conservation Zone 11), consistent with this objective, will increase the extent and connectivity of this natural community. It will substantially increase suitable habitat for saltmarsh harvest mouse, Suisun shrew, California clapper rail, California black rail, and covered endemic plant species such Suisun thistle, Suisun Marsh aster, and soft bird's-beak, in addition to a diversity of noncovered plant and wildlife species. Restored tidal brackish emergent wetland will also benefit covered fish species and other aquatic organisms through increased production of invertebrates and other organic material that will be transported through tidal action into areas where covered fish feed. Tidal brackish emergent wetlands are also expected to filter nonpoint 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 (Nobriga 2008).

Restored tidal brackish emergent wetland will displace approximately 3,600 acres of existing managed wetland. Managed wetland is not sustainable for wildlife in Suisun Marsh with projected sea level rise and levee instability, which will likely lead to extensive flooding of managed wetland areas. Tidal brackish emergent wetland, on the other hand, will provide habitat with long-term stability and persistent in Suisun Marsh (U.S. Fish and Wildlife Service 2010).

The tidal brackish emergent wetland strategy will focus on restoration rather than on protection because of the very limited extent of this community compared to historical conditions, and because almost all of the existing natural community has either been protected or is unlikely to be developed. The restoration of 4,800 acres of tidal brackish emergent wetland will increase the extent of this community that is protected in the Plan Area by 58% (from 5,102 acres protected to 9,902 acres protected).

The extent of tidal brackish emergent wetland targeted for restoration is based, in part, on the availability of sites that are appropriate for restoration as a function of marsh plain elevations, hydrodynamic conditions, historic conditions, and environmental gradients. Restoring at least 4,800 acres is consistent with the tidal marsh recovery plan (U.S. Fish and Wildlife Service 2010). This minimum acreage of tidal brackish emergent wetland restoration also ensures that the total extent of wetlands in Suisun Marsh (tidal brackish emergent wetland and managed wetland combined) is not diminished by the establishment of tidal perennial aquatic natural community, which would adversely affect species such as saltmarsh harvest mouse that depend on both these wetland

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community types and would be displaced by encroachment of the tidal perennial aquatic natural community.

Objective TBEWNC1.2 Rationale: Restoring connectivity of tidal brackish emergent wetland, consistent with this objective, is necessary to provide dispersal pathways between populations allowing for healthy gene flow, as well as avenues for escape for during catastrophic flood events. This objective is based on the recognition that past development has fragmented what was once a well-connected tidal brackish emergent wetland in Suisun Marsh. Restoration of the tidal brackish emergent wetland natural community in Suisun Marsh will improve foraging and/or dispersal dynamics for a variety of wildlife species. Unfragmented communities are at less risk from long-term population loss to stochastic events than isolated ones because corridors of connection allow rapid colonization after loss. Opportunities for meeting this objective include providing a more contiguous connection between Hill and Peytonia Sloughs, and between Cutoff and Suisun Sloughs.

Objective TBEWNC1.3 Rationale: Creating topographic heterogeneity in restored tidal brackish emergent wetlands will result in a diversity of inundation characteristics and vegetative composition. Topographic heterogeneity is an important ecological factor influencing species richness and diversity in tidal natural communities (Collin et al. 2010; Mozaria-Luna 2004). Although creation of a network of tidal channels, consistent with Objective L2.8, will contribute toward this topographic heterogeneity (Mozaria-Luna 2004), mounds and depressions will also be integrated into the restoration design to increase topographic heterogeneity as described in *CM4 Tidal Natural Communities Restoration.*

Objective TBEWNC1.4 Rationale: Consistent with this objective, the extent of existing wetlands undergoing restoration at any given time will be limited. For covered species that use both managed wetland and tidal brackish marsh communities at Suisun Marsh there will be a temporal habitat loss between the period when managed wetland habitat is initially lost as a result of tidal restoration inundation and when the newly restored tidal brackish marsh finally develops into the habitat structure suitable for those species. The restoration of tidal perennial aquatic natural community restoration should be spread out in time and space so as to minimize these adverse impacts on managed wetland. This timing will be balanced with the need to offset the impacts of tidal perennial aquatic wetland restoration by restoring tidal brackish marsh.

3.3.4.4 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 cultivated lands. 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. In 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 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 (Figure 3.2-5). It frequently experiences long-duration flooding.

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Prior to the 1860s, the tidal freshwater emergent wetland natural community covered an estimated 87% 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 (0.1% of the Plan Area), 4,991 acres (56%) 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.

Although reduced in extent, the remaining tidal perennial emergent wetland natural community in the Plan Area provides considerable ecological function and value. It serves to recharge groundwater and filter pollutants, and it produces invertebrates and other organic matter that is introduced into the water column via tidal action to provide food for fish and other aquatic organisms. 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, amphibians, and fish. Many tidal freshwater emergent wetlands remaining in the Plan Area are highly altered. This has substantially reduced their value as habitat for many plant and wildlife species. However, the remaining tidal freshwater emergent wetlands are essential habitat for migratory birds. Many fish in the tidal perennial aquatic natural community 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).

The conservation for tidal freshwater emergent wetland involves restoration at least 13,900 acres of this community distributed among several conservation zones and along an elevation gradient, and manage this community to provide a diversity of native species and vegetation characteristics. The conservation measures that will be implemented to achieve the goals and objectives described belwo are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.4.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the tidal freshwater emergent wetland natural community are included below.

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Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities. • **Objective L1.7:** To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.

Objectives L1.4 and L1.7 Benefits: Restoring tidal freshwater emergent wetlands 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, provide nutrients and food to adjacent subtidal aquatic habitat, and contribute to the long-term conservation of tidal freshwater marsh-associated covered species.

Incorporating upland transition zones adjacent to restored freshwater tidal marshes ensures that tidal freshwater emergent wetlands are sustainable in the event of predicted future rises in sea level. Without upland transition zones with shoreline gradients allowing expansion of shallow water zones, water levels at both existing emergent wetlands and future wetlands would become too deep to support emergent vegetation. Achieving Objective L1.7 will help to ensure the persistence of tidal freshwater marsh in the face of rising sea levels.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.

Objective L2.7 Benefits: Achieving this objective will increase species diversity in the tidal freshwater emergent wetland natural community which will, in turn, contribute to community stability and resilience. Reducing invasive plants will promote diversity of native plant species. Additionally, reducing the introduction and proliferation of nonnative wildlife will benefit native wildlife using the tidal freshwater emergent wetland natural community. The tidal marsh will be monitored and nonnative invasive species will be controlled if they pose a threat to covered species populations or native plant diversity, as described in *CM11 Natural Communities Enhancement and Management.*

Objective L2.8 Benefits: Tidal channels also expected to convey nutrients into the marsh, and allow organic material produced in the marsh to be transported to the tidal perennial aquatic natural community and support the aquatic foodweb.

3.3.4.4.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the tidal freshwater emergent wetland natural community within

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the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7. • **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objectives TFEWNC1.1 and TFEWNC1.2 Rationale: Achieving these objectives will result in the restoration of at least 13,900 acres of tidal freshwater emergent wetland in large, interconnected patches. It will result in a 155% increase in protected tidal freshwater emergent wetland in the Plan Area. 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. 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. 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.

Goal TFEWNC2: Biologically diverse tidal freshwater emergent wetland that is enhanced for native species and sustained by natural ecological processes and functions.
• **Objective TFEWNC2.1:** Restore and sustain a diversity of marsh vegetation that reflects historical species compositions and high structural complexity.

Objective TFEWNC2.1 Rationale: Achieving this objective will promote vegetation diversity and structural complexity in restored tidal freshwater marsh. High plant diversity and vegetation structure creates a variety of ecological niches to support high wildlife diversity. The diversity of plant types in freshwater tidal marshes provides complex structure that supports a greater diversity of animals, especially birds and insects, than in saline marshes (Nobriga 2008). This objective will be achieved by incorporating a diversity of plant species into restoration design as described in *CM4 Tidal Natural Communities Restoration.*

3.3.4.5 Valley/Foothill Riparian

Before European settlement, the Central Valley supported close to 1 million acres of riparian forest. Today, only 2 to 6% of that acreage remains (Katibah 1984). Historic accounts of the Delta describe lower portions of the rivers where they flow into the Delta as being surrounded by wide swaths of riparian forest. Riparian forests in more interior portions of the Delta occurred in narrow bands along the high points of natural levees (Fremier et al. 2008). Today, the valley/foothill riparian natural community represents less than 4% of the BDCP Plan Area with 17,930 acres of this natural

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community in the plan area, 30% of which (5,424 acres) are currently protected. In general, riparian areas are distributed across the Plan Area as narrow corridors along watercourses or as isolated remnant patches near watercourses (Figure 3.2-6).

Substantial reductions in the extent, distribution, and condition of valley/foothill riparian communities have resulted from agricultural conversion, stream channelization and armoring, and urbanization. These factors, coupled with reduced flood flows and the impoundment of sediment behind upstream dams (thereby reducing the spread of new sediment strata during peak flows), have greatly reduced the open floodplain and nursery sites for pioneer vegetation (Vaghti and Greco 2007).

More than 225 species of birds, mammals, reptiles, and amphibians use riparian areas in California for forage, water, thermal and escape cover, nesting and breeding, and migration and dispersal (Riparian Habitat Joint Venture 2004). Riparian communities are critical for the conservation of resident and migratory land birds in California (Gains 1980 in Vaghti and Greco 2007). Remnant valley/foothill riparian communities in the Plan Area, while highly degraded relative to their historic state, provide habitat for many covered species, including riparian brush rabbit, Swainson's hawk, white-tailed kite, yellow-breasted chat, and valley elderberry longhorn beetle. Riparian areas also serve an important function as movement corridors for mammals and other wildlife if they provide suitable connections between larger blocks of habitat (Fischer et al. 2000). Additionally, riparian vegetation adjacent to streams moderates water temperature for fish and other aquatic wildlife, produces invertebrates that serve as a vital food source for fish and other wildlife, and is a source of coarse woody and other organic material that provides habitat and substrate and food for the aquatic foodweb for macroinvertebrates and fish (Pusey and Arthington 2003).

Riparian conservation is intended to increase the protection, extent, and connectivity of riparian areas, restore processes necessary to sustain this community, and create important structural conditions that provide habitat for a diversity of wildlife. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.5.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the valley/foothill riparian natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5**: Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.5 Benefits: Achieving this objective will protect upland transitional adjacent to riparian vegetation as described in *CM3 Natural Communities Protection and Restoration,* and *CM5 Seasonally Inundated Floodplain Restoration.* A number of riparian covered species and other native wildlife species depend on lands that seldom or never flood, adjacent to riparian vegetation. The

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least Bell's vireo, western yellow-billed cuckoo, yellow-breasted chat and other riparian birds use such areas as flood refugia and for supplemental foraging. Riparian brush rabbits and riparian woodrats require upland refugia during flood events, and riparian brush rabbits forage in grasslands adjacent to riparian scrub. These adjacent uplands can also serve as buffers to minimize effects from adjacent agricultural and urban lands such as noise, dust, invasive species, and disturbance from human activities. Sufficient upland transitional areas will be protected and managed adjacent to restored and protected valley/foothill riparian to provide these necessary transitional upland habitat values and refugia from flooding. As described in *CM7 Riparian Natural Community Restoration*, mounds will also be created and managed in riparian brush rabbit and riparian woodrat habitat to provide additional refugia during high flood events that might occasionally flood even in these higher transitional uplands.

Objective L1.6 Benefits: Achieving this objective will restore and protect the riparian natural community in areas that increase size and connectivity of protected riparian areas as described in *CM3 Natural Communities Protection and Restoration.* Fragmentation of the riparian natural community has adverse effects on wildlife populations (Whitcomb et al. 1981; Terborgh 1992) by increasing exposure to noise, lighting, pets and human disturbance, increasing susceptibility to predation, and reducing habitat patch size to below wildlife territory size or below acreage necessary to support minimum viable populations. Increasing the size and connectivity of protected riparian natural community will eliminate this stressor within the reserve system.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances.
- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objectives L2.1, L2.2, and L2.4 Benefits: Achieving these objectives will restore natural flooding regimes along rivers as described in, *CM5 Seasonally Inundated Floodplain Restoration.* Flooding is one of the primary factors influencing riparian structural diversity. Fluvial geomorphic processes such as channel migration, erosion and deposition, and overland scour determine the form of river channels and floodplains and deposit sediment that provides soil for riparian plant growth. These disturbance processes as well as seasonal inundation patterns drive plant succession and vegetation structure and are especially important in maintaining early seral stage vegetation The riparian natural community is temporally and spatially heterogeneous and dynamic as a result of fluvial disturbances.

Most riparian plant species with long-lived seeds germinate during waterlogged conditions following floodwater recession. Flood flows also contribute to riparian seed dispersal (Capon and Dove 2006). Riparian plants are adapted to particular inundation regimes and the recruitment and/or survival of each species changes seasonally, annually, and decadally (Fremier et al. 2008).

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Many nonnative plant species are flood intolerant, and the loss of regular scouring floods has facilitated their invasion throughout the Central Valley (Riparian Habitat Joint Venture 2004).

Historically, riparian areas around the margins of the Delta and in the lower Yolo Bypass Basin were subject to strong fluvial control from adjacent rivers—notably the Sacramento, Cosumnes, Mokelumne, and the San Joaquin. More tidally influenced areas of the Delta likely exhibited slower rates of geomorphic disturbance. In these areas, vegetation structure was heavily influenced by long periods of runoff and inundation from spring snowmelt along with tidal action and salinity (Fremier et al. 2008). Channelization and levee construction in the Delta have since diminished the natural fluvial processes upon which healthy riparian natural communities depend. Floodplain restoration will promote regeneration of riparian natural community vegetation and structural diversity. It will also promote fluvial processes that create fresh sediment deposits, making bare mineral soils available for colonization by native vegetation.

Connecting rivers to their floodplains will also replenish groundwater supplies on which some riparian plants may be partially or totally dependent (Capon and Dove 2006).

Objective L2.7 Benefits: Achieving this objective will increase the native biodiversity and relative cover of native plant species through riparian restoration (e.g., planting a diversity of native species), and through enhancement and management (e.g., invasive plant management) as described in *CM7 Riparian Natural Community Restoration* and *CM11 Natural Communities Enhancement and Management.* High species diversity promotes natural community resilience, and native biodiversity in riparian systems generates structural diversity that constitutes habitat for many riparian wildlife species.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Achieving this objective will improve habitat linkages by protecting large blocks of habitat. Riparian areas serve an important function as movement corridors for mammals and other wildlife if they provide suitable connections between larger blocks of habitat (Fischer et al. 2000). However, the existing riparian vegetation in the Plan Area is highly fragmented and provides few opportunities for long-distance wildlife movement through contiguous riparian corridors. Habitat linkages will be improved as described in *CM3 Natural Communities Protection and Restoration*, and *CM7 Riparian Natural Community Restoration.*

3.3.4.5.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the valley/foothill riparian natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

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Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near term implementation period
- **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Objective VFRNC1.1 Rationale: Achieving this objective will restore 5,000 acres of riparian forest and scrub in Conservation Zones 1, 2, 4, 5, 6, and 7. The majority of existing riparian acreage is distributed among Conservation Zones 2 through 7. Much of the riparian acreage in the north (Sacramento River system) and east (Cosumnes and Mokelumne Rivers) Delta is protected; greater than two-thirds of the existing acreage in Conservation Zones 2 and 4 is protected and a large portion of the riparian at higher elevations of Conservation Zone 5 is protected. Most of the remaining unprotected riparian areas in Conservation Zones 5 and 6 are in deeply subsided portions of the Delta where the long-term persistence of any terrestrial vegetation is unlikely, or on small mid-channel islands that are at little risk of development, and therefore protection is not a high priority. Conservation Zone 7 in the south Delta has relatively large patches of unprotected riparian associated with the San Joaquin, Old, and Middle Rivers. These patches and the existing corridors of riparian between them provide habitat for several covered and other native species and could be connected to other protected lands south of the Delta. Protection of existing riparian community is therefore focused in Conservation Zone 7.

Approximately 2,000 acres of riparian restoration will be distributed in tidal and channel margin restoration areas and will occur generally as long narrow strips. The majority of restoration, approximately 3,000 acres, will occur in the south Delta seasonal floodplain restoration site in Conservation Zone 7, where the lack of existing constraints allows restoration of larger tracts of riparian natural community. Large tracts of this vegetation are an important component of habitat for covered species such as the yellow-billed cuckoo, which only breed in large patches (minimum 100 acres) of habitat. The establishment of large tracts of riparian community will also establish large core areas that are better buffered from encroachment of humans, invasive plants, and nonnative animals as well as from noise and other disturbances associated with surrounding agricultural and urban land uses. Restoration of riparian community in Conservation Zone 7 will also provide habitat for riparian brush rabbit and riparian woodrat which have a very limited distributions, restricted only to areas within and adjacent to Conservation Zone 7.

Riparian restoration in the Plan area will create the potential for many species to recolonize some of their historic range. Several BDCP covered species, such as yellow-billed cuckoo, least Bell's vireo, riparian brush rabbit, side-flowering skullcap, and valley elderberry longhorn beetle are riparian obligates and are found almost exclusively within this natural community. Other species, such as Swainson's hawk and white-tailed kite, forage in open country, but nest in tall trees, often in patches of riparian forest. For many of the BDCP covered species, as well as numerous other native riparian species, population declines and/or range contractions have been linked to loss of riparian habitat. The restoration or creation of 5,000 acres and protection of 750 existing acres in the Plan Area will be an important step toward the conservation and recovery of those species. Restoration will increase the total amount of valley/foothill riparian natural community in the Plan Area by 22%, as

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well as increase the amount under protected status by 32%. For the implementation schedule of valley/foothill restoration, see Chapter 6, *Plan Implementation.*

Objective VFRNC1.2 Rationale: Achieving this objective will protect 750 acres of valley/foothill riparian forest in the near term to compensate for the temporal loss of the community resulting from a delay between riparian loss and riparian restoration. Approximately 750 acres of riparian natural community will be lost in the near term implementation period, while most of the riparian restoration will take place after the near term implementation period. After the restoration construction is completed, it can take several years for the restored community to become functional. Riparian protection will take place in Conservation Zone 7 because this zone supports one of only two remaining populations of riparian brush rabbit, is adjacent to nesting locations for least Bell's vireo and riparian woodrat occurrences to the south, and provides habitat for many riparian wildlife species.

Objective VFRNC1.3 Rationale: Achieving this objective will establish riparian vegetation along channel margins as described in *CM6 Channel Margin Enhancement.* This will provide a narrow strip of riparian vegetation that provides shading, aquatic structure, and organic matter to support food resources for fish and other aquatic vertebrates, as well as helping to support connectivity for movement of terrestrial species.

Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.

- **Objective VFRNC2.1:** Restore, maintain and enhance structural heterogeneity with adequate vertical and horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands.
- **Objective VFRNC2.2:** Maintain at least 1,000 acres of early- to mid-successional vegetation with a well-developed understory of dense shrubs.
- **Objective VFRNC2.3:** Maintain 500 acres of mature riparian forest in large blocks (which must have a minimum patch size of at least 50 acres each) in Conservation Zones 4 and/or 7.

Objective VFRNC2.1 Rationale: Achieving this objective will restore, maintain, and enhance the structural heterogeneity of riparian vegetation in the reserve system as described in *CM7 Riparian Natural Community Restoration* and *CM11 Natural Communities Enhancement and Management.* Structural complexity, including understory (low shrubs), midstory (large shrubs and small trees) and overstory (upper canopy formed from large trees) is important to provide habitat requirements for a diversity of wildlife species. Different bird species nest and forage at different vegetation heights, necessitating the presence of multiple vegetation layers. Low shrubs provide cover for many wildlife species, tall trees provide perching opportunities, and canopy cover provides shading. Horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands increases opportunities for insects produced in riparian vegetation to be distributed into channels and other communities to provide food supply for wildlife.

Objectives VFRNC2.2 and VFRNC2.3 Rationale: Both early to mid-successional and late successional riparian vegetation will be maintained as described in *CM7 Riparian Natural Community Restoration* and *CM11 Natural Communities Enhancement and Management.* Wildlife species require certain types of vegetation structure for breeding, foraging, and nesting. Vegetation structure can be defined as the foliage volume (or cover of foliage) by height for a given area

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(Riparian Habitat Joint Venture 2009). Where natural processes dominate, riparian natural communities tend to vary widely in terms of both vegetation structure and composition, representing areas that are at different successional (temporal) stages. To meet the ecological requirements of a variety of wildlife species, riparian communities should include the full range of seral stages that are characterized by a mixture and diversity of trees and shrubs and vegetative cover at a wide range of heights and volumes (Riparian Habitat Joint Venture 2009). For example, least Bell's vireo is more likely to occur in willow-dominated, early seral stage riparian forest, whereas yellow-billed cuckoo is more likely to occur in a relatively dense, mature cottonwood/willow forest with light gaps and a heavy shrub component (Efseaff et al. 2008).

Extent and patch size parameters in Objective VFRNC2.3 are determined primarily by the breeding requirements of western yellow-billed cuckoo; the rationale for these parameters is described in Section 3.3.5.27, *Western Yellow-Billed Cuckoo,* and additional details regarding western yellow-billed cuckoo habitat requirements are provided in in *CM7 Riparian Natural Community Restoration.*

Goal VFRNC3: Maintain or increase native biodiversity that characterizes the valley/foothill riparian community.
• **Objective VFRNC3.1:** Maintain or increase abundance and distribution of rare and uncommon shrubs characteristic of riparian communities, especially buttonwillow and elderberry bushes.

Objective VFRNC3.1 Rationale: Achieving this objective will ensure that riparian restoration projects are designed to maintain or increase the abundance and distribution of rare and sensitive shrubs characteristic of riparian communities, as described in *CM7 Riparian Natural Community Restoration.* The maintenance or increase of these rare and sensitive shrubs will maintain or increase riparian biodiversity. The importance of biodiversity is described above, under the rationale for Objective L2.7. Although Objective L2.7 addresses the need for biodiversity, Objective VFRNC3.1 is a natural community-specific objective to ensure that the naturally high biodiversity of the riparian natural community is restored and maintained.

3.3.4.6 Nontidal Perennial Aquatic and Nontidal Freshwater Perennial Emergent Wetland

The nontidal freshwater perennial emergent wetland community is closely associated with the nontidal perennial aquatic community. These two communities typically co-occur as a complex mosaic collectively referred to as nontidal freshwater marsh.

The nontidal perennial aquatic community includes freshwater open water streams, sloughs, canals, ditches, ponds, and marshes that are located above tidal influence. This community does not include managed permanent and semi-permanent aquatic areas in managed wetlands in the Yolo Bypass and Suisun Marsh. In the Delta, nontidal perennial aquatic habitat ranges in size from small farm ponds to small lakes such as the north and south Stone Lakes located at the northern end of the study area. Fringes of nontidal perennial aquatic communities often merge into emergent wetlands.

The nontidal freshwater perennial emergent wetland natural community is composed of perennially saturated wetlands dominated by emergent plant species that do not tolerate saline or brackish conditions (CALFED Bay-Delta Program 2000). Nontidal freshwater perennial emergent wetland communities in the Plan Area occur in small fragments in association with the nontidal perennial aquatic natural community.

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Currently, the nontidal perennial aquatic community makes up 5,421 acres (less than 1%) of the Plan Area, and the nontidal freshwater perennial emergent wetland community makes up approximately 1,135 acres (less than 1%) of the Plan Area (Figure 3.2-7). Prior to agricultural development of the Delta, there was more extensive tidal influence in the Delta than there is today (San Francisco Estuary Institute 2010), so nontidal marsh was probably never common.

Covered species that use nontidal freshwater marsh include Townsend's big-eared bat, giant garter snake, western pond turtle, and California red-legged frog. A variety of native and nonnative freshwater invertebrates and resident fish species, waterfowl, pisciverous birds, semi-aquatic mammals, insectivorous birds, also inhabit or forage in nontidal freshwater marsh. Invertebrates and organic material produced in the nontidal freshwater perennial emergent wetland community supports the aquatic foodweb and production of food for covered fish and other native aquatic organisms.

The conservation approach for freshwater marsh is restoration of a mosaic of nontidal freshwater marsh and nontidal freshwater perennial emergent wetland natural communities, and protection and management to provide habitat values for covered species and other native wildlife.

The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.6.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the nontidal perennial aquatic and nontidal freshwater perennial emergent wetland natural communities are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Consistent with this objective, nonnative invasive plants and wildlife will be managed and controlled as needed to sustain native biodiversity and protect covered species in the nontidal marsh. Nonnative fish and other invasive nonnative predators will be reduced as needed to protect populations of native amphibians and aquatic reptiles.

3.3.4.6.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the nontidal perennial aquatic and nontidal freshwater perennial emergent wetland natural communities within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

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Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle. • **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objective NFEW/NPANC1.1 Rationale: The restoration of 400 acres of nontidal marsh, consisting of at least 250 acres of nontidal perennial aquatic and at least 100 acres of nontidal perennial freshwater emergent wetland (the remainder of which will consist of either or both of these two communities) will result in a net increase of nontidal freshwater marsh and no net loss of each component natural community. Furthermore, the restoration will occur in blocks that will be contiguous with the larger reserve system compared to the small, fragmented patches that will be lost as a result of BDCP activities. The net effect is expected to be an increase in acreage and ecological function of nontidal marsh in the Delta for giant garter snake, western pond turtle, and a diversity of native species that use nontidal marsh.

Objective NFEW/NPANC1.2 Rationale: By focusing nontidal marsh restoration in the vicinity of existing giant garter snake subpopulations, the restoration will contribute to the recovery of this species; this is further described in Section 3.3.5, *Species Biological Goals and Objectives*. Restoration in these locations will also benefit western pond turtle and a diversity of other native species.

3.3.4.7 Alkali Seasonal Wetland Complex

The alkali seasonal wetland complex natural community occurs on areas of clay soils that contain a relatively high concentration of dissolved salts. These wetlands remain saturated throughout the wet season and during the early part of the dry season, with areas of shallow ponding often present during the wet season. Two contrasting types of vegetation are represented in this natural community: the more common saltgrass-dominated association, and the much rarer woody iodine bush scrub found near the Clifton Court Forebay. Depending on its location, the alkali seasonal wetland complex often transitions into other natural communities such as tidal brackish emergent wetland, vernal pool complex, grassland, valley/foothill riparian, and cultivated landscapes. For more information on ecological characteristics of the alkali seasonal wetlands natural community, see Section 2.3.4.8, *Alkali Seasonal Wetland Complex.*

Alkali seasonal wetlands were once very common in the Central Valley and in portions of the Plan Area. However, conversion of land to agriculture, livestock grazing, commercial uses, and urban uses has reduced the extent and degraded the condition of this community throughout much of its historical range. Within the Plan Area, this community is associated with seasonally saturated alkali soils along the northwestern and southwestern margins of the Delta and around the perimeter of Suisun Marsh (Figure 3.2-8). An estimated 3,722 acres of alkali seasonal wetland complex natural community remain in the Plan Area. Alkali seasonal wetlands have been subject to fragmentation, hydrologic alteration, and invasion by nonnative species. The decline in the extent, distribution, and

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condition of alkali seasonal wetland complex has reduced the diversity of native plant species uniquely associated with alkali soils, as well as habitat for associated covered and other native wildlife.

The remaining alkali seasonal wetland complexes support many native, endemic, and rare species. This natural community provides habitat for covered plant species, including heartscale, brittlescale, San Joaquin spearscale, Delta button celery, and Carquinez goldenbush. Grassland-dependent covered wildlife species such as western burrowing owl and San Joaquin kit fox use the grassland component of alkali seasonal wetlands. Alkali seasonal wetlands also enhance groundwater recharge, moderate seasonal flooding, and provide valuable foraging habitat for migrating and wintering waterfowl and other bird species.

Of the 3,722 acres of alkali seasonal wetland complex in the Plan Area, 2,769 acres (74%) is currently under protected status. The BDCP takes two general approaches to alkali seasonal wetlands conservation: protect larger, interconnected expanses of natural communities, including alkali seasonal wetland complex within a matrix of other vegetation types; and maintain and enhance ecological functions necessary to sustain native alkali seasonal wetland species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.7.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the alkali seasonal wetland complex natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.6 Benefits: Achieving this objective will increase the size and connectivity of protected lands, including alkali seasonal wetland complexes within a matrix of other natural community types. This will be achieved through implementation of *CM3 Natural Communities Protection and Restoration*, building on the existing reserve system and applying the principles described in Section 3.2.4.2.1, *Conservation Land Assembly Principles*. Protecting alkali seasonal wetlands within a large, interconnected reserve system prevents further habitat fragmentation within the reserve system that can disrupt hydrologic processes and gene flow. Size and connectivity of the reserves that include alkali seasonal wetland are also important in order to provide sufficient upland habitat for the protection of plant pollinators, provide for the dispersal of alkali seasonal wetland-associated plants and animals, and sustain important predators of herbivores such as rodents and rabbits (U.S. Fish and Wildlife Service 2005). Furthermore, with interconnected reserves, alkali seasonal wetlands are less likely to be adversely affected by adjacent disturbances related to urban development such as urban runoff.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Achieving this objective will maintain or increase native biodiversity in alkali seasonal wetlands. This is expected to maintain or increase the stability of this natural community in the Plan Area. (See Section 3.3.3, *Landscape-Scale Biological Goals and Objectives*, for a description of how biodiversity increases the stability of a natural community.) Furthermore, increasing the cover of native alkali seasonal wetland plants relative to invasive nonnative species will minimize competition posed by invasive plants to native plant species, and improve overall habitat suitability for native wildlife. Native biodiversity will be maintained and enhanced through *CM11 Natural Communities Enhancement and Management*, which will include activities such as control of invasive plants and fencing alkali seasonal wetland areas to protect them from adverse effects of grazing livestock.

3.3.4.7.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the alkali seasonal wetland complex natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

Goal ASWCNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex.
• **Objective ASWNC1.1:** Protect 150 acres of alkali seasonal wetland in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

Objective ASWCNC1.1 Rationale: Achieving this objective will provide at least 150 acres of protected alkali seasonal wetland within a mosaic of protected grasslands and vernal pool complex. In determining the extent and distribution of alkali seasonal wetland complex natural community to be protected, the following criteria were considered: the extent and level of fragmentation of alkali seasonal wetland in the Plan Area; the extent, proportion, and distribution of the community in the Plan Area that is currently under protected status; the interspersion of alkali seasonal wetlands with other high value habitats (e.g., vernal pool complex) that warrant protection; and the projected effects on the community resulting from implementation of the BDCP.

Alkali seasonal wetland complex natural community in the Plan Area is currently found in Conservation Zones 1, 2, 4, 5, 6, 8, 9, 10, and 11. The largest contiguous areas of alkali seasonal wetlands are in Conservation Zone 2, where most of this community is already protected. The alkali seasonal wetland in Conservation Zone 5 is also already protected. Only small, isolated patches of alkali seasonal wetland surrounded by cultivated and developed lands are present in Conservation Zones 4, 6, 9, and 10. While alkali seasonal wetlands in Conservation Zones 1, 8, and 11 also consists of small patches, these patches are within a larger mosaic of grasslands and vernal pool complex. Conservation Zones 1, 8, and 11 provide the greatest opportunity for conserving alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex, adjacent to existing protected lands. Furthermore, Conservation Zone 8 provides the only opportunity in the Plan Area to protect the rarer woody iodine bush scrub.

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There are 3,722 acres of alkali seasonal wetland complex in the Plan Area, of which 2,769 (74%) are currently in protected status. With protection of an additional 150 acres, 78% of the alkali seasonal wetland complex in the Plan Area will be protected. Because the unprotected alkali seasonal wetlands in the Plan Area are in small, widely dispersed patches, opportunities to protect large areas of alkali seasonal wetland are limited. Protecting and enhancing alkali seasonal wetlands that support the highest concentrations of rare and sensitive plant species in conjunction with other adjoining natural communities, is expected to maintain or increase the abundance of native wildlife and plant species, improve connectivity among habitat areas both within and adjacent to the Plan Area, and contribute to the long-term conservation of this native community and its associated covered species.

Goal ASWCNC2: Alkali seasonal wetlands that are managed and enhanced to sustain populations of native alkali seasonal wetland species.
• **Objective ASWCNC2.1:** Provide appropriate seasonal flooding characteristics for supporting and sustaining alkali seasonal wetland species.

Objective ASWCNC2.1 Rationale: Achieving this objective will ensure that appropriate hydrologic conditions are maintained to support alkali seasonal wetlands in the reserve system. These conditions include seasonal flooding with overland flow and some ephemeral ponding. These conditions are necessary to sustain native species adapted to seasonally wet conditions in alkaline soils. Diversion of urban or agricultural runoff into alkali seasonal wetland, or topographic alteration, can alter duration on inundation or saturation of soils, rendering these areas unsuitable for some alkali seasonal wetland species. Topographic alteration and habitat fragmentation through placement of roads, canals, and other hydrologic barriers can disrupt both subsurface water exchange and surface water conveyance.

3.3.4.8 Vernal Pool Complex

Vernal pools are ephemeral wetlands that form in shallow depressions underlain by bedrock or by an impervious, near-surface soil horizon. These depressions fill with rainwater and runoff during the winter and may remain inundated until spring or early summer, sometimes filling and emptying repeatedly during the wet season. The vernal pool complex natural community consists of both interconnected and isolated groups of vernal pools and seasonal swales that are generally within a matrix of either grassland or alkali seasonal wetland vegetation. For more information on ecological characteristics of the vernal pool natural community, see Section 2.3.4.9, *Vernal Pool Complex* in Chapter 2, *Existing Ecological Conditions.*

Vernal pool complexes in the western United States are distributed from eastern Washington to northern Baja California, Mexico (Moran 1984). Within this range, the remaining vernal pool acreage represents less than 10% of that prior to anthropogenic alteration of these landscapes, which began in 1800s (Keeley and Zedler 1998). Most of the remaining vernal pool complexes are highly fragmented and degraded (U.S. Fish and Wildlife Service 2005). Vernal pool complexes historically occurred around the perimeter of the Plan Area, within a continuous, intact mosaic of meadows, nontidal wetlands and channels, alkali grasslands, and alkali sink scrub, which transitioned to tidal wetlands and mudflats. Today, the Plan Area contains 7,908 acres of vernal pool complex consisting of fragmented complexes in four distinct regions in the upper elevations along the margins of the Plan Area (Figure 3.2-9) (Witham 2003; Leigh Fisher Associates 2005; Williamson et al. 2005; Witham 2006; Kleinschmidt Associates 2008; Rains et al. 2008).

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- 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.
- West of the San Joaquin River from Byron to Discovery Bay.

Anthropogenic influences on the vernal pool landscape have resulted in the reduction, fragmentation, loss of biodiversity, and degradation of this natural community type. The remaining natural community has been degraded by the invasion of nonnative species and hydrologic alteration. In many areas, vernal pool connectivity and hydrology have been altered by physical barriers such as roads, canals, and urban development. Elsewhere, vernal pools have been degraded by increased surface and subsurface flow from increased urban runoff (e.g., impervious surfaces, storm drains) and agricultural runoff (U.S. Fish and Wildlife Service 2005). Disking, leveling, and deep ripping activities have also resulted in alteration or elimination of vernal pool hydrology and species diversity. 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 in the Plan Area.

The vernal pool complexes that remain are still rich in biodiversity, and have many native, endemic, and rare species. Vernal pools provide all life-history requirements for some covered plant and invertebrate species (e.g., vernal pool shrimp) as well as requirements for a specific part of the life history of other BDCP covered wildlife species (e.g., California tiger salamander and western spadefoot toad). See Table 2-4 for covered species that are supported by vernal pool complexes. Vernal pools also enhance groundwater recharge, moderate seasonal flooding, and provide valuable foraging habitat for migrating and wintering waterfowl (Medeiros 1976; Reiner and Swenson 2000) and other bird species.

Of the 7,908 acres of vernal pool complex in the Plan Area, 4,536 acres (57%) is currently under protected status. The BDCP takes three general approaches to vernal pool conservation: protect and restore vernal pool complex extent and connectivity, recover native biodiversity of vernal pool species through restoration and improved management, and maintain and enhance ecological functions such as local hydrology necessary to sustain this natural community. =The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.8.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the vernal pool complex natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.6 Benefits: This objective will provide sufficient upland habitat to protect plant pollinators, provide for the dispersal of vernal pool complex-associated plants and animals, and

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sustain important predators of herbivores such as rodents and rabbits (U. S. Fish and Wildlife Service 2005). Furthermore, with larger reserves in association with grasslands and alkali seasonal wetlands, vernal pool complexes are less likely to be adversely affected by adjacent disturbances related to urban development such as urban runoff. Refer to *CM3 Natural Communities Protection and Restoration* for a description of how the size and connectivity of protected lands, including vernal pool complexes within a matrix of other natural community types, will be increased by adding to the existing reserve system and applying conservation land assembly principles.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.7:** Increase native plant and wildlife biodiversity, and relative cover of native plant species and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: This objective will contribute to the resiliency and long-term stability of this natural community. Biodiversity is relatively high in vernal pools; a single vernal pool may support over 100 species of native plants and animals (U. S. Fish and Wildlife Service 2007). However, habitat loss has been, and continues to be, a threat to vernal pool complexes. Agricultural and urban impacts on vernal pools have resulted in an estimated 15 to 33% of the original biodiversity of Central Valley vernal pool crustaceans since the 1800s (King 1998). Many ecosystem processes are sensitive to declines in biodiversity: declines in regional and local biodiversity can reduce ecosystem resistance to environmental perturbations such as drought. Ecosystem processes such as soil nitrogen levels, water use, plant productivity, and pest and disease cycles can become more variable as diversity declines (Naeem et al. 1999:2). Although the maintenance and increase of native biodiversity in vernal pools (Objective VPCNC2.1) will not restore vernal pool complexes to presettlement levels of biodiversity, it is expected to maintain or increase the stability of vernal pool complexes in the Plan Area. Furthermore, increasing the cover of vernal pool plants relative to invasive nonnative species will help to minimize competition posed by invasive plants with native plant species, and improve overall habitat suitability for native wildlife. Refer to *CM3 Natural Communities Protection and Restoration* for a description of activities such as control of invasive plants that would be implemented to achieve this objective.

3.3.4.8.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the vernal pool complex natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

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Goal VPCNC1: Vernal pool complexes comprised of large, interconnected or contiguous expanses that represent a range of environmental conditions.

- **Objective VPCNC1.1:** Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005).
- **Objective VPCNC1.2:** Restore vernal pool complex in Conservation Zones 1, 8, and/or 11 to achieve no net loss of vernal pool acreage.
- **Objective VPCNC1.3:** Increase the size and connectivity of protected vernal pool complex within the Plan Area and increase connectivity with protected vernal pool complex adjacent to the Plan Area.
- **Objective VPCNC1.4:** Protect the range of inundation characteristics that are currently represented by vernal pools throughout the Plan Area.

The vernal pool objectives under Goal VPCNC1 will dictate the extent, distribution, and configuration of vernal pool complexes in the BDCP reserve system. In determining the extent of vernal pool complex natural community to be protected and restored, the following criteria were considered: opportunities to expand and connect existing protected lands; the extent and proportion of the community in the Plan Area that is currently under protected status; and the feasibility of acquiring unprotected vernal pools and suitable restoration areas for conservation on a willing-seller basis. BDCP actions will increase the amount or extent of vernal pool complex natural community in protected status in the Plan Area by 600 acres from 4,536 acres to 5,136 acres, or 65% of the total 7,908 acres of vernal pool complex.

The BDCP will also restore additional vernal pool complex natural community in the Plan Area to achieve no net loss of vernal pool acres. The maximum potential impact on vernal pool complex is 89 acres. Assuming that 89 acres of vernal pool complex will be restored[6], a net increase in the area of both restored and protected vernal pool complex will result in protecting a total of 66% of the vernal pool complex. Consistent with Objective L1.3, the 600 acres of protected vernal pool complex and additional restored vernal pool complex will be components of a large, interconnected reserve system incorporating a mosaic of grasslands, vernal pool complex, and alkali seasonal wetlands to optimize protection of plant pollinators, provide for the dispersal of plants and animals, sustain important predators of herbivores such as rodents and rabbits (U. S. Fish and Wildlife Service 2005), and minimize effects of adjacent urbanization.

Objectives VPCNC1.1 and VPCNC1.2 Rationale: These objectives will target spatial distribution of areas for vernal pool conservation (Figure 3.2-9) that correspond closely to core vernal pool recovery areas as identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). Vernal pool complex natural community in the Plan Area is currently found in Conservation Zones 1, 2, 4, 8, 9, and 11, while core recovery areas are only found in Conservation Zone 1 (Jepson Prairie core recovery area), Zone 11 (Jepson Prairie and Suisun core recovery area), and Zone 8 (Altamont Hills core recovery area). These targeted conservation areas are situated at elevations that are suitable as upland habitats adjacent to restored tidal habitats, and can be protected to build on existing and planned preserves in Solano County between Conservation Zones 1 and 11. Protection of additional vernal pool complex natural community in Conservation Zones 1 and 11 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. Vernal pool complexes in Conservation Zones 2, 4, and 9 are not

[6] Acreage of restored vernal pools will depend on the actual acreage of vernal pool impact from covered activities.

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targeted for protection because they do not support core recovery areas and most of the community present in Conservation Zones 2 and 4 is already protected. In Conservation Zone 9, it consists of small patches that are isolated among developed areas and cultivated land.

To maximize the probability that vernal pool plants and wildlife will persist despite weather variations, climate change, or catastrophic events, it is important to retain vernal pools with a range of conditions such as soil and landform, geographic distribution, and the size and type of vernal pool (U.S. Fish and Wildlife Service 2005). The strategic distribution of vernal pool protection provided by this objective will ensure that the reserve system within the Plan Area (including currently protected areas and areas to be protected and restored under the BDCP) conserves a range of landforms, hydrogeomorphic conditions, and vegetation alliances. The vernal pool complex natural community in the Plan Area consists of four fairly uniform types. These vernal pool types differ in characteristics of geomorphology, hydrology, and vegetation (e.g., the alkaline sink/meadow vernal pools support halophytic vegetation, while the annual grassland vernal pools in the Stones Lakes area generally support species adapted to non-alkaline soils) as described in detail in Section 2.3.4.9.1. *Vernal Pool Complex, Vegetation.* All four vernal pool types will be conserved in the Plan Area (including both future protection through BDCP and current protection).

- Annual grassland vernal pools in the Stone Lakes area: this type is in Conservation Zone 4, where all 1,082 acres of vernal pool complex are already protected.
- Clay alluvium vernal pools and playa pools running from Putah Creek south to Cache Slough: this type is in Conservation Zones 1 and 2, where all but an isolated patch is already protected.
- Montezuma Block vernal pools and playa pools in the Jepson Prairie/Montezuma Hills area: this type is targeted for conservation in Conservation Zones 1 and 11, and is where all the BDCP-related effects on vernal pool complex will occur.
- Alkaline sink/meadow vernal pools in the Byron/Clifton Court Forebay area: this type is targeted for protection in Conservation Zone 8, although no vernal pools in this area will be affected by BDCP related activities.

Refer to *CM3 Natural Communities Protection and Restoration* for a description of the protection requirements and reserve design criteria that will be applied to meet this objective.

Objective VPCNC1.1 will protect the full range of vernal pool types in the Plan Area and a range of vernal pool inundation characteristics. The protection of larger, deeper pools with long inundation periods and smaller, shallower pools with short inundation periods will increase the probability of sustaining species during both long-term high and low rainfall periods. The protection of a range of vernal pool inundation characteristics will also contribute to biodiversity, since many vernal pool species depend on a narrow range of inundation periods (U.S. Fish and Wildlife Service 2005).

Objective VPCNC1.2 will restore vernal pools to achieve no net loss of vernal pool acreage. This is consistent with the federal policy on no-net-loss of wetlands. Restoration will be implemented, as part of *CM9 Vernal Pool Complex Restoration*, to replace any vernal pool acreage lost as a result of BDCP covered activities, in areas that build on the larger vernal pool complex reserve system. This will maintain the acreage of habitat for vernal pool species in the Plan Area.

Objective VPCNC1.3 Rationale: Conserving intact vernal pool complexes prevents further habitat fragmentation that can disrupt hydrologic processes and gene flow (see discussion on hydrology, below). Size and connectivity of vernal pool reserves are also important in order to provide

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sufficient upland habitat for the protection of vernal pool plant pollinators, provide for dispersal of vernal pool plants and animals, and sustain important predators of herbivores such as rodents and rabbits (U.S. Fish and Wildlife Service 2005). For example, establishing a protected corridor in between Suisun Marsh and the Cache Slough area will facilitate movement of several covered species including California tiger salamander and western spadefoot from occupied habitats in the Montezuma Hills and Jepson Prairie into the grassland and vernal pool complex habitats in Conservation Zone 1. This objective will be achieved by implementation of *CM3 Natural Communities Protection and Restoration*, by adding to the existing reserve system, and applying the conservation land assembly principles described in Section 3.2.4.2.1, *Conservation Land Assemble Principles.*

Goal VPCNC2: Vernal pool complexes that are managed and enhanced to sustain populations of native vernal pool species.
• **Objective VPCNC2.1**: Maintain or enhance vernal pool complexes to provide the appropriate inundation (ponding) characteristics for supporting and sustaining vernal pool species. • **Objective VPCNC2.2:** Maintain and enhance pollination service in the vernal pool complex, especially by native invertebrates including native solitary bees.

Protected and restored vernal pool complexes in the Plan Area will be managed and enhanced to optimize biodiversity and ecological processes (e.g., hydrology, pollination) that are characteristic of a vernal pool natural community, as part of *CM11 Natural Communities Enhancement and Management*, to meet Objectives VPCNC2.1 and VPCNC2.2.

Objective VPCNC2.1 Rationale: Hydrologic functions in vernal pool complexes include surface water storage in the pool, subsurface water exchange, and surface water conveyance (Butterwick 1998:52). Aspects of surface water storage such as timing, frequency, and duration of inundation are critical to the survival of vernal pool plants and wildlife. Subsurface water exchange (i.e., lateral flow between pools through subsurface soil) is important within some vernal pool complexes for the purpose of damping water level fluctuations during the late winter and early spring (Hanes and Stromberg 1998:38). Surface water conveyance, through sheet flow or swales, is important for the purpose of filling pools at lower elevations in the watershed, and for dispersal of seeds and vernal pool invertebrates.

Various environmental stressors adversely affect the duration of vernal pool inundation. The percentage of nonnative vegetation in a vernal pool is closely tied to length of inundation (Bauder 1987, in U.S. Fish and Wildlife Service 2005, page I-20). Invasion of nonnative plants can lead to excessive vegetation in pools, which can lead to increased evapotranspiration and early drying of pools (Barry 1998, in U.S. Fish and Wildlife Service 2005, page I-20). For example, removal of grazing led to increases of invasive vegetation and a subsequent reduction in the inundation period of vernal pools below the amount of time required by the western spadefoot to successfully metamorphose (Marty 2004, in U.S. Fish and Wildlife Service 2005, page III-7). Alternatively, diversion of urban or agricultural runoff into vernal pools or topographic alteration can result in longer inundation periods that are unsuitable for many vernal pool species. Topographic alteration and habitat fragmentation through placement of roads, canals, and other hydrologic barriers can disrupt both subsurface water exchange and surface water conveyance. Invasive species control and other management and enhancement described in *CM11 Natural Communities Enhancement and Management* to maintain or enhance vernal pool hydrology will benefit the vernal pool complex natural community by reducing or eliminating these stressors in the reserve system.

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Objective VPCNC2.2 Rationale: Many rare and endemic vernal pool plant species depend on insects such as bees, flies, and beetles for pollination. Solitary bees, important pollinators for many native vernal pool plants (Eaton 2001), are limited in their flight and dispersal capabilities (Thorp and Leong 1995) and may not be able to travel substantial distances to disperse or re-colonize areas where they have been locally extirpated. Assembling a large, interconnected reserve system consistent with Goal VPCNC1, including optimization of connectivity between upland and lower portions of the watersheds within vernal pool complexes, will contribute to solitary bee conservation by reducing fragmentation effects. Vernal pool complexes will be managed and enhanced consistent with *CM11 Natural Communities Enhancement and Management*, and monitored and adaptively managed as described in Section 3.6, *Adaptive Management and Monitoring Program*, to achieve Objective VPCNC2.2.

3.3.4.9 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 primarily for waterfowl. Hydrology within managed wetlands is managed by operating floodgates on dikes and levees. Undesirable plants are controlled by a combination of discing and controlled flooding. Typically, managed wetlands are flooded during the winter in anticipation of the arrival of migratory birds. See Section 2.3.4.10, *Managed Wetland* in Chapter 2, *Existing Ecological Conditions,* for more detail on managed wetlands. Although this community is artificially created and managed, it is considered a natural community because of the habitat values it provides for native wildlife, including some covered species.

In the 1800s, the Central Valley of California supported 4 million acres of tidal and nontidal wetland habitat. After the passage of the Swamp Land Act of 1850, these wetlands began to be reclaimed; i.e., converted to urban or agricultural development. Today, only 5% of the original wetland acreage remains. Many of these wetlands are managed wetlands, which are former cultivated lands that have been managed back to emergent wetland by controlling seasonal flooding. Currently, 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 (Figure 3.2-10). Most of this natural community in the Plan Area 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. The plan area includes 64,861 acres of managed wetland, of which 81% (52,689 acres) are currently protected.

A wide variety of waterfowl and other birds migrating along the Pacific Flyway use the managed wetland natural community when it is inundated. In the Plan Area, BDCP covered species such as 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.

The primary stressors to the community are invasive nonnative species such as perennial pepperweed, and aging floodgate structures that no longer effectively control water flow. The primary threat to the existence of managed wetlands is the breaching of the levees that maintain the community in order to convert the managed wetlands to tidal marsh. Managed wetlands are also

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under threat from projected sea level rise, which is expected to increase risk of levee failures and resultant tidal flooding of these lands.

Planned BDCP tidal restoration actions will result in the conversion of some areas of managed wetlands back to their historic tidal brackish or freshwater emergent marsh. The conservation approach for this natural community focuses on managed wetland protection, creation, management and enhancement for the benefit of covered and other native species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.9.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the managed wetland natural community are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Management of nonnative invasive plants consistent with this objective will benefit the managed wetland natural community. This 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 manipulating flooding duration, there are more opportunities to control invasive species in this natural community than in others. One managed wetland invasive, perennial pepperweed, is a serious threat that may be spread through discing, thereby 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*). Objective L2.7 initiates enhancement operations that promote the biological diversity of native species.

3.3.4.9.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the managed wetlands natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

Goal MWNC1: Managed wetland that is managed and enhanced to provide suitable habitat conditions for covered species.
• **Objective MWNC1.1:** Protect and enhance at least 1,500 acres of managed wetland in the Grizzly Island Marsh Complex consistent with the salt marsh harvest mouse recovery plan. • **Objective MWNC1.2:** Create at least 320 acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the greater sandhill crane Winter Use Area in Conservation Zones 3, 4, 5, or 6, with consideration of sea level rise.

Objective MWNC1.1 Rationale: Although this objective is designed to protect and enhance habitat for the salt marsh harvest mouse, as described in Section 3.3.5.14, *Salt Marsh Harvest Mouse*, it is

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also expected to benefit the managed wetland natural community and the diversity of species that use it, including migratory waterfowl and the western pond turtle. By acquiring 1,500 acres of managed wetland for protection, the Implementation Office will be able to manage and enhance these lands as needed to achieve BDCP biological goals and objectives, such as the control of invasive species measures to increase the diversity of native species.

Objective MWNC1.2 Rationale Although this objective is designed to provide roosting habitat for greater sandhill crane as described in Section 3.3.5.21, *Greater Sandhill Crane*, achieving this objective will also increase the extent of managed wetlands available for migratory waterfowl, western pond turtle, giant garter snake, and other native wildlife.

3.3.4.10 Other Natural Seasonal Wetland

*[**Note to Reviewers:** This natural community is minor in extent, has limited habitat values, and impacts can be avoided. At the recommendation of DFG and USFWS, a conservation strategy is not included for other natural seasonal wetlands. This section will be deleted from the public review draft.]*

3.3.4.11 Grassland

Although California native grassland originally covered approximately 25% of the landmass of the state (Barbour et al. 2007; Stromberg 2010), it has recently been identified as one of the 20 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 nonnative plant species. In the BDCP Plan Area, valley grassland is one of the two most common natural or semi-natural vegetation communities, occupying approximately 9.8% of the Plan Area (77,495 acres) and 27% of noncultivated lands (Figure 3.2-11).

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 200 years.

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 with remaining grasslands. Some animal species have also adjusted well to nonnative grassland. Thus, the current grassland community still offers highly valuable habitats to many grassland dependent species.

The conservation strategy for grasslands involves increasing protection of grassland, including connectivity to improve habitat quality; recovering native biodiversity; and restoring ecological functions necessary to sustain this natural community. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

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3.3.4.11.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the grassland natural community are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6**: Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands. • **Objective L1.7:** To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.

Objective L1.5 Benefits: Achieving this objective will provide noncultivated upland areas, including grasslands, adjacent to restored and protected valley/foothill riparian natural community. This will provide supplemental foraging habitat and upland refuge from flooding for riparian brush rabbit, riparian woodrat, and other native riparian species.

Objective L1.6 Benefits: Achieving this objective will increase the size and connectivity of protected grasslands in association with vernal pool complex, alkali seasonal wetland complex, and other natural communities, and will eliminate grassland fragmentation in the reserve system. Grassland fragmentation limits movement of widely ranging wildlife, and limits dispersal of covered species such as California red-legged frog and California tiger salamander. It also limits dispersal of some grassland insects (Collinge and Palmer 2002) and grassland plant species with wind-dispersed seeds (Soons et al. 2005). Vernal pool complex and alkali seasonal wetland complex natural communities consist of vernal pools and seasonal wetlands within a grassland matrix that accounts for a substantial proportion of the large, unfragmented grassland areas in the Plan Area. Protecting a large, interconnected mosaic of these three natural community types will provide landscape-scale benefits to a grassland-dependent species.

Objective L1.7 Benefits: Achieving this objective will provide grassland and other noncultivated natural lands adjacent to tidally restored areas, to accommodate sea level rise and to provide habitat and high-tide refugia for native wildlife. Protected and restored grasslands will include areas adjacent to restored tidal marsh to reestablish an important historical environmental gradient, along the water-to-land interface, that has been largely lost as a result of levee construction and wetland reclamation. Grassland functions and values will be maintained within the protected area until these areas are converted to tidal natural communities as a result of sea level rise. Sufficient grassland will be protected and restored beyond the elevation of projected sea level rise to provide long-term upland habitat values adjacent to tidally influenced areas that will be maintained in the Plan Area throughout the permit term.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.7**: Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Achieving this objective in grasslands will increase diversity and relative cover of native plant species. Nonnative grass species such as wild oats (*Avena* spp.) and bromes (*Bromus* spp.) are so well established in California grasslands that they are considered naturalized, and are unlikely to ever be eradicated (Reiner et al. 1999). Management practices such as controlled livestock grazing, however, can reduce nonnative species in favor of native species, and grassland management is necessary to reduce or eradicate aggressive nonnatives that provide unfavorable habitat conditions for native wildlife such as star thistle (*Centaurea solstitialis*) (Reiner et al. 1999). This objective will be achieved through grassland management as described in *CM11 Natural Communities Enhancement and Management*.

Goal L.3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.

- **Objective L3.1**: Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Achieving this objective will protect and restore grasslands to improve opportunities for the movement of native organisms within and between natural communities inside and connecting to areas outside of the Plan Area. Grasslands will be protected and restored in Conservation Zones 1 and 11 to build on existing and planned reserves between these two zones in Solano County. Protection of additional grasslands in this area will maintain an important connection between Suisun Marsh and the Cache Slough area. Grassland protection in Conservation Zone 8 will link protected grasslands with large areas of protected grasslands near the Bryon Airport in eastern Contra Costa County, including those associated with the East Contra Costa County HCP/Natural Community Conservation Plan (NCCP).

3.3.4.11.2 Natural Community Goals and Objectives

The landscape-scale goals, objectives, and associated conservation measures are expected to contribute to the conservation of the grassland natural community within the reserve system. The goals and objectives below are driven by additional needs specific to this natural community that will not be met at the landscape scale.

Goal GNC1: Extensive grasslands comprised of large interconnected patches or contiguous expanses.

- **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8 at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.
- **Objective GNC1.2:** Restore 2,000 acres of grasslands to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia.
- **Objective GNC1.3**: Protect stock ponds and other aquatic features within protected grasslands to provide aquatic breeding habitat for native amphibians and aquatic reptiles.

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Objective GNC1.1 Rationale: Achieving this objective will increase the protected grassland in Conservation Zones 1, 8, and 11 from 19% to 55%, comparable with Conservation Zones 2 and 4 (75% and 67%, respectively). This would increase the proportion of protected grassland in the entire Plan Area from 24% to 36%. In determining the aerial extent and spatial configuration of grassland to be conserved, the following criteria were considered: habitat value of the grassland currently in the Plan Area; ecological and evolutionary processes that sustain grasslands; and spatial and functional needs of covered grassland species, including genetic exchange.

Large, contiguous grasslands 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 only have many small fragments of grassland distributed throughout a matrix of urban and cultivated land. Of those zones with large areas of existing grasslands, grasslands in Zones 2 and 4 have been largely protected: Approximately 76% of grassland in Zone 2 (Yolo Bypass Wildlife Area) and 67% of grassland in Zone 4 (Stone Lakes National Wildlife Refuge and Cosumnes River Preserve) are currently protected.

Conservation Zone 6 contains large areas of unprotected grassland, but this zone is in the deeply subsided portion of the Delta and is intersected by large channels that make connections to adjacent islands impossible for ground-dwelling grassland species. The fact that the grasslands occur on deeply subsided areas also makes them susceptible to future levee failures and does not allow for establishing 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 Conservation 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 marsh, as described above for Objective L1.7. Grasslands in these zones often co-occur with vernal pool or seasonal wetland natural communities. Some protected grasslands in Conservation Zones 1 and 11 can be conserved to build on existing planned preserves between these two zones in Solano County. Conservation 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 (and not all of which will be acquired by that plan). Habitats in these three zones support a variety of covered species and are especially important areas in the Plan Area for vernal pool plant and animal species, California tiger salamander, burrowing owl, and rare grassland plant species. In addition to providing habitat for these species, Conservation Zone 8 supports and is adjacent to the best habitats in the BDCP Plan Area for California red-legged frog and San Joaquin kit fox. To a lesser extent, the strategy includes grassland protection in Conservation Zone 7 to provide upland refugia and foraging habitat for riparian brush rabbit and other wildlife species occurring in restored floodplains.

Objective GNC1.3 Rationale: Achieving this objective will protect aquatic habitat for California red-legged frog, California tiger salamander, western spadefoot, western pond turtle, and other native amphibians and reptiles within the protected grasslands in the reserve system. Stock ponds, intermittent drainages, and other aquatic features are common in grasslands throughout the Plan Area. No quantitative target for stock ponds and other aquatic features is included in this objective because these features tend to be small (less than 0.5 acre) and are largely unmapped at the scale of the land cover mapping for the Plan. Therefore, their extent and distribution in the Plan Area is unknown. However, the experience with land acquisition for the San Joaquin County HCP and the East Contra Costa County HCP/NCCP suggests that these features will be consistently supported in the grasslands acquired for the reserve system. Grasslands that support suitable aquatic features for

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covered and other native amphibian species will be prioritized for acquisition, as described in *CM11 Natural Communities Enhancement and Management*.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.1:** Restore and sustain a mosaic of grassland vegetation alliances, reflecting localized water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states. • **Objective GNC2.2:** Increase the extent, distribution, and density of native perennial grasses intermingled with other native species, including annual grasses, geophytes, and other forbs. • **Objective GNC2.3:** Increase burrow availability for burrow-dependent species. • **Objective GNC2.4:** Increase prey, especially small mammals and insects, for grassland-foraging species. • **Objective GNC2.5**: Maintain and enhance aquatic features in grasslands to provide suitable inundation depth and duration and suitable composition of vegetative cover to support breeding for covered amphibian and aquatic reptile species.

Objectives GNC2.1 and GNC2.2 Rationale: Achieving these objectives will increase the extent and diversity of native grassland plant species and grassland vegetation alliances in the reserve system. Valley grassland is species-rich, with 50 plant species typically found in 30-by-30-meter plots (Heady et al. 1991). Grassland plant species exist in patches of plant associations called vegetation alliances, which are unevenly distributed throughout the grassland and sometimes extend into other nearby natural communities. Valley grassland is an extremely productive natural community, but is still not well understood.

Before the introduction of livestock grazing and modern agricultural practices, vegetation alliances characterized by perennial grasses were common in the Central Valley. Barry (1972) estimated that 99% of the precontact purple needlegrass (*Nassella pulchra*) alliance has disappeared from the valley grassland community. While its historical extent and abundance are still under debate (and classification of subassociations under this alliance remains incomplete), perennial grasses are assumed to have been widely distributed in the Central Valley before changes in land use affected this natural community (D'Antonio et al. 2007). Native grassland vegetation alliances are likely to be found in the BDCP Plan Area, but these grasslands are expected to be degraded (i.e., low relative cover of native species) resulting from past and current land use practices (e.g., deep soil disturbance and heavy grazing) and the competitive spread of nonnative plants.

In the BDCP Plan Area, there is now a limited distribution of purple needlegrass, along with several other perennial grass alliances. Another bunchgrass, alkali sacaton (*Sporobolus airoides*), is often found on an alkali or sodic (high sodium) stratum. In contrast, stolonous (nonbunching) creeping ryegrass (*Leymus triticoides*) covers wetter areas at the margins of riparian and emergent wetland communities. Valley grasslands, in this sense, are transitional zones that 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). These soils are enriched by critical microorganisms (fungi, bacteria, nematodes) and bioturbation by burrowing rodents. In native grasslands, these subterranean processes in turn contribute to the diversity of aboveground

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plant composition. On the other hand, annual nonnative grasses cause local soil homogenization which is thought to create a feedback loop encouraging further invasion by nonnative grasses.

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 composed of native perennial grasses, will likely benefit not only the characteristic species, but valley grassland as integrated communities (as well as nearby natural communities) by promoting essential ecological functions.

This objective will be met by incorporating native species into grassland restoration design as described in *CM8 Grassland Natural Community Restoration* and through grassland management and enhancement practices that promote native species, as described in *CM11 Natural Communities Enhancement and Management.*

Objective GNC2.3 Rationale: Achieving this objective will increase burrow availability in protected grasslands. A large proportion of animal species that inhabit grasslands are either fossorial or burrow-dependent, attributes that require 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 are 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), California red-legged frog, California tiger salamander, and western spadefoot (upland aestivation sites). However, 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 burrows, many native species will benefit. This objective will be achieved through grazing to promote favorable conditions for ground squirrels and elimination of ground squirrel control on protected lands, as described in *CM11 Natural Communities Enhancement and Management.*

Objective GNC2.4 Rationale: Achieving this objective will increase prey for grassland-dependent species. Grasslands in the planning 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 hawks, other hawks, and golden eagles. Grassland conservation and restoration will also help offset effects on cultivated lands (e.g., alfalfa) that produce prey for covered species. This objective will be achieved through grassland restoration and management as described in *CM8 Grassland Natural Community Restoration* and *CM11 Natural Communities Enhancement and Management.*

Objective GNC2.5 Rationale: Achieving this objective will increase the native diversity and value of protected grasslands for covered and other native amphibian species, including California red-legged frog, California tiger salamander, western spadefoot, Pacific chorus frog, and western pond turtle. Maintaining appropriate depth and duration of aquatic features is important for native amphibians to ensure that conditions are favorable for supporting the entire aquatic life cycle from

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breeding through metamorphosis from larval to adult stages. Furthermore, features that are dry in late summer are less likely to support bullfrogs and nonnative fish that prey on native amphibians. Additionally, livestock exclusion and other measures will be implemented as described in *CM11 Natural Communities Enhancement and Management* to promote growth of aquatic vegetation with appropriate cover characteristics favorable to native amphibians and aquatic reptiles.

3.3.4.12 Inland Dune Scrub

*[**Note to reviewer:** USFWS and DFG are currently in discussion to decide whether the BDCP should include a conservation strategy for this community, since it isn't affected by covered activities.]*

3.3.4.13 Cultivated Lands

Cultivated lands in the Plan Area consist of a dynamic matrix of a variety of land cover types, including perennial, semi-perennial, and seasonally or annually rotated crops. The large extent of rotated crops results in a cover type matrix that is subject to change annually based primarily on agricultural economic conditions.

The Plan Area formerly supported extensive brackish and freshwater wetlands, open grasslands, broad riparian systems, and oak woodlands. By the mid-1800s, conversion of wetlands began to transform the Delta into an agricultural region with a complex system of channelized waterways and Delta "islands." The majority (64%) of lands in the Plan Area are currently cultivated (Figure 3.2-12). Cultivated lands total 503,779 acres, of which 11% (57,165 acres) are currently protected.

Although the conversion of natural vegetation to cultivated lands has eliminated large areas of native habitats, some agricultural systems continue to support abundant wildlife and provide important breeding, foraging, and roosting habitat for many resident and migrant wildlife species. Upland and seasonally flooded cultivated lands and wetlands of the Delta support an estimated 10% of the waterfowl population that annually winter in California (CALFED 1998). BDCP covered species that use cultivated lands include Swainson's hawk, giant garter snake, and sandhill crane. These species have come to rely on the habitat value of certain cultivated lands, farming practices, and crop types. Swainson's hawks in the Central Valley and Delta rely on cultivated lands for foraging, given the lack of grassland foraging habitat remaining in California (Hartman and Kyle 2010). Cultivated lands, however, support a less diverse and less dense community of wildlife compared with natural communities (Fleskes et al. 2005; EDAW 2007; U.S. Fish and Wildlife Service 2007; Kleinschmidt 2008).

The dynamic cropping patterns in the Plan Area result in regular changes in habitat values at the site level for cultivated land-associated covered species. These dynamic cropping patterns can be compatible with wildlife use as long as the overall amount of crops and types agricultural practices that provide high-value habitat for covered species remains relatively constant at the regional scale. Major regional shifts in crop types or agricultural practices may diminish wildlife habitat values at a regional level. Changes in crop production can have substantial effects on the habitat value of cultivated lands for wildlife, particularly birds. Hay, grain, row crops, and irrigated pastures support abundant rodent populations, providing a prey base for many wildlife species. Conversion of these cultivated lands to orchards and vineyards has been noted as a factor adversely affecting native wildlife, including raptors such as Swainson's hawk (Estep 2008). Orchards and vineyards develop a dense overstory canopy that generally precludes access to ground-dwelling prey by foraging

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Swainson's hawks, white-tailed kites, western burrowing owls, and other covered species associated with cultivated lands.

The conservation approach for cultivated lands is to protect at a regional scale cultivated lands that provide high-value foraging and other habitat values for covered species in the Plan Area.

The goals and objectives that will benefit cultivated lands are included below. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.4.13.1 Applicable Landscape-Scale Goals and Objectives

No landscape-scale biological goals and objectives are integral to the conservation strategy for cultivated lands.

3.3.4.13.2 Natural Community Goals and Objectives

The goals and objectives below are driven by needs specific to the conservation of cultivated lands.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.
• **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species. • **Objective CLNC1.2:** Annually maintain 4,600 acres of rice lands or similarly functioning habitat for giant garter snake in Conservation Zone 2. • **Objective CLNC1.3**: Target cultivated land conservation to provide connectivity between other protected lands. • **Objective CLNC1.4:** Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objective CLNC1.1 Rationale: Cultivated landscapes are highly dynamic and subject to seasonal and annual changes in overall crop patterns and vegetation type and structure. Wildlife species that use these habitats have learned to exploit those elements within this landscape that provide them with suitable and accessible food or other resource values. The sustainability of these habitats is a function of agricultural economics and thus long-term security of a suitable cultivated landscape that provides essential habitat for covered species is also uncertain.

Achieving this objective will ensure maintenance of cultivated lands in the reserve system that provide the highest habitat values for covered species. Irrigated pastures, alfalfa, and annually cultivated irrigated cropland provide foraging habitat for BDCP covered species including 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. Rice fields provide foraging habitat for many bird species as well as important aquatic habitat for giant garter snakes and western pond turtle.

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Objective CLNC1.2 Rationale: This objective will ensure that a minimum acreage of rice is sustained in Yolo Bypass to provide habitat for giant garter snake. The rationale for this objective is described further in Section 3.3.5, *Species Biological Goals and Objectives.*

Objective CLNC1.3 Rationale: While some covered species associated with cultivated lands, 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 parcels that facilitate expansion of existing populations and dispersal and other movements between occupied areas and connectivity to suitable unoccupied areas, consistent with this objective. For example, protected cultivated lands (and restored tidal and nontidal marsh) in Conservation Zone 4 will maintain existing connectivity to Stone Lakes National Wildlife Refuge and facilitate northward expansion of the Coldani Marsh/White Slough giant garter snake subpopulation.

Objective CLNC1.4 Rationale: Cropland vegetation is typically grown as a monoculture using tillage or herbicides to eliminate unwanted plants. Interspersed within cultivated lands, however, are small patches or linear corridors of natural vegetation and other natural features that provide important habitat for a wide variety of native species. Small patches of riparian woodland and scrub, wetlands, ponds, hedgerows, tree rows, and isolated native or nonnative trees support songbirds, raptors, reptiles, amphibians, and small mammals. Maintenance of these small but important wildlife habitats, consistent with this objective, will benefit BDCP covered wildlife species as well as a diversity of noncovered native wildlife. Cultivated lands are used primarily for foraging by several species that nest in riparian areas, roadside trees, or isolated trees and groves. Wetlands, streams, ponds, hedgerows, groves, and other remnant natural or created habitats must be maintained to provide the full range of habitat elements necessary to support BDCP covered species in cultivated lands. Therefore, consistent with this objective, protection and management of cultivated lands will include maintenance of these key elements.

3.3.5 Species Biological Goals and Objectives

Species-specific goals and objectives are outlined below. Applicable landscape-scale and natural community goals and objectives are listed, each followed by a description of the benefits to the species that would result from achieving each objective. Species-specific goals and objectives are then listed, with a description of the approach and rationale used to establish each objective. Further detail regarding how biological goals and objectives for covered fish species were developed can be found in Section 3.2.3.1, *Process for Developing Fish Species Biological Goals and Objectives*. Conservation measures designed to meet all objectives are found in Section 3.4, *Conservation Measures*. Table 3.3-3 shows the habitat functions of the natural communities that support the covered species; Table 3.3-4 show the expected extent of species habitat with full BDCP implementation.

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Table 3.3-3. Habitat Functions of BDCP Natural Communities That Support Primary Habitats of Covered Terrestrial Wildlife and Plant Species

Covered Species	Tidal Perennial Aquatic	Tidal Mudflat	Tidal Brackish Emergent Wetland	Tidal Freshwater Emergent Wetland	Valley/Foothill Riparian	Nontidal Perennial Aquatic	Nontidal Freshwater Perennial Emergent Wetland	Alkali Seasonal Wetland Complex	Vernal Pool Complex	Managed Wetland	Other Natural Seasonal Wetland[1]	Grassland	Inland Dune Scrub[2]	Cultivated Land
Mammals														
Riparian brush rabbit[3]					All life-history requirements							Foraging		
Riparian woodrat (San Joaquin Valley)[7]					All life-history requirements									
Salt marsh harvest mouse			All life-history requirements							All life-history requirements		Upland refugia during high tides		
San Joaquin kit fox								All life-history requirements	All life-history requirements			All life-history requirements		
Suisun shrew			All life-history requirements							All life-history requirements		Upland refugia during high tides		
Townsend's big-eared bat	Foraging	Foraging	Foraging	Foraging	Roosting and Foraging	Foraging	Foraging	Foraging	Foraging	Foraging	Foraging	Foraging	Foraging	Foraging
Birds														
California black rail			All life-history requirements	All life-history requirements			All life-history requirements			All life-history requirements				
California clapper rail		Foraging	All life-history requirements											
California least tern	Foraging													
Greater sandhill crane								Foraging	Foraging	Foraging and roosting	Foraging	Foraging		Roosting and foraging
Least Bell's vireo					All life-history requirements.									
Suisun song sparrow			All life-history requirements	All life-history requirements						All life-history requirements				
Swainson's hawk					Breeding			Foraging	Foraging	Foraging	Foraging	Foraging		Foraging
Tricolored blackbird			Winter roosting	Breeding	Breeding		Breeding	Foraging	Foraging	Breeding and Foraging	Foraging	Foraging		Foraging
Western burrowing owl								Foraging	Foraging	Foraging	Foraging	Breeding and foraging		Breeding and foraging
Western yellow-billed cuckoo					All life-history requirements									
White-tailed kite					Breeding			Foraging	Foraging	Foraging	Foraging	Foraging		Foraging
Yellow-breasted chat					All life-history requirements									

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Covered Species	Tidal Perennial Aquatic	Tidal Mudflat	Tidal Brackish Emergent Wetland	Tidal Freshwater Emergent Wetland	Valley/Foothill Riparian	Nontidal Perennial Aquatic	Nontidal Freshwater Perennial Emergent Wetland	Alkali Seasonal Wetland Complex	Vernal Pool Complex	Managed Wetland	Other Natural Seasonal Wetland[1]	Grassland	Inland Dune Scrub[2]	Cultivated Land
Reptiles														
Giant garter snake	Breeding, foraging, and move-ment			Breeding, foraging, and movement		Breeding, foraging, and movement	Breeding, foraging, and movement	Aestivation and movement	Aestivation and movement	Aestivation and movement		Aestivation and movement		Breeding (rice), foraging, aestivation, and movement
Western pond turtle	Foraging and move-ment		Foraging and movement	Foraging and movement	Breeding, foraging, aestivation, and movement	Foraging and movement	Foraging and movement			Foraging and movement		Breeding, foraging, aestivation, and movement		Foraging, and movement
Amphibians														
California red-legged frog				Breeding, foraging and movement	Foraging, aestivation, and movement	Breeding, foraging	Breeding, foraging and movement	Movement	Foraging, aestivation, and movement	Foraging and movement		Foraging, aestivation, and movement		Foraging and movement
California tiger salamander								Foraging and movement	Breeding and foraging			Foraging, cover, and movement		
Western spadefoot[7]						Breeding		Foraging, aestivation, and movement	Breeding and foraging		Foraging, and breeding	Foraging, aestivation, and movement		
Invertebrates														
California linderiella									All life-history requirements					
Conservancy fairy shrimp									All life-history requirements					
Longhorn fairy shrimp									All life-history requirements					
Midvalley fairy shrimp									All life-history requirements					
Valley elderberry longhorn beetle					All life-history requirements							All life-history requirements		
Vernal pool fairy shrimp									All life-history requirements					
Vernal pool tadpole shrimp									All life-history requirements					
Plants														
Alkali milk-vetch[4]								All life-history requirements	All life-history requirements					
Boggs Lake hedge-hyssop								All life-history requirements	All life-history requirements					
Brittlescale[5]								All life-history requirements	All life-history requirements			All life-history requirements		
Caper-fruited tropidocarpum												All life-history requirements		

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Covered Species	Tidal Perennial Aquatic	Tidal Mudflat	Tidal Brackish Emergent Wetland	Tidal Freshwater Emergent Wetland	Valley/Foothill Riparian	Nontidal Perennial Aquatic	Nontidal Freshwater Perennial Emergent Wetland	Alkali Seasonal Wetland Complex	Vernal Pool Complex	Managed Wetland	Other Natural Seasonal Wetland[1]	Grassland	Inland Dune Scrub[2]	Cultivated Land
Carquinez goldenbush[12]								All life-history requirements				All life-history requirements		
Delta button celery[11]					All life-history requirements			All life-history requirements	All life-history requirements			All life-history requirements		
Delta mudwort[15]		All life-history requirements	All life-history requirements	All life-history requirements	All life-history requirements									
Delta tule pea[13]			All life-history requirements	All life-history requirements	All life-history requirements									
Dwarf downingia								All life-history requirements	All life-history requirements					
Heartscale[5]								All life-history requirements	All life-history requirements			All life-history requirements		
Heckard's peppergrass[14]								All life-history requirements	All life-history requirements			All life-history requirements		
Legenere								All life-history requirements	All life-history requirements					
Mason's lilaeopsis[15]		All life-history requirements	All life-history requirements	All life-history requirements	All life-history requirements									
San Joaquin spearscale[6]								All life-history requirements	All life-history requirements			All life-history requirements		
Side-flowering skullcap					All life-history requirements									
Slough thistle[8]					All life-history requirements									
Soft bird's-beak[10]			All life-history requirements											
Suisun Marsh aster[16]			All life-history requirements	All life-history requirements	All life-history requirements									
Suisun thistle[9]			All life-history requirements											

1 **Note to reviewers:** This natural community is minor in extent, has limited habitat values, and impacts can be avoided. At the recommendation of DFG and USFWS, a conservation strategy is not included for other natural seasonal wetlands. This section will be deleted from the public review draft.

2 **Note to reviewer:** USFWS and DFG are currently in discussion to decide whether BDCP should include a conservation strategy for this community, since it isn't affected by covered activities.

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

4 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.

5 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.

6 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.

7 Not known to occur in the Plan Area or restoration opportunity areas.

8 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.

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

10 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

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Covered Species	Tidal Perennial Aquatic	Tidal Mudflat	Tidal Brackish Emergent Wetland	Tidal Freshwater Emergent Wetland	Valley/Foothill Riparian	Nontidal Perennial Aquatic	Nontidal Freshwater Perennial Emergent Wetland	Alkali Seasonal Wetland Complex	Vernal Pool Complex	Managed Wetland	Other Natural Seasonal Wetland[1]	Grassland	Inland Dune Scrub[2]	Cultivated Land

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.

11 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.

12 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.

13 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.

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

15 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.

16 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.

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Table 3.3-4. Expected Extent of Conserved Terrestrial Species Habitat Types in Conservation Zones 1 through 11 with BDCP Implementation

Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
Mammals				
Riparian brush rabbit				
Riparian Habitat	2,894	138	2,756	5%
Grassland Habitat	3,103	314	2,789	10%
Total	**5,997**	**452**	**5,545**	**8%**
Riparian woodrat (San Joaquin Valley)				
Total	**2,156**	**101**	**2,055**	**5%**
Salt marsh harvest mouse:				
Wetland habitat	14,265	12,390	1,875	87%
Upland habitat	3,733	3,149	584	84%
Total	**17,998**	**15,539**	**2,459**	**86%**
San Joaquin kit fox				
Breeding, Foraging, and Dispersal	5,217	638	4,579	12%
Total	**5,217**	**638**	**4,579**	**12%**
Suisun shrew				
Primary Habitat	20,411	17,114	3,297	84%
Secondary Habitat	3,805	3,152	653	83%
Total	**24,216**	**20,266**	**3,950**	**84%**
Townsend's big-eared bat				
Primary foraging habitat	10,880	3,640	7,240	33%
Roosting and primary foraging habitat	7,493	1,959	5,534	26%
Secondary foraging habitat	768,626	165,495	603,131	22%
Total	**787,000**	**171,094**	**615,906**	**22%**

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Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
Birds				
California black rail				
Primary Habitat	19,317	15,951	3,366	83%
Secondary Habitat	7,136	5,170	1,966	72%
Total	**26,453**	**21,121**	**5,332**	**80%**
California clapper rail				
Primary Habitat	10,858	9,363	1,495	86%
Secondary Habitat	14,387	10,232	4,155	71%
Total	**25,245**	**19,595**	**5,650**	**78%**
California least tern				
Total	**86,231**	**18,077**	**68,154**	**21%**
Greater sandhill crane				
Primary Use Area	4,556	1,710	2,846	38%
Secondary Use Area	191,531	38,285	153,246	20%
Total	**196,087**	**39,995**	**156,092**	**20%**
Least Bell's vireo				
Total	**14,731**	**5,090**	**9,641**	**35%**
Suisun song sparrow				
Primary Habitat	3,431	2,218	1,213	65%
Secondary Habitat	22,248	17,765	4,483	80%
Total	**25,678**	**19,983**	**5,695**	**78%**
Swainson's hawk				
Foraging habitat	435,087	75,695	359,392	17%
Nesting habitat	10,149	3,254	6,895	32%
Total	**445,235**	**78,949**	**366,286**	**18%**

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Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
Tricolored blackbird				
Breeding Habitat-Ag Foraging	68,830	7,053	61,777	10%
Breeding Habitat-Foraging	59,660	23,952	35,708	40%
Breeding Habitat-Nesting	13,157	10,002	3,155	76%
Nonbreeding Hab-Foraging Ag	293,846	34,127	259,719	12%
Nonbreeding Hab-Roosting	18,226	9,751	8,475	54%
NonBreeding Habitat-Foraging	37,719	9,096	28,623	24%
Total	**491,438**	**93,981**	**397,457**	**19%**
Western burrowing owl				
High-value habitat	67,906	20,008	47,898	29%
Moderate-value habitat	58,790	21,365	37,425	36%
Low-value habitat	294,238	33,754	260,484	11%
Total	**420,935**	**75,127**	**345,808**	**18%**
Western Yellow-billed Cuckoo				
Breeding Habitat	4,735	2,172	2,563	46%
Migratory Habitat	7,868	2,136	5,732	27%
Total	**12,603**	**4,308**	**8,295**	**34%**
White-tailed kite				
Breeding habitat	14,315	4,600	9,715	32%
Foraging habitat	494,710	104,688	390,022	21%
Total	**509,026**	**109,288**	**399,738**	**21%**
Yellow-breasted chat				
Primary Nesting and Migratory Habitat	7,384	2,191	5,193	30%
Secondary Nesting and Migratory Habitat	5,530	1,894	3,636	34%
Suisun Marsh/Upper Yolo Bypass Nest and Migratory Habitat	1,849	933	916	50%
Total	**14,764**	**5,018**	**9,746**	**34%**

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Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
REPTILES				
Giant garter snake				
Aquatic Breeding, Foraging and Movement	29,430	7,384	22,046	25%
Upland-High	18,377	6,479	11,898	35%
Upland-Moderate	40,192	10,012	30,180	25%
Upland-Low	36,709	3,509	33,200	10%
Total	**124,708**	**27,384**	**97,324**	**22%**
Miles of Aquatic Breeding, Foraging and Movement habitat	1,298	274	1,024	21%
Western pond turtle:				
Aquatic habitat	81,509	32,820	48,689	40%
Dispersal habitat	619,335	117,131	502,204	19%
Upland nesting and overwintering	46,089	14,859	31,230	32%
Total	**746,934**	**164,810**	**582,124**	**22%**
Amphibians				
California red-legged frog:				
Aquatic habitat	149	20	129	13%
Upland cover and dispersal habitat	9,055	1,590	7,465	18%
Dispersal habitat	19,644	151	19,493	1%
Total	**28,848**	**1,761**	**27,087**	**6%**
Miles of Aquatic habitat	29	3	26	10%
California tiger salamander:				
Aquatic Breeding Habitat	7,332	4,166	3,166	57%
Terrestrial Cover and Aestivation Habitat	28,895	8,388	20,507	29%
Total	**36,226**	**12,554**	**23,672**	**35%**

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Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
Western spadefoot				
Aquatic Breeding Habitat	7,335	4,167	3,168	57%
Terrestrial Cover and Aestivation Habitat	29,546	8,436	21,110	29%
Total	**36,881**	**12,603**	**24,278**	**34%**
Miles of Aquatic Breeding Habitat	78	27	51	35%
Invertebrates				
Valley elderberry longhorn beetle:				
Riparian vegetation	17,796	5,397	12,399	30%
Non-riparian channels and grasslands	16,485	4,283	12,202	26%
Total	**34,281**		**34,281**	**0%**
All Vernal Pool Crustaceans				
High Quality Habitat	7,770	4,475	3,295	58%
Low Quality Habitat	2,631	745	1,886	28%
Total	**10,401**	**5,220**	**5,181**	**50%**
Plants				
Alkali milk-vetch				
Vernal pool Complex	7,907	4,536	3,371	57%
Degraded Vernal Pool Complex	2,494	684	1,810	27%
Total	**10,401**	**5,220**	**5,181**	**50%**
Boggs Lake hedge-hyssop			-	
Vernal pool Complex	7,907	4,536	3,371	57%
Degraded Vernal Pool Complex	2,494	684	1,810	27%
Total	**10,401**	**5,220**	**5,181**	**50%**
Brittlescale				
Total	**472**		**346**	**27%**

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Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
Caper-fruited tropidocarpum				
Total	**1,410**	**21**	**1,389**	**1%**
Carquinez goldenbush				
Total	**1,019**	**380**	**639**	**37%**
Delta button celery				
Total	**3,330**	**270**	**3,060**	**8%**
Delta mudwort				
Total	**6,074**	**1,501**	**4,573**	**25%**
Delta tule pea				
Total	**5,817**	**3,669**	**2,148**	**63%**
Dwarf downingia			-	
Vernal pool Complex	7,907	4,536	3,371	57%
Degraded Vernal Pool Complex	2,494	684	1,810	27%
Total	**10,401**	**5,220**	**5,181**	**50%**
Heartscale				
Total	**6,071**	**2,759**	**3,312**	**45%**
Heckard's peppergrass			-	
Vernal pool Complex	7,907	4,536	3,371	57%
Degraded Vernal Pool Complex	2,494	684	1,810	27%
Total	**10,401**	**5,220**	**5,181**	**50%**
Legenere			-	
Vernal pool Complex	7,907	4,536	3,371	57%
Degraded Vernal Pool Complex	2,494	684	1,810	27%
Total	**10,401**	**5,220**	**5,181**	**50%**
Mason's lilaeopsis				
Total	**6,074**	**1,501**	**4,573**	**25%**

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Covered Species	Existing Conditions			
	Total Extent of Modeled Habitat (acres)	Total Protected (acres)	Total Unprotected (acres)	Percent Protected
San Joaquin spearscale			-	
Vernal pool Complex	7,907	4,536	3,371	57%
Degraded Vernal Pool Complex	2,494	684	1,810	27%
Total	**10,401**	**5,220**	**5,181**	**50%**
Side-flowering skullcap				
Total	**2,495**	**701**	**1,794**	**28%**
Slough thistle				
Total	**1,834**	**188**	**1,646**	**10%**
Soft bird's-beak				
Total	**1,225**	**869**	**356**	**71%**
Suisun Marsh aster				
Total	**5,817**	**3,669**	**2,148**	**63%**
Suisun thistle				
Total	**1,129**	**830**	**299**	**74%**

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*[**Note to Reviewers:** Development of the aquatic biological goals and objectives has been an extensive process, involving stakeholders, agency biologists and independent scientists. There has been extensive discussion and review of the so-called "Logic Chain", a method used to link stressors, objectives and species improvement goals. The species-specific aquatic biological goals and objectives below have been influenced by all of that input, but most of all by the June 2011 Science Advisors Draft Report on BDCP Goals and Objectives for Covered Fish Species. This report provided context on the limitations of developing specific,quantitative numeric objectives for fish species, and recommended an approach and key objectives for three of the eleven covered fish species: winter-run Chinook salmon, Sacramento splittail, and delta smelt.*

The science advisors identified objectives for these species that they believed were: "(a) achievable by some combination of conservation measures; (b) measureable, for the most part, in terms of key processes (growth, survival, reproduction, and migration), which relate to population effects; and (c) likely to promote the continued survival of the species in the Delta. The advisors noted that a major issue was the extent to which the objectives could be quantified. They recommended, however, that "if the available information does not support quantitative objectives or assessment of objectives is infeasible (e.g., sampling limitations), then more generally expressed objectives (e.g., expressed in terms of historical benchmarks) can be used to effectively direct conservation planning and provide a level of accountability." They also noted that "In many cases, the best that could be done was to state the objectives in the context of intended qualitative improvements. At the very least, such objectives can show how the conservation measures are intended to mitigate the intensity of the identified stressors on life stages that use the BDCP area; this is in keeping with the Logic Chain process. While qualitative, such objectives are measurable through trend analyses."

The recommended objectives for winter-run Chinook salmon, Sacramento splittail and delta smelt were developed by focusing on stressors the advisors considered important to continued survival of those species.

- Winter-run Chinook salmon: juvenile growth, juvenile survival and upstream adult passage
- Sacramento splittail: dry-year floodplain inundation and larval/juvenile growth
- Delta smelt: juvenile growth, adult entrainment and juvenile entrainment.

The objectives described below for these three species are targeted at the same factors, although some of the specific numeric targets have been modified in response to comments received on achievability relative to existing conditions and findings from the effects analysis. To the extent possible, the objectives for the remaining eight fish species were developed with the same principle in mind, that is, to select objectives that were achievable, measurable and likely to promote species recovery.

The following species-specific objectives are recommended by the ICF consultant team and have not been fully reviewed or approved by DWR. Ideally, we would have preferred to share this product with agency biologists and other stakeholders prior to presenting them here, but time constraints made that impossible. We look forward to continued discussion on the objectives .]

3.3.5.1 Delta Smelt

Delta smelt inhabit low-salinity waters at the interface between brackish and fresh water in the upper Bay-Delta estuary. Because the location of the low salinity zone is determined by the interaction of river outflow and tidal inflow of marine water from San Francisco Bay, the daily

distribution of adult delta smelt can vary by many kilometers in response to the tidal dynamics of the estuary (Bennett 2005).

Delta smelt are most often found in shallow, low-salinity water upstream of the low salinity zone (low salinity zone defined as 0.5 to 6.0 practical salinity units) (Kimmerer 2004; Nobriga and Herbold 2009). Moyle et al. (1992) reported that delta smelt were collected primarily from waters with a mean salinity of 2 parts per thousand (ppt) and having a mean temperature of 15°C (59°F), but were found in salinities ranging from 0 to 14 ppt and at temperatures ranging from 6°C to 23°C (43°F to 73°F). Subadult and adult delta smelt densities are positively correlated with turbidity. This positive correlation may reflect greater foraging effectiveness and/or easier predator avoidance in more turbid waters (Miller 2007).

Delta smelt occur throughout the Delta, Cache Slough, Suisun Bay and Suisun Marsh, and within the Napa and Petaluma Rivers. Results of fishery surveys conducted by the California Department of Fish and Game (DFG) and U.S. Fish and Wildlife Service (USFWS) using many different collection methods, in addition to past records and habitat conditions for delta smelt, have been used to determine the current trends in abundance (Figure 3.3-1) (California Department of Fish and Game 2012). The delta smelt population size was at historic lows from 2004 to 2010. In 2011, the population size was estimated to be at its highest level since 2001.

Multiple threats and stressors affect delta smelt, and appear to act in complicated and synergistic ways to influence the distribution and abundance of the species (Moyle 2002). Individual stressors affect delta smelt at different times based on environmental conditions. Because delta smelt have a short lifespan (1 to 2 years), low fecundity, low abundance, and limited geographic range, they are particularly vulnerable to threats and stressors such as reduced food availability, reduced extent of suitable rearing habitat, elevated water temperature, reduced turbidity, reduced spawning habitat, predation by or competition with nonnative species, entrainment, and exposure to toxins. Refer to Appendix 2.A, *Covered Species Accounts*, for a detailed discussion of this species and of these stressors.

The USFWS recovery strategy for delta smelt is contained in the Sacramento-San Joaquin Delta Native Fishes Recovery Plan (U.S. Fish and Wildlife Service 1996). The objective of this plan is to recover the species through restoration of its abundance and geographic distribution. The basic strategy for recovery is to manage the estuary in such a way that it provides better habitat for native fish in general and delta smelt in particular[7].

The BDCP conservation strategy for delta smelt focuses on three primary stressors for the species: food, predators, and entrainment. The BDCP includes creation, restoration, and enhancement of substantial tidal and nontidal aquatic habitat that will dramatically increase the extent of intertidal and shallow water habitat. This will increase production of food resources important to delta smelt, both within habitat occupied by delta smelt and in other locations that will transport food resources to habitats occupied by delta smelt. Actions to control nonnative predators will focus on specific "hotspots" in the Plan Area, and reduce the abundance of nonnative predators, such as striped bass, that prey on delta smelt, which is expected to contribute to an increase in the abundance of delta smelt. Changing the primary point of diversion to the north Delta will contribute to maintaining or

[7] Since 1996, scientific understanding of the biology of and threats to delta smelt has improved substantially. USFWS has formed the Delta Native Fishes Recovery Team to prepare an updated recovery plan, which is expected to be released in the near future.

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reducing the low levels of entrainment of delta smelt as currently required under the biological opinion (BiOp) restrictions. The entrainment levels required under the BiOp are much lower than have historically been the case and will be maintained or reduced under the BDCP. The installation of fish screens in the new north Delta diversions will avoid entrainment of delta smelt and minimize impingement. As described in the species-specific goals and objectives, BDCP conservation measures are expected to improve the performance of delta smelt by achieving the following benefits.

- Increasing survival, and thus the abundance of adult and juvenile delta smelt.
- Increasing the growth of juvenile delta smelt.
- Increasing the spatial distribution of juvenile and prespawning adults.

The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.1.1 Applicable Landscape-Scale Goals and Objectives

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]*

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities. • **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.

Objective L1.3 Benefits: Meeting this objective will enhance the seasonally inundated floodplains and tidally influenced natural communities that produce food resources for delta smelt. Providing a gradient of floodplain and tidally influenced natural communities will provide a range of conditions suitable for food production and rearing. The proposed habitat restoration actions are intended to increase the amount of available habitat for covered fish species, and to enhance the ecological function of the Delta. Refer to Objective TPANC1.1 for a discussion of these benefits.

Objective L1.4 Benefits: Meeting this objective will increase the extent of environmental gradients in order to make a greater range of habitat conditions, food resources, and habitat complexity available for delta smelt and the organisms upon which they prey, thereby increasing the extent of available habitat across a range of conditions (e.g., flow, water temperatures, and turbidity). Delta smelt have a short lifecycle and occur only in the Bay-Delta region, so providing a greater range of potentially suitable habitat conditions for delta smelt and their prey will increase the extent of

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habitats available across varied conditions of flow, water temperature, turbidity, and other habitat constituents.

Objective L1.8 Benefits: Meeting this objective will provide a range of suitable habitat conditions for delta smelt in the future. Delta smelt distribution appears to be strongly correlated to the low salinity zone, and their distribution can be expected to show an eastward shift over the long term in response to sea level rise.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.3:** Allow lateral river channel migration. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers. • **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2 and L2.3 Benefits: Meeting this objective will restore natural fluvial processes to improve habitat conditions through floodplain inundation, which can increase sediment inputs and thereby increase turbidity, which facilitates delta smelt foraging effectiveness and predator avoidance (Nobriga and Herbold 2009).

Objective L2.4 Benefits: Meeting this objective will increase river-floodplain connectivity to improve hyporheic processes such as groundwater recharge, thereby improving water quality, providing cool water inputs, and maintaining flow inputs to surface waters. Allochthonous inputs such as terrestrial insects and plant matter provide a nutrient source increase the productivity of aquatic systems, thereby contributing to a more diverse and robust forage base.

Objective L2.5 Benefits: Meeting this objective will reduce the amount of pollution in stormwater runoff entering Delta waterways. This will benefit delta smelt by reducing pesticides and herbicides can be highly toxic to plankton, which form the base of the foodweb, and by reducing sublethal effects of contaminants (e.g., effects on behavior, tissues and organs, reproduction, growth, and immune system), such as pyrethroids and other chemicals from urban and stormwater runoff. These water quality improvements are also likely to support a more robust foodweb and thereby contribute to increasing food resources for delta smelt.

Objective L2.6 Benefits: Meeting this objective will provide a range of environmental gradients to ensure that a diversity of spawning and rearing conditions exists for delta smelt within the Plan Area over the life of the BDCP. Maintaining or increasing life-history diversity is not as applicable to delta smelt as some of the other covered species, such as Chinook salmon.

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Objective L2.8 Benefits: Meeting this objective will increase natural dendritic channels in tidal marsh habitats to promote food production and transport, which will benefit juvenile delta smelt rearing in the low salinity zone. These dendritic channels may also transport increased fine sediment, which could result in increased turbidity in delta smelt habitat downstream; this would provide greater cover from predators for delta smelt and increased success in capturing prey.

Objective L2.9 Benefits: Meeting this objective may contribute to providing rearing habitat and cool water refugia. Within the West Delta Restoration Opportunity Area (ROA), restoration is expected to provide local areas of cool water refugia for delta smelt, but may be relatively limited in terms of spatial extent.

Objective L2.10 Benefits: Meeting this objective will increase food resources important to delta smelt such as mesozooplankton, which will result in increased growth rates, with likely increased survival and fecundity in adults. See the rationale for Objective TPANC1.1, below.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.2:** Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic fish species. • **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.2 Benefits: Meeting this objective will increase connectivity between low salinity zone habitat and upstream freshwater spawning habitat, which will benefit delta smelt adults by improving access to spawning habitat and providing a range of suitable spawning conditions through a variety of habitat conditions. Delta smelt migrate from brackish water to fresh water and have been known to migrate "downstream" to the Napa River to spawn. Under high flow conditions, some delta smelt may not migrate at all; if their brackish rearing habitat becomes fresh, they can spawn in suitable microhabitats nearby (Nobriga and Herbold 2009). The BDCP will increase connectivity by creating, restoring, and enhancing habitats across a range of environmental gradients, including tidal marsh, floodplains, channel margins, and nontidal marsh, which will increase primary productivity. Modifications to water operations will provide greater flexibility in delivery of water to water users as well as greater flexibility in providing freshwater flows to the Delta to benefit delta smelt. The primary benefit to delta smelt from increased connectivity and modifications in water operations associated with the BDCP will be the increase in primary productivity and the transport of food resources to low-salinity areas occupied by delta smelt.

Further, the BDCP will address water quality issues in the Plan Area, such as the DO levels in the Stockton DWSC and urban stormwater. The BDCP will include funding to the Port of Stockton to continue operation of the aerator in the Stockton DWSC, which will directly improve the connectivity between areas downstream of Turner Cut and the San Joaquin River upstream of Stockton by minimizing the low DO condition that persist in this area. The BDCP will also provide funding to urban centers that contribute stormwater to the Plan Area to help them reduce inputs of polluted stormwater to the Delta. Reducing the inputs of pollution from urban stormwater will contribute to improved water quality and increased health of the Delta.

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Objective L3.3 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, and will allow BDCP to provide flow conditions that can more easily coincide with the timing of delta smelt larval migration, which will improve larval delta smelt survival and growth. Delta smelt larvae are nourished from a yolk-sac for up to 12 days before they need to begin capturing prey (Bennett 2005 in Nobriga and Herbold 2009). Once the yolk-sac is depleted, they must immediately feed or they will starve. Thus, flow conditions must be adequate to transport larval delta smelt downstream to suitable foraging and rearing habitat.

Objective L3.4 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, which will allow the BDCP to provide flow conditions that can better provide appropriate cues to adult delta smelt to begin their spawning migration. Adult delta smelt are cued to move by freshets during winter and spring (Grimaldo et al. 2009 in Nobriga and Herbold 2009). During low outflow conditions, delta smelt move into the Delta to spawn. During high outflow conditions, spawners are more widely distributed and ripe individuals have been found in the Delta, Suisun Marsh, and the Napa River (Bennett 2005 and Hobbs et al. 2007 in Nobriga and Herbold 2009). Essentially, delta smelt migrate from brackish water to fresh water to spawn. Providing greater flexibility in water operations will provide a greater range of potentially suitable flow conditions for adults, which can increase the distribution of spawning adults and increase the spatial diversity of the species. However, providing flows that support the movement of adults to natal spawning habitats must be coupled with increased connectivity between low-salinity habitat and freshwater habitats and an increase in suitable habitats through restoration of a range of aquatic habitats/natural communities (refer to L3.2 and *Applicable Natural Community Goals and Objectives*, below).

Goal L4: Reduce mortality of covered species in the Plan Area.

- **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities.
- **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species.
- **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 Benefits: Meeting this objective will avoid and minimize direct effects on delta smelt resulting from BDCP covered activities.

Objective L4.2 Benefits: Meeting this objective will reduce predation on delta smelt by nonnative predators. Although predation is a natural part of aquatic community dynamics, excessive predation has been identified as a stressor for BDCP covered fish species, especially delta smelt (Baxter et al. 2008). Refer to *CM15 Predator Control* for discussion of the management of nonnative predators within the Plan Area.

Objective L4.4 Benefits: Meeting this objective will reduce the entrainment of delta smelt. The role of entrainment on the long-term and recent declines of delta smelt continues to be discussed (Baxter et al. 2010). While Maunder and Deriso (2011) have concluded that entrainment of delta smelt does not have an overall population level effect, entrainment of delta smelt results in direct mortality, and lower levels of entrainment are desirable for the benefit of the species. Kimmerer (2008) concluded that losses of adult delta smelt due to entrainment were important in certain years, while in other years the population-level effects were small. The most recent pelagic organism decline synthesis, prepared by the Interagency Ecological Program (2005) continued in this logic of entrainment likely

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being important under certain conditions but not universally important in all years. Historically, delta smelt entrainment levels were substantial in some years, running in the tens of thousands. In more recent years, entrainment has declined to significantly lower levels, as a result of pumping restrictions imposed under the current BiOps and reduced population levels.

In general, the effects analysis has found that entrainment of delta smelt was reduced under the preliminary proposal relative to existing biological conditions, reflecting the reduced south Delta exports. The BDCP will generally maintain or enhances the low entrainment from south Delta pumping regulations assumed under the existing biological conditions. For adults, a number of different methods (salvage density, Old Middle River regressions based on unadjusted and adjusted Kimmerer [2011] estimates of proportional entrainment, and the Manly salvage estimation technique) generally gave the same basic results: across all water years entrainment will be substantially reduced (25 to almost 100%), with the magnitude of decrease being greatest in wet years (greater than 50%) ranging to little change from existing biological conditions in dry and critical years. Refer to species-specific objective DTSM1.2, below and Appendix 5.B, *Entrainment* for further discussion of entrainment of delta smelt.

3.3.5.1.2 Applicable Natural Community Goals and Objectives

Those natural community-scale biological goals and objectives that are integral to the conservation strategy for delta smelt are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Meeting this objective will restore tidal perennial aquatic natural communities that provide habitat conducive to primary productivity, which is essential to maintain a robust food base for delta smelt. Delta smelt larvae feed primarily on the larval stages of three copepods: *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae (Nobriga and Herbold 2009). Similarly, juvenile delta smelt also eat zooplankton, but they can capture larger varieties than larval stages including cladocerans, mysids, amphipods, and larval fish (Moyle et al. 1992; Lott 1998 in Nobriga and Herbold 2009). Restoring or creating at least 10,000 acres of tidal perennial aquatic habitat in Conservation Zones 1, 2, 4, 5, 7, and 11 will be a substantial increase the amount of habitat contributing to primary productivity and food resources important to delta smelt, such as copepods. This substantial increase in tidal perennial aquatic habitat will help to offset the historic loss of such habitat within the Plan Area.

Of the Delta habitats, the tidal marsh sloughs have the highest particulate organic matter and phytoplankton concentrations and support the greatest zooplankton growth rates (Müller-Solger et al. 2002; Sobczak et al. 2002).

Habitat restoration in the Cache Slough Complex at the southern end of the Yolo Bypass, in combination with floodplain enhancement, is expected to provide tidal freshwater wetland structure and functions adjacent to open water habitat. Tidal wetlands also have the capacity to export food resources to adjacent channels and to downstream systems (Cloern et al. 2007; Lehman et al. 2008). The export of food may include movement of phytoplankton and zooplankton by

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advection and tidal exchanges as well as the export of productivity in the form of macroinvertebrates, small fishes, and other larger organisms (Kneib 1997, 2003).

The export of marsh production helps to transfer the higher production of shallow-water habitats to the deepwater habitats preferred by pelagic fish species such as delta smelt (Lucas et al. 2002). Production from the lower Yolo Bypass, including Liberty Slough and Cache Slough marshes, stays relatively intact as it moves down the estuary (Monsen 2003). This production may contribute significantly to the greater foodweb, ultimately benefitting open-water species such as delta smelt (Brown 2004). Refer to Appendix 5.F, *Ecological Effects*, for a detailed discussion of the foodweb.

Additionally, delta smelt spawn in shallow water, most often on sand or gravel (Nobriga and Herbold 2009). Providing a gradient of floodplain and tidally influenced natural communities will also provide a range of potentially suitable habitats for spawning.

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Meeting this objective will address the nonnative aquatic vegetation that limits turbidity in the Delta, which has decreased over time (Jassby et al. 2002 in Nobriga and Herbold 2009). It is hypothesized that one of the primary causes of the decrease in turbidity is biological filtration by SAV (Brown and Michniuk 2007 in Nobriga and Herbold 2009). Controlling invasive plants, especially SAV, is anticipated to result in some degree of increased turbidity. Delta smelt have evolved in turbid waters and have adapted to life in turbid waters to avoid predators and to successful forage on prey organisms, so increases in turbidity would be expected to improve delta smelt survival and growth.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

ObjectiveTBEWNC1.1 Benefits: Meeting this objective will restore tidal freshwater emergent wetland and result in increased primary productivity, which could yield more abundant food resources for delta smelt.

Objective TBEWNC1.2 Benefits: Meeting this objective will restore connectivity to isolated patches of tidal emergent marsh to potentially increase the transport of food resources from tidal marsh habitats to areas occupied by delta smelt, thereby increasing the food resources available. Greater availability of food resources will contribute to an increase in growth, survival, and fecundity.

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Objective TBEWNC1.3 Benefits: Meeting this objective will promote effective exchange throughout the marsh plain to increase transport of food resources for delta smelt from restored wetland habitats to low salinity zone habitats occupied by delta smelt. Increasing the transport of food resources is anticipated to contribute to an increase in growth, survival and fecundity.

Objective TBEWNC1.4 Benefits: Meeting this objective will protect tidal brackish emergent wetland to increase primary productivity, which could yield more abundant food resources for delta smelt.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7. • **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objective TFEWNC1.1 Benefits: Meeting this objective will restore tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7, resulting in increased primary productivity, which could yield more abundant food resources for delta smelt.

Objective TFEWNC1.2 Benefits: Meeting this objective will promote effective exchange throughout the marsh plain to increase transport of food resources for delta smelt from restored wetland habitats to low salinity zone habitats occupied by delta smelt. Increasing the transport of food resources is anticipated to contribute to an increase in growth, survival and fecundity.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle. • **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Meeting these objectives will restore nontidal marsh to increase habitat suitable for production of food resources important to larvae and juvenile delta smelt (refer to benefits of Objective TPANC1.1 for further discussion). Restoring the nontidal marsh will provide suitable habitat for increasing the production of food resources important to delta smelt, contributing to a potential increase in growth, survival, and fecundity.

3.3.5.1.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for delta smelt within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for

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covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for delta smelt are presented in the context of broader global goals and objectives developed by USFWS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for delta smelt will be achieved via altered flow management and habitat restoration. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce the spatial overlap of diversion intakes and delta smelt occurrence, thereby substantially reducing entrainment. Altered flow management is also expected to increase the spatial distribution of juvenile and prespawning adults, and improve habitat conditions. Habitat restoration benefits will chiefly derive from tidal wetland restoration that is expected to support greater primary and secondary production and provide increased food resources for delta smelt.

Global Goals and Objectives Developed by the U.S. Fish and Wildlife Service Independent of BDCP[8]

Global Goal: Remove delta smelt from the state and federal list of endangered species through restoration of its abundance and distribution.
• **Global Objective 1 (Abundance):** Recovery Index ≥ 239 for at least 2 years of any 5 consecutive year period; the midpoint of any two consecutive Recovery Index values cannot be lower than 84. • **Global Objective 2 (Entrainment):** Cumulatively ≤ 5%[9] per year across all life stages. • **Global Objective 3 (Spatial Distribution):** Collect delta smelt in all 4 zones in at least 2 years of any 5 consecutive year period in the fall midwater trawl survey; in at least 2 of the 4 zones in at least 1 of the remaining 3 years in any 5 consecutive year period; in at least 1 of the 4 zones in the remaining 2 years.

As stated previously, the global goals and objectives were developed by USFWS independent of the BDCP and are associated with the USFWS' responsibility to recover species protected under the ESA. The BDCP delta smelt goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of delta smelt recovery.

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[8] Citation to be provided.

[9] This proportion could be increased—possibly substantially—if carrying capacity and juvenile life stage density-dependence are restored to historical levels.

Goal DTSM1 (Abundance): Increased spawning success and improve the survival of adult and juvenile delta smelt.
• **Objective DTSM1.1 (Growth and Health):** Achieve a fall mean body length increase of at least 2 mm longer than existing conditions in December as collected in Fall Midwater Trawl (62 mm vs. 60 mm fork length) within 15 years of BDCP implementation. • **Objective DTSM1.2 (Survival):** Limit entrainment mortality associated with project operations to ≤10% of the delta smelt population on average over a 10-year period (across all life stages, not to exceed 20% in any given year) within 15 years of BDCP implementation.
Assumed Stressors: Lack of food resources and entrainment. **Stressor Reduction Targets:** • **Food**. Increase the density of copepods and other food resources that delta smelt prefer (currently Calanoid copepods) and that co-occur with the delta smelt in suitable habitat. • **Adult entrainment.** Maintain the proportion of the adult delta smelt population that are entrained in the SWP/CVP facilities during December to March at a level that is below values estimated for years with historically low entrainment and high delta smelt population growth during the late long-term. • **Juvenile entrainment.** Maintain the proportion of the juvenile delta smelt lost to entrainment at the project diversions (during spring and early summer) to a level that is below historical entrainment relative to the Kodiak trawl index during the late long-term.

Objective DTSM1.1 (Growth and Health) Rationale: This objective will address the conditions that favor growth in juveniles, which is a critical fitness measure that transfers across life stages and has been shown to influence egg production (i.e., fecundity) in adults. Food availability is a limiting factor for delta smelt and changes in food resources have been identified as an important factor contributing to their decline (Baxter et al. 2010; Maunder and Deriso 2011). Kimmerer (2008) noted a statistically significant relationship between juvenile smelt survival and zooplankton biomass. There has also been a decline in the mean size of young-of-the-year (YOY) delta smelt in December following the introduction of the clam *C. amurensis*, an invasive competitor for the delta smelt's zooplankton prey (Sweetnam 1999; Bennett 2005). Small size at the end of the growing season is thought to lead to possible delay in maturation and lower fecundity (Bennett et al. 2008). Delta smelt growth is also potentially limited, at least during summer, by a combination of high water temperature, low food quality and low food quantity (Baxter et al. 2010).

Water temperature influences the growth rate of delta smelt as well as the availability of prey resources. Water temperature will also modulate the effects of increased food. In a bioenergetics sub-model equation developed by the Science Advisors (Anderson et al. 2011), water temperature affects both maximum consumption and respiration. Basically, water temperature controls scope for growth. Water temperatures in the Delta in the summer are controlled by climate conditions. Thus, water temperature is not a stressor that can be controlled or affected by the BDCP, but it may be possible to enhance, restore, or create habitat for delta smelt in areas that are less susceptible to water temperatures that would restrict juvenile delta smelt growth. One such area is Suisun Marsh.

Optimal water temperatures are known for egg survival (10 to 18°C [50 to 64°F) and juvenile growth (18 to 22°C [64 to 72°F). Ideally, temperatures would be in the ranges for egg survival and juvenile growth for as long as possible to allow cohort recruitment over a longer period of time or for adults to spawn twice witin a spawning season. The water temperature range for spawning is 14 to 18 °C. For larvae, it is important to have suitable water temperatures during April and May in the upper and lower Sacramento River, Delta, and lower San Joaquin River.

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Achieving the target average growth for delta smelt will be accomplished by implementing conservation measures to protect, restore and enhance floodplain and tidal marsh habitats conducive to increasing the density of zooplankton in the lower Sacramento River, lower San Joaquin River, and confluence areas in low-outflow years, and confluence areas and lower in high-outflow years. Increasing the density of zooplankton will be further achieved by increasing the timing, frequency and duration of floodplain inundation in Yolo Bypass *CM2 Yolo Bypass Fisheries Enhancement*, constructing new tidal wetlands *CM4 Tidal Natural Communities Restoration*; providing for greater floodplain inundation *CM5 Seasonally Inundated Floodplain Restoration*, and enhancing channel margin habitat along up to 20 miles of currently leveed channel by restoring riparian, marsh and mudflat habitats along levees *CM6 Channel Margin Enhancement*. Each of these conservation measures is expected to contribute to an increase in the quantity and quality of zooplankton available to delta smelt. The restoration is also expected to provide increased production of periphyton, phytoplankton, macroinvertebrates, insects, and small fish that contribute to the local and regional trophic foodweb associated with each restoration area. As mentioned previously, a phytoplankton growth model was developed to estimate the change in food production expected from tidal restoration in the ROAs. The model was based on a strong relationship between phytoplankton growth rate and depth. The model could not be extended to zooplankton production, the primary food of many of the covered fish, due to uncertainty in that relationship and the unknown effects of invasive filter feeders such as the Asian clam, although, overall primary productivity is assumed to translate directly to increases in food production for covered fish.

However, certain other conservation actions that are anticipated to occur within the Plan Area that are not associated with BDCP may need to occur to realize the full benefit of BDCP conservation measures; otherwise it may be difficult for the BDCP to fully achieve certain goals and objectives. Specifically for delta smelt, the other conservation action that may need to occur is the Sacramento Regional County Sanitation District's wastewater treatment plant upgrades to reduce ammonia discharges to the Delta (detailed in Section 3.5, *Important Regional Actions*). If this conservation action does not occur as expected, it could hinder the anticipated increase in primary productivity in habitats restored as part of the BDCP, potentially limiting anticipated increases in delta smelt growth. Alternatively, if there is delay in implementing treatment plant upgrades that reduce ammonia discharges, the timeline for achieving this objective may not be appropriate.

Objective DTSM1.2 (Survival) Rationale: This objective will address entrainment of delta smelt, which has been the focus of many studies (e.g., Kimmerer 2008; Grimaldo et al. 2009). The role of entrainment on the long-term and recent declines of delta smelt continues to be discussed (Baxter et al. 2010). Kimmerer (2008) concluded that losses of adult delta smelt due to entrainment were important in certain years, while in other years, the population-level effects were small. The most recent pelegiac organism decline synthesis, prepared by the Interagency Ecological Program (2005) continued in this logic of entrainment likely being important under certain conditions but not universally important in all years. While Maunder and Deriso (2011) concluded that entrainment of delta smelt does not have an overall population level effect, entrainment of delta smelt results in direct mortality, and lower levels of entrainment are desirable for the benefit of the species.

Sufficient information is available to set a numerical objective for reducing the entrainment of adult delta smelt. Entrainment can be estimated from the salvage data, and both the fall midwater trawl index and the Kodiak index provide a basis for expressing the entrainment losses relative to the population. Different methods for estimation of past and future entrainment can produce significantly different entrainment level estimates. However, as long as the entrainment target is

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projected and measured using the same method, a target can reasonable be established relative to historical levels.

Achieving the entrainment objectives for adult and juvenile delta smelt will be accomplished by relocating the primary point of diversion to the north Delta and reducing the spatial overlap of diversion intakes and delta smelt; this will be achieved by implementing *CM1 Water Facilities and Operation*. Reducing water diversions in the tidal region of the Delta will substantially reduce the risks of entrainment and impingement. Relocating the primary point of diversion will also result in increased operational flexibility and contribute to a more natural flow pattern in the Delta, reducing the occurrence of reverse flows which can contribute to adult and juvenile entrainment.

The current regulatory requirements regarding entrainment established by the BiOp were imposed at a time when the delta smelt population had declined substantially, and are therefore highly restrictive. Based on data from 2002 through 2006, USFWS (2008) estimated that incidental take limits under the BiOp would be approximately 5% of the prespawning adult population. Such estimates were not made for the larval and juvenile population. Retrospective calculations were made of the average percentage of the larval and juvenile population lost to entrainment in years when incidental take would have been exceeded (16%) and years when incidental take would not have been exceeded (4%). These data suggest the incidental take limits for larvae and juveniles may represent a similar proportion of the population as for adults and that taken together this would be around 10% of the population. Thus, an objective of 10% across all life stages would correspond to maintenance of the proportion of the delta smelt population currently lost to entrainment. As indicated by the analysis of south Delta entrainment in Appendix 5.B, *Entrainment*, there may be lower entrainment of adult delta smelt under the preliminary proposal compared to existing conditions, whereas entrainment of larvae and juveniles may be similar. In relative terms, the objective should be achievable although there is uncertainty in the actual percentage of the population entrained.

While this objective is appropriate based on the current delta smelt population size, it would need to be re-examined (and potentially increased) should the delta smelt population increase.

Goal DTSM2 (Spatial Distribution): Increased spatial distribution of juvenile and pre-spawning adult delta smelt in preferred habitat areas.
• **Objective DTSM2.1 (Spatial Distribution):** Increase the extent of suitable habitat in the Plan Area by 15,000 acres during the near-term (NT), 22,000 acres during early long-term (ELT), and 49,000 acres during late long-term (LLT), and expand the distribution of juvenile and pre-spawn adult delta smelt into that habitat.
Assumed Stressor: Lack of suitable biotic and abiotic habitat. **Stressor Reduction Target:** Increase the extent of suitable biotic and abiotic habitat within the Plan Area.

Objective DTSM2.1 (Spatial Distribution) Rationale: This objective will increase the spatial distribution of juvenile and pre-spawning adult delta smelt by increasing the availability of suitable habitat from mid-July through mid-December (to coincide with historic juvenile and pre-spawning adult distribution patterns). Creation, restoration, enhancement and protection of a diverse range of aquatic habitats are intended to increase the habitat diversity and complexity (geographic and spatial distributions) that offer potential habitat for a wide range of covered fish species, including delta smelt, and life stages. For example, enhanced food production, spatial diversity and complexity

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of habitat types, including; variation in water depths, tidal hydrodynamics, water velocities and residence times, salinity gradients from fresh water to brackish water, areas that are inundated seasonally only in response to higher flow events, daily tidal cycles that affect intertidal habitat areas, and permanently inundated subtidal habitats will contribute to the biological and spatial diversity of populations of covered fish species, including delta smelt. When considered in conjunction with actions to improve food availability and increase survival, the net result is anticipated to be an increase in the abundance of spawning delta smelt adults.

Restoration actions implemented as part of the BDCP will increase the extent of habitat available for delta smelt, and will occur throughout the Plan Area. However those restoration actions that are focused in the Cache Slough, West Delta and Suisun Marsh ROAs will provide the greatest benefit to delta smelt and will contribute toward achieving this objective by restoring suitable spawning habitat and thus contributing to increased abundance and expanded distribution into new areas, such as Cache Slough. Restoration actions in the south Delta also have the potential to increase the extent of suitable habitat there as well.

3.3.5.2 Longfin Smelt

Longfin smelt spawn in fresh or slightly brackish water over sandy or gravel substrates at temperatures ranging from 7 to 14.5°C (44.6 to 58.1°F) (Moyle 2002). Approximately 90% of juveniles inhabit areas with salinities lower than 18 ppt (Baxter 1999), while larger individual have been captured in salinities of 32 ppt (Baxter unpublished data *in* Rosenfield 2010). Longfin smelt actively avoid areas with water temperatures greater than 22°C (72°F) in combination with salinities greater than 26 ppt. These conditions occur between August and September almost annually in south San Francisco Bay and periodically in shallower portions of San Pablo Bay. The effect of turbidity on longfin smelt geographic distribution or habitat preferences is unknown. However, longfin smelt larvae hatch coincident with annual peak Delta outflows, which typically coincide with high turbidity.

The longfin smelt population is the southernmost, and also the largest, spawning population in California. Longfin smelt occur primarily in the lower Sacramento River (downstream of Rio Vista), lower San Joaquin River, and western Delta and Suisun Bay within the Plan Area. Longfin smelt occur in relatively low abundance in the south Delta. The typical distribution of juvenile and adult longfin smelt (brackish water and coastal marine waters of San Pablo and San Francisco bays) is downstream of the Plan Area. Longfin smelt abundance within the Bay-Delta estuary has been highly variable as reflected in the DFG fall midwater trawl surveys (Figure 3.3-2), although recent indices are low compared to prior years.

Multiple threats and stressors affect longfin smelt, and appear to act in complicated and synergistic ways to influence the distribution and abundance of the species (Rosenfield and Baxter 2007). Individual stressors affect longfin smelt at different times based on environmental conditions. Important threats and stressors to longfin smelt include reduced spawning habitat, reduced access to rearing habitat, decreases in the quality and availability of food, competition with and predation by nonnative species, reduced turbidity, entrainment at water diversion facilities, exposure to toxins, and degraded water quality conditions (i.e., high temperatures and low DO). Refer to Appendix 2.A, *Covered Species Accounts* for a full species account and discussion of these stressors.

Longfin smelt is included in the 1996 Sacramento-San Joaquin Delta Native Fishes Recovery Plan, which also includes the delta smelt, Sacramento splittail, green sturgeon, Sacramento perch, and

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three races of Chinook salmon. USFWS or NMFS has the responsibility to review and update the recovery plan for these species. To accomplish this task, USFWS formed the Delta Native Fishes Recovery Team to assist in the preparation of this updated recovery plan. An updated recovery plan is expected to be completed in the near future. Longfin smelt are not covered by other adjacent or overlapping HCPs or NCCPs in the area.

Dual operation of new and existing diversion facilities is expected to reduce levels of entrainment of native longfin smelt at the south Delta SWP/CVP facilities. Other conservation approaches would be to ensure adequate food availability during the critical yolk-sac larval stage, provide quality habitat in the Delta and Suisun Bay, restore tidal brackish emergent wetland habitat, improve the inundation regime Plan Area floodplains to increase phytoplankton and zooplankton production, restore shallow subtidal habitat, and develop new and expanded conservation hatcheries.

The BDCP conservation strategy for longfin smelt focuses on juvenile abundance, adult abundance, and survival. Because of the uncertainty related to longfin smelt use of the Plan Area, a potential research action would focus on increasing scientific understanding of longfin smelt ecology. Refer to Section 3.6, *Adaptive Management and Monitoring Program,* for more information. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.2.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for longfin smelt are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities. • **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.

Objectives L1.3, L1.4, and L1.8 Benefits: Benefits of these objectives for longfin smelt are similar to those described for delta smelt.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.3:** Allow lateral river channel migration.
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat.
- **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.
- **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
- **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
- **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2 through L2.6 and L2.8 Benefits: Benefits of these objectives for longfin smelt are similar to those described for delta smelt.

Objective L2.9 Benefits: Achieving this objective will provide refugia habitat for migrating and resident longfin smelt, which will reduce potential predation effects, although juveniles, subadults, and sexually mature adults tend to aggregate in deep and high-velocity water environments where turbidity may provide greater overall refugial benefits (Rosenfield 2010).

Objective L2.10 Benefits: Benefits of this objective for longfin smelt are similar to those described for delta smelt.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.

- **Objective L3.2:** Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic fish species.
- **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.
- **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.2 Benefits: Achieving this objective will increase connectivity between low salinity zone habitat and upstream freshwater spawning habitat, which will benefit longfin smelt adults by improving access to suitable spawning habitats and providing a range of suitable spawning conditions through a variety of habitat conditions. Despite the strong correlation between flow and longfin smelt production, Baxter (1999) and Dege and Brown (2004) found little correlation between freshwater inflow and larval abundance, which hints that freshwater flow affects larval to juvenile survival more than it influences spawning habitat availability or hatching success. However, relatively little is known about longfin smelt spawning behavior and preference. Nonetheless, promoting connectivity between low salinity zone habitats and freshwater habitats may increase

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the potential extent of suitable spawning habitat under a range of flow conditions and low salinity zone locations.

Objective L3.3 Benefits: Achieving this objective will provide increased flexibility for water operations of the north diversions, and will allow the BDCP to provide flow conditions that can more easily coincide with the timing of longfin smelt larvae as they are transported downstream via river flow. A strong positive correlation between the extent of longfin smelt larval distribution and average winter-spring outflow has been documented (U.S. Fish and Wildlife Service 1995; Baxter 1999), although the mechanism underlying this correlation is not known.

Objective L3.4 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, which will allow the BDCP to provide flow conditions that can better provide appropriate cues to longfin smelt to begin their spawning migration. The strong correlation between longfin smelt production and flow indicates that providing flow conditions more similar to natural flow conditions may provide a greater range of potentially suitable spawning habitat options for longfin smelt, thereby increasing the spatial diversity of the species (Rosenfield and Baxter 2007). The exact location of spawning sites and the factors that determine the rate and success of longfin smelt embryogenesis are not well understood in this estuary (Rosenfield 2010). Although juvenile and subadult longfin smelt aggregate in deep water (Rosenfield and Baxter 2007), it is not clear that spawning occurs in deep water habitats; sexually mature longfin smelt may migrate to shallower locations briefly to spawn (Rosenfield 2010). If longfin smelt choose spawning sites based solely on physical characteristics of the substrate (e.g., grain/cobble size, depth, vegetation), then spawning locations may not change much from year to year. If, as seems more likely, spawning locations represent the overlap of acceptable hydrologic, chemical (e.g., salinity), and physical conditions (e.g., substrate grain size), and proximity to high-productivity mixing zones in the Delta, then spawning location would, historically, have shifted depending on freshwater outflow conditions in a particular year. The distribution of young longfin smelt larvae provides support for the latter option (California Department of Fish and Game 2009). Because the natural hydrology of the Delta was much more variable in the past than it is today, the geographic distribution of potential spawning habitat may have been more extensive in the past than it is currently (Rosenfield 2010). The BDCP will contribute to greater hydrologic variability, which may increase the geographic distribution of potential spawning habitat that is more similar to natural conditions than the current baseline condition.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 Benefits: Meeting this objective will avoid and minimize direct effects on longfin smelt resulting from BDCP covered activities.

Objective L4.2 Benefits: Meeting this objective will reduce predation on longfin smelt by nonnative predators. Although predation is a natural part of aquatic community dynamics, excessive predation

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of longfin smelt in certain areas, such as Clifton Court Forebay, is believed to be high (Rosenfield 2010). Although the primary predators of longfin smelt are unknown, striped bass are are probably major predators on longin smelt larvae (Rosenfield 2010). Moyle (2002) suggested that the invasion of this estuary by inland silverside may have accelerated the decline in longfin smelt productivity that occurred about the same time, due to predation by silverside. In addition, the diversity and populations of invasive predator species have increased in recent decades (Rosenfield 2010). Targeted harvest, capture, and removal of nonnative predators is expected to reduce predation impacts on longfin smelt populations. Refer to *CM15 Predator Control* for a discussion of the management of nonnative predators in the Plan Area.

Objective L4.3 Benefits: Benefits of this objective for longfin smelt are similar to those described for delta smelt.

Objective L4.4 Benefits: Meeting this objective will reduce the entrainment of longfin smelt. Overall, the BDCP will substantially reduce exports from the south Delta facilities in most months relative to the existing biological conditions. Entrainment is expected to be reduced most in wetter years when a greater percentage of flow will be diverted from the north Delta (Appendix 5.B, *Entrainment*).

Mortality of juvenile longfin smelt associated with human water development for agricultural, municipal, or industrial purposes may represent a significant effect on the longfin smelt population in some years (Rosenfield 2010). Longfin smelt entrainment (and probable mortality) at the south Delta pumps is greatest during low outflow years. As a result of the BDCP, entrainment of larval and adult longfin smelt at the south Delta export facilities may decrease relative to existing biological conditions, whereas juvenile entrainment could remain similar to existing biological conditions or slightly increase (Appendix 5.B, *Entrainment*).

3.3.5.2.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for longfin smelt are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Meeting this objective will restore tidal perennial aquatic natural communities that provide habitat conducive to primary productivity, which is essential to maintain a robust food base for longfin smelt to increase growth and survival. The substantial decline in *Eurytemora affinis* over the last several decades (Kimmerer 2002) may make successful first-feeding less likely for larval longfin smelt. Furthermore, the summertime decline in *Eurytemora* may create a period of low food availability prior to availability of other food items like calanoid copepods. (Rosenfield 2010). Restoring or creating at least 10,000 acres of tidal perennial aquatic habitat in Conservation Zones 1, 2, 4, 5, 7, and 11 will substantially increase the amount of habitat contributing to primary productivity and food resources important to longfin smelt, such as copepods. This substantial increase in tidal perennial aquatic habitat will help to offset the historic loss of such habitat in the Plan Area.

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Of the Delta habitats, the tidal marsh sloughs have the highest particulate organic matter and phytoplankton concentrations and support the greatest zooplankton growth rates (Müller-Solger et al. 2002; Sobczak et al. 2002).

Habitat restoration in the Cache Slough Complex at the southern end of the Yolo Bypass, in combination with floodplain enhancement, is expected to provide tidal freshwater wetland structure and functions adjacent to open water habitat. Tidal wetlands also have the capacity to export food resources to adjacent channels and to downstream systems (Cloern et al. 2007; Lehman et al. 2008). The export of food may include movement of phytoplankton and zooplankton by advection and tidal exchanges as well as the export of macroinvertebrates, small fishes, and other larger organisms (Kneib 1997, 2003).

The export of marsh production helps to transfer the higher production of shallow-water habitats to the deepwater habitats preferred by pelagic fish species such as longfin smelt (Lucas et al. 2002). Production from the lower Yolo Bypass, including Liberty Slough and Cache Slough marshes, stays relatively intact as it moves down the estuary (Monsen 2003). This production may contribute significantly to the greater foodweb, ultimately benefitting open-water species such as longfin smelt (Brown 2004).

Although juvenile and subadult longfin smelt aggregate in deep water (Rosenfield and Baxter 2007), it is not clear that spawning occurs in deep water habitats; sexually mature longfin smelt may migrate to shallower locations briefly to spawn (Rosenfield 2010). Thus, providing a broad range of floodplain and tidally influenced natural communities will contribute to a greater range of potentially suitable spawning habitats for longfin smelt.

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Benefits of this objective for longfin smelt are similar to those described for delta smelt.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 through TBEWNC1.4 Benefits: Benefits for these objectives for longfin smelt are similar to those described for delta smelt.

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Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7. • **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objective TFEWNC1.1 and TFEWNC1.2 Benefits: Benefits of these objectives for longfin smelt are similar to those described for delta smelt.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle. • **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Benefits of these objectives for longfin smelt are similar to those described for delta smelt.

3.3.5.2.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for longfin smelt within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for longfin smelt are presented in the context of broader global goals and objectives developed by USFWS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for longfin smelt will be achieved via habitat restoration and altered flow management. Habitat restoration benefits will chiefly derive from habitat restoration that is expected to support greater primary and secondary productivity and provide increased food resources for longfin smelt. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce the spatial overlap of diversion intakes and longfin smelt occurrence, thereby substantially reducing entrainment. Altered flow conditions are also expected to increase the connectivity between low salinity zone habitat and upstream freshwater spawning habitat, thereby improving access to suitable spawning habitats and providing a range of suitable spawning conditions.

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Habitat restoration is anticipated to increase productivity in the Plan Area. Restoration of tidal, seasonally inundated floodplain, channel margin and riparian habitat is anticipated to contribute to an increase in primary productivity and will provide benefits to longfin smelt in two major ways: the resident population of longfin smelt will benefit directly from an anticipated increase in copepod abundance, while larvae and juveniles will derive an indirect benefit to the extent that suitable food resources are exported downstream to rearing areas in the low salinity zone.

Global Goals and Objectives Developed by the U.S. Fish and Wildlife Service Independent of BDCP[10]

Global Goal: Improve the foodweb productivity and increase the abundance and distribution of longfin smelt.
• **Global Objective 1 (Abundance):** Productivity (abundance indices) must be equal to or greater than predicted for 5 of 10 years based upon a regression of 1967-1987 abundance on December through May mean outflow (or X_2). • **Global Objective 2 (Abundance):** Implement actions to benefit longfin smelt abundance (winter-spring outflow enhancements), to minimize threats (reduce exports) and to improve the scientific understanding of their ecology to benefit future management. • **Global Objective 3 (Spatial Distribution):** (1) longfin smelt must be captured in at least 40% of Carquinez Strait and Suisun Bay Fall Midwater Trawl stations in at least 80% of years sampled, and (2) during each sampling year for the Fall Midwater Trawl individual trawl catches of 13 longfin smelt or more must be made at least once (this reflects a return to historical schooling behavior).

As stated previously, the global goals and objectives were developed by USFWS independent of the BDCP and are associated with USFWS' responsibility to recover species protected under the ESA. The BDCP longfin smelt goals and objectives presented below have been developed to contribute toward the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of longfin smelt recovery.

[10] Citation to be provided.

Goal LFSM1 (Abundance): Increase abundance of longfin smelt within 15 years of BDCP Implementation.
• **Objective LFSM1.1 (Abundance):** Achieve an annual average of the abundance indices from 1987to 2000 per year, within 15 years of BDCP implementation. • **Objective LFSM1.2 (Resilience):** During wet years, achieve a Fall Midwater Trawl abundance index ≥ the abundance index predicted based on regression of prior (1987–2000) longfin abundance and outflow. • **Objective LFSM1.3 (Survival):** Increase survival of longfin smelt larvae immediately following yolk-sac absorption within 15 years of BDCP implementation.
Assumed Stressors: Lack of food resources, entrainment, and spawning habitat conditions. **Stressor Reduction Targets:** • **Entrainment.** From February through June, entrainment of juveniles in combined SWP and CVP facilities shall not exceed ___ ratio of salvage to fall midwater trawl index from the previous September through December matched by water year type. (Additional analysis is needed to develop appropriate target.) Reducing entrainment will contribute to increased longfin smelt juvenile abundance, and over time increased adult abundance. • **Food.** Increase the average late winter and early spring (late February to April) density of zooplankton in the lower Sacramento, western Delta, and Suisun Bay and/or supply adequate transport flows (sustained or pulse flows) to move longfin smelt larvae to adequate food resources within 15 years of implementation. (Additional analysis is needed to develop appropriate prey density target.). Increasing food abundance will contribute to increased longfin smelt juvenile survival immediately following yolk-sac absorption by providing food resources suitable for juvenile longfin smelt within the Plan Area. • **Spawning habitat.** Increase overlap of suitable spawning substrate and suitable flow conditions in lower San Joaquin River such that spawning will be detected in at least three of the following locations in all years (Lower Sacramento, Cache Slough Complex, Lower San Joaquin, Suisun Bay, and Suisun Marsh). Increasing the extent of suitable spawning habitat for longfin smelt will contribute to an increase in spawning success, thereby contributing to an increase in juvenile and, over-time, adult longfin smelt abundance.

Objective LFSM1.1 (Abundance), LFSM1.2 (Resilience) and LFSM1.3 (Survival) Rationale: Meeting these objectives will be achieved by addressing three stressors; entrainment, food and spawning habitat. The role of entrainment on the long-term and recent longfin smelt declines continues to be discussed (Baxter et al. 2010). Longfin smelt entrainment is a greater concern during low outflow periods when X_2 is nearer the south Delta export facilities. Currently, the SWP is operating under a 2081 incidental take permit issued by DFG. The permit dictates certain OMR flow limits from January to June in order to protect larval and juvenile longfin smelt from entrainment.

Nearly all the longfin smelt that are recorded in annual surveys are found downstream of the confluence of the Sacramento and San Joaquin Rivers. The fraction of the longfin population found at or east of the lower San Joaquin River is low—averaging 0.5% for adult longfin smelt from 2002 to 2008 and 6% for larvae and juveniles from 1995 to 2007. Over those same periods, the average percentage of larval, juvenile, and adult longfin smelt found east of Franks Tract, where water export pumps are located, was 0%. These data suggest that the threat of entrainment may be relatively low. However, the species has exhibited changes in distribution over time, so it would be prudent to continue to track entrainment over time.

Reducing entrainment for adult and juvenile longfin smelt will be accomplished by relocating the primary point of diversion to the north Delta and reducing the spatial overlap of diversion intakes

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and longfin smelt, as described in *CM1 Water Facilities and Operation*. Reducing water diversions in the tidal region of the Delta is expected to reduce the risks of entrainment and impingement. Relocating the primary point of diversion will also result in more natural flow patterns in the Delta, reducing the occurrence of reverse flows which can contribute to entrainment. These changes are expected to improve the overall abundance and survival of larval and adult longfin smelt in the Plan Area.

Food availability is also a limiting factor for longfin smelt, particularly during the initial feeding stage when the larval yolk-sac is absorbed. Researchers have hypothesized that a major factor in the decline of longfin smelt abundance is related to the invasion by the Amur River clam *Corbula amurensis* and its subsequent disruption of the foodweb (Carlton et al. 1990; Alpine and Cloern 1992; Orsi and Mechum 1996; Baxter et al. 2007 p. 36). Rosenfield and Baxter (2007) speculate that the estuary has experienced a fundamental change in its carrying capacity for pelagic fishes. There is evidence that the disruption of the foodweb is the most significant change in the estuary's carrying capacity. Rosenfield and Baxter (2007) concluded that food limitation is consistent with their finding of reduced age-1 productivity and the reduction in age-2 recruitment. Hobbs et al. (2006) further documented poor growth and condition of longfin smelt in the south channel region of Suisun Bay. Densities of *C. amurensis* are high in Suisun Bay (Carlton et al. 1990).

Over the past several decades, substantial changes in the species composition and reductions in the abundance of the preferred prey for larval, juvenile, and adult longfin smelt have been observed (Kimmerer and Orsi 1996; Jassby et al. 2002; Thompson 2007). The fall midwater trawl index for longfin smelt is positively correlated in a multiple linear regression with the previous spring's *Eurytemora affinis* abundance (important prey organism) after weighting the data by the proportion of smelt at each *Eurytemora* sampling station and normalizing by the previous year's fall midwater trawl index (California Department of Fish and Game 2010). The spring population abundance of *Eurytemora* has itself been positively correlated with outflow between March and May since the introduction of *Corbula* (Kimmerer 2002). However, Glibert (2011) also found a positive correlation between changed nutrient ratios, resulting from municipal wastewater treatment plant discharge into the Delta, and *Corbula* abundance.

Achieving an increase in the abundance and survival of longfin smelt will be accomplished by implementing conservation measures to protect, restore, and enhance floodplain and tidal marsh habitats conducive to increasing the density of zooplankton in the lower Sacramento River, lower San Joaquin River, and confluence areas in low-outflow years, and confluence areas and lower in high-outflow years. Increasing the density of zooplankton will be further achieved by reduced water diversions (and associated phytoplankton and zooplankton entrainment) in the south Delta (*CM1 Water Facilities and Operatio*); increasing the timing, frequency and duration of floodplain inundation in Yolo Bypass (*CM2 Yolo Bypass Fisheries Enhancement*), constructing new tidal wetlands (*CM4 Tidal Natural Communities Restoration*); providing for greater floodplain inundation (*CM5 Seasonally Inundated Floodplain Restoration*), and enhancing channel margin habitat along up to 20 miles of current levee channel by restoring riparian, marsh and mudflat habitats along levees (*CM6 Channel Margin Enhancement*). Each of these conservation measures is expected to contribute to an increase in the quantity and quality of zooplankton available to longfin smelt. The restoration is also expected to provide increased production of periphyton, phytoplankton, macroinvertebrates, insects, and small fish that contribute to the local and regional trophic foodweb associated with each restoration area. Proving greater food resources will contribute to an increase in the abundance and survival of longfin smelt.

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Demonstrating an increase in abundance during wet years will demonstrate population resilience, similar to the historical population response, thereby indicating that the population is likely still healthy. If a response is not similar to the response predicted, it may indicate that the population may not be strong or that another factor may be affecting the population. Monitoring longfin smelt abundance and expected population response to wet years will provide a better indication of the health of the longfin smelt population.

Reduced spawning habitat has also been hypothesized as a stressor impacting longfin smelt abundance. Spawning habitat for longfin smelt has been reduced by the reclamation, channelization, and riprapping of historical freshwater intertidal and shallow subtidal wetlands. The degree to which conservation measures addressing these modifications contribute to achieving the adult abundance objective will depend on where spawning occurs. Longfin smelt have not been observed spawning, so the exact location of sites is not well understood, but location in the regions of the Plan Area can be inferred by DFG surveys that collect larval smelt. Based on the distribution of gravid females (Spring Kodiak Trawl Study) the spawning habitat of longfin smelt probably includes the DWSC, Cache-Liberty Island Complex, lower Sacramento River, eastern Suisun Bay (including upper Grizzly Bay), and Montezuma Slough in Suisun Marsh. Spawning rarely occurs in the San Joaquin River within the south Delta region, but when it occurs it is usually below Twitchell Island (Moyle 2002). Adult and subadult longfin smelt aggregate in deep water within channels, but it is not clear that spawning occurs there; spawning may occur on shoals adjacent to deep channels similar to delta smelt (Rosenfield and Baxter 2007). Spawning usually takes place over sandy or gravel substrates, rocks, and aquatic plants (Moyle 2002). Potential locations include Suisun Bay, Suisun Marsh, West Delta, lower Sacramento River, and lower San Joaquin River, and may include shallow water habitats.

Although juvenile and subadult longfin smelt aggregate in deep water (Rosenfield and Baxter 2007) it is not clear that spawning occurs in deep water habitats; sexually mature longfin smelt may migrate to shallower locations briefly to spawn (Rosenfield 2010). If longfin smelt choose spawning sites based solely on physical characteristics of the substrate (e.g.,grain/cobble size, depth, vegetation), then spawning locations may not change much from year to year. If, as seems more likely, spawning locations represent the overlap of acceptable hydrologic, chemical (e.g., salinity), and physical conditions (e.g., substrate grain size), and proximity to high-productivity mixing zones in the Delta, then spawning location would, historically, have shifted depending on freshwater outflow conditions in a particular year. The distribution of young longfin smelt larvae provide support for the latter option (California Department of Fish and Game 2009). Because the natural hydrology of the Delta was much more variable in the past than it is today, the geographic distribution of potential spawning habitat may have been more extensive in the past than it is currently (Rosenfield 2010). The BDCP will contribute to greater hydrologic variability, which will contribute to an increase in the geographic distribution of potentially suitable spawning habitat that is more similar to natural conditions that the current baseline condition. An increase in the extent of suitable spawning habitat will contribute to an increase in spawning success, and thus an increase in abundance and survival, when coupled with increases in primary productivity.

3.3.5.3 Chinook Salmon, Winter-Run

Winter-run Chinook salmon are listed as endangered under the federal ESA. Spawning habitat for Sacramento River winter-run Chinook salmon is currently restricted to the Sacramento River primarily between Red Bluff Diversion Dam and Keswick Dam, where releases of water from Lake

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Shasta keep temperatures cool (Williams 2009). Rearing habitat quality is strongly affected by habitat diversity and complexity, food supply, and fish and avian predators; this occurs primarily in the lower Cosumnes River, and the Sacramento River upstream of Colusa. Migration habitat in the channeled, leveed, and riprapped river reaches and sloughs common along the Sacramento River and throughout the Delta, typically haslow complexity, low abundance of food organisms, and offers little protection from predation by fish and birds. Estuarine areas have a high conservation value because they function to support juvenile Chinook salmon growth, smolting, avoidance of predators, and provide a transition to the ocean environment.

Between the late 1960s and mid-1990s, winter-run Chinook salmon abundance declined from a high of about 120,000 adults to less than 500 fish in some years. Beginning in the mid-1990s and continuing to date, adult escapement has shown an increasing trend, approaching 20,000 fish in 2006 (Figure 3.3-3). This trend is likely due to improved water temperatures and water management in the Shasta Reservoir and the mainstem river, improved operations of the Red Bluff Diversion Dam (keeping holding gates open for a longer period), favorable hydrological and ocean rearing conditions, habitat enhancements, reductions in loading of toxic chemicals, improved fish screens on major water diversions, and reduced harvest rates. Subsequent declines to several thousand fish since 2006, is likely due to reduced productivity of near-shore coastal waters and reduced prey availability resulting in poor juvenile salmon growth and high mortality during the juvenile ocean rearing phase (MacFarlane et al. 2008b).

Important threats and stressors to winter-run Chinook salmon are summarized below. Refer to Appendix 2.A, *Covered Species Accounts,* for a full discussion of these stressors.

- **Reduced staging and spawning habitat.** Access to much of the historical upstream spawning habitat for winter-run Chinook salmon has been eliminated or degraded by man-made structures (e.g., dams and weirs) associated with water management operations. The remaining available habitat is currently maintained by cool water releases from Shasta and Keswick Dams, in the mainstem Sacramento River. The construction and operation of the Red Bluff Diversion Dam has been identified as one of the primary factors contributing to the decline in winter-run Chinook salmon abundance that lead to listing of the species under the ESA.
- **Reduced rearing and out-migration habitat.** Channel margins throughout the Delta have been leveed, channelized, and fortified with riprap for flood protection and island reclamation, reducing and degrading the quality of natural habitat available for juvenile Chinook salmon rearing (Brandes and McLain 2001). Human-made barriers and water diversions further reduce and degrade rearing and migration habitat and delay juvenile out-migration, and result in increased diversion screen impingement, entrainment, disease, and predation.
- **Predation by nonnative species.** Predation on juvenile salmon by nonnative fish (e.g., small- and largemouth bass, striped bass, catfish, Sacramento pikeminnow, and northern pike) is an important threat to winter-run Chinook salmon, and changes in the system have enhanced suitable habitat for these species. Water temperatures are generally lower during out-migration of winter-run salmon compared to other salmonids, potentially reducing predation pressures which can increase with increasing water temperature (Lindley and Mohr 2003).
- **Harvest.** Commercial and recreational harvest of winter-run Chinook salmon in the ocean and inland fisheries, as well as illegal poaching, result in incidental harvest of wild Chinook salmon, which are less able to withstand high harvest rates than hatchery-based stocks. However, recent changes in fishing regulations and harvest restrictions, have minimized these impacts.

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- **Reduced genetic diversity and integrity.** Artificial propagation programs have resulted in genetic introgression with naturally spawning fish. Such introgressions introduce maladaptive genetic changes to the wild winter-run salmon stocks and may reduce overall fitness (Myers et al. 2004; Araki et al. 2007). Reducing the effects of introgression is part of recovery planning and conservation of the species.
- **Entrainment.** Entrainment and salvage at SWP/CVP export facilities, numerous other diversions, and power plant intakes affect Chinook salmon populations (Kjelson and Brandes 1989). Juvenile winter-run Chinook salmon tend to be distributed in the central and southDelta where they have an increased risk of entrainment and salvage between February and April. These facilities also change the hydrodynamics in Delta channels, and directly or indirectly increase vulnerability to entrainment at unscreened diversions. However, the effects of entrainment mortality on the population dynamics and overall adult abundance of winter-run Chinook salmon are not well understood.
- **Exposure to toxins.** Toxins from agricultural drainage and return flows, municipal wastewater treatment facilities, and other point and nonpoint discharges include mercury, selenium, copper, pyrethroids, and endocrine disruptors. These have the potential to affect fish health and condition, and adversely affect salmon distribution and abundance. Sublethal concentrations may interact with other stressors (e.g., seasonally elevated water temperatures, predation or disease) to increase vulnerability of salmonids to mortality.
- **Increased water temperature.** Higher water temperatures cause physiological stress, reduced growth rates, prespawning mortality, reduced spawning success, and increased mortality of salmon (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). The installation of the Shasta Temperature Control Device in 1998 and improved reservoir management are believed to be important factors contributing to the increase in adult winter-run Chinook salmon abundance in recent years. However, climate change and global warming patterns, in combination with current stressors may adversely affect the long-term health and viability of Sacramento River winter-run Chinook salmon (Crozier et al. 2008).

The Public Draft Recovery Plan for Central Valley salmonids, including Sacramento River winter-run Chinook salmon, was released by NMFS on October 19, 2009. Although not final, the overarching goal in the public draft is the removal of, among other listed salmonids, Sacramento River winter-run Chinook salmon from the federal list of endangered and threatened wildlife (National Marine Fisheries Service 2009a). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations within each historical diversity group, as well as other measurable biological criteria. The recovery plan is based on a stepwise strategy that first addresses more urgent near-term needs, and builds toward full recovery. The strategic planning framework incorporates viability at both the ESU and population levels, prioritizes watersheds based on currently occupancy, and prioritizes unoccupied watersheds for reintroductions. Winter-run Chinook are also covered in Solano County HCP and the East Alameda County Conservation Strategy.

The conservation approach for winter-run Chinook salmon will focus on those life stages occurring in the Plan Area, and ensure efforts to benefit those specific life stages occur when these life-stages would be present in the Plan Area. Juvenile Chinook salmon foraging and rearing habitat has been compromised by floodplain modifications, contributing to reductions in the abundance and

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distribution of Chinook salmon. Therefore, the conservation approach will include tidal natural communities restoration to increase rearing habitat in the Suisun Marsh, Cache Slough, West Delta, and South Delta ROAs. The approach also includes reducing the relative percentage of juvenile outmigrants that are entrained at the SWP/CVP South Delta facilities, and reducing the predation levels in the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures.*

3.3.5.3.1 Applicable Landscape-Scale Goals and Objectives

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]*

Those natural community-scale biological goals and objectives that are integral to the conservation strategy for winter-run Chinook salmon are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.2**: Protect sufficient lands for the restoration of natural communities as described in Objective L1.3. • **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objective L1.2 Benefits: Meeting this objective will ensure that restoration actions can be feasibly implemented in the Plan Area. In many cases, restoration of aquatic natural communities will occur on public lands. However, in some cases land may be acquired to secure sufficient land and water to allow restoration of aquatic communities.

Objective L1.3 Benefits: Meeting this objective will restore or create seasonally inundated floodplains and tidally influenced natural communities that are very important for winter-run Chinook salmon. The BDCP Implementation Office will restore 65,000 acres of tidal wetland in the Delta, approximately 10,000 acres of seasonally inundated floodplain, up to 20 miles of channel margin habitat, and at least 5,000 acres of riparian habitat to benefit covered fish species (in addition to other restoration actions specific to terrestrial species also covered in the BDCP). The habitat restoration actions have two principal objectives: to increase the amount of available habitat for covered fish species as required at each life stage, and to enhance the ecological function of the Delta. Refer to TPANC1.1 for a discussion of the benefits.

Restoring and creating seasonally inundated floodplains and tidally influenced natural communities will provide a broad gradient of environmental conditions and a range of potentially suitable habitats for juvenile Chinook salmon rearing within the Plan Area. Seasonally inundated floodplains and tidally influenced natural communities are important for primary productivity and food

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resources for Chinook salmon. Jeffres et al. (2008) found that juvenile Chinook grew more rapidly on the vegetated Cosumnes River floodplain when it was inundated than in the mainstem river, either within or upstream of the tidally influenced area. Food was very abundant, and the fish grew well even though the water temperature averaged 21°C for a week, with daily maximums up to 25°C. The loss of overbank and tidal habitat available for juvenile rearing, caused by extensive levees, may rival the significance of the loss of upstream spawning habitat (Williams 2009).

Objective L1.4 Benefits: Meeting this objective will increase the extent of environmental gradients in order to make a greater range of habitat conditions, food resources, and habitat complexity available for Chinook salmon during their out-migration and juvenile rearing phases. Providing a greater range of potentially suitable habitat conditions for juvenile Chinook salmon, and the organisms upon which they prey is anticipated to benefit by increasing the extent of habitats and prey resources available across a greater range of varied conditions of flow, water temperature, turbidity and other habitat constituents.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.3:** Allow lateral river channel migration. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers. • **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objective Objective L2.2 Benefits: Restoring natural fluvial processes will improve habitat conditions through floodplain inundation, which can increase sediment inputs, refugia from high flows and potential predator avoidance. Floodplain inundation will also increase primary productivity, which will in turn contribute toward increased growth for those juvenile Chinook salmon that use inundated floodplain habitats, such as Yolo Bypass for rearing.

Objective L2.3 Benefits: Lateral channel migration is a natural fluvial process that creates a range of environmental gradients and potentially suitable habitat and channel conditions for Chinook salmon.

Objective L2.4 Benefits: Meeting this objective will increase river-floodplain connectivity to improve hyporheic processes such as groundwater recharge, thereby improving water quality, providing cool water inputs, and maintaining flow inputs to surface waters. Allochthonous inputs such as terrestrial insects and plant matter provide a nutrient source increase the productivity of aquatic systems, thereby contributing to a more diverse and robust forage base.

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Objective L2.5 Benefits: Meeting this objective will reduce the amount of pollution in stormwater runoff entering Delta waterways. This will benefit Chinook salmon by reducing pesticides and herbicides can be highly toxic to plankton, which form the base of the foodweb, and by reducing sublethal effects of contaminants (e.g., effects on behavior, tissues and organs, reproduction, growth, and immune system), such as pyrethroids and other chemicals from urban and stormwater runoff. These water quality improvements are also likely to support a more robust foodweb and thereby contribute to increasing food resources for Chinook salmon.

Objective L2.6 Benefits: Meeting this objective will provide a range of environmental gradients to ensure that a diversity of rearing conditions exists for Chinook salmon in the Plan Area over the life of the BDCP. Maintaining or increasing life-history diversity is very applicable to species such as Chinook salmon, which has three races that occur within the Plan Area (i.e., spring-run, fall-run and winter-run) that exhibit different life-history strategies, such as during of rearing in freshwater before smoltification. Providing a range of environmental gradients will contribute to suitable habitat conditions for the diversity of life-history strategies exhibited by the covered species.

Objective L2.8 Benefits: Meeting this objective will increase natural dendritic channels in tidal marsh habitats to promote food production and transport, which will benefit juvenile Chinook salmon rearing in and/or migrating through the Plan Area by providing food resources. This will benefit juvenile Chinook salmon rearing in the freshwater and low salinity zones of the Plan Area, as they grow and develop critical osmoregulatory capacities that allow them to enter the ocean.

Objective L2.9 Benefits: Meeting this objective will expand and improve available refuge habitat for juvenile Chinook salmon in the Plan Area, to improve growth and survival of outmigrants. Juvenile Chinook salmon prefer to use natural stream banks, floodplains, marshes, and shallow water habitats for rearing prior to their emigration to the ocean. However, much of the Delta has been leveed, channelized, and fortified with riprap. The low spatial complexity of the existing channelized waterways provide virtually no cover protection from predators, and the limited habitat diversity elsewhere in the Delta also reduces refuge cover and protection of salmon and steelhead from predators (Raleigh et al. 1984; Missildine et al. 2001). Diversity and richness of habitat and food sources in the estuary allow juveniles to attain a larger size before entry into the ocean, thereby increasing their chances for survival in the marine environment. Flow modifications provided by the BDCP, and the resulting changes to the extent and duration of inundation of floodplains and other flow-dependent habitat will benefit juvenile salmon and steelhead rearing and migration success.

Objective L2.10 Benefits: Meeting this objective will increase food resources important to Chinook salmon, which will contribute to increased growth rates. Juvenile Chinook are opportunistic feeders, and reports on diet vary from study to study, but broad patterns are evident (Williams 2009). Smaller juveniles occupying marsh channels often feed heavily on larval and pupal chironomids (Shreffler et al. 1992; Lott 2004). This has been observed in a remnant tidal marsh in the Delta (Simenstad et al. 2000), as well as in overbank habitats close to the Delta (Sommer et al. 2001, 2005; Jeffres et al. 2008). As the fish grow, larger prey become more important, and as they move farther offshore and into deeper water, their diet shifts toward other available prey.

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Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.3 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, and will allow BDCP to provide flow conditions that can more easily coincide with the timing of juvenile Chinook salmon out migration, to more closely match their arrival time in the Delta with their physiological development such that they will be able to adapt to increased salinities (smoltification). Providing a flow regime that mimics more natural flow conditions, both in terms of timing and duration, will contribute toward reducing migration delays and survival through the Delta. Some Chinook salmon grow primarily in streams and rivers above the Delta (Healey 1994). After smoltification in upstream areas, these fish migrate through the Delta rapidly.

Further, the BDCP will address water quality issues in the Plan Area, such as the low DO levels in the Stockton DWSC and urban stormwater. The BDCP will include funding to the Port of Stockton to continue operation of the aerator in the Stockton DWSC, which will directly improve the connectivity between areas downstream of Turner Cut and the San Joaquin River upstream of Stockton by minimizing the low DO condition that persist in this area. The BDCP will also provide funding to urban centers that contribute stormwater to the Plan Area to help them reduce inputs of polluted stormwater to the Delta. Reducing the inputs of pollution from urban stormwater will contribute to improved water quality and increased health of the Delta.

Objective L3.4 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, and will allow the BDCP to better provide flow conditions that can more easily coincide with the timing of adult Chinook salmon migrations (adult spring-run migrations begin in March and continue into September, peaking in May and June). Chinook salmon use mid- to high-elevation streams that provide appropriate seasonal water temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama et al. 1998). Efforts to minimize delays in adult spawning migrations of Chinook salmon will improve spawning success and population recruitment and diversity.

Spring-run Chinook salmon mature in the riverine environment before migrating to upriver spawning areas, so short delays caused by current flow regimes or at diversion structures may not be significant (Williams 2009). Current flow management may inhibit the return of Chinook salmon to the Sacramento River and Bay-Delta estuary by restricting seasonal flow necessary as cues for migration and/or spawning. Increased connectivity between habitats and safe and timely passage will contribute towards increased spatial distribution of spawning and reduced opportunities for adult mortality.

Providing greater flexibility in water operations will provide a greater range of potentially suitable flow conditions for adults through the Plan Area. However, providing flows that support the movement of adults through the Plan Area to natal spawning habitats must be coupled with increased connectivity between low-salinity habitat and freshwater habitats and an increase in

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suitable habitats through restoration of a range of aquatic habitats/natural communities (refer to L3.2 and applicable natural community goals and objectives).

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 Benefits: Meeting this objective will avoid and minimize direct effects on Chinook salmon resulting from BDCP covered activities. Avoidance and minimization measures will include project planning and site-specific surveys to identify covered species and suitable habitat for which these measures apply, preconstruction surveys if timing restrictions require such surveys in the months or weeks prior to construction, implementation of construction BMPs, and operation and maintenance associated with long-term activities (e.g., operation and maintenance of the water conveyance facilities), and ongoing covered species habitat enhancement and management. These measures are intended to avoid and minimize direct effects on individual covered species and their habitats, as well as natural communities as a result of construction activities and operation and maintenance activities.

Objective L4.2 Benefits: Meeting this objective will reduce predation on Chinook salmon by nonnative predators. Although predation is a natural part of aquatic community dynamics, excessive predation has been identified as a stressor for BDCP covered fish species, although the actual extent of predation remains uncertain for smaller juveniles (Williams 2009). Refer to *CM15 Predator Control* for discussion of the management of nonnative predators within the Plan Area.

Objective L4.3 Benefits: Meeting this objective will also reduce predation, but rather than contributing to a reduction in the abundance of nonnative predators, this objective will contribute to reducing encounters with nonnative predators by encouraging juvenile fish to avoid migratory pathways that are known predator "hot spots." Actions include providing alternative migration corridors (e.g., Yolo Bypass) and installing features (e.g., weirs and nonphysical fish barriers) to encourage juvenile Chinook salmon to avoid areas that have a high risk for predation.

Objective L4.4 Benefits: Meeting this objective will reduce the entrainment of Chinook salmon. Across the five water-year types, exports from the south Delta decrease from 100% of total exports under the existing biological conditions to an average of about 58% under the BDCP. The proportion of total exports that will come from the south Delta facilities under the BDCP is lowest in wet water years (about 35%) and is highest in critical water years (about 84%). The BDCP will increase total exports over baselines during April, May, and June but will do so largely by taking water from the north Delta intakes. Exports from the south Delta facilities during the spring months are generally similar or reduced relative to the existing biological conditions. With the BDCP, total exports from combined north and south Delta intakes will increase in the early and late long term relative to the existing biological conditions in wet, above normal, and below normal water years. Under dry and critical water years, total exports will decrease under the BDCP relative to existing biological conditions. Overall, the BDCP will substantially reduce exports from the south Delta facilities in most

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months relative to the existing biological conditions. Entrainment is expected to be reduced most in wetter years because a greater percentage of flow will be diverted from the north Delta in wet years than in dry years (Appendix 5.B, *Entrainment*).

Consistent with the general pattern of decreased south Delta exports under the preliminary proposal reducing entrainment relative to existing biological conditions, entrainment of juvenile salmonids at the south Delta export facilities also generally would be lower under BDCP compared to existing biological conditions, with differences according to species and water-year type.

Entrainment of juvenile Chinook salmon was estimated to be similar or somewhat lower under the preliminary proposal than under existing biological conditions across all water years (considering the all-year salvage-density results and the average results from the Delta Passage Model). The salvage-density results suggested that substantial decreases in entrainment in wet years under the preliminary proposal (around 60%, but with large numbers of fish) contrasted with appreciable increases in below normal (50 to 90%) and dry years (50 to 80%), albeit with lower numbers of fish estimated to be entrained in the latter year types. The estimates of the percentage of spring-run Chinook salmon juveniles entrained at the south Delta export facilities from the salvage-density method was up to 5% for the preliminary proposal and over 10% for existing biological conditions, but these percentages are probably an overestimate because the length-based classification method may classify fall-run Chinook salmon as spring-run. As with winter-run Chinook salmon, the estimates of salvage from the Delta Passage Model were considerably less than the entrainment loss estimates from the salvage-density method, even accounting for losses not included in the Delta Passage Model estimates. Refer to Appendix 5.B, *Entrainment* for more information.

3.3.5.3.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for winter-run Chinook salmon are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Meeting this objective will restore tidal perennial aquatic natural communities that provide habitat conducive to primary productivity, which is essential to maintain a robust food base for juvenile salmonids. Salmonid behaviors in the Delta can be generally categorized as foraging and migrating. Some populations, such as winter-run and fall-run Chinook, enter the Delta primarily as smolts and either migrate through rapidly (2 to 3 weeks) or rear for an extended period of time (2 to 3 months) to feed and grow prior to smoltification and movement to marine areas (McLain and Castillo 2010), although del Rosario et al. (in review) indicate that smolts move through the Delta much slower than previously thought. Based on analysis of winter-run-sized fish, average residence time is typically more than 1 month and often much longer. Other populations, such as some spring-run Chinook salmon, emigrate primarily as fry, with a relatively small portion migrating as yearlings.

Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and shallow water areas with emergent aquatic vegetation. Most

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salmonid populations exhibit a mix of these behaviors, and all juvenile salmonids forage and migrate to varying degrees as they move through the Delta. The tidal marsh restoration under CM4 is likely to primarily benefit juvenile foraging salmon; those that are primarily migrating are usually in deeper water and spend less time in the tidal marsh areas of the Delta.

Fry migrants to low gradient streams move quickly downstream from the gravel-bed reaches where spawning occurs and rear in low-gradient reaches in the valley floor before migrating rapidly through the Delta (Williams 2009. The size of fish recaptured at Sherwood Harbor, near Sacramento, indicates that they mainly rear upstream of the Delta, presumably in the Butte Sinks or the Sutter Bypass, until they are larger than 70 mm; then they move rapidly through the Delta (Williams 2009). The Yolo Bypass offers similar habitat to Sacramento River populations when water spills into it over the Freemont Weir, and several studies indicate that fish do well there (Sommer et al. 2001a, 2005)

Juvenile Chinook salmon, *Oncorhynchus tshawytscha*, including Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and Central Valley fall- and late fall-run Chinook salmon, and Central Valley steelhead (*Oncorhynchus mykiss*) feed on zooplankton, benthic macroinvertebrates, amphipods, chironomid larvae, terrestrial insect drift, and larval fish on Delta floodplains to put on critical weight before entering the ocean (Sommer et al. 2001a, 2001b and Jeffres et al. 2008). Young steelhead and Chinook salmon also forage in tidal habitat as fry and juveniles. Calanoid copepods, which have declined substantially in abundance in the Delta, are a key food resource for juvenile Chinook salmon (Moyle 2002).

The presumed benefit of proposed habitat enhancements for Chinook salmon and steelhead is the provision of food resources for outmigrating smolts. However, the magnitude of benefits is uncertain because Delta rearing is one relatively short period in the overall life of salmonids and may not be a key limiting factor for spring-run, winter-run, or late fall–run salmon, or steelhead. Other factors such as upstream spawning and rearing habitats and water diversion structures and operations are also important in the overall life history for these salmonids. There are no studies that evaluate the importance of Delta habitats for these species.

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Meeting this objective will address the nonnative plant species that limit turbidity in the Delta, which has decreased over time (Jassby et al. 2002 in Nobriga and Herbold 2009). It is hypothesized that one of the primary causes of the decrease in turbidity is biological filtration by SAV (Brown and Michniuk 2007 in Nobriga and Herbold 2009). Controlling invasive plants, especially SAV, is anticipated to result in some degree of increased turbidity as well as reduce suitable habitat for nonnative predators. Habitat structure and heterogeneity can affect opportunities for encounter and capture by predators. As discussed above, SAV beds appear to provide habitat that is more favorable to nearshore fishes such as largemouth bass and sunfish that also can take advantage of increased water clarity to find prey (Brown 2003; Nobriga et al. 2005; Nobriga and Feyrer 2007).

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objective TBEWNC1.1 Benefits: Meeting this objective will restore tidal freshwater emergent wetland and increase primary productivity, which could yield more abundant food resources for juvenile salmonids.

Objective TBEWNC1.2 Benefits: Meeting this objective will restore connectivity to isolated patches of tidal emergent marsh to potentially increase the transport of food resources from tidal marsh habitats to areas occupied by juvenile salmonids, thereby increasing the food resources available. Greater availability of food resources will contribute to an increase in growth and survival, although spring-run Chinook salmon tend to migrate relatively quickly through the Delta (Williams 2009), although del Rosario et al. (in review) indicate that smolts move through the Delta much slower than previously thought. Based on analysis of winter run sized fish, average residence time is typically more than one month and often much longer.

Objective TBEWNC1.3 Benefits: Promoting effective exchange throughout the marsh plain is intended to increase transport of food resources from restored wetland habitats to low salinity zone habitats. While spring-run Chinook salmon tend to migrate relatively quickly through the Delta, which may result in fewer benefits to these salmonids, slower migrations have been observed with juvenile fall-run Chinook salmon as they approach the Delta (Williams 2009); the benefits of this objective will vary by Chinook salmon race, depending on the duration of migration and habitat use during migration. In general, spring-run Chinook salmon will benefit the least due to their relatively rapid migration through the Delta and use of deeper water habitat during migration, whereas fall-run Chinook salmon are likely to benefit the most due to reduced migration, as compared to spring-run, and more extensive use of a wider variety of habitats.

Objective TBEWNC1.4 Benefits: Meeting this objective will protect tidal brackish emergent wetland to increase primary productivity, which could yield more abundant food resources for salmonids.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

- **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.
- **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

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Objective Objective TFEWNC1.1 Benefits: Restoration of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7 is expected to increase primary productivity in those areas, which could contribute greater quantity of food resources to Chinook salmon.

Objective TFEWNC1.2 Benefits: Meeting this objective will promote effective tidal exchange throughout the marsh plain, increasing transport of food resources for juvenile Chinook salmon from restored wetland habitats to main channel habitats occupied by juvenile salmonids. Increasing the transport of food resources is anticipated to contribute to an increase in growth and survival.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Riparian habitat provides important functions to the aquatic system (e.g., large woody debris recruitment, increased bank stability, reduced erosion, flow attenuation during flood events, allochthonous inputs, shade, and thermal insulation) that provide benefits to covered salmonids.

Objective VFRNC1.1 Benefits: Restoring or creating 5,000 acres of valley/foothill riparian forest habitat will contribute directly and/or indirectly to the production of food resources to the aquatic system, as well as other benefits such as increased habitat complexity and thermal insulation, that may be of importance to juvenile salmonids. An increase in food resources is expected to contribute to increased growth and survival.

Objective VFRNC1.2 Benefits: Protecting 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 will ensure those riparian communities continue to contribute directly and/or indirectly to the production of food resources to the aquatic system that may be of importance to juvenile Chinook salmon. An increase in food resources is expected to contribute to increased growth and survival.

Objective VFRNC1.3 Benefits: Restoring corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin river systems will contribute directly and/or indirectly to the production of food resources to the aquatic system, as well as other benefits such as increased habitat complexity and thermal insulation, that may be of importance to juvenile salmonids. An increase in food resources is expected to contribute to increased growth and survival of juveniles.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.

- **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle.
- **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

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Objectives NFEW/NPANC1.1 and **NFEW/NPANC1.2 Benefits:** Meeting these objectives will restore nontidal marsh to increase habitat suitable for production of food resources important to juvenile salmonids.

3.3.5.3.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives and associated conservation measures are expected to protect, restore, and enhance suitable habitat for winter-run Chinook salmon within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for winter-run Chinook salmon are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation plan for Chinook salmon will be achieved via habitat restoration and altered flow management. Habitat restoration benefits will chiefly derive from tidal habitat restoration, seasonally inundated floodplain restoration, channel margin enhancement, and riparian habitat restoration that is expected to increase primary and secondary production to contribute to increased food resources for salmonids as well as increase habitat complexity. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce the spatial overlap of diversion intakes and Chinook salmon occurrence, thereby substantially reducing entrainment.

Increasing the availability of floodplain and channel margin habitat is anticipated to increase productivity within the Plan Area. The proposed seasonally inundated floodplain habitat restoration actions are expected to increase the amount and quality of accessible rearing habitat for juvenile salmon. The intent is to route salmon away from the interior Delta and through habitat that is favorable for growth. These expected benefits are supported by a number of existing studies (e.g., Sommer et al. 2001a; Whitener and Kennedy 1999; Moyle et al. 2007).

Reducing passage delays at anthropogenic barriers will reduce migratory delays and increase survival of adult salmonids during their upstream migration to spawning areas. Reducing migratory delays will contribute to an increase in survival of adult salmonids as they are exposed to less potential stress, stranding and illegal harvest.

Global Goal and Objective Developed by the National Marine Fisheries Service Independent of BDCP[11]

Global Goal: Increase winter-run Chinook salmon abundance
• **Global Objective 1 (Abundance and Life-History Diversity):** Achievement of 6-year geometric mean escapement levels of: 59,000 naturally produced adults in the Sacramento River and its tributaries, with no year below 30,000.

[11] Citation to be provided.

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As stated previously, the global goals and objectives were developed by NMFS independent of the BDCP and are associated with the NMFS' responsibility to recover species protected under the ESA. The BDCP winter-run Chinook salmon goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of Chinook salmon recovery.

Goal WRCS1 (**Abundance and Life-History Diversity):** Improved survival (to contribute to increased abundance) of immigrating and emigrating winter-run salmon through the Plan Area.
• **Objective WRCS1.1 (Juvenile Survival):** Achieve a through-Delta survival rate of juveniles of at least 30% measured as a 4-year running average within 15 years of BDCP implementation. • **Objective WRCS1.2 (Adult Passage)**: Limit passage delays in the Yolo Bypass and other anthropogenic barriers and impediments to no more than 36 hours, within 15 years of BDCP implementation.
Assumed Stressors: Entrainment, lack of rearing habitat, spatial structure, adult passage and illegal harvest. **Stressor Reduction Targets:** • **Entrainment**. Reduce mortality in CVP and SWP South Delta Facilities to less than 1% for fish entering facilities within 5 years of implementation. • **Lack of Rearing Habitat.** Improve the availability of floodplain habitat in November through February when the majority of winter-run are detected upstream of the Fremont Weir within 5 years of operation of the notched weir at the Fremont Weir. Maintain availability of floodplain habitats in >40% of years. • **Spatial Structure.** Increase the heterogeneity of habitat along key migration corridors to provide greater spatial structure for juvenile salmonids within 10 years of implementation. Improved habitat conditions are expected to increase fish growth and, in the case of the Yolo, to divert fish away from predators and areas of entrainment thereby contributing to the BDCP survival objective. They are also expected to contribute to life-history diversity. • **Adult Passage.** Limit adult passage delays at anthropogenic barriers and impediments in the Delta to no more than 36 hours, within 15 years of implementation. • **Illegal Harvest.** Reduce illegal harvest in the Delta within 5 years of implementation.

Objective WRCS1.1 (Juvenile Survival) Rationale: Survival of juveniles and adults during freshwater emigration and immigration through the Delta is a factor limiting Central Valley Chinook salmon, and improvements in survival are expected to have beneficial impacts on populations. Survival studies conducted in the last several years using coded wire tags and acoustic tags indicate that survival of juvenile salmonids is highly variable ranging from 0 to 80%. The DRERIP life-history conceptual model (Williams 2009) indicates that predation, access to floodplain habitat, food, and the associated growth of outmigration juveniles are highly important, well understood and predictable factors influencing survival and the transition probability to later life stages. Survival of juvenile Chinook salmon during freshwater emigration through the Delta depends on a number of factors, includingflow, temperature, Delta Cross Channel gate status, tides, predation rates, and water clarity; juvenile travel time through the Plan Area; migration distance (Anderson et al. 2005); toxics; food availability; availability of suitable rearing habitat; and entrainment. In particular, survival depends on distance traveled in the river when water velocity is dominated by the river flow as well as travel time through the Delta when water velocity is dominated by the tides.

Existing data on juvenile Chinook salmon survival through the Delta is limited. Two years of survival estimates based on hydroacoustic tag studies (Perry et al. 2010) indicate survival from Sacramento

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to Chipps Island of fall-run juvenile Chinook was about 50% with a standard error of about 10%. These data, however, are based on studies of fall-run hatchery fish and may not be representative of naturally produced winter-run Chinook fish, which tend to be smaller in size than fall-run fish.

Other studies indicate that the relative survival of Chinook fall-run fry rearing in Yolo Bypass to Chipps Island was on average 50% higher than fish passing over the comparable section of the Sacramento River (Sommer et al. 2001b). Survival of Sacramento fish passing through the interior of the Delta was lower than fish passing through the Sacramento River (0.35 mean ratio of survival probabilities) (Newman and Brandes 2010).

In evaluating the juvenile survival as a BDCP goal, several caveats need to be noted. Survival studies conducted in the Central Valley have focused on fall-run or late-fall-run Chinook salmon of hatchery origin, many of which are of a larger size than winter-run Chinook salmon and not likely as adept at predator avoidance as wild fish. Also, the two runs have different migration timing so extrapolation of the measured survivals to winter-run Chinook salmon has some uncertainty. In particular, the smaller migrating fish, fry less than 55 mm, make up a considerable portion of the adults returning to the Central Valley (Miller et al. 2010).

The BDCP goal is to achieve a through-Delta survival rate of juveniles of at least 30% measured as a 4-year running average within 15 years of Plan implementation, which is sufficient to contribute to stable or expanding populations. The recent 5-year moving average cohort replacement rate is 0.63 (National Marine Fisheries Service 2009a; Pacific Fishery Management Council 2011) and the long term average is 1.54. Further, the 4-year running average is intended to exceed typical drought cycle of 2 years, and amortize across multiple generations (3- to 4-year lifespan). The 15-year time frame is intended to allow time to permit and construct Fremont Weir improvements as the primary conservation measure supporting the objective, and the objective is less dependent on operation of the north Delta facilities. This timeframe also balances need for time to realize BDCP benefits and providing an incentive to implement measures quickly.

Objective WRCS2.1 (Adult Passage) Rationale: While adult Chinook salmon upstream passage is generally unobstructed in the Delta, modifications of the migratory corridors are warranted, particularly within the Yolo Bypass/Fremont Weir (within the Plan Area) and Sutter Bypass/Tisdale Weir to minimize fish delays in passing weirs. Operations at the Fremont Weir do not currently support year-round flows on the floodplain, and thus may prevent passage by some Central Valley salmonids (Harrell and Sommer 2003). Delta exports and diversions can also affect Delta flow rates and hydrodynamics resulting in migration delays (National Marine Fisheries Service 1997). Low DO conditions in the area of the Sacramento DWSC can also be a threat to adult winter-run Chinook salmon migration through the Delta (National Marine Fisheries Service 2009a). The Delta Cross Channel can also delay or block passage to salmon that migrate through the central Delta (National Marine Fisheries Service 2009a). Reducing adult passage delays at anthropogenic barriers is intended to contribute to increased survival of adult salmonids.

3.3.5.4 Chinook Salmon, Spring Run

Historically, spring-run Chinook salmon occurred throughout the Central Valley occupying the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit Rivers, and most tributaries with sufficient habitat. Completion of Friant Dam extirpated the native spring-run Chinook salmon population from the San Joaquin River and its tributaries. Naturally spawning populations are currently restricted to Butte, Deer, and Mill

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Creeks. Spawning areas and migratory corridors also function as rearing habitat for juveniles, although no spawning habitat is known in the Plan Area. The bulk of the production in Butte Creek emigrate as fry, with the remainder migrating as yearlings. Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and shallow water areas with emergent aquatic vegetation. High water temperature is a major stressor for Chinook salmon in the Delta, causing delays in or obstructing migration.

Central Valley spring-run Chinook salmon were once the most abundant run of salmon in the Central Valley. The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s. Broad fluctuations in adult abundance occurred between 1961 and 2009, with a generally positive trend in escapement in these waterways between 1992 and 2005, followed by a steep decline. The Central Valley spring-run Chinook salmon ESU is composed of three diversity groups with fish exhibiting spring-run Chinook salmon life histories occurring in 12 watersheds, although only three of those 12 watersheds contain viable populations.

Important threats and stressors to winter-run Chinook salmon are summarized below. Refer to Appendix 2.A, *Covered Species Accounts*, for a full discussion of these stressors.

- **Population effects.** Access to historical spawning areas is primarily restricted to, Butte, Deer, Chico, and Mill Creeks making the ESU susceptible to environmental changes. Only three of the estimated 17 historical populations remain.
- **Reduced staging and spawning habitat.** Access to much of the high quality historical upstream spawning habitat for spring-run Chinook salmon has been eliminated or degraded by human-made structures (e.g., dams and weirs) associated with water management operations.
- **Reduced rearing and out-migration habitat.** Channel margins throughout the Delta have been leveed, channelized, and fortified with riprap for flood protection and island reclamation, reducing and degrading the quality and connectivity of natural habitat available for juvenile Chinook salmon rearing (Brandes and McLain 2001). Human-made barriers and water diversions further reduce and degrade rearing and migration habitat and delay juvenile out-migration, and result in increased diversion screen impingement, entrainment, disease, and predation.
- **Predation by nonnative species.** Predation on juvenile salmon by nonnative fish (e.g., small- and largemouth bass, striped bass, catfish, Sacramento pikeminnow and northern pike) has been identified as an important threat, particularly to YOY fry emigrating through the Delta, and changes in the system have enhanced suitable habitat for these species.
- **Harvest.** Commercial and recreational harvest of winter-run Chinook salmon in the ocean and inland fisheries, as well as illegal poaching result in incidental harvest of wild Chinook salmon, which are less able to withstand high harvest rates when compared to hatchery-based stocks. However, recent changes in fishing regulations and harvest restrictions have minimized these effects.
- **Reduced genetic diversity/integrity.** The small and limited populations and their restricted distribution make them particularly sensitive to environmental changes and genetic introgression from artificial propagation programs. Reducing the effects of introgression is part of recovery planning and conservation of the species.

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- **Entrainment.** The loss of juvenile spring-run Chinook salmon to entrainment and salvage at SWP/CVP export facilities, numerous other diversions, and power plant intakes affects Chinook salmon populations. The small size of many of the juvenile emigrants increases their vulnerability to entrainment at unscreened diversions. However, the effects of entrainment mortality on the population dynamics and overall adult abundance of spring-run Chinook salmon is not well understood.
- **Exposure to toxins.** Toxins from agricultural drainage and return flows, municipal wastewater treatment facilities, and other point and nonpoint discharges include mercury, selenium, copper, pyrethroids, and endocrine disruptors. These have the potential to affect fish health and condition, and adversely impact salmon distribution and abundance. Sublethal concentrations may interact with other stressors (e.g., seasonally elevated water temperatures, predation or disease) to increase vulnerability of salmonids to mortality.
- **Increased water temperature.** Higher water temperatures cause physiological stress, reduced growth rates, prespawning mortality, reduced spawning success, and increased mortality of salmon. While juvenile spring-run Chinook migrate earlier in the season than other Chinook salmon, reducing the influence of increased water temperatures, the early-returning adults are susceptible to temperature-related mortality during pre-spawning holding periods.

The Public Draft Recovery Plan for Central Valley salmonids, including Central Valley spring-run Chinook salmon, was released by NMFS on October 19, 2009. Although not final, the overarching goal in the public draft is the removal of, among other listed salmonids, Central Valley spring-run Chinook salmon from the federal list of threatened and endangered species (National Marine Fisheries Service 2009a). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations within each historical diversity group, as well as other measurable biological criteria. The recovery plan is based on a stepwise strategy which first addresses more urgent near-term needs, and builds toward full recovery. The strategic planning framework incorporates viability at both the ESU and population levels, prioritizes watersheds based on currently occupancy, and prioritizes unoccupied watersheds for reintroductions. Spring-run Chinook are also covered in Solano County HCP and the East Alameda County Conservation Strategy, and efforts are also underway to re-establish spring-run Chinook salmon in the San Joaquin River under the San Joaquin River Litigation Settlement.

While the initial focus of the BDCP was to address the conservation of Delta fish species that are currently at very low population levels, including spring-run Chinook salmon, the conservation strategy has evolved to include measures to address a broad range of species and habitats in the Plan Area. The conservation approach for spring-run Chinook salmon will focus on those life stages occurring within the Plan Area, and ensure that efforts to benefit those specific life stages occur when those stages would be present in the Plan Area. For spring-run Chinook salmon, the focus is on improving juvenile survival rates, which includes reducing the relative percentage of juvenile outmigrants that are entrained at the south Delta SWP/CVP facilities, and reducing the predation levels in the Plan Area. For adult Chinook salmon, the approach includes minimizing fish passage delays at anthropogenic barriers and impediments. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C. Effects on this species are discussed in Chapter 5, *Effects Analysis.*

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3.3.5.4.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for spring-run Chinook salmon are included below.

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]*

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.

- **Objective L1.2**: Protect sufficient lands for the restoration of natural communities as described in Objective L1.3.
- **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities.
- **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objectives L1.2 through L1.4 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.3:** Allow lateral river channel migration.
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat.
- **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.
- **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
- **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
- **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2 through L2.6, and L2.8 through L2.10 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

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Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.3 and L3.4 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 through L4.4 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

3.3.5.4.2 Applicable Natural Community Goals and Objectives

Those natural community-scale biological goals and objectives that are integral to the conservation strategy for spring-run Chinook salmon are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Benefits of this objective for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Benefits of this objective for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 through TBEWNC1.4 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

- **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.
- **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objectives TFEWNC1.1 and TFEWNC1.2 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period.
- **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Objectives VFRNC1.1 and VFRNC1.3 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

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Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle. • **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Benefits of these objectives for spring-run Chinook salmon are similar to those described for winter-run Chinook salmon.

3.3.5.4.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for spring-run Chinook salmon within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for spring-run Chinook salmon are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for Chinook salmon will be achieved via altered flow management and habitat restoration. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce entrainment in the south Delta, but may increase entrainment in the north Delta depending upon water type year and model used to evaluate entrainment (refer to Appendix 5.B, *Entrainment*). Habitat restoration benefits will chiefly derive from tidal habitat restoration, seasonally inundated floodplain restoration, channel margin enhancement, and riparian habitat restoration that is expected to increase primary and secondary production to contribute to increased food resources for salmonids as well as increase habitat complexity.

Reducing passage delays at anthropogenic barriers will reduce migratory delays and increase survival of adult salmonids during their upstream migration to spawning areas. Reducing migratory delays will contribute to an increase in survival of adult salmonids as they are exposed to less potential stress, stranding and illegal harvest.

Increasing the availability of floodplain and channel margin habitat is anticipated to increase productivity within the Plan Area. The proposed seasonally inundated floodplain habitat restoration actions are expected to increase the amount and quality of accessible rearing habitat for juvenile salmon. The intent is to route salmon away from the interior Delta and through habitat that is favorable for growth. These expected benefits are supported by a number of existing studies (e.g., Sommer et al. 2001a; Whitener and Kennedy 1999; Moyle et al. 2007).

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Global Goals and Objectives Developed by the National Marine Fisheries Service Independent of BDCP[12]

Global Goal: Increase spring-run Chinook salmon spatial distribution and abundance.
• **Global Objective 1 (Abundance):** Achievement of 6-year geometric mean escapement levels of: 59,000 naturally produced adults in the Sacramento River and its tributaries, with no year below 30,000; and a five year annual average escapement of 30,000 naturally produced adults in the San Joaquin River and its tributaries, with no year below 10,000. [These numbers do not include hatchery produced fish]. • **Global Objective 2 (Life-History Diversity and Spatial Distribution):** By 2060, restoration of eight self-sustaining independent populations including six regions of the Sacramento River and two populations in the San Joaquin River drainage.

As stated previously, the global goals and objectives were developed by NMFS independent of the BDCP and are associated with the NMFS' responsibility to recover species protected under the federal ESA. The BDCP spring-run Chinook salmon goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of Chinook salmon recovery.

Goal SRCS1 (Abundance): Improved survival (to contribute to increased abundance) of emigrating juvenile spring-run salmon through the Plan Area.
• **Objective SRCS1.1 (Juvenile Survival):** Achieve a 4-year running average through-Delta juvenile survival rate, which will result in stable or expanding population[13]) within 15 years of BDCP implementation.
Assumed Stressors: Entrainment, predation and lack of rearing habitat. **Stressor Reduction Targets:** • **Entrainment.** Reduce mortality in CVP and SWP South Delta Facilities to less than 1% for fish entering facilities within 5 years of implementation. • **Predation.** Reduce predation in CCFB and at the CVP trashracks to achieve mortality rate of less than 1% across CCFB and past CBP trashracks within 5 years of implementation.

Objective SRCS1.1 (Juvenile Survival): Survival of juvenile Chinook salmon during freshwater emigration through the Delta depends on a number of factors, including flow, temperature, Delta Cross Channel gate status, tides, predation rates, and water clarity; juvenile travel time through the Plan Area; migration distance (Anderson et al. 2005); toxics; food availability; availability of suitable rearing habitat; and entrainment. In particular, survival depends on distance traveled in the river when water velocity is dominated by the river flow as well as travel time through the Delta when water velocity is dominated by the tides.

The recommended approach to establishing survival targets involves a process where technical experts collectively determine what survival rate is needed in the Delta, given average conditions in other phases of the lifecycle and a specific timeframe to achieve the larger goals. The specific values

[12] Citation to be provided.

[13] Through-Delta survival targets to be refined using similar analysis used for San Joaquin River flow objectives recommendations to the State Water Resources Control Board (U.S. Department of Interior 2011). Potential to measure: can be measured (e.g., see papers by Perry and Skalksi 2008; MacFarlane and Norton 2001; Brandes 1996; Newman 2008).

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are then developed by a small technical group and could vary by water year type, as described below. Regardless of the ultimate survival rate, meeting the target is expected to result in improvements that can contribute to the larger global escapement goals.

Existing data on juvenile Chinook salmon survival through the Delta is limited. Two years of survival estimates based on hydroacoustic tag studies (Perry et al. 2010) indicate survival from Sacramento to Chipps Island of fall-run juvenile Chinook was about 50% with a standard error of about 10%. These data, however, are based on studies of fall-run hatchery fish and may not be representative of naturally produced spring-run Chinook survival.

Other studies indicate that the relative survival of Chinook fall-run fry rearing in Yolo Bypass to Chipps Island was on average 50% higher than fish passing over the comparable section of the Sacramento River (Sommer et al. 2001b). Survival of Sacramento fish passing through the interior of the Delta was lower than fish passing through the Sacramento River (mean ratio of survival probabilities, 0.35) (Newman and Brandes 2009).

Data from studies on juvenile Chinook survival for fish emigrating from the San Joaquin River indicate that survival through the Delta is highly variable, ranging from a high of 80% to a low of 0 (Figure 3.3-4).

In evaluating the survival as a BDCP goal, several caveats need to be noted. Survival studies conducted in the Central Valley have focused on fall-run or late fall-run Chinook salmon and primarily hatchery fish, and may not be as adept at predator avoidance. Also, the two runs have different migration timing so extrapolation of the measured survivals to spring-run Chinook salmon has some uncertainty. In particular, the smaller migrating fish, fry smaller than 55 mm, make up a considerable portion of the adults returning to the Central Valley (Miller et al. 2010).

Analysis completed on the San Joaquin drainage estimated survival for each of several key life stage criteria. Modeling results suggest that a 50% through-Delta survival would support a cohort replacement rate of 1.7, which would be sufficient to achieve the Anadromous Fish Restoration Plan (U.S. Department of the Interior 2011) doubling goal (result includes several critical assumptions relative to survival in other life stages). As mentioned previously, a small technical team should be convened to vet survival targets, including the proposed San Joaquin survival target, to determine survival targets for the BDCP covered species. A similar analysis could be completed for the Sacramento River drainage to refine conservation targets based on basin-specific conditions and provide projections of survival rates and associated population levels necessary to achieve self-sustaining populations.

The BDCP goal is to provide through-Delta juvenile spring-run survival rates from the upper Sacramento River to Chipps Island to achieve a 4-year running average that is sufficient to contribute to stable or expanding populations within 15 years of BDCP implementation. The recent 5-year moving average cohort replacement rate is 0.63 (National Marine Fisheries Service 2009a; Pacific Fishery Management Council 2011) and the long-term average is 1.54.

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Goal SRCS2 (Abundance): Reduce passage delays (to contribute to increased migration and spawning success, and thus abundance) at anthropogenic impediments of adult spring-run migrating through the Delta.
• **Objective SRCS2.1 (Migration)**: Reduce adult passage delays at anthropogenic barriers and impediments that cause median passage times of >36 hours, within 15 years of BDCP implementation.
Assumed Stressor: Migration delays. **Stressor Reduction Target:** • **Adult Passage.** Limit adult passage delays at anthropogenic barriers and impediments in the Delta to no more than 36 hrs, within 15 years of implementation.

Objective SRCS2.1 (Migration) Rationale: While adult Chinook salmon upstream passage is generally unobstructed in the Delta, modifications of the migratory corridors are warranted, particularly within the Yolo Bypass/Fremont Weir (within the Plan Area) and Sutter Bypass/Tisdale Weir to ensure that fish delays in passing weirs are minimal. Operations at the Fremont Weir do not currently support year-round flows on the floodplain, and thus may prevent passage by Central Valley salmonids (Harrell and Sommer 2003), including spring-run Chinook salmon. Delta exports and diversions can also affect Delta flow rates and hydrodynamics resulting in migration delays (National Marine Fisheries Service 1997). The Delta Cross Channel can also delay or block passage for salmon that migrate through the central Delta (National Marine Fisheries Service 2009a). Reducing adult passage delays at anthropogenic barriers is intended to contribute to increased survival of adult salmonids.

Goal SRCS3 (Life-History Diversity and Spatial Distribution): Improved availability of floodplain and channel margin habitat to support spring-run migration and rearing through the Delta.
• **Objective SRCS3.1 (Habitat)**: Increase availability of floodplain habitat by 1,000 acres within 15 years of BDCP implementation, and channel margin habitat by 5 miles within 10 years of BDCP implementation, for spring-run migration and rearing compared to baseline conditions.
Assumed Stressor: Lack of rearing and migration habitat. **Stressor Reduction Target:** • **Juvenile Rearing and Migration Habitat**. Determine potential to provide suitable rearing habitat to emigrants within the specified timeframe. • **Migration Routes (Sac).** Identify and assess alternative migratory pathways in terms of adequacy, frequency of availability and routing schemes.

Objective SRCS3.1 (Habitat) Rationale: Ensuring that floodplain habitat is available in Yolo Bypass and that setback levees are available on the Sacramento River will increase the heterogeneity of habitat in the mainstem Sacramento River to provide spatial structure for juvenile salmonids within 10 years of Plan implementation. Studies suggest that restoring river-floodplain connectivity in the Plan Area will enhance both primary production (Ahearn et al. 2006) and zooplankton growth (Grosholz and Gallo 2006), ultimately benefitting higher level consumers like fish species. Extensive research on the Yolo Bypass and lower Cosumnes River, in addition to some research in the Sutter Bypass, indicates that native fish such as Sacramento splittail and juvenile Chinook salmon show enhanced growth and fitness when they have access to floodplain habitats (Swenson et al. 2003; Moyle and Grosholz 2003; Sommer et al. 2001b, 2004; Crain et al. 2004; Ribeiro et al. 2004; Feyrer et al. 2004).

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Historically, the rivers were not contained by their channels during high flows, and spread out over large areas to provide extensive floodplain habitat for juvenile salmonids (Kelley 1989; Williams 2006). The overbank habitat along the lower rivers included the extensive tidal marsh habitat of the Delta and the bays. Although data are lacking, it seems likely that juvenile salmon historically used tidal and subtidal habitats all across the Delta (Williams 2009). Channel modifications (levees) have eliminated or substantially reduced the extent and frequencies of these overbank inundations, thereby reducing access to these highly productive areas for juvenile salmonid rearing, except for the Butte Sink, the Sutter and Yolo Bypasses, unleveed reaches of the Cosumnes River, and remnant tidal marshes in the Delta. Williams (2009) hypothesized that this loss of overbank and tidal juvenile rearing habitat could be as important to the decline of salmonid fish runs as the loss of upstream spawning habitat. Therefore, improving access to these overbank, channel margin and floodplain habitats is expected to enhance the overall growth and survival of juvenile salmonids.

3.3.5.5 Chinook Salmon, Fall- and Late-Fall Run

The Central Valley fall- and late fall-run Chinook salmon ESU includes all naturally spawned populations of fall- and late fall-run Chinook salmon in the Sacramento and San Joaquin River basins and their tributaries east of Carquinez Strait, California (64 *Federal Register* [FR] 50394). On September 16, 1999, after reviewing the best available scientific and commercial information, NMFS determined that listing Central Valley fall- and late fall-run Chinook salmon ESU was not warranted. On April 15, 2004, the Central Valley fall- and late fall-run Chinook salmon ESU was identified by NMFS as a species of concern (69 FR 19975). The Central Valley fall- and late fall-run Chinook salmon ESU are not listed under the California Endangered Species Act (CESA). Fall-run and late fall-run Chinook salmon are identified as a California species of special concern (Moyle et al. 1995).

The abundance of Central Valley fall- and late fall-run Chinook salmon escapement before 1952 is poorly documented. Reynolds et al. (1993) estimated that production of fall- and late fall-run Chinook salmon on the San Joaquin River historically approached 300,000 adults and probably averaged approximately 150,000 adults. Calkins et al. (1940) estimated fall- and late fall-run Chinook salmon abundance at 55,595 adults in the Sacramento River Basin from 1931 through 1939. In the early 1960s, adult fall- and late fall-run Chinook salmon escapement was estimated to be 327,000 fish in the Sacramento River basin (California Department of Fish and Game 1965). In the mid-1960s, fall- and late fall-run Chinook salmon escapement to the San Joaquin River basin was estimated to be about 2,400 fish, which spawned in the San Joaquin River tributaries—the Stanislaus, Tuolumne, and Merced Rivers.

Long-term trends in adult fall-run Chinook salmon escapement indicate that abundance in the Sacramento River has been consistently higher than abundance in the San Joaquin River (Figure 3.3-5). Escapement on the Sacramento River has been characterized by relatively high interannual variability ranging from approximately 100,000 to over 800,000 fish. Sacramento River escapement showed a marked increase in abundance between 1990 and 2003 followed by a decline in abundance over the period from 2004 through present. In 2009, adult fall-run Chinook salmon returns to the Central Valley rivers showed a substantial decline in both the Sacramento and San Joaquin River systems. Similar declines in adult escapement were also observed for coho salmon and Chinook salmon returning to other river systems in California (MacFarlane et al. 2008b).

Important threats and stressors to winter-run Chinook salmon are summarized below. Refer to Appendix 2.A, *Covered Species Accounts,* for a full discussion of these stressors.

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Reduced staging and spawning habitat. Access to the upper extent of the historical upstream spawning habitat for fall- and late fall-run Chinook has been eliminated or degraded by human-made structures (e.g., dams and weirs) associated with water storage and conveyance, flood control, and diversions and exports for municipal, industrial, agricultural, and hydropower purposes (Yoshiyama et al. 1998). Because spawning locations of fall- and late fall-run Chinook salmon are typically in the lower reaches of rivers, fall- and late fall-run Chinook salmon have been less affected by dam construction relative to other Central Valley salmonids.

Reduced rearing and out-migration habitat. Much of the Sacramento and San Joaquin River corridor and the Delta have been leveed, channelized, and modified with riprap for flood protection, thereby reducing and degrading the quality and availability of natural habitat for rearing and emigrating juvenile Chinook salmon (Brandes and McLain 2001). Juvenile out-migration delays associated with human-made passage impediments can reduce fitness and increase susceptibility to diversion screen impingement, entrainment, disease, and predation.

Predation by nonnative species. Predation on juvenile salmon by nonnative fish has been identified as an important threat to fall- and late fall-run Chinook salmon in areas with high densities of nonnative fish (e.g., small- and largemouth bass, striped bass, and catfish) that prey on out-migrating juvenile salmon (Lindley and Mohr 2003). Nonnative aquatic vegetation, such as Brazilian waterweed and water hyacinth, provide suitable habitat for nonnative predators (Nobriga et al. 2005; Brown and Michniuk 2007).

Harvest. Commercial or recreational harvest of fall- and late fall-run Chinook salmon populations in the ocean and inland fisheries has been a subject of management actions by the California Fish and Game Commission and the Pacific Fishery Management Council. Harvest as a result of the commercial and recreational fisheries may be having detrimental effects on wild spawners in this mixed stock fishery, but few data are available.

Reduced genetic diversity and integrity. Artificial propagation programs (hatchery production) for fall- and late fall-run Chinook salmon in the Central Valley present multiple threats to naturally propagated Chinook salmon populations, including genetic introgression by hatchery origin fish that spawn naturally and interbreed with local wild populations (U.S. Fish and Wildlife Service 2001; U.S. Bureau of Reclamation 2004; Goodman 2005). The potential for interbreeding between Central Valley spring- and fall-run salmon stocks is generally identified as a genetic concern (Yoshiyama et al. 1998); however, some studies indicate no evidence of natural hybridization among Chinook salmon runs despite the spatial and temporal overlap (Banks et al. 2000).

Entrainment. Losses to entrainment mortality at diversions and intakes affect Chinook salmon populations (Kjelson and Brandes 1989). Juvenile fall-run Chinook salmon tend to be distributed in the central and south Delta where they have an increased risk of entrainment or salvage between January and April. Juvenile late fall-run Chinook salmon tend to be distributed within the Delta primarily between December and January and again between April and May. The effect of changing hydrodynamics in Delta channels, such as reversed flows in Old and Middle Rivers resulting from SWP/CVP export operations, has the potential to increase attraction of emigrating juveniles into false migration pathways, delay emigration through the Delta, and directly or indirectly increase vulnerability to entrainment at unscreened diversions, risk of predation, and the duration of exposure to seasonally elevated water temperatures and other water quality impairments. SWP/CVP exports have been shown to affect tidal hydrodynamics (e.g., water current velocities and direction). In

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addition to SWP/CVP exports, approximately 2,589 nonproject diversions exist throughout the Plan Area.

Exposure to toxins. Toxic chemicals occurring in the Delta include mercury, selenium, copper, pyrethroids, and endocrine disruptors. These contaminants have the potential to affect fish health and condition, and adversely affect salmon distribution and abundance. Sublethal concentrations of toxins may interact with other stressors to cause adverse effects on salmonids, such as increasing their vulnerability to mortality as a result of exposure to seasonally elevated water temperatures, predation, or disease (Werner 2007).

Increased water temperature. Higher water temperatures can lead to physiological stress, reduced growth rate, delayed passage, *in vivo* egg mortality of spawning adults, prespawning mortality, reduced spawning success, and increased mortality of salmon (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). The effects of climate change and global warming patterns, in combination with changes in precipitation and seasonal hydrology in the future have been identified as important factors that may adversely affect the health and long-term viability of Central Valley spring-run Chinook salmon (Crozier et al. 2008). The rate and magnitude of these potential future environmental changes, and their effect on habitat quality and availability for fall- and late fall-run Chinook salmon, however, are subject to a high degree of uncertainty.

The conservation strategy for fall-run Chinook salmon focuses on life stages occurring in the Plan Area, and targets efforts to benefit those life stages when they are present in the Plan Area. Juvenile Chinook salmon foraging and rearing habitat has been compromised by floodplain modifications, contributing to reductions in the abundance and distribution of Chinook salmon. Therefore, the conservation approach will include tidal natural community restoration to increase rearing habitat in the Suisun Marsh, Cache Slough, West Delta, and South Delta ROAs. The approach also includes reducing the relative percentage of juvenile outmigrants that are entrained at the SWP/CVP south Delta facilities, and reducing the predation levels in the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.5.1 Applicable Landscape-Scale Goals and Objectives

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]*

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for fall-run Chinook salmon are included below.

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Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.

- **Objective L1.2**: Protect sufficient lands for the restoration of natural communities as described in Objective L1.3.
- **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities.
- **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objective L1.2 Benefits: Benefits of this objective for fall-run Chinook salmon the same as those described for winter-run Chinook salmon.

Objective L1.3 Benefits: Late fall-run Chinook salmon, which tend to migrate through the Delta rather slowly (Williams 2009), rely heavily on seasonally inundated floodplains and tidally influenced natural communities. Benefits of this objective for fall-run Chinook salmon are the same as those described for winter-run Chinook salmon.

Objective L1.4 Benefits: Benefits of this objective for fall-run Chinook salmon are the same as those described for winter-run Chinook salmon.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.3:** Allow lateral river channel migration.
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat.
- **Objective L2.6:** Maintain or increase life-history diversity of native fishes and a diversity of spawning and rearing conditions for native fishes over time.
- **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
- **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
- **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2 through L2.6, and L2.8 through L2.10 Benefits: Benefits of these objectives for fall-run Chinook salmon are the same as those described for winter-run Chinook salmon.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.

- **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.
- **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

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Objectives L3.3 and L3.4 Benefits: Benefits of these objectives for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objectives L4.1 through L4.4 Benefits: Benefits of these objectives for fall-run Chinook salmon are the same as those described for winter-run Chinook salmon.

3.3.5.5.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for fall-run Chinook salmon are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Benefits of this objective for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon, with the exception of the timing. Most fall-run Chinook salmon fry rear in freshwater from December through June, with emigration as smolts occurring from April through June. Smolts that arrive in the estuary after rearing upstream migrate quickly through the Delta and Suisun and San Pablo Bays. A very small number (generally less than 5%) of fall-run juveniles spend over a year in fresh water and emigrate as yearling smolts the following November through April. Late fall-run fry rear in fresh water from April through the following April and emigrate as smolts from November through April. The timing of migration varies somewhat due to changes in river flows, dam operations, seasonal water temperatures, and hydrologic conditions (water year type).

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Benefits of this objective for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 through TBEWNC1.4 Benefits: Benefits of these objectives for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

- **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.
- **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objectives TFEWNC1.1 and TFEWNC1.2 Benefits: Benefits of these objectives for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Objectives VFRNC1.1 and VFRNC1.3 Benefits: Benefits of these objectives for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.

- **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle.
- **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Benefits of these objectives for fall-run Chinook salmon are similar to those described for winter-run Chinook salmon.

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3.3.5.5.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve protect, restore, and enhance suitable habitat for fall- and late fall-run Chinook within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for fall-run Chinook salmon are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for Chinook salmon will be achieved via habitat restoration and altered flow management. Habitat restoration benefits will chiefly derive from tidal habitat restoration, seasonally inundated floodplain restoration, channel margin enhancement, and riparian habitat restoration, which are expected to increase primary and secondary production to contribute to increased food resources for salmonids as well as increase habitat complexity. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce the spatial overlap of diversion intakes and Chinook salmon occurrence, thereby substantially reducing entrainment.

Increasing the availability of floodplain and channel margin habitat is anticipated to increase productivity within the Plan Area. The proposed seasonally inundated floodplain habitat restoration actions are expected to increase the amount and quality of accessible rearing habitat for juvenile salmon. The intent is to route salmon away from the interior Delta and through habitat that is favorable for growth. These expected benefits are supported by a number of existing studies (e.g., Sommer et al. 2001a; Whitener and Kennedy 1999; Moyle et al. 2007).

Reducing passage delays at anthropogenic barriers will reduce migratory delays and increase survival of adult salmonids during their upstream migration to spawning areas. Reducing migratory delays will contribute to an increase in survival of adult salmonids as they are exposed to less potential stress, stranding, and illegal harvest.

Global Goal and Objective Developed by the National Marine Fisheries Service Independent of BDCP[14]

Global Goal 1: Increase fall-run Chinook salmon abundance
• **Global Objective 1.1 (Abundance):** Increase the life-history and genetic diversity within the ESU. • **Global Objective 1.2 (Abundance):** Reduce in-river and in-Delta loss of juvenile Chinook salmon. • **Global Objective 1.3 (Abundance):** Improve the quality and extent of freshwater rearing habitat. • **Global Objective 1.4 (Abundance):** Improve juvenile outmigration success

[14] Citation to be provided.

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Global Goal 2: Increase spatial distribution of fall-run Chinook salmon
• **Global Objective 2.1 (Life-History Diversity and Spatial Distribution):** Increasing the life-history and genetic diversity within the ESU. • **Global Objective 2.2 (Lif- History Diversity and Spatial Distribution):** Promoting the utilization and excapement of fall-run Chinook salmon in smaller, lesser known tributaries. • **Global Objective 2.3 (Life-History Diversity and Spatial Distribution):** Improve the quality and extent of freshwater rearing habitat. • **Global Objective 2.4 (Life-History Diversity and Spatial Distribution):** Reduce cyclical fluctuations in population abundance from non-ocean driven events. • **Global Objective 2.5 (Life-History Diversity and Spatial Distribution):** Stabilize and reverse dramatic populations of the San Joaquin River watershed.

As stated previously, the global goals and objectives were developed by NMFS independent of the BDCP and are associated with the NMFS' responsibility to recover species protected under the federal ESA. The BDCP fall-run Chinook salmon goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of Chinook salmon recovery.

Goal FRCS1 (**Abundance):** Improved survival (to contribute to increased abundance) of emigrating juvenile fall-run salmon through the Plan Area.
• **Objective FRCS1.1 (Juvenile Survival):** Achieve a 4-year running average through-Delta juvenile survival rate, which will result in stable or expanding population[15] within 15 years of BDCP implementation.
Assumed Stressors: Entrainment, lack of rearing habitat, spatial structure, adult passage and illegal harvest. **Stressor Reduction Targets:** • **Entrainment**. Reduce mortality in SWP/CVP South Delta Facilities to less than 1% for fish entering facilities within 5 years of implementation. • **Predation.** Reduce predation in CCFB and at the CVP trashracks to achieve mortality rate of less than 1% across CCFB and past CVP trashracks within 5 years of implementation.

Objective FRCS1.1 (Juvenile Survival) Rationale: Survival of juvenile Chinook salmon during freshwater emigration through the Delta depends on a number of factors, including flow, temperature, Delta Cross Channel gate status, tides, predation rates, and water clarity; juvenile travel time through the Plan Area; migration distance (Anderson et al. 2005); toxics; food availability; availability of suitable rearing habitat; and entrainment. In particular, survival depends on distance traveled in the river when water velocity is dominated by the river flow as well as travel time through the Delta when water velocity is dominated by the tides.

The objective is to improve survival from the upper Sacramento and San Joaquin Rivers to Chipps Island to a 4-year running average, which is sufficient enough to contribute to a stable and expanding population. The recommended approach to establishing survival targets involves a

[15] Through-Delta survival targets to be refined using similar analysis used for San Joaquin River flow objectives recommendations to the State Water Resources Control Board (U.S. Department of Interior 2011). Potential to measure: can be measured (e.g., see papers by Perry and Skalksi 2008; MacFarlane and Norton 2001; Brandes 1996; Newman 2008).

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process where technical experts collectively determine what survival is needed in the Delta, given average conditions in other phases of the life cycle and a specific timeframe to achieve the larger goals. The specific values would be developed by a small technical group and could vary by water year type, as described below. Regardless of the ultimate survival rate, meeting the target is expected to result in improvements that can contribute to the larger global escapement goals.

Existing data on juvenile Chinook salmon survival through the Delta is limited. Two years of survival estimates based on hydroacoustic tag studies (Perry et al. 2010) indicate survival from Sacramento to Chipps Island of fall-run juvenile Chinook was about 50% with a standard error of about 10%.

Other studies indicate that the relative survival of Chinook salmon fall-run fry rearing in Yolo Bypass to Chipps Island was on average 50% higher than fish passing over the comparable section of the Sacramento River (Sommer et al., 2001b). Survival of Sacramento fish passing through the interior of the Delta was lower than fish passing through the Sacramento River (0.35 mean ratio of survival probabilities) (Newman and Brandes 2009).

Data from studies on juvenile Chinook salmon survival for fish emigrating from the San Joaquin River indicate that survival through the Delta is highly variable ranging from a high of 80% to a low of 0 (Figure 3.3-4).

Analysis completed on the San Joaquin drainage estimated survival for each of several key life stage criteria (U.S. Department of Interior 2011). Modeling results suggest that a 50% through-Delta survival would support a cohort replacement rate of 1.7, which would be sufficient to achieve the Anadromous Fish Restoration Plan doubling goal (U.S. Department of the Interior 2011)(result includes several critical assumptions relative to survival in other life stages). As mentioned previously, a small technical team should be convened to vet survival targets, including the existing proposed San Joaquin target survival rate, to determine survival targets for BDCP covered fish species. A similar analysis could be completed for the Sacramento River drainage to refine conservation targets based on basin-specific conditions and provide projections of survival rates and associated population levels necessary to achieve self-sustaining populations.

The BDCP goal is to provide through-Delta juvenile fall-run Chinook salmon survival rates from the upper Sacramento and San Joaquin Rivers to Chipps Island to achieve a 4-year running average, which is sufficient to contribute to stable or expanding populations within 15 years of BDCP implementation. The recent 5-year moving average cohort replacement rate is 0.63 (National Marine Fisheries Service 2009a; Pacific Fishery Management Council 2011) and the long-term average is 1.54.

Goal FRCS2 (Abundance): Reduce passage delays (to contribute to increased migration and spawning success and thus abundance) at anthropogenic impediments of adult fall-run migrating through the Delta.
• **Objective FRCS2.1 (Migration):** Reduce passage delays at anthropogenic barriers and impediments that cause median passage times of more than 36 hours, within 3 years of BDCP implementation.
Assumed Stressor: Migration delays. **Stressor Reduction Target:** • **Adult Passage.** Limit adult passage delays at anthropogenic barriers and impediments in the Delta to no more than 36 hrs, within 15 years of implementation.

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Objective FRCS2.1 (Migration) Rationale: While adult Chinook salmon upstream passage is generally unobstructed in the Delta, modifications of the migratory corridors are warranted, particularly within the Yolo Bypass/Freemont Weir (within the Plan Area) and Sutter Bypass/Tisdale Weir to ensure that fish delays in passing weirs are minimal. Operations at the Fremont Weir do not currently support year-round flows on the floodplain, and thus may prevent passage by some Central Valley salmonids (Harrell and Sommer 2003). Delta exports and diversions can also affect Delta flow rates and hydrodynamics resulting in migration delays (National Marine Fisheries Service 1997). Low DO conditions in the Sacramento and Stockton DWSCs can also be a threat to adult fall- and late-fall-run Chinook salmon migration through the Delta (National Marine Fisheries Service 2009a). The Delta Cross Channel can also delay or block passage to salmon that migrate through the central Delta (National Marine Fisheries Service 2009a). Reducing adult passage delays at anthropogenic barriers is intended to contribute to increased survival of adult salmonids. Several conservation measures will address some of these issues, including *CM1Water Facilities and Operation*, which will address flow conditions within the Plan Area; *CM2 Yolo Bypass Fisheries Enhancement*, which will address anthropogenic barriers and migration delays within the Yolo Bypass; and *CM14 Stockton Deep Water Ship Channel Dissolved Oxygen Levels*, which will address the low DO conditions that occur in the Stockton DWSC and affect salmonid migrations.

Goal FRCS3 (Life-History Diversity and Spatial Distribution): Improved availability of floodplain and channel margin habitat to support fall-run migration and rearing through the Delta.
• **Objective FRCS3.1 (Life-History Diversity and Spatial Distribution):** Increase availability of floodplain habitat by 1,000 acres within 15 years of BDCP implementation, and channel margin habitat by 5 miles within 10 years of BDCP implementation, for fall-run migration and rearing compared to baseline conditions.
Assumed Stressors: Lack of rearing habitat, migration routes. **Stressor Reduction Targets:** • **Floodplain Habitat**. Improve the availability of floodplain habitat in January through mid-May when the majority of fall- and late fall-run Chinook salmon are detected upstream of the Fremont Weir within 1 year of plan implementation. Maintain availability of floodplain habitats in > 40% of years. • **Channel Margin Habitat**. Increase the heterogeneity of channel margin habitat along key migration corridors to provide spatial structure for juvenile salmonids within 10 years of plan implementation. • **Migration Routes**. Create at least one alternative (non-mainstem) migration pathway on the lower Sacramento River and San Joaquin River in >40% of years, within 10 years of implementation.

Objective FRCS3.1 (Life-History Diversity and Spatial Distribution) Rationale: Ensuring that floodplain habitat is available in Yolo Bypass and setback levees are available on the Sacramento River will increase the heterogeneity of habitat in the mainstem Sacramento River to provide spatial structure for juvenile salmonids. Studies suggest that restoring river-floodplain connectivity in the Plan Area will enhance both primary production (Ahearn et al. 2006) and zooplankton growth (Grosholz and Gallo 2006), ultimately benefitting higher-level consumers like fish species. Extensive research on the Yolo Bypass and lower Cosumnes River, in addition to some research in the Sutter Bypass, indicates that native fish such as Sacramento splittail and juvenile Chinook salmon show enhanced growth and fitness when they have access to floodplain habitats (Swenson et al. 2003; Moyle and Grosholz 2003; Sommer et al. 2001b, 2004; Crain et al. 2004; Ribeiro et al. 2004; Feyrer et al. 2004).

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Historically, the rivers were not contained by their channels during high flows, and spread out over large areas to provide extensive floodplain habitat for juvenile salmonids (Kelley 1989; Williams 2006). The overbank habitat along the lower rivers included extensive tidal marsh habitat of the Delta and the bays. Although data are lacking, it seems likely that juvenile salmon historically used tidal and subtidal habitats all across the Delta (Williams 2009). Channel modifications (levees) have eliminated or substantially reduced the extent and frequencies of these overbank inundations, thereby reducing access to these highly productive areas for juvenile salmonid rearing, except for the Butte Sink, the Sutter and Yolo Bypasses, unleveed reaches of the Cosumnes River, and remnant tidal marshes in the Delta. Williams (2009) hypothesized that this loss of overbank and tidal juvenile rearing habitat could be as important to the decline of salmonid fish runs as the loss of upstream spawning habitat. Therefore, improving access to these overbank, channel margin, and floodplain habitats is expected to enhance the overall growth and survival of juvenile salmonids.

Goal FRCS4 (Life-History Diversity and Spatial Distribution): Reduced illegal take (to contribute to increased abundance and genetic and life-history diversity) of fall-run adults in the Delta.
• **Objective FRCS4.1 (Life-History Diversity and Spatial Distribution):** Increase enforcement efforts to reduce illegal take in the Plan Area within 5 years of BDCP implementation.
Assumed Stressors: Illegal Harvest. **Stressor Reduction Targets:** • **Illegal Harvest**. Assess, and as appropriate reduce illegal harvest in the Delta within 5 years of plan implementation.

Objective FRCS4.1 (Life-History Diversity and Spatial Distribution) Rationale: Excessive losses from fishing could affect covered species by intentional capture of allowed species (fall-run Chinook salmon, white sturgeon), incidental capture of nontarget listed species (steelhead, green sturgeon), and poaching (white sturgeon for caviar). Rates of illegal harvest are unknown but are likely to include harvest of relatively few individuals within the population as a whole. However, harvest tends to occur of larger adults, which have a much greater reproductive potential for the population than smolts or fry because of their higher survival and reproductive rates.

For covered species with small population sizes, such as spring-run Chinook, or species with low recruitment rates, such as sturgeon, harvest could have a disproportionately greater effect than on species with larger population sizes or more rapid recruitment. Sturgeon populations could be substantially affected by harvest because of their long interval to maturity and infrequent reproduction.

The objective is intended to reduce illegal harvest of Chinook salmon, Central Valley steelhead, green sturgeon, and white sturgeon in the Delta, bays, and upstream waterways, based on the assumption that the number of adults is a key limiting factor for these populations, and increased enforcement will decrease poaching mortality and increase adult survival. This objective will contribute to an increase in adult survival, and thus an increase in abundance.

3.3.5.6 Steelhead (Central Valley DPS)

Within the Plan Area, habitat for steelhead consists of freshwater spawning, rearing, and migration habitat, as well as estuarine migration and rearing habitat.

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Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, egg incubation, and larval development. Spawning habitat for Central Valley steelhead primarily occurs in mid- to upper-elevation reaches or immediately downstream of dams located throughout the Central Valley, which contain suitable environmental conditions (e.g., seasonal water temperatures, substrate, DO) for spawning and egg incubation. Spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of steelhead.

Freshwater steelhead rearing sites are those with suitable instream flows, water quantity (e.g., water temperatures) and floodplain connectivity to form and maintain physical habitat conditions that support juvenile growth and mobility, provide forage species and include cover such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Spawning areas and migratory corridors may also function as rearing habitat for juveniles, which feed and grow before and during their out-migration. Rearing habitat quality is strongly affected by habitat complexity, food supply, and the presence of predators. Some of these more complex and productive habitats with floodplain connectivity are still present in the Central Valley (e.g., the lower Cosumnes River and Sacramento River reaches with set-back levees [primarily upstream of Colusa]). The channeled, leveed, and riprapped river reaches and sloughs common in the lower Sacramento and San Joaquin Rivers and throughout the Delta, however, typically have low habitat complexity, low abundance of food organisms, and offer little protection from predation by fish and birds. Freshwater rearing habitat has a high conservation value because juvenile steelhead are dependent on the function of this habitat for successful survival and recruitment to the adult population.

Optimal freshwater steelhead migration corridors (including river channels, channels through the Delta, and the Bay-Delta estuary) support mobility, survival, and food supply for juveniles and adults. Migration corridors should be free from obstructions (passage barriers and impediments to migration), provide favorable water quantity (instream flows) and quality conditions (seasonal water temperatures), and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Migratory corridors are typically downstream of the spawning area and include the lower Sacramento and San Joaquin Rivers, the Delta, and the San Francisco Bay complex extending to coastal marine waters. These corridors allow the upstream passage of adults and the downstream emigration of juvenile steelhead. Migratory corridor conditions are strongly affected by the presence of passage barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality. For freshwater migration corridors to function properly, they must provide adequate passage, provide suitable migration cues, reduce false attraction, avoid areas where vulnerability to predation is increased, and avoid impediments and delays in both upstream and downstream migration. For this reason, freshwater migration corridors are considered to have a high conservation value.

Estuarine migration and juvenile rearing habitats should be free of obstructions (i.e., dams and other barriers) and provide suitable water quality, water quantity, and salinity conditions to support juvenile and adult physiological transitions between fresh and salt water. Natural cover, such as submerged and overhanging large wood, aquatic vegetation, and side channels, provide juvenile and adult foraging. Estuarine areas contain a high conservation value as they function to support juvenile steelhead growth, smolting, avoidance of predators, and provide a transition to the ocean environment.

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Central Valley steelhead were widely distributed historically throughout the Sacramento and San Joaquin Rivers (Busby et al. 1996; McEwan 2001). Steelhead inhabited waterways from the upper Sacramento and Pit River systems (now inaccessable due to Shasta and Keswick Dams) south to the Kings River and possibly the Kern River systems, and in both east- and westside Sacramento River tributaries (Yoshiyama et al. 1996). Lindley et al. (2006) estimated that there were historically at least 81 independent Central Valley steelhead populations distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin Rivers.

The geographic distribution of spawning and juvenile rearing habitat for Central Valley steelhead has been greatly reduced by the construction of dams (McEwan and Jackson 1996; McEwan 2001). Presently, impassable dams block access to 80% of historically available habitat, and all spawning habitat for approximately 38% of historical populations (Lindley et al. 2006). Existing wild steelhead stocks in the Central Valley inhabit the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks, and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

Historical Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, steelhead run size had declined to approximately 40,000 adults (McEwan 2001). Over the past 30 years, naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, recent monitoring has detected small, self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good et al. 2005). Some of these fish, however, may have been resident rainbow trout, which are the same species but are not anadromous.

Important threats and stressors to steelhead are summarized below. Refer to Appendix 2.A, *Covered Species Accounts,* for a full discussion of these stressors.

- **Reduced staging and spawning habitat.** Adult steelhead historically migrated upstream into higher gradient reaches of rivers and tributaries where water temperatures were cooler, turbidity was lower, and gravel substrate size was suitable for spawning and egg incubation (McEwan 2001). The majority of historical adult staging, holding, and spawning habitat for Central Valley steelhead is no longer accessible to upstream migrating steelhead or has been eliminated or degraded by human-made structures (e.g., dams and weirs) associated with water storage and conveyance, diversions, flood control, municipal, industrial, agricultural, and hydropower purposes (McEwan and Jackson 1996; McEwan 2001; Bureau of Reclamation 2004; Lindley et al. 2006; National Marine Fisheries Service 2007). Reduced flows from dams and upstream water diversions can lower attraction cues for adult spawners, causing straying and delays in spawning or the inability to spawn (California Department of Water Resources 2005). Adult steelhead migration delays can reduce fecundity and egg viability and increase susceptibility to disease and harvest.

- **Reduced rearing and out-migration habitat.** Juvenile steelhead prefer to use natural stream banks, floodplains, marshes, and shallow water habitats for rearing during out-migration. Much of

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the Delta has been leveed, channelized, and fortified with riprap for flood protection, reducing and degrading the quality and availability of natural habitat for use by steelhead during migration (McEwan 2001). Furthermore, effects on the quality, quantity, and availability of suitable habitat are likely to reduce fitness and increase susceptibility to entrainment, disease, exposure to contaminants, and predation.

- **Predation by nonnative species.** In general, the effect of nonnative predation on the Central Valley steelhead DPS is unknown. However, nonnative predation is likely an important threat to Central Valley steelhead in areas with high densities of nonnative fish (e.g., small- and largemouth bass, striped bass, and catfish) are thought to prey on out-migrating juvenile steelhead. Nonnative aquatic vegetation, such as Brazilian waterweed and water hyacinth, provide suitable habitat for nonnative predators (Brown and Michniuk 2007). The low spatial complexity of channelized waterways (e.g., riprap-lined levees that provide virtually no cover protection from predators) and general low habitat diversity elsewhere in the Delta reduces refuge cover and protection of steelhead from predators (Raleigh et al. 1984; Missildine et al. 2001; 70 FR 52488).
- **Harvest.** Steelhead have been, and continue to be, an important recreational fishery within inland rivers throughout the Central Valley. Although there are no commercial fisheries for steelhead, inland steelhead fisheries include tribal and recreational fisheries. The effects of illegal harvest occurring in the Delta and tributary rivers is thought to be relatively minor for Chinook salmon and steelhead. The effects of recreational fishing and the unknown level of illegal harvest on the abundance and population dynamics of wild Central Valley steelhead have not been quantified.
- **Reduced genetic diversity and integrity.** It is now recognized that Central Valley hatcheries are a significant and persistent threat to wild Chinook salmon and steelhead populations and fisheries (National Marine Fisheries Service 2009a). One major concern with hatchery operations is the genetic introgression by hatchery origin fish that spawn naturally and interbreed with local natural populations (U.S. Fish and Wildlife Service 2001; Bureau of Reclamation 2004; Goodman 2005). Such introgression introduces maladaptive genetic changes to the wild steelhead stocks (McEwan and Jackson 1996; Myers et al. 2004).
- **Entrainment.** Juvenile steelhead migrating downstream through the Delta are vulnerable to entrainment and salvage at the SWP/CVP export facilities, primarily between March and May. There are also multiple factors that can influence the vulnerability of juvenile steelhead to entrainment by SWP/CVP export facilities, including the geographic distribution of steelhead within the Delta and hydrodynamic factors such as reverse flows in Old and Middle Rivers, which are a function of export operations relative to San Joaquin River inflows, and southward flows of Sacramento River water toward pumps through an open Delta Cross Channel and Georgiana Slough. In addition to SWP/CVP export facilities, there are over 2,200 small water diversions within the Delta, of which the majority are unscreened (Herren and Kawasaki 2001). The risk of entrainment is a function of the size of juvenile fish and the slot opening of the screen mesh (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987). Although entrainment or salvage of steelhead at the SWP/CVP export facilities is well documented, it is unclear how many juvenile steelhead are entrained at other unscreened Delta diversions.

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- **Exposure to toxins.** Toxic chemicals are widespread throughout the Delta and may occur on a more localized scale in response to episodic events (e.g., stormwater runoff, point source discharges, etc.). These toxic substances include mercury, selenium, copper, pyrethroids, and endocrine disruptors with the potential to affect fish health and condition, and negatively affect steelhead distribution and abundance directly or indirectly. Sublethal concentrations may interact with other stressors (e.g., seasonally elevated water temperatures, predation or disease) to increase vulnerability of steelhead to mortality.
- **Increased water temperature.** Higher water temperatures can lead to physiological stress, reduced growth rate, reduced spawning success, and increased mortality of steelhead (Myrick and Cech 2001). Temperature can also indirectly influence disease incidence and predation (Waples et al. 2008). Exposure to seasonally elevated water temperatures may occur as a result of reductions in flow as a result of upstream reservoir operations, reductions in riparian vegetation, channel shading, local climate, and solar radiation.

The Public Draft Recovery Plan for Central Valley Salmonids, including steelhead, was released by NMFS on October 19, 2009. Although not final, the overarching goal in the public draft is the removal of, among other listed salmonids, the Central Valley steelhead DPS from the federal list of endangered and threatened wildlife (National Marine Fisheries Service 2009a). Several objectives and related criteria represent the components of the recovery goal, including the establishment of at least two viable populations within each historical diversity group, as well as other measurable biological criteria.

The conservation approach for steelhead will focus on those life stages occurring in the Plan Area, and ensure efforts to benefit those specific life stages occur when they would be present in the Plan Area. Steelhead are generally thought to move quickly through estuarine habitats due to their larger size at out-migration. However, young Chinook salmon and steelhead forage in tidal habitat and will benefit from the increase in production at the base of the foodweb. Emergent vegetation communities support invertebrate populations and provide refuge from water currents and predation. Juveniles forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs. (Healey 1982; Levy and Northcote 1981; Simenstad et al. 1982; Moyle 2002). Some studies have found a benefit to size at ocean entry and survival when juvenile steelhead rear in estuarine marshes (Morgan 2006). Therefore, the conservation approach will include reducing the relative percentage of outmigrants that are entrained at the SWP/CVP south Delta facilities, and increasing the spatial distribution of steelhead habitat, such as floodplain and channel margin habitat within the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.6.1 Applicable Landscape-Scale Goals and Objectives

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]*

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Those landscape-scale biological goals and objectives that are integral to the conservation strategy for steelhead are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.

- **Objective L1.2**: Protect sufficient lands for the restoration of natural communities as described in Objective L1.3.
- **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities.
- **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objectives L1.2 through L1.4 Benefits: Benefits for steelhead similar to those described for winter-run Chinook salmon.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.3:** Allow lateral river channel migration.
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat.
- **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.
- **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
- **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
- **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2 through L2.6, L2.8, L2.9, and L2.10 Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.

- **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats.
- **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objectives L3.3 and L3.4 Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon.

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Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objectives L4.1 through L4.4 Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon.

3.3.5.6.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for steelhead are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Benefits of this objective for steelhead are similar to those described for winter-run Chinook salmon, with the exception of timing. Most steelead generally spend 1 (29%), or 2 (70%) years in their natal streams, with a small percentage (1%) spending 3 years before becoming smolts and migrating out of the Sacramento-San Joaquin River system (Hallock 1961). Smolts that arrive in the estuary after rearing upstream migrate quickly through the Delta and Suisun and San Pablo Bays. The timing of migration varies somewhat due to changes in river flows, dam operations, seasonal water temperatures, and hydrologic conditions (water year type).

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Benefits of this objective for steelhead are similar to those described for winter-run Chinook salmon

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 through TBEWNC1.4 Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

- **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.
- **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objective TFEWNC1.1 and TFEWNC1.2: Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Objective VFRNC1.1 and VFRNC1.3: Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.

- **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle.
- **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Benefits of these objectives for steelhead are similar to those described for winter-run Chinook salmon.

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3.3.5.6.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for steelhead within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for steelhead are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for steelhead will be achieved via habitat restoration and altered flow management. Habitat restoration benefits will chiefly derive from tidal habitat restoration, seasonally inundated floodplain restoration, channel margin enhancement, and riparian habitat restoration that is expected to increase primary and secondary production to contribute to increased food resources for salmonids as well as increase habitat complexity. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce the spatial overlap of diversion intakes and steelhead occurrence, thereby substantially reducing entrainment and predation.

Increasing the availability of floodplain and channel margin habitat is anticipated to increase productivity within the Plan Area. The proposed seasonally inundated floodplain habitat restoration actions are expected to increase the amount and quality of accessible rearing habitat for juvenile salmonids. The intent is to route salmonids away from the interior Delta and through habitat that is favorable for growth. To put on critical weight before entering the ocean, juvenile steelhead feed on zooplankton, benthic macroinvertebrates, amphipods, chironomid larvae, terrestrial insect drift, and larval fish on Delta floodplains (Sommer et al. 2001b; Moyle 2002; Moyle et al. 2004; Jeffres et al. 2008).

Global Goals and Objectives Developed by the National Marine Fisheries Service Independent of BDCP[16]

Global Goal 1: Increase steelhead abundance
• **Global Objective 1.1 (Abundance):** Achievement of 6-year geometric mean excapement levels of: 11,000 naturally produced adult steelhead in the Sacramento River and its tributaries, with no year below 5,000; and 1,700 in the San Joaquin River and its tributaries, with no year below 800. These numbers do not include hatchery produced steelhead.

[16] Citation to be provided.

Global Goal 2: Increase spatial distribution of steelhead
• **Global Objective 2.1 (Spatial Distribution):** Restoration of ten self-sustaining, independent populations of naturally produced steelhead in watersheds of the Sacramento and San Joaquin River drainages, broken down by region. • **Global Objective 2.2 (Spatial Distribution):** Restoration of ten self-sustaining, independent populations of naturally produced steelhead in the Sacramento and San Joaquin River drainages, broken down by region.

As stated previously, the global goals and objectives were developed by NMFS independent of the BDCP and are associated with NMFS' responsibility to recover species protected under the federal ESA. The BDCP steelhead goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of steelhead recovery.

Goal STHD1 (**Abundance):** Improved survival (to contribute to increased abundance) of juvenile steelhead emigrants form the Sacramento and San Joaquin River systems through the Plan Area.
• **Objective STHD1.1 (Juvenile Survival):** Achieve a 4-year running average through-Delta juvenile survival rate which will result in stable or expanding population[17] within 15 years of BDCP implementation.
Assumed Stressors: Entrainment and predation. **Stressor Reduction Targets:** • **Entrainment**. Limit entrainment to levels at or below the baseline condition in all water type years. Develop method similar to that presented by Nobriga and Cadrett (2001) for calculating the proportion of the population entrained in the SWP/CVP facilities to allow past and future extimates of proportion of population entrained on an annual basis. • **Predation.** Decrease predator density in known hot spots (Clifton Court Forebay, CVP Trashrack, Head of Old River, Georgiana Slough, Sutter Slough, Steamboat Slough, the proposed north diversion intake structures, and the SWP/CVP facilities) to achieve measurable decrease in steelhead predation within 15 years of plan implementation.

Objective STHD1.1 (Juvenile Survival) Rationale: Achieving this objective will contribute to stable or expanding populations within 15 years of BDCP implementation. Survival of juvenile Chinook salmon during freshwater emigration and immigration through the Delta is a major factor limiting fitness of all Central Valley Chinook salmon (assumed for steelhead), and moderate improvements in survival are expected to have significant beneficial effects on populations. Survival studies conducted in the last several years using coded wire tag and acoustic tags indicate that survival of juvenile salmonids is highly variable ranging from 0 to 80%. Survival levels in the San Joaquin River are generally much lower than those on the Sacramento River and low relative to other systems. Based on a small sample size, survival estimates for wild steelhead smolts from the American River to Golden Gate were found to be about 23% (National Marine Fisheries Service 2009); additional acoustic tagging studies (Sanstrom pers.comm.) may be available to determine baseline survival.

[17] Through-Delta survival targets to be refined using similar analysis used for San Joaquin River flow objectives recommendations to the State Water Resources Control Board (U.S. Department of Interior 2011). Potential to measure: can be measured (e.g., see papers by Perry and Skalksi 2008; MacFarlane and Norton 2001; Brandes 1996; Newman 2008).

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Survival of juvenile Chinook salmon during freshwater emigration through the Delta depends on a number of factors including the following (which are assumed to be applicable to steelhead): predator density, water clarity, temperature and flow, which affect predator encounters; smolt size, which affects the predators success in preying upon smolts; juvenile travel time through the Plan Area; migration distance (Anderson et al. 2005); toxics; food availability; availability of suitable rearing habitat; and entrainment. In particular, survival depends on distance traveled in the river when water velocity is dominated by the river flow as well as travel time through the Delta when water velocity is dominated by the tides. Similar to the approach outlined for fall-run Chinook salmon, a small technical team should be convened to vet survival targets for steelhead in order to determine survival targets for BDCP.

Goal STHD2 (Life-History Diversity and Spatial Distribution): Improved spatial distribution of juvenile steelhead in the Delta.
• **Objective STHD2.1 (Habitat) Rationale:** Increase availability of floodplain habitat by 1,000 acres within 15 years of BDCP implementation, and channel margin habitat by 5 miles within 10 years of BDCP implementation, for steelhead migration and rearing compared to baseline conditions.
Assumed Stressor: Lack of juvenile rearing habitat. **Stressor Reduction Target:** • **Juvenile Habitat**. Ensure that floodplain habitat is available in Yolo Bypass and set back levees are available on the Sacramento River to increase the heterogeneity of habitat in the mainstem Sacramento River to provide spatial structure foro juvenile salmonids within 10 years of implementation.

Objective STHD2.1 (Habitat) Rationale: Ensuring that floodplain habitat is available in Yolo Bypass and setback levees are available on the Sacramento River will increase the heterogeneity of habitat in the mainstem Sacramento River and provide spatial structure for juvenile salmonids. Studies suggest that restoring river–floodplain connectivity in the Plan Area will enhance both primary production (Ahearn et al. 2006) and zooplankton growth (Grosholz and Gallo 2006), ultimately benefitting higher-level consumers like fish species. To put on critical weight before entering the ocean, juvenile Chinook salmon and steelhead feed on zooplankton, benthic macroinvertebrates, amphipods, chironomid larvae, terrestrial insect drift, and larval fish on Delta floodplains (Sommer et al. 2001b; Moyle 2002; Moyle et al. 2004; Jeffres et al. 2008).

Historically, the rivers were not contained by their channels during high flows, and spread out over large areas to provide extensive floodplain habitat for juvenile salmonids (Kelley 1989; Williams 2006). The overbank habitat along the lower rivers included extensive tidal marsh habitat of the Delta and the bays. Although data are lacking, it seems likely that juvenile salmonids historically used tidal and subtidal habitats all across the Delta (Williams 2009). Channel modifications (levees) have eliminated or substantially reduced the extent and frequencies of these overbank inundations, thereby reducing access to these highly productive areas for juvenile salmonid rearing, except for the Butte Sink, the Sutter and Yolo Bypasses, unleveed reaches of the Cosumnes River, and remnant tidal marshes in the Delta. Williams (2009) hypothesized that this loss of overbank and tidal juvenile rearing habitat could be as important to the decline of salmonid fish runs as the loss of upstream spawning habitat. Therefore, improving access to these overbank, channel margin and floodplain habitats is expected to enhance the overall growth and survival of juvenile salmonids.

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3.3.5.7 Sacramento Splittail

Sacramento splittail appear to spawn in shallow water (less than 2 meters deep) over flooded vegetated habitat in the Yolo and Sutter Bypasses and along the Cosumnes River. Relatively warm temperatures and an abundance of food allow rapid growth and development. Maintaining and increasing this seasonally inundated floodplain habitat suitable for splittail spawning and juvenile rearing has been identified as a factor that will help maintain successful reproduction and increase juvenile abundance and genetic diversity during prolonged drought events (Sommer et al. 2002). Juvenile and subadult splittail commonly inhabit regions of the estuary characterized by salinities of 10 to 18 ppt, while adult splittail can survive salinities up to 29 ppt. Splittail also inhabit a broad range of temperature and DO levels, making them well suited to slow moving sections of sloughs and rivers. Channel margin and backwater habitats can be critical to the survival of splittail, providing refugia from predatory fishes and feeding sites as fish grow in upstream regions before and during downstream migration. Channel margin habitat also provides potential spawning habitat for Sacramento splittail, and may gain additional importance in drier years when floodplain habitat is not available.

The abundance of juvenile splittail is highly variable from one year to the next and positively correlated with hydrologic conditions within the rivers and Delta during the late winter and spring spawning period and the magnitude and duration of floodplain inundation. However, the abundance of juveniles in a given year may not be a good predictor of adult splittail abundance for this long-lived species (5 to 7 years). Results of DFG fall midwater trawl surveys indicate a marked decline in overall splittail abundance and consistently low population levels since 2002 (Figure 3.3-6).

Important threats and stressors to Sacramento splittail include reduced habitat for all life stages, reduced food, exposure to toxins, nonnative species, entrainment at water diversion facilities, and harvest. Refer to Appendix 2.A, *Covered Species Accounts*, for a full discussion of these stressors.

Although Sacramento splittail is not listed, it is included in the USFWS 1996 Sacramento-San Joaquin Delta Native Fishes Recovery Plan, which also includes the delta smelt, Sacramento splittail, green sturgeon, Sacramento perch, and three races of Chinook salmon (U.S. Fish and Wildlife Service 1996). An updated recovery plan from USFWS is expected to be completed soon. Splittail are also covered under the San Joaquin County and Solano County HCPs.

The conservation approach for Sacramento splittail includes minimizing entrainment, increasing available tidal mudflat, floodplain, and low velocity shallow side channel habitat to create spawning and rearing habitat; increasing available food resources; providing important linkages between current and future upstream restored habitat; and improving the inundation regime in Plan Area floodplains. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.7.1 Applicable Landscape-Scale Goals and Objectives

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The*

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landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for Sacramento splittail are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.

- **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities.
- **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.
- **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.

Objective L1.3, L1.4, and L1.8 Benefits: Benefits of these objectives for Sacramento splittail are similar to those described for delta smelt.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.

- **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt).
- **Objective L2.3:** Allow lateral river channel migration.
- **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.
- **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat.
- **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time.
- **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.
- **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species.
- **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objective L2.2 and L2.3 Benefits: Restoring natural fluvial processes such as flooding and later channel migration will contribute to improving habitat conditions for Sacramento splittail. Floodplains are important habitat for splittail, and increasing the frequency and extent of their inundation can increase the extent of spawning habitat and spawning success. Inundation also provides sediment inputs and thereby increases turbidity, which is important to Sacramento splittail for predator avoidance and capturing prey, as well as spawning (Kratville 2008). Splittail populations show a remarkable response to floodplain inundation (Moyle et al. 2004). Juveniles are most abundant in shallow (less than 2 meters), turbid water with a current, and are often found in small, narrow sloughs lined with tules and other emergent plants; mature, ripe splittail have been found in association with high turbidity, temperature below 15°C, and flooded terrestrial vegetation (Moyle et al. 2004).

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Objective L2.4 Benefits: Benefits of this objective for Sacramento splittail are similar to those described for delta smelt.

Objective L2.5 Benefits: Meeting this objective will reduce the amount of pollution in stormwater runoff entering Delta waterways, maintaining or improving water quality conditions to contribute to increasing food resources for Sacramento splittail. Reducing the amount of pollution in stormwater runoff entering Delta waterways will benefit Sacramento splittail by improving spawning success (Kratville 2008). There is insufficient information on the environmental tolerances of larva and eggs and toxic effects on floodplains from pesticides; selenium and mercury bioaccumulation, and endocrine disrupters. However, a reduction in pollution is anticipated to provide a benefit to larvae and eggs.

Objective L2.6 Benefits: Benefits of this objective for Sacramento splittail are similar to those described for delta smelt.

Objective L2.8 Benefits: Meeting this objective will support sinuous, high-density, dendritic networks through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered species. This is expected to promote food production and transport, which will benefit juvenile Sacramento splittail growth and survival. Such dendritic channels provide connectivity between inundated floodplain spawning habitat and juvenile rearing habitat. These channels may also transport increased fine sediment, which could result in increased turbidity, which would provide greater cover from predators.

Objective L2.9 Benefits: Meeting this objective will enhance floodplain connectivity and inundation, which will provide appropriate refugia and migration conditions for Sacramento splittail. Splittail are dependent on inundated floodplains for spawning success, and adequate connectivity to prevent stranding of juveniles (Kratville 2008). In addition to local access to the floodplain, both adult and juvenile splittail need adequate natural edge habitats in the channels between rearing and spawning areas (Kratville 2008). Channel margins provide refugia from predators, and food resources for growth and survival. Sacramento splittail production is substantially reduced in low flow years, as a result of limited spawning and early rearing habitat (Moyle et al. 2004).

Objective L2.10 Benefits: Benefits of this objective for Sacramento splittail are similar to those described for delta smelt.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.2:** Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic fish species. • **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.2 Benefits: Meeting this objective will increase connectivity between low salinity zone habitat and upstream freshwater spawning habitat anticipated to benefit Sacramento splittail. Adults spawn in inundated marsh areas with relatively high salinities, while juveniles prefer lower salinity areas. Overall, Sacramento splittail have a high tolerance to a wide variety of water quality

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parameters including salinity, temperature, and DO. They also exhibit a dynamic life-history regime, allowing the use of various spawning and rearing habitats, depending on annual variations in flow (Daniels and Moyle 1983; Kratville 2008).

Objective L3.3 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, and will allow the BDCP to provide flow conditions that can more easily coincide with the timing of the movement of larval and juvenile life stages of native fish to downstream rearing habitat important for Sacramento splittail, as spawning and early rearing typically occurs in inundated floodplains and larval and juvenile stages need to move to channel margins to prevent stranding (Kratville 2008). A strong positive relationship exists between juvenile Sacramento splittail production and the amount of inundated floodplain habitat (Kratville 2008). Equally as important is the connectivity of channels between spawning and rearing areas and the rate of receding waters; the rate should be sufficient to prevent stranding.

Objective L3.4 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, which will allow the BDCP to provide flow conditions that can better provide appropriate cues and access for adults to their preferred inundated floodplain spawning habitat. The abundance of YOY juvenile splittail is highly variable from one year to the next and positively correlated with hydrologic conditions within the rivers and Delta during the late winter and spring spawning period and the magnitude and duration of floodplain inundation (Sommer et al. 1997).

Goal L4: Reduce mortality of covered species in the Plan Area.

- **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities.
- **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species.
- **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta.
- **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta.

Objective L4.1 Benefits: Benefits of this objective for Sacramento splittail are similar to those described for delta smelt.

Objective L4.2 Benefits: Meeting this objective will reduce predation on larval and small juvenile splittail in flooded areas by an array of invertebrate predators, as well as by juveniles of both native and nonnative fishes that invade the areas during flood events. Major nonnative, predatory fish introduced into the Bay-Delta estuary, such as striped and largemouth bass, have resided in the Delta for over a century (Dill and Cordone 1997), and splittail have persisted. However, reduced turbidity in the Delta combined with increased habitat for nonnative predatory species provided by Brazilian waterweed and water hyacinth has enhanced both largemouth bass abundance and their ability to visually forage, thus increasing predation risk to splittail (Toft et al. 2003; Brown and Michniuk 2006). However, most adult alien predatory fishes such as largemouth bass and bluegill seldom venture far from permanent waterways onto the floodplain (Moyle et al. 2004).

Another major concern is the potential invasion of the Delta by the highly predatory northern pike. The pike, recently present in Lake Davis on the Feather River, is currently the target of a major eradication effort (California Department of Fish and Game 2007a). If eradication fails and pike

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escape downstream to the Delta, they would likely become abundant in many of the same habitats as splittail (Moyle 2002). Refer to *CM15 Predator Control* for discussion of the management of nonnative predators within the Plan Area.

Objective L4.3 Benefits: Meeting this objective will manage flows to influence the distribution of covered fish species and thus minimize movements into areas of high predation risk in the Delta. Longer inundation periods will also allow for extended and multiple spawning events as well as other foodweb-associated benefits during early rearing phases of Sacramento splittail. Floodplains also do not allow for residency of nonnative predators. Therefore, managing for higher flows may result in a wider distribution of Sacramento splittail and a reduction in predation and mortality rates.

Objective L4.4 Benefits: Meeting this objective will reduce the entrainment of Sacramento splittail. While small water diversion are not likely to cause substantial entrainment, the SWP and the CVP have relatively high rates of salvage when splittail populations are at high levels; YOY fish have critical swimming velocities that are below or near the water velocities of the large pumps and are entrained at these facilities (Young and Cech 1996). Power plants in the Plan Area also have the potential to entrain large number of YOY fish. Overall, the BDCP will substantially reduce exports from the south Delta facilities in most months relative to the existing biological conditions. Entrainment is expected to be reduced most in wetter years because a greater percentage of flow will be diverted from the north Delta in wet years than in dry years (Appendix 5.B, *Entrainment*).

3.3.5.7.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for Sacramento splittail are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Increasing the extent of tidal perennial aquatic habitats suitable for food production will increase zooplankton and detrital food resources available to Sacramento splittail and thus increase growth and survival. Larval splittail feed extensively on zooplankton, while larger fish feed primarily on detritus, calanoid, and harpactocoid copepods (Kurth and Nobriga 2001; Moyle et al. 2004).

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: Benefits of this objective for Sacramento splittail are similar to those described for delta smelt.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 through TBEWNC1.4 Benefits: Benefits of these objectives for Sacramento splittail are similar to those described for delta smelt.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7. • **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objectives TFEWNC1.1 and TFEWNC1.2 Benefits: Benefits of these objectives for Sacramento splittail are similar to those described for delta smelt.

3.3.5.7.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for Sacramento splittail within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for Sacramento splittail are presented in the context of broader global goals and objectives developed by USFWS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for Sacramento splittail is to improve and restore access to spawning and rearing habitat. The species-specific objective to support achieving this goal focuses on managing flows to provide periodic floodplain inundations and restoring floodplain habitat. Altered flow management will be achieved primarily through implementing *CM1 Water Facilities and Operation*, which addresses the relocation and operation of the primary point of diversion to the north Delta (thereby reducing the spatial overlap of diversion intakes and Sacramento splittail occurrence, and substantially reducing entrainment); providing flow conditions more similar to natural flows in the Plan Area (thereby maintaining and/or increasing seasonally inundated floodplain habitat suitable for splittail spawning and juvenile rearing); and supporting greater primary and secondary production contributing to increased food resources.

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Global Goals and Objectives Developed by the U.S. Fish and Wildlife Service Independent of BDCP[18]

Global Goal 1 (Abundance): Manage the estuary to improve foodweb productivity for splittail.
• **Objective1 (Food Resources):** Enhance the pelagic foodweb to increase mysid numbers and increase foraging opportunities.

Global Goal 2 (Spatial Distribution): Restore habitat linkages both to new marshes and along migratory pathways into and within the Sacramento, San Joaquin, Mokelumne, Cosumnes, Napa and Petaluma rivers. Improve riparian habitat and river to floodplain access to enhance splittail survival and reproduction, and to enhance the current broad spawning and rearing distribution.
• **Objective 2 (Migration)**: Identify and ameliorate reaches of poor habitat quality along spawning migration and juvenile emigration pathways.

As mentioned previously, the species-specific goal and objective complements existing global goals and objectives developed by USFWS. The global goals and objectives are broad measures intended to guide conservation and/or recovery of the covered fish species. These global goals and objectives are not part of the BDCP; however, the BDCP species-specific goal and objective contributes toward the achievement of the global goals and objectives.

Goal SAST1 (Spawning and Rearing Habitat): Improved habitat and restored linkages to enhance survival, reproduction and distribution of Sacramento splittail in the Plan Area.
• **Objective SAST1.1 (Spawning and Rearing Habitat):** Maintain 5-year running average of splittail index of abundance in the Plan Area of 150% of baseline conditions by providing access to suitable spawning and rearing habitat in the Plan Area within 15 years of BDCP implementation.
Assumed Stressors: Lack of suitable rearing habitat. **Stressor Reduction Targets:** • **Spawning and Rearing Habitat:** Restore activated floodplain habitat with the following criteria beginning in the near term and continuing through the late long-term: ○ Floodplain inundation occurs at least once every five to seven years between March 15 and May 15 and, ○ Floodplain inundation persists for at least 30 days (Sommer pers. comm.) ○ Areas of floodplain habitat with water depths less than 2 meters (Moyle et al. 2004; Sommer et al. 2008) ○ Flooded terrestrial vegetation (Crain et al. 2004; Sommer et al, 2008) ○ Establish floodplain benches and areas of native riparian and emergent vegetation with large woody debris (habitat complexity).

Objective SAST1.1 (Spawning and Rearing Habitat) Rationale: Meeting this objective will contribute to an increase in splittail abundance through the protection and enhancement of spawning and rearing habitat in the Plan Area. Sacramento splittail typically spawn in inundated floodplain and riparian areas within submerged terrestrial vegetation (Moyle 2002). Splittail juveniles rear extensively in channel edge habitat over a wide range of water quality conditions, transitioning to offshore habitats as they transition from juveniles to adults. The abundance of YOY juvenile splittail is highly variable from one year to the next and positively correlated with

[18] Citation to be provided.

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hydrologic conditions within the rivers and Delta during the late winter and spring spawning period, and the extent and duration of floodplain inundation (Sommer et al. 1997; Feyrer et al. 2006). Evidence from DFG fishery surveys, salvage data from the south Delta export facilities, and USFWS beach seine data demonstrates that splittail spawn in all years, but spawning success, as reflected in juvenile abundance, is typically greatest in wet years (when floodplains are inundated extensively for a prolonged period) (Baxter 1999; Moyle et al. 2004). No sampling program is specifically intended to assess the population size of splittail, but the abundance index for splittail collected in the fall midwater trawl is positively correlated with high Delta inflows and associated outflows (Kimmerer 2002), and outflows are related to the amount of inundated floodplain within the Delta (Baxter et al., 1996; Sommer et al. 1997) and upstream (Moyle et al. 2004). BDCP actions will increase the extent and duration of floodplain inundation, particularly in Yolo Bypass. Based on a regression analysis using *days of inundation* as a proxy for splittail abundance, which was selected due to the correlation between the days of inundation and the fall midwater trawl index (Sommer et al. 1997), the BDCP is expected to contribute to an increase in splittail abundance. Based on preliminary analysis, the BDCP is expected to increase the days of inundation of the Yolo Bypass by 224 to 242% over the baseline condition. The resulting increase in splittail abundance is expected to range from 150 to 200%, as indicated by the regression analysis and based on professional judgment.

In wet years, there is usually sufficient floodplain habitat in the Delta to support spawning and early rearing of splittail. Because splittail live 5 to 7 years, as long as wet years occur at no less than 5- to 7-year intervals, the splittail population will likely continue to thrive. In dry years, when inundated floodplain habitat in the Yolo Bypass and elsewhere is scarce, shallow, vegetated channel margins that are not armored by riprap may serve to provide some spawning and nursery habitat for splittail (Moyle et al. 2004; Feyrer et al. 2005). Increasing the availability of inundated floodplain and vegetated channel margin habitats, particularly in dry years, is expected to support greater spawning and rearing success.

Although the Yolo Bypass floods in nearly 70% of all years (Kirkland pers. comm.), the acreage flooded and the number of consecutive days the floodplain is inundated are critical for high production of splittail (Sommer et al. 1997; Feyrer et al. 2006). Sacramento splittail will benefit directly from increased production in restored wetlands within Cache Slough, as well as from production that is exported downstream to highly used areas such as Suisun Bay and Suisun Marsh, where it will support splittail rearing.

Rapid growth is highly important for splittail, especially the larvae and young juveniles because, as is true for most fish species, the smallest splittail are the most vulnerable to predation and other mortality factors and, therefore, the more quickly they grow, the greater their chance of survival. The increased growth rates improve the chances of juveniles attaining the size at which emigration from floodplain habitats normally occurs (30 to 40 mm) before the floodwaters recede (Feyrer et al. 2006). However, measuring the growth rate of larval and juvenile splittail would be very difficult and/or results would be difficult to interpret. Therefore, while improved growth is identified as a goal, it is not recommended as a specific, measurable objective. Based on the species conceptual model, achieving the objective of increasing the quantity and quality of spawning and rearing habitat is expected to contribute to achieving the overall goal of enhanced survival, reproduction and distribution of splittail.

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Anticipated benefits of floodplain restoration and enhancements to nonspawning Sacramento splittail are based on the premise that these restored areas will improve the aquatic foodweb by exporting materials from floodplains to downstream nearshore and offshore habitats, thereby improving the availability of food for juvenile and adult splittail. Extensive research on the Yolo Bypass and lower Cosumnes River, in addition to some research in the Sutter Bypass, indicates that Sacramento splittail exhibit enhanced growth and fitness when they have access to floodplain habitats (Swenson et al. 2003; Moyle and Grosholz 2003; Sommer et al. 2001, 2004; Crain et al. 2004; Ribeiro et al. 2004; Feyrer et al. 2004).

Thus, increasing the extent of suitable spawning and rearing habitat, through creation, restoration, enhancement, and protection of tidal wetland, seasonally inundated floodplain, and channel margin habitat is anticipated to contribute to an increase in splittail abundance in the Plan Area. A high degree of uncertainty is associated with the expected benefits; monitoring and adaptive management are necessary as part of the conservation strategy to ensure splittail are using these habitats and the habitats are functioning in a way that benefits splittail (e.g., duration of inundation is sufficient for incubation and some inundation occurs during dry years).

3.3.5.8 Green Sturgeon (Southern DPS)

North American green sturgeon spawning areas are currently limited to accessible reaches of the Sacramento River upstream of Hamilton City and downstream of Keswick Dam. Preferred spawning habitats are thought to contain large cobble in deep and cool pools with turbulent water (California Department of Fish and Game 2002; Moyle 2002; Adams et al. 2002). After hatching, sturgeon larvae rear for 1 to 2 months in the Sacramento River, between Keswick Dam and Hamilton City. Juveniles spend 1 to 4 years in freshwater and estuarine habitat before migrating to the ocean.

North American green sturgeon populations have declined by 88% throughout much of their range. The estimated abundance within the Bay-Delta estuary has ranged between 175 and 8,000 adults between 1954 and 2001, with an annual average of 1,509 adults. In the Sacramento River, the green sturgeon population has declined over the last two decades, with less than 50 spawning green sturgeon being sighted annually in the best spawning habitat (Corwin pers. comm.). In addition, the San Joaquin River population appears extirpated.

Important threats and stressors to green sturgeon are summarized below. Refer to Appendix 2.A, *Covered Species Accounts*, for a full discussion of these stressors.

- **Reduced spawning habitat.** Access to historical spawning habitat has been reduced by construction of migration barriers, such as Keswick Dam on the Sacramento River and Oroville Dam on the Feather River (Lindley et al. 2004; National Marine Fisheries Service 2005). In the Central Valley, approximately 4.6% of the total river kilometers have suitable spawning habitat characteristics, although only 12% of this habitat is currently occupied by sturgeon. Of the 88% that is unoccupied, 44.2% is currently inaccessible due to dams (Neuman et al. 2007).
- **Exposure to toxins.** Exposure to toxics can lower reproductive success, decrease early life stage survival, and cause abnormal development, even at low concentrations. Improved treatment and drainage management in recent years have reduced Iron Mountain Mine runoff toxicity, although negative effects of trace elements are suspected. Although unquantified, the consumption of overbite and Asian clams, known to bioaccumulate selenium, could cause

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mortality of green sturgeon larvae. Sediment concentrations of methylmercury can also increase juvenile mortality.

- **Harvest.** As a long-lived, late-maturing fish with relatively low fecundity and periodic spawning, the green sturgeon is particularly susceptible to threats from overfishing, related to bycatch from some Oregon and Washington fisheries. Green sturgeon are also vulnerable to recreational sport fishers in the Bay-Delta estuary, Sacramento River, and San Pablo and Suisun Bays, particularly those targeting the more desirable white sturgeon. Poaching (illegal harvest) of sturgeon is known to occur in the Sacramento River, particularly in areas where sturgeon have been stranded (e.g., Fremont Weir).
- **Reduced rearing habitat.** Historical reclamation of wetlands and islands, as well as channelization and hardening of levees with riprap, have reduced and degraded the availability of suitable in- and off-channel rearing habitat for green sturgeon.
- **Increased water temperature.** High temperatures in the Sacramento River from February to June no longer appear to be a major concern for green sturgeon spawning, egg incubation, and juvenile rearing, due to improvements in water management in the upper Sacramento River. However, high temperatures will continue to affect habitat quality for green sturgeon on the lower Feather River and the mainstem San Joaquin River. Juvenile sturgeon are also exposed to increased water temperatures in the Delta during the late spring and summer.
- **Nonnative species.** Green sturgeon have been affected, both positively and negatively, by nonnative species introductions in the Delta and Suisun Bay. Sturgeon regularly consume overbite and Asian clams, although there are particular concerns because of the high bioaccumulation rates of these clams. Nonnative invasive plant species may contribute to raising temperatures, reducing turbidity and DO levels (thereby enhancing habitat for predator species), and inhibiting access to shallow water habitat by juvenile sturgeon.
- **Dredging.** Hydraulic dredging is a common practice in the Sacramento and San Joaquin Rivers, navigation channels within the Delta, and Suisun, San Pablo, and San Francisco Bays to allow commercial and recreational vessel traffic. Such dredging operations pose risks to bottom-oriented fish such as green sturgeon, from direct mortality to reduced benthic prey and resuspended toxics.
- **Reduction in turbidity.** Reduced turbidity levels in the Delta may have had detrimental effects on green sturgeon, due to their increased susceptibility to predation.
- **Entrainment.** Although unquanitified, larval sturgeon are susceptible to entrainment from nonproject water diversion facilities as a result of their migratory behavior and habitat selection within the rivers and Bay-Delta estuary. In addition, the effectiveness of NMFS and DFG screening criteria for salmonids is unknown for sturgeon. The operation of unscreened water diversions on the Feather River are also a possible threat to juvenile green sturgeon. The larger SWP/CVP export facilities are located where a low number of juvenile green sturgeon have been recorded.
- **Stranding.** Green sturgeon that are attracted by high flows in the Yolo Bypass move onto the floodplain and eventually concentrate behind Fremont Weir, where they are blocked from further upstream migration. As waters in the YoloBypass recede, these sturgeon become stranded behind the flashboards of the weir and can be subjected to heavy illegal fishing pressure.

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While NMFS has begun recovery planning efforts, a recovery plan has not yet been developed. However, ongoing conservation efforts in the Plan Area are expected to provide some benefit to sturgeon. These include the Anadromous Fish Restoration Program, Central Valley Project Improvement Act and CALFED programs. The combination of increased law enforcement and new sportfishing regulations adopted over the past several years specifically to protect sturgeon and reduce their harvest is expected further reduce illegal fishing practices as well as the effects of incidental harvest of green sturgeon by recreational anglers throughout the range of the species. Green sturgeon are also covered under the San Joaquin County HCP and the East Alameda County Conservation Strategy.

The conservation approach for green sturgeon will focus on those life stages occurring within the Plan Area, and ensure efforts to benefit those specific life stages occur when they would be present in the Plan Area. The conservation approach includes increasing rearing habitat; increasing the local production of food and availability of food by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in tidal channels; minimizing entrainment; and improving upstream adult passage conditions. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.8.1 Applicable Landscape-Scale Goals and Objectives

*[**Note to Reviewers:** Landscape-scale and natural community goals and objectives are presented here to provide context and summarize the broad scope of BDCP and the linkages between the various levels of goals and objectives to be achieved by BDCP and the intended benefits to the covered species. The landscape and natural community goals and objectives presented below are still in development. This text shows how they were worded in January 2012.]*

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for green sturgeon are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objective L1.3 Benefits: Meeting this objective will restore or create seasonally inundated floodplains and tidally influenced natural communities that are very important for green sturgeon. The BDCP will restore 65,000 acres of tidal wetland in the Delta, approximately 10,000 acres of seasonally inundated floodplain, up to 20 miles of channel margin habitat, and at least 5,000 acres of riparian habitat to benefit covered fish species (in addition to other restoration actions specific to terrestrial species also covered in the BDCP). The habitat restoration actions have two principal objectives: to increase the amount of available habitat relevant to the needs of each covered species and life stage, and to enhance the ecological function of the Delta. Refer to TPANC1.1 for a discussion of the benefits.

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Tidal habitat restoration also is expected to produce food and export food, which would benefit sturgeon, by providing permanent year-round rearing habitat. Sturgeon have been observed in the Lower Sacramento River and North Delta between May and October and in the Delta throughout the year, and spend up to 3 years in freshwater and brackish habitats before migrating to the San Francisco Bay and the ocean (Allen et al. 2006a; Allen et al. 2006b). Providing a gradient of floodplain and tidally influenced natural communities will provide a range of potentially suitable habitats for spawning, as well as conditions suitable for food production during the sturgeon's extensive juvenile rearing stage.

Objective L1.4 Benefits: Meeting this objective will increase the extent of environmental gradients and provide a greater range of habitat conditions, food resources, and habitat complexity available for green sturgeon during their juvenile rearing phase. A greater extent of habitats and prey resources available across a greater range of varied conditions of flow, water temperature, turbidity and other habitat constituents will benefit the species. Juveniles are fairly tolerant of variable temperature and DO conditions, and are likely mobile enough to select favorable habitats if conditions change (Israel and Klimley 2008).

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.3:** Allow lateral river channel migration. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers. • **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objective L2.2 Benefits: Restoring natural fluvial processes will improve habitat conditions through floodplain inundation, which can increase sediment inputs and provide refugia from high flows and potential predators. Floodplain inundation will also increase primary productivity, which will in turn contribute toward increased growth for those juvenile sturgeon that use inundated floodplain habitats, such as Yolo Bypass, for rearing.

Objective L2.3 Benefits: Lateral channel migration is a natural fluvial process that creates a range of environmental gradients and potentially suitable habitat and channel conditions for green sturgeon. Once larvae grow into juveniles, their survival may be limited by lack of rearing habitat, insufficient food, and possibly contaminants. Restoring natural fluvial processes, which create suitable habitat and conditions, will benefit the species. Juveniles are also mobile enough to select more favorable habitats.

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Objective L2.4 Benefits: This objective will support increased river-floodplain connectivity to improve hyporheic processes such as groundwater recharge, thereby improving water quality, providing cool water inputs, and maintaining flow inputs to surface waters. Allochthonous inputs such as terrestrial insects and plant matter provide a nutrient source increase the productivity of aquatic systems, thereby contributing to a more diverse and robust forage base.

Objective L2.5 Benefits: This objective is expected to reduce the amount of pollution in stormwater runoff entering Delta waterways, thus reducing pesticides and herbicides loading, which can be highly toxic to plankton that form the base of the foodweb. Reducing pollutant loads of pyrethroids and other chemicals from urban and stormwater runoff is also likely to reduce potential sublethal effects (e.g., effects on behavior, tissues and organs, reproduction, growth, and immune system). Water quality improvements are also likely to support a more robust foodweb and thereby contribute to increasing food resources for green sturgeon.

Water releases from SWP/CVP facilities help to maintain water temperatures and flows on the Sacramento and Feather Rivers during the spring and summer, which benefits downstream sturgeon spawning, incubation, and rearing (Cech et al. 2000 in COSEWIC 2004; Mayfield and Cech 2004; Van Eenennaam et al. 2005; Allen et al. 2006b). However, elevated or fluctuating temperatures do not appear to have adverse effects on post-larval juveniles if food is abundant and DO is available (Israel and Klimley 2008).

Objective L2.6 Benefits: Maintaining flow conditions similar to natural flow conditions in the Plan Area will provide a diversity of spawning and rearing conditions for green sturgeon, and potentially increase the resiliency of the species. Data suggest that females spawn regardless of whether there are preferred physical conditions. Therefore, increasing the diversity of spawning conditions is expected to increase the diversity within the population. The estimated number of green sturgeon contributing to juvenile samples collected at Red Bluff Diversion Dam between 2002 and 2006 increased with greater flows at Bend Bridge (Israel 2007). This increased spawning success may be due to higher flows that increase turbulence in optimal spawning habitats, which may increase fertilization rates, or it may be due to more reproductive individuals reaching optimal spawning habitats.

Objective L2.8 Benefits: Increasing natural dendritic channels in tidal marsh habitats will promote food production and transport, which will benefit juvenile green sturgeon rearing in the freshwater and low salinity zones of the Plan Area, as they grow and develop critical osmoregulatory capacities that allow them to enter the ocean. Juvenile green sturgeon develop these capacities between their first and second year (Allen and Cech 2007). Therefore, restoring subtidal freshwater and brackish habitats can provide important habitats for juvenile green sturgeon. These dendritic channels may also provide greater cover from predators for larval and juvenile green sturgeon (Israel and Klimley 2008).

Objective L2.10 Benefits: This objective is expected to provide increased food resources important to green sturgeon and contribute toward increased growth and survival rates.

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Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.2:** Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic fish species. • **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.2 Benefits: Operations of the north diversions under the BDCP will potentially provide flexibility to allow flows to coincide with the movement of larval and juvenile life stages of native fish. This will benefit green sturgeon larvae as they are transported downstream via river flow. While egg and larval green sturgeon are confined to freshwater portions of the Sacramento River mainstem, juveniles are able to tolerate brackish conditions downstream. Providing flow conditions similar to natural flow conditions within the Plan Area, to coincide with the timing of downstream green sturgeon larval migrations, will support these early life-stage requirements and promote increased foraging opportunities, growth, and survival. Further, the BDCP will address water quality issues in the Plan Area, such as the low DO levels in the Stockton DWSC and urban stormwater. The BDCP will include funding to the Port of Stockton to continue operation of the aerator in the Stockton DWSC, which will directly improve the connectivity between areas downstream of Turner Cut and the San Joaquin River upstream of Stockton by minimizing the low DO condition that persists in this area. The BDCP will also provide funding to urban centers that contribute stormwater to the Plan Area to help them reduce inputs of polluted stormwater to the Delta. Reducing the inputs of pollution from urban stormwater will contribute to improved water quality and increased health of the Delta.

Objective L3.3 Benefits: This objective will provide increased flexibility for water operations of the north diversions, which will improve flow conditions that coincide with the timing of adult green sturgeon migrations and thus minimize delays and improve spawning success and population recruitment. Reproductively mature green sturgeons migrate into rivers prepared to spawn, and are presumed to migrate directly to upper Sacramento River spawning areas, though they may aggregate temporarily in the upper Delta during the spring or summer to facilitate coordinated migration (Israel and Klimley 2008). Current flow management may inhibit the return of green sturgeon to the Sacramento River and Bay-Delta estuary by restricting the seasonal flow necessary as cues for spawning. Once adult green sturgeons have spawned they appear to reside in rivers for up to six months until autumn or winter (Israel and Klimley 2008). Unimpeded connectivity between habitats and safe and timely passage are critical features of the Central Valley rivers to increase spatial distribution of spawning and reduce opportunities for adult mortality.

Objective L3.4 Benefits: Maintaining flow conditions similar to natural flow conditions in the Plan Area will provide a diversity of spawning and rearing conditions for green sturgeon, and potentially increase the resiliency of the species. Data suggest that females spawn regardless of whether there are preferred physical conditions. Therefore, increasing the diversity of spawning conditions is expected to increase the diversity within the population. The estimated number of green sturgeon contributing to juvenile samples collected at Red Bluff Diversion Dam between 2002 and 2006 increased with greater flows at Bend Bridge (Israel 2007). This increased spawning success may be due to higher flows that increase turbulence in optimal spawning habitats, which may increase

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fertilization rates, or it may be due to more reproductive individuals reaching optimal spawning habitats.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 Benefits: Avoidance and minimization measures will include project planning and site-specific surveys to identify covered species and suitable habitat for which these measures apply, preconstruction surveys if timing restrictions require such surveys in the months or weeks prior to construction, implementation of construction BMPs, and operation and maintenance associated with long-term activities (e.g., operation and maintenance of the water conveyance facilities), and ongoing covered species habitat enhancement and management. These measures are intended to avoid and minimize direct effects on individual covered species and their habitats and on natural communities as a result of construction activities and operation and maintenance activities.

Objective L4.2 Benefits: Managing the distribution and abundance of nonnative predators, with targeted harvest, capture, and removal activities, is expected to reduce population-scale effects on early life stages of green sturgeon. Due to their extended rearing phase in the river and estuary, juvenile green sturgeon are likely subject to substantial predation by nonnative predators in the Plan Area. Nonnative striped bass are often observed in areas downstream of green sturgeon spawning areas, and are presumed to feed on sturgeon eggs. Therefore, removing nonnative predators such as striped bass is anticipated to increase the abundance of green sturgeon.

Actively managing the distribution and abundance of predators such as striped bass is expected to contribute to an increase in the abundance of green sturgeon. Predation is likely and substantial reason for reduced survival of green sturgeon rearing in the interior Delta. However, tidal channels are thought to provide protection from predatory fishes (Lott 2004), so the loss of tidal habitat may increase predation (Williams 2009). Refer to *CM15 Predator Control* for discussion of the management of nonnative predators within the Plan Area.

Objective L4.3 Benefits: Meeting this objective will provide alternative migration corridors (e.g., Yolo Bypass) and install features (e.g., weirs and nonphysical fish barriers) to encourage juvenile green sturgeon to avoid areas that have a high risk for predation. However, predation risks are also expected to occur during the extended rearing phase of juvenile green sturgeon in the Delta.

Objective L4.4 Benefits: Providing flow conditions that reduce entrainment of green sturgeon is expected to improve survival of larval and juvenile life stages. While green sturgeon are vulnerable to impingement or entrainment at screened diversions when they are less than 30 mm in length, screening criteria for delta smelt (0.1 foot per second) and juvenile salmon (0.33 foot per second) were protective to juvenile green sturgeon (larger than 30 mm) in experiments (Swanson et al. 2004). It is possible that juveniles can also be entrained in water diversions for farmland irrigation, although their benthic behavior likely limits this effect, and this is not well understood.

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

3.3.5.8.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for green sturgeon are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Increasing the extent of tidal perennial aquatic habitats is anticipated to increase food resources available to juvenile green sturgeon and thus increase growth and survival. Channelization of the estuary has likely negatively affected the amount of subtidal and intertidal habitat available for green sturgeon foraging. These habitats have been lost along San Pablo and Suisun Bays, where subadult and adult green sturgeon are commonly found (Israel and Klimley 2008). Once juveniles have the capacity to live in saltwater, they are believed to spend 1 to 3 years in estuaries before making an initial ocean migration.

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objective TPANC2.1 Benefits: This objective addresses the nonnative plant species that limit turbidity in the Delta, which has decreased over time (Jassby et al. 2002; Nobriga and Herbold 2009). It is hypothesized that one of the primary causes of the decrease in turbidity is biological filtration by SAV (Brown and Michniuk 2007; Nobriga and Herbold 2009). Controlling invasive plants, especially SAV, is anticipated to result in some degree of increased turbidity as well as reducing suitable habitat for nonnative predators.

Habitat structure and heterogeneity can affect opportunities for encounter and capture by predators. As discussed above, SAV beds appear to provide habitat that is more favorable to nearshore fishes such as largemouth bass and sunfish that also can take advantage of increased water clarity to find prey (Brown 2003; Nobriga et al. 2005; Nobriga and Feyrer 2007). Invasive plant species in the estuary have also likely impacted the quantity of shallow habitat available to coastal migrant and adult green sturgeon (Israel and Klimley 2008). Control of SAV and the restoration of native aquatic plant communities in treated areas are also expected to increase the quantity and quality of habitat suitable for some prey resources (such as crustaceans, annelids, mollusks, fish, and midges) important to sturgeon.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objective TBEWNC1.1 Benefits: Achieving this objective will increase primary productivity, which could result in a greater quantity of food resources for green sturgeon. The substantial reduction in historical tidal wetlands in the Delta has likely reduced nursery and foraging habitats for YOY through spawning adult life stages. As a result, restoring tidal marsh habitat is expected to benefit these same life stages.

Objective TBEWNC1.2 Benefits: Achieving this objective will potentially increase the transport of food resources and nutrients from tidal marsh habitats to areas occupied by green sturgeon. This is expected to increase available food resources to contribute to an increase in growth and survival of green sturgeon.

Objective TBEWNC1.3 Benefits: Achieving this objective will promote effective exchange throughout the marsh plain to increase the transport of nutrients and food resources from restored wetland habitats to low salinity zone habitats typically occupied by older (older than 1 year of age) juvenile green sturgeon. Increasing the transport of food resources is anticipated to contribute to an increase in growth and survival of juvenile green sturgeon.

Objective TBEWNC1.4 Benefits: Meeting this objective will protect tidal brackish emergent wetland to increase primary productivity, which could yield more abundant food resources for green sturgeon.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

- **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.
- **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objective TFEWNC1.1 Benefits: Achieving this objective will result in an increase in primary productivity, which could contribute greater quantity of food resources to green sturgeon.

Objective TFEWNC1.2 Benefits: Promoting effective tidal exchange throughout the marsh plain will increase the transport of nutrients and food resources from restored wetland habitats to low salinity zone habitats occupied by green sturgeon. Increasing the transport of food resources is anticipated to contribute to an increase in growth and survival.

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Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period. • **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Objectives VFRNC1.1, VFRNC1.2, and VFRNC1.3 Benefits: Riparian habitat provides important functions to the aquatic system (e.g., large woody debris recruitment, increased bank stability, reduced erosion, flow attenuation during flood events, allochthonous inputs, shade/insulation) that benefit the covered fish species. Restoring and protecting riparian habitat in the Plan Area will ensure these riparian communities continue to contribute directly and/or indirectly to the production of food resources to the aquatic system, important for increased growth and survival of larval and juvenile green sturgeon.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle. • **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1and NFEW/NPANC1.2 Benefits: Achieving these objectives will increase habitat suitable for the production of food resources important to larvae and juvenile green sturgeon, thereby contributing to a potential increase in growth and survival.

3.3.5.8.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for green sturgeon within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for green sturgeon are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

It should be noted that the global goals and objectives presented below have not been formally adopted by NMFS and are subject to change. While formal comments regarding the global goals and

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objectives have not been received from NMFS, informal discussions indicate that the global goals and objectives are being refined, and will ultimately read differently than presented below.

Global Goals and Objectives Developed by the National Marine Fisheries Service Independent of BDCP[19]

Global Goal 1: Ensure green sturgeon utilize all currently occupied areas within the Bay-Delta and its tributaries and are able to take advantage of any unoccupied areas which arise from restoration activities. Maintain stable population size and age structure.
• **Global 1 Objective: (Abundance):** Increase abundance and productivity by providing a diversity of depths, necessary for shelter, foraging, and migration of juvenile, sub-adult and adult life stages in estuarine habitats.

Global Goal 2: Ensure green sturgeon utilize all currently occupied areas within the Bay-Delta and its tributaries and are able to take advantage of any unoccupied areas which arise from restoration activities. Maintain a stable population and age structure.
• **Global Objective 2.1 (Spatial Distribution):** Increase spatial distribution. Protect and increase life-history and genetic diversity. • **Global Objective 2.2 (Spatial Distribution):** Provide water quality and other chemical characteristics for optimal behavior, growth, and viability in all life stages.

The goals of the BDCP are to increase the abundance of all life stages of green sturgeon, and increase the spatial distribution of these life stages as they relate to the Plan Area. Species-specific objectives that support achieving these goals focus on expanding and improving suitable habitat, increasing the production of suitable prey, reducing illegal harvest and/or stranding of adults, and improving water quality conditions.

BDCP objectives for green sturgeon will be achieved via altered flow management and habitat restoration. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. Habitat restoration benefits will chiefly derive from tidal habitat restoration, seasonally inundated floodplain restoration, channel margin enhancement, and riparian habitat restoration that are expected to increase primary and secondary productivity to contribute to increased food resources for sturgeon as well as increase habitat complexity.

Reducing passage delays at anthropogenic barriers will reduce migratory delays and increase survival and spatial distribution of adult sturgeon during their upstream migration to spawning areas. Reducing migratory delays will contribute to an increase in survival of adult sturgeon as they are exposed to less potential stress, stranding and illegal harvest.

Increasing the availability of floodplain and channel margin habitat is anticipated to increase productivity within the Plan Area. The proposed seasonally inundated floodplain habitat restoration actions are expected to increase the amount and quality of accessible rearing habitat for juvenile sturgeon. The intent is to route sturgeon away from the interior Delta and through habitat that is favorable for growth.

[19] Citation to be provided.

Goal GRST1 (Abundance): Increased abundance of green sturgeon in the Plan Area.
• **Objective GRST1.1 (Abundance):** Increase spawner adult abundance-to-juvenile abundance ratio compared to existing conditions.
Assumed Stressor: Incubation and rearing and illegal harvest. **Stressor Reduction Target:** • **Incubation and Rearing:** Improved incubation and rearing conditions in the Bay-Delta and its tributaries within 15 years of Plan implementation. • **Illegal Harvest:** Reduce illegal harvest of juvenile/subadult and adult green sturgeon in the Plan Area based on a running average of the previous 5 year's observed quantity. **Next Steps:** • **Incubation and Rearing**: Document distribution of incubation and rearing conditions and identify opportunities for improvement • **Illegal Harvest**: Set appropriate target

Objective GRST1.1 (Abundance) Rationale:

Incubation and Rearing. Achieving this objective will increase the adult spawner-to-juvenile abundance ratio by improving incubation and rearing conditions. Adult green sturgeon are observed in the Sacramento and Feather Rivers between late March and late July (Benson et al. 2007; Heublein 2006), which can be a period of regulated flows in these rivers. Thus, flow operations may influence whether conditions are suitable for green sturgeon spawning, egg incubation, and larval and juvenile survival. While optimal water temperatures for egg and larval incubation and development have been identified via laboratory tests, flows necessary for successful spawning and juvenile survival remain uncertain.

Green sturgeon critical habitat should have a "flow regime with stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 to 19°C [51.5 to 66.2°F])" (74 FR 52323) (Cech et al. 2000 in COSEWIC 2004; Mayfield and Cech 2004; Van Eenennaam et al. 2005; Allen et al. 2006b). Water releases from SWP/CVP facilities help to maintain water temperatures and flows on the Sacramento and Feather Rivers during the spring and summer for winter-run and spring-run Chinook salmon, respectively. These measures also provide suitable water temperature conditions for a portion of the green sturgeon spawning, incubation, and rearing periods.

Flow characteristics necessary for spawning, incubating eggs and larval rearing are unknown, although research occurring under the current NMFS BiOp (National Marine Fisheries Serviced 2009b) will provide information characterizing optimal conditions for these green sturgeon life stages. If linkages between the Sacramento River white sturgeon population and hydraulic processes are similar to those for the green sturgeon, white sturgeon may be a reasonable surrogate for green sturgeon and measures that enhance white sturgeon populations will likely benefit green sturgeon.

Flow relationships examined by DFG indicated that greater flows during the late spawning and early life stages between April and July resulted in greater YOY production (Kohlhorst et al. 1991; Fish 2011). Recruitment was significantly positively correlated with Delta outflow in all months from April to July, but there was no correlation with mean daily volume of diversions. The BDCP aims to

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minimize Sacramento and Feather River flow reductions that result from SWP/CVP operations, thus reducing effects on egg and larval survival and successful juvenile recruitment.

Juvenile green sturgeon develop the critical osmoregulatory capacities between their first and second year that permit them to enter saltwater at a size of 75 centimeters and weight of 1.5 kilograms (Allen and Cech 2007). Restored subtidal freshwater and brackish habitats can provide important habitats for juvenile green sturgeon. Outflow may indirectly influence juvenile survival by modifying the availability of these freshwater and low-salinity restored habitats in the Delta and Suisun Bay during green sturgeon's first year of life. Israel et al. (2009) described the effect of certain water quality parameters on white sturgeon development (Table 3.3-5). Additional analysis will be required to determine the potential for the BDCP to influence water quality parameters to benefit green sturgeon.

Table 3.3-5. Optimal and Suboptimal Water Quality Parameters for White Sturgeon (a Surrogate for Green Sturgeon) from DRERIP White Sturgeon Conceptual Model

Life Stage	Suboptimal Low Temperatures	Optimal Temperature Range	Suboptimal Upper Temperatures
Eggs/larvae	<9 °C	11–17 °C	17.1–19 °C
Young-of-year (YOY) juveniles		15–19 °C	19.1–20 °C
Source: Mayfield and Cech 2004; Van Eenennaam et al. 2005; Allen et al. 2006a; National Marine Fisheries Service 2006; Israel et al. 2009.			

Illegal Harvest. Achieving this objective will increase abundance of all life stages of green sturgeon by reducing the illegal harvest of adults, which are the source of future generations. Green sturgeon males reach a reproductive age (14 years old) earlier and have a shorter lifespan compared to females. Females may mature as early as 16 years old (Van Eenennaam et al. 2005). Species fecundity peaks at around 24 years old, when all females in this age cohort have matured (Beamesderfer et al. 2007). Green sturgeon are a long-lived species, living until about 50 years (Beamesderfer and Webb 2002) and possibly up to 60 or 70 years (Moyle 2002).

Historically, green sturgeon were harvested as bycatch in commercial fisheries and as a target species in the upper Sacramento River. The states of Washington, Oregon, and California eliminated legal sportsfishing and commercial bycatch of green sturgeon between 2006 and 2008. While uncommon, green sturgeon are still captured in Pacific Northwest, San Francisco Bay, and Sacramento River sports fisheries. The retention of green sturgeon is no longer allowed in California or along the Pacific coast, except in tribal fisheries on the Klamath River (Adams et al. 2007). Poaching for sturgeon is a threat in the Sacramento River and Feather River, and green sturgeon may be illegally harvested during white sturgeon fisheries in the rivers, Delta, and/or bays.

Chronic stress (i.e., chasing, confinement, or depth reduction) has been observed to influence the bioenergetics of green sturgeon, though it does not influence their swimming performance (Lankford et al. 2005). The effects of fishing-associated mortality on green sturgeon are not well documented, and targeted studies and law enforcement are necessary to reduce poaching of subadult and adult green sturgeon. Increased warden activities in the Sacramento and Feather Rivers, as well as Bay-Delta, are expected to maintain the abundance of green sturgeon and protect spawning adults. However, uncertainties about sturgeon population sizes and dynamics make it difficult to predict the effectiveness of this measure for these species.

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Goal GRST2 (Stranding): Improved connectivity that facilitates timely passage and reduces stranding of adult green sturgeon.
• **Objective GRST2.1 (Stranding):** Reduce stranding of adult green sturgeon at Fremont Weir by 75% over baseline conditions within 15 years of BDCP implementation.
Assumed Stressor: Connectivity **Stressor Reduction Target:** • **Connectivity:** Improve connectivity between the Sacramento River and Yolo Bypass for timely passage and decrease stranding of adult green sturgeon between January and May within 10 years of BDCP implementation. • **Passage:** Reduce passage delays and stranding at existing impediments (physical and DO) located in migratory corridors by 75% within 15 years of BDCP implementation. **Next Steps:** Inventory existing migratory impediments and identify opportunities for improvement.

Objective GRST2.1 (Stranding) Rationale: River flow is diverted through the Yolo and Sutter Bypasses for flood control purposes during periods of high flow in the Sacramento River associated with winter storms, which may attract migrating adults. As waters recede in these systems, upstream passage options become very limited within Yolo Bypass and sturgeon on their way to the spawning grounds can become stranded which leaves them vulnerable to illegal harvest, desiccation, scavenging, and death unless they are rescued (Matica pers. comm.). The Fremont Weir is a documented barrier to sturgeon and DFG occasionally has to conduct rescue operations of sturgeon (and other fishes) at the structure. A recent set of studies provide design and operational criteria for sturgeon passage at Fremont Weir (California Department of Water Resources 2007). These criteria should be incorporated into anticipated modifications to the Fremont Weir to facilitate the Yolo Bypass Fisheries Enhancement Plan and improve passage for adult sturgeon to reduce stranding and related negative impacts.

Fish Passage. Green sturgeon are highly migratory fish, often passing rapidly between freshwater and marine habitats. These individuals quickly ascend northern Central Valley rivers to undertake immediate spawning or emigrate following over-summering to physiologically optimal marine habitats for foraging. Unimpeded connectivity between habitats and safe and timely passage are critical features of the Central Valley rivers that increase spatial distribution of spawning and reduce opportunities for adult mortality. These objectives can be met through implementation of seasonal sturgeon fish passage at Fremont Weir and operational monitoring programs at gates, barriers, and diversions. Prior to implementing these objectives, gates, barriers, and diversions information on green sturgeon travel times, directionality, and disposition should be used to determine measureable outcome regarding necessary safe and timely passage.

Limited stranding and rescue data indicate that appreciable percentages (10% or more), of the green sturgeon spawning population may be negatively affected by the passage impediment caused by the Fremont Weir. Within Yolo Bypass, stranding is known to occur at the large pool at the base of the Fremont Weir. It is assumed the majority of the stranding that occurs in the Yolo Bypass occurs in this large pool. Whether green sturgeon are also stranded at other locations in the Yolo Bypass is unknown. Thus, the75% reduction in passage delays target is appropriate as the BDCP will focus on eliminating stranding at the large pool at the base of the Fremont Weir, while determining whether stranding may be occurring at other areas within the bypass and working to reduce stranding at those locations as practicable.

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Between 2002 and 2006, approximately 50 sturgeon (no species identification given) were rescued over the course of four rescue operations at the Fremont Weir (California Department of Fish and Game 2006 unpublished). In 2011, 14 green sturgeon (and 19 white sturgeon) were rescued at the Fremont Weir (Healey and Vincik 2011). The efficacy of the passage improvements at the Fremont Weir and other locations in the Yolo Bypass (e.g., Lisbon Weir) cannot be estimated, but will be monitored, and adjustments will be made through adaptive management to improve passage. Resulting improvements in migration may vary by year type as a result of differing inundation frequencies and volumes, but BDCP implementation is expected to have a major positive effect on upstream migrating sturgeon in terms of passage.

Spawning adults may be delayed in reaching spawning grounds in the Sacramento River due to misleading water flows through the south and central Delta. Sturgeon immigrating in the San Joaquin River may be confused by Sacramento River flows entering the south Delta via the Delta Cross Channel, which can cause delays and can block passage. Delta exports and diversions can also affect Delta flow rates and hydrodynamics resulting in migration delays (National Marine Fisheries Service 1997). Low DO conditions in the area of the Sacramento DWSC can also act as a physical barrier to migration.

Information on green sturgeon travel times, directionality, and disposition should be used to characterize measureable outcomes regarding safe and timely passage before implementing the adult distribution and diversity objectives.

Goal GRST3 (Spatial Distribution): Increased spatial distribution of YOY and juvenile green sturgeon in the Delta compared to existing conditions.
• **Objective GRST3.1 (Distribution):** Improve water quality parameters and physical habitat characteristics in the Bay-Delta (see target water quality parameters Table 3.3-5).
Assumed Stressor: Water quality conditions restrict access to appropriate YOY and juvenile rearing habitat **Stressor Reduction Target:** See target water quality parameters outlined in Table 3.3-5. **Next Steps:** Convene small technical group to vet and establish target water quality and physical habitat parameters.

Objective GRST3.1 (Distribution) Rationale: Achieving this objective will increase the spatial distribution and survival of YOY and juvenile green sturgeon by providing water quality conditions that support optimal behavior, growth, and viability of these and subsequent life stages. Water quality is likely a limiting factor during early life-history stages of green sturgeon (Israel and Klimley 2008). Water quality in the Sacramento and San Joaquin Rivers and the Delta is influenced by a variety of point and nonpoint source pollutants from urban, industrial, and agricultural land uses. Runoff from residential, agricultural, and industrial areas introduces pesticides, oil, grease, heavy metals, other organics, and nutrients that contaminate drainage waters and deteriorate the quality of aquatic habitats necessary for sturgeon survival (National Marine Fisheries Service 1996; California Regional Water Quality Control Board-Central Valley Region 1998). Reducing these pollutant sources is expected to improve rearing conditions for green sturgeon.

Habitat suitability for juvenile sturgeon rearing is primarily dependent on water quality and food availability. Juvenile sturgeon can use a broad range of habitats defined by their temperature, DO, and salinity tolerances; thus the distribution of juvenile habitat fluctuates seasonally in freshwater and brackish environments. Green sturgeons have a high rate of oxygen consumption and require

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high levels of DO to avoid stress (Gisbert et al. 2001; Lankford et al. 2003; Mayfield and Cech 2004). Therefore, low DO levels in the Plan Area likely result in chronic stress in young green sturgeon (Lankford et al. 2003), which forage in subtidal and intertidal Delta habitats and the Stockton DWSC. However, there is high uncertainty and no knowledge about the presence of these conditions in particular habitats.

Invasive SAV can alter water quality, including parameters important for covered fish species such as temperature and DO. SAV causes reduced water flow, and this reduction may cause water temperatures to rise. The control of SAV in the Plan Area is expected to result in beneficial outcomes on water quality and covered fish species populations without significant negative effects.

Salinity can also affect green sturgeon, although the predictability of this stressor is also limited (Israel and Klimley 2008). Some juvenile green sturgeon are adapted to entering seawater earlier than others, who may be subjected to reduced foraging and survival in more saline environments (Allen and Cech 2007). Once in estuarine and seawater environments, seawater-tolerant green sturgeons seem to not be limited by the physical properties of the water due to their high mobility within these environments.

3.3.5.9 White Sturgeon

White sturgeon spawn primarily in the Sacramento River upstream of the Plan Area, in the reach between Red Bluff Diversion Dam and Jelly's Ferry Bridge, in areas with swift currents and deep pools with gravel. white sturgeon migration downstream from spawning areas and through the mainstem Sacramento River, Delta, and San Francisco Bay estuary. It has been hypothesized that migration is affected by a variety of factors, including barriers such as damsand gates. Rearing habitat condition and function may be affected by annual and seasonal variation in flow and water temperatures. White sturgeon are most abundant in the Sacramento River and San Francisco Bay-Delta estuary, and have been reported from the San Joaquin River system, particularly in wet years.

In the Central Valley, white sturgeon populations have declined from an estimated 144,000 adults in 1994 to 10,000 adults in 2005 (Bland 2006). The number of adults fluctuates annually and appears to be the result of highly variable juvenile production; the population is dominated by a few strong year classes associated with high spring outflows (Moyle 2002).

Important threats and stressors to white sturgeon are summarized below. Refer to Appendix 2.A, *Covered Species Accounts,* for a full discussion of these stressors.

- **Harvest.** White sturgeon are a popular gamefish in the Bay-Delta estuary and Sacramento River and support commercial fisheries in Oregon and Washington estuaries. White sturgeon are also vulnerable to illegal harvest, or poaching. The California Fish and Game Commission has recently adopted more restrictive sport fishing regulations designed to reduce the effects of angler harvest on white sturgeon in the Bay-Delta estuary. However, the effects of legal and illegal harvest on the population dynamics and abundance of white sturgeon within the Bay-Delta estuary are largely unknown.
- **Reduced spawning habitat.** Access to historical spawning habitat has been reduced by construction of barriers to upstream migration. Major dams include Keswick Dam on the Sacramento River and Oroville Dam on the Feather River. Other potential migration barriers include structures such as the Red Bluff Diversion Dam, Sacramento DWSC locks, Sutter Bypass,

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and Delta Cross Channel gates on the Sacramento River, and Shanghai Bench and Sunset Pumps on the Feather River (70 FR 17386).

- **Exposure to toxins.** Exposure to toxics can lower reproductive success, decrease early life stage survival, and cause abnormal development in white sturgeon, even at low concentrations. Organic contaminants from agricultural returns, and urban runoff, and high concentrations of trace elements (boron, selenium, and molybdenum) can decrease early life-stage survival, causing abnormal development and high mortality in yolk-sac fry at concentrations of only a few parts per billion. Contaminants that adsorb to sediments, such as pyrethroids, selenium, and mercury are of particular concern. Overbite and Asian clams, the principal component of sturgeon diet in the Delta, are known to bioaccumulate selenium; exposure to these food sources could cause mortality of larval sturgeon.
- **Reduced rearing habitat.** Historical reclamation of wetlands and islands, channelization, and riprapping of levees have reduced and degraded in- and off-channel rearing habitat for white sturgeon.
- **Increased water temperature.** While juvenile and adult white sturgeon are tolerant of higher temperatures, water temperatures greater than 17°C (63°F) have been shown to increase sturgeon egg and larval mortality. Active water management in the Sacramento River has improved conditions in recent years, but temperatures in the lower Feather River may still be unsuitable for sturgeon spawning and egg incubation. This may be one reason why neither green nor white sturgeon are found in the river in low-flow years. Reduced flow on the San Joaquin River resulting from dam and diversion operations and agricultural return flows contributes to seasonally elevated water temperatures in the mainstem river. Seasonally elevated water temperatures on the San Joaquin River and within the Delta have been identified as a factor affecting habitat quality and availability for sturgeon migration, spawning, and juvenile rearing.
- **Nonnative species.** White sturgeon have been affected both positively and negatively by the introduction of nonnative species into the Bay-Delta estuary. Nonnative species such as the overbite clam and Asian clam are now a major component of the white sturgeon diet, and these benthic filter feeders can accumulate various toxic substances, which may adversely impact the health and survival of sub-adult and adult sturgeon and their reproduction. Nonnative invasive plant species may contribute to raising temperatures, reducing turbidity and DO levels (thereby enhancing habitat for predator species), and inhibiting access to shallow water habitat by juvenile sturgeon.
- **Dredging.** Hydraulic dredging to maintain vessel access is a common practice in the Sacramento and San Joaquin Rivers, navigation channels within the Delta, and Suisun, San Pablo, and San Francisco Bays. Such dredging operations can affect bottom-oriented fish such as white sturgeon by causing entrainment, reducing benthic prey availability, and resuspending toxics.
- **Reduced turbidity.** Reduced turbidity levels in the Delta could have had detrimental effects by increasing the susceptibility of white sturgeon to predation. However, the relationship between turbidity and the vulnerablity of white sturgeon to predation has not been demonstrated in the Delta.
- **Stranding.** White sturgeon that are attracted by high flows in the Yolo Bypass, move onto the floodplain and eventually concentrate behind Fremont Weir, where they are blocked from

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further upstream migration. As Yolo Bypass flows decline, these sturgeon become stranded behind the flashboards of the weir and can be subjected to heavy illegal fishing pressure. Refer to species-specific goals and objectives for further information on how BDCP will address stranding.

- **Entrainment at diversions.** There is little evidence that the overall population of white sturgeon is influenced by entrainment. Adults are not likely to be entrained due to their large size and benthic habits. Larval sturgeon are more susceptible to entrainment from water diversion facilities as a result of their migratory behavior within the water column and reduced swimming capability. The larger SWP/CVP export facilities are located where a low number of juvenile white sturgeon have been recorded.

White sturgeon are not currently protected under the federal ESA, and thus no recovery plan has been developed. However, there are ongoing conservation efforts in the Plan Area, including the Anadromous Fish Restoration Plan, Central Valley Project Improvement Act, and CALFED programs. The combination of increased law enforcement and new sport fishing regulations adopted over the past several years to protect sturgeon and reduce their harvest is expected further reduce the effects of illegal and incidental harvest of white sturgeon by recreational anglers throughout the range of the species. White sturgeon are also covered under the San Joaquin County HCP and the East Alameda County Conservation Strategy.

The conservation strategy for white sturgeon focuses on life stages occurring within the Plan Area, and is intended to benefit those specific life stages when they would be present in the Plan Area. The conservation strategy includes increasing rearing habitat; increasing local production of food; increasing the availability and production of food by exporting organic material from the marsh plain and enhancing phytoplankton, zooplankton, and biological production in tidal channels;minimizing entrainment; improving upstream adult passage conditions; and minimizing illegal harvest.

The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.9.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for white sturgeon are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

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Objective L1.3 and L1.4 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives below for further information on food availability.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.3:** Allow lateral river channel migration. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers. • **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2, through L2.6, L2.8, and L2.10 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives below for more information on food availability.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.3 and L3.4 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives for further information on how BDCP will address connectivity and passage.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 through L4.4 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to *CM15 Predator Control* for discussion of the management of nonnative predators within the Plan Area.

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3.3.5.9.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for white sturgeon are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11 that support aquatic food production and habitat for covered and other native species.

Goal TPANC2: Tidal perennial aquatic natural community that supports viable populations of native fish.
• **Objective TPANC2.1:** Control invasive plants, including Brazilian waterweed, Eurasian watermilfoil, and other nonnative plant species that adversely affect native fish populations.

Objectives TPANC1.1 and TPANC2.1 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives below for more information on food availability.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 through TBEWNC1.4 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives below for more information on food availability.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7. • **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objectives TFEWNC1.1 and TFEWNC1.2 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives below for more information on food availability.

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Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period. • **Objective VFRNC1.3:** Restore corridors of riparian vegetation along 20 miles of channel margin in the Sacramento and San Joaquin River systems to provide habitat along important migratory routes for anadromous fish and improve wildlife movement.

Objectives VFRNC1.1 through VFRNC1.3 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle. • **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Benefits of these objectives for white sturgeon are similar to those described for green sturgeon. Refer to species-specific goals and objectives below for more information on food availability.

3.3.5.9.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance white sturgeon within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for white sturgeon are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for white sturgeon will be achieved via altered flow management and habitat restoration. Altered flow management will be achieved primarily through *CM1 Water Facilities and Operation*, which will relocate and operate the primary point of diversion in the north Delta. Habitat restoration benefits will chiefly derive from tidal habitat restoration, seasonally inundated floodplain restoration, channel margin enhancement, and riparian habitat restoration, which are expected to contribute to increased food resources for sturgeon as well as increased habitat complexity.

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Reducing passage delays at anthropogenic barriers will reduce overall migratory delays and increase survival and spatial distribution of adult sturgeon during their upstream migration to spawning areas. Reducing migratory delays will contribute to an increase in survival of adult sturgeon as they are exposed to less potential stress, stranding and illegal harvest.

Increasing the availability of floodplain and channel margin habitat is anticipated to increase productivity within the Plan Area. The proposed seasonally inundated floodplain habitat restoration actions are expected to increase the amount and quality of accessible rearing habitat for juvenile sturgeon. The intent is to route sturgeon away from the interior Delta and through habitat that is favorable for growth.

The BDCP species-specific goals and objectives for white sturgeon are presented in the context of broader global goals and objectives developed by NMFS (Section 3.3.1, *Framework for the Goals and Objectives*).

Global Goals and Objectives Developed by the National Marine Fisheries Service Independent of BDCP[20]

Global Goal: Abundance: Ensure white sturgeon utilize all currently occupied areas within the Bay-Delta and its tributaries and are able to take advantage of any unoccupied areas which arise from restoration activities. Maintain stable population size and age structure.
• **Global Objective 1 (Abundance):** Increase abundance. Demonstrate stable or increasing abundance, and reproduction and recruitment.

Global Goal: Spatial Distribution: Ensure white sturgeon utilize all currently occupied areas within the Bay-Delta and its tributaries and are able to take advantage of any unoccupied areas which arise from restoration activities. Maintain a stable population and age structure.
• **Global Objective 1 (Spatial Distribution):** Increase spatial distribution. Protect and increase life-history and genetic diversity. • **Global Objective 2 (Spatial Distribution):** Provide water quality and other chemical characteristics for optimal behavior, growth, and viability in all life stages.

It should be noted that the global goals and objectives presented above have not been formally adopted by the NMFS and are subject to change. The BDCP white sturgeon goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives, but are not intended to achieve them alone. The global goals and objectives are provided here for broader context of white sturgeon conservation.

[20] Citation to be provided.

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Goal WTST1 (Abundance): Increased abundance of white sturgeon in the Plan Area.
• **Objective WTST1.1:** Increase the spawner-adult-abundance-to-juvenile-abundance ratio compared to existing conditions within 15 years of BDCP implementation.
Assumed Stressors: Incubation and rearing conditions, food availability, entrainment, illegal harvest. **Stressor Reduction Target:** • **Rearing:** Document distribution of incubation and rearing conditions and identify opportunities for improvement. Achieve improved rearing conditions in the Bay-Delta and its tributaries within 15 years of Plan implementation. • **Food Availability:** Identify areas with prey resource enhancement opportunities. Determine appropriate rate and schedule for implementation. Increase the quantity and quality of habitats suitable for prey resources important to white sturgeon (crustaceans, annelids, mollusks, fish, and midges) within 10 years of BDCP implementation. • **Entrainment:** Determine impact of entrainment to the white sturgeon population, and manage entrainment levels to support stable and/or increase population trends. • **Illegal Harvest:** Determine an appropriate reduction target, and then reduce illegal harvest of subadult and adult white sturgeon in the Plan Area by the target quantity within 15 years of plan implementation.

Objective WTST1.1 (Abundance) Rationale: The primary approach to this objective is to increase spawner adult to-juvenile abundance ratio, by improving rearing conditions, increasing food availability, reducing entrainment and reducing illegal harvest.

Rearing. The majority of white sturgeon in the San Francisco estuary appear to use the Sacramento River for reproduction. Although they also spawn in the San Joaquin, Feather, and Mokelumne Rivers, little is known about these spawning populations. The Delta and Suisun Bay serve as a migratory corridor, feeding area, and juvenile rearing area for white sturgeon. Larval and juvenile white sturgeon inhabit the lower reaches of the Sacramento and San Joaquin Rivers and the Delta (Stevens and Miller 1970). Water temperatures likely play an important role in the distribution of juvenile white sturgeon in nursery habitat. Water temperatures at low depths (1 meter or less) in the Sacramento-San Joaquin estuary averaged 20.5°C during summer, which is the upper limit of the thermal optima for white sturgeon (Cech et al. 1984).

While flows necessary for juvenile survival remain uncertain, DFG found that greater flows during the early life stages between April and July resulted in greater YOY production (Kohlhorst et al. 1991; Fish 2010). Recruitment was significantly positively correlated with Delta outflow in all months from April to July, but there was no correlation with mean daily volume of diversions. Sufficient outflow is important for dispersal of larvae into habitat in the bay and Delta, and may also disperse larvae away from high predation areas in the river (Israel et al. 2009).

While it is unknown how far the early life stages of white sturgeon drift in the river, embryos and larvae are intolerant of brackish water, and survival may be limited by saltwater intrusion. Restored subtidal freshwater habitats can provide important habitats for early life stages of white sturgeon. Salinity is also an important characteristic of juvenile white sturgeon habitat (Israel et al. 2009). Juvenlies appear to show preference for fresh water over brackish water (Brannon et al. 1985), although salinity tolerance appears to increase with age. Outflow may also indirectly influence juvenile survival by modifying the availability of these freshwater and low-salinity restored habitats in the Delta and Suisun Bay during white sturgeon's first year of life. Rearing habitat for larvae and YOY white sturgeon may be lacking currently, due to channel and tidal marsh modification.

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Creation, restoration, enhancement, and protection of a diverse range of aquatic habitats are intended to increase the habitat diversity and complexity (geographic and spatial distributions) that offer potential habitat for a wide range of covered fish species, including white sturgeon, and life stages. For example, enhanced spatial diversity and complexity of habitat types, including variation in water depths, tidal hydrodynamics, water velocities, residence times, salinity gradients, seasonal inundation, daily tidal cycles, and permanently inundated subtidal habitats are expected to contribute to an increase in the juvenile abundance over time. When considered in conjunction with actions to improve food availability and increase survival, the net result is anticipated to be an increase in the abundance of spawning adult white sturgeon over time.

Food availability. White sturgeon use the lower Sacramento River and Bay-Delta as juveniles, subadults, and adults. In the Delta, YOY white sturgeon sampled in the late summer and fall consumed amphipods, shrimp, and larval and adult midges (Schreiber 1960). When juvenile white sturgeons migrate from the river into the estuary, their diet shifts to larger benthic food items, though they remain generalists and opportunists (Israel et al. 2009). In the Delta, mysid shrimp and amphipods were observed to be the primary food items in juvenile (less than 39 centimeters) white sturgeon stomachs (Radtke 1966). As white sturgeon juveniles grow, they are presumed to become more piscivorous, consuming herring and their eggs, American shad, starry flounder, and goby (Radtke 1966; McKechnie and Fenner 1971). Available benthic food items in the Bay-Delta estuary have changed in the recent past and invasive invertebrates have replaced native mollusks and shrimps. Kogut (2008) found that the invasive overbite clam (*Corbula amurensis*) was a major component of the white sturgeon diet. The BDCP aims to increase growth of juvenile white sturgeon and restore key habitat elements for juvenile white sturgeon by increasing access to and quality of habitats within the Plan Area that produce benthic invertebrates and other important food items.

Increasing the timing, frequency and duration of floodplain inundation in Yolo Bypass (*CM2 Yolo Bypass Fisheries Enhancement*), constructing new tidal wetlands (*CM4 Tidal Natural Communities Restoration*), providing for greater floodplain inundation (*CM5 Seasonally Inundated Floodplain Restoration*), and enhancing channel margin habitat along up to 20 miles of current levee channel by restoring riparian, marsh, and mudflat habitats along levees (*CM6 Channel Margin Enhancement*) is expected to contribute to provide increased production of periphyton, phytoplankton, macroinvertebrates, insects, and small fish that contribute to the local and regional trophic foodweb associated with each restoration area and thereby contribute to an increase in white sturgeon.

Entrainment. The SWP/CVP facilities, like other diversions in the study area, entrain downstream migrating larvae, juvenile, and adult white sturgeon in varying degrees that depend on life stage, location, timing and quantity of water diversion. There is little documentation of entrainment at most such diversions. No sturgeon entrainment was observed during an agricultural diversion study on the Sacramento River in the north Delta (Nobriga et al. 2004). South Delta water diversions were recorded as a source of mortality for white sturgeon during the high-flow years of 1982 and 1983. White sturgeon entrainment at the state and federal pumps varies and estimates ranged from zero upward to the thousands between 1981 and 2006. Larger juvenile sturgeons (larger than 200 mm) had lower entrainment at diversions with angled bar racks and louvers (Amaral et al. 2002). Assuming that export pumping in the south Delta is proportional to entrainment of juvenile white sturgeon, entrainment of this species will decrease under the BDCP relative to existing conditions. The decrease will be greater in wet and above normal years (40 to 60%) than in below normal, dry, and critical years (10 to 30% or less). Refer to Appendix 5.B, *Entrainment*, for further information.

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Illegal Harvest. Reducing illegal havest will contribute to an increase in the abundance of adult white sturgeon, which are the source of future generations. The life-history characteristics of white sturgeon (long lived, late maturing, with infrequent spawning) coupled with the cyclic recruitments in the Sacramento River population make them susceptible to illegal harvest and overexploitation. Illegal harvest of white sturgeon is a serious and increasing threat to the population (Gingras pers. comm.). While the mortality rates and magnitude of this illegal activity are unquantifiable, they may be quite high. For example, Schaffter and Kohlhorst (1999) postulated that illegal harvest played a role in the decreasing trend in annual survival rates during the 1990s. There is a tremendous financial incentive for poachers to exploit this population and this incentive has become evident as several organized poaching rings have been exposed and prosecuted since 2000. The BDCP will provide funding to DFG to increase the number of game wardens in the Delta to reduce illegal poaching. However, uncertainties about sturgeon population sizes and dynamics make it difficult to predict the effectiveness of this measure for these species. Overharvest may be one of the greatest stressors for adult white sturgeon. Maintaining acceptable levels of spawning stock biomass per recruit is critical to sturgeon conservation. It has been suggested that maintaining an adult biomass of at least 20% (Goodyear 1993) to 50% (Boreman et al. 1984) should be targeted for rebuilding the population. The development of a white sturgeon fisheries management plan would provide a strong foundation for protecting and enhancing the white sturgeon population. *CM17 Illegal Harvest Reduction* will increase enforcement within the Plan Area and reduce illegal harvest, thereby increasing adult white sturgeon abundance.

Goal WTST2 (Life-History Diversity and Spatial Distribution): Improved habitat connectivity that facilitates timely passage and reduced stranding of adult white sturgeon.
• **Objective WTST2.1 (Passage and Stranding):** Reduce stranding of adult white sturgeon at Fremont Weir by 75% over baseline conditions within 15 years of BDCP implementation.
Assumed Stressor: Passage and stranding. **Stressor Reduction Target:** • **Passage/Stranding:** Improve passage between the Sacramento River and Yolo Bypass for timely passage and 75% decrease in stranding of adult white sturgeon between January and May within 15 years of BDCP implementation.

Objective WTST2.1 (Passage and Stranding) Rationale: White sturgeon are highly migratory fish, often passing rapidly between freshwater and marine habitats. Individuals quickly ascend northern Central Valley rivers to spawn, and unimpeded connectivity between habitats and safe and timely passage are critical to increasing the spatial distribution of spawning and reducing adult mortality, passage delays and stranding. These objectives can be met through implementation of seasonal sturgeon fish passage at Fremont Weir and operational monitoring programs at gates, barriers, and diversions. Prior to implementing these programs, information on white sturgeon travel times, directionality, and disposition should be used to determine measureable outcomes regarding necessary safe and timely passage.

Limited stranding and rescue data indicate that appreciable percentages (10% or more), of the green sturgeon spawning population in particular currently may be negatively affected by the passage impediment caused by the Fremont Weir. Within Yolo Bypass, stranding is known to occur at the large pool at the base of the Fremont Weir. It is assumed the majority of the stranding that occurs in the Yolo Bypass occurs within this large pool. Whether white sturgeon are also stranded at other locations with the Yolo Bypass is unknown. Thus, the75% decrease in stranding target is

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appropriate as the BDCP will focus to eliminate stranding at the large pool at the base of the Fremont Weir, while determining whether stranding may be occurring at other areas in the Yolo Bypass and working to reduce stranding at those locations as practicable.

Between 2002 and 2006, approximately 50 sturgeon (no species identification given) were rescued over the course of four rescue operations at the Fremont Weir (California Department of Fish and Game 2006 unpublished). In 2011, 19 white sturgeon (and 14 green sturgeon) were rescued at the Fremont Weir (Healey and Vincik 2011). The efficacy of the passage improvements at the Fremont Weir and other locations in the Yolo Bypass (e.g., Lisbon Weir) cannot be estimated, but will be monitored, and adjustments will be made through adaptive management to improve passage. Resulting, improvements in migration may vary by year type as a result of differing inundation frequencies and volumes, but BDCP implementation is expected to have a major positive effect on upstream migrating sturgeon in terms of passage.

Spawning adults may be delayed in reaching spawning grounds in the Sacramento River due to misleading flow cues associated with unnatural flow conditions (e.g., reverse flows) in south and central Delta waterways. Sturgeon immigrating in the San Joaquin River may be confused by Sacramento River flows entering the south Delta via the Delta Cross Channel, which can cause delays and block passage. Delta exports and diversions can also affect Delta flow rates and hydrodynamics resulting in migration delays (National Marine Fisheries Service 1997). Low DO conditions in the area of the Stockton DWSC can also act as a physical barrier to migration.

River flow is diverted through the Yolo Bypass for flood control purposes during periods of high flow associated with winter storms. As waters recede in this system, passage options become very limited and sturgeon on their way to the spawning grounds can become stranded, leaving them vulnerable to illegal harvest, desiccation, scavenging, and death unless they are rescued (Matica, pers. comm.). The Fremont Weir is a documented barrier to sturgeon and the DFG occasionally has to conduct rescue operations of sturgeon (and other fishes) at this structures. A recent set of studies provide design and operational criteria for sturgeon passage at Fremont Weir (California Department of Water Resources 2007). These criteria will be incorporated into anticipated modifications to the Fremont Weir to facilitate *CM2 Yolo Bypass Fisheries Enhancement* and improve passage for adult white sturgeon.

Goal WTST3 (Spatial Distribution): Increased spatial distribution of YOY and juvenile white sturgeon in the Bay-Delta compared to existing condition SWP/CVP regulatory requirements.
• **Objective WTST3.1 (Distribution):** Improve water quality parameters and physical habitat characteristics in the Bay-Delta to increase the spatial distribution of white sturgeon in the Plan Area within 15 years of BDCP implementation.
Assumed Stressor: Water quality **Stressor Reduction Target:** • **Water Quality:** Reduce pollutants and improve water quality, with targets to be set by the adaptive management technical team on the basis of developing understanding of sturgeon sensitivity to water quality impairments.

Objective WTST3.1 (Distribution) Rationale: Achieving this objective will increase the spatial distribution and survival of white sturgeon by providing water quality conditions that support optimal behavior, growth and viability. Water quality in the Sacramento and San Joaquin Rivers and the Delta is influenced by a variety of point and nonpoint source pollutants from urban, industrial,

and agricultural land uses. Runoff from residential, agricultural, and industrial areas introduces pesticides, oil, grease, heavy metals, other organics, and nutrients that contaminate drainage waters and deteriorate the quality of aquatic habitats necessary for white sturgeon survival (National Marine Fisheries Service 1996; California Regional Water Quality Control Board-Central Valley Region 1998). Reducing these pollutant sources is expected to improve rearing conditions for white sturgeon.

Habitat suitability for juvenile sturgeon rearing is primarily dependent on water quality and food availability. Juvenile sturgeon can use a broad range of habitats defined by their temperature, DO, and salinity tolerances; thus, the distribution of juvenile habitat fluctuates seasonally in freshwater and brackish environments. White sturgeon forage in subtidal and intertidal habitats in the west and south Delta, where low DO can occur seasonally. High water temperatures in the southern portion of the Delta may limit use by sturgeon in some months. Therefore, water quality is likely a limiting factor during early life-history stages of white sturgeon (Israel et al. 2009). However, little is known regarding sensitivity of white sturgeon to water quality impairments. An adaptive management technical team should be established to set targets, based on the most current research and best professional judgment, for pollutant reductions to improve water quality in those portions of the Plan Area important to white sturgeon, such as the west and south Delta. Reducing pollutants in the Plan Area will be accomplished by implementing *CM12 Methylmercury Management* and *CM19 Urban Stormwater Treatment*, which will contribute to improving water quality and physical habitat parameters within the Plan Area, and thus increase the extent of habitat suitable for white sturgeon.

3.3.5.10 Pacific and River Lamprey

Pacific and river lamprey migrating in and out of the Sacramento and San Joaquin River watersheds pass through the Plan Area, but their use of the Plan Area for other purposes is unknown. In the Central Valley, Pacific and river lamprey occur in the lower Sacramento and San Joaquin Rivers and in many of their tributaries including the Stanislaus, Tuolumne, Merced, and Kings Rivers (Brown and Moyle 1993).

Neither Pacific nor river lamprey are currently listed as either a threatened or endangered species under CESA or ESA, and no recovery plan has been developed for either specie. There have been very few efforts to conserve either Pacific or river lamprey in the Central Valley of California. The CALFED Ecosystem Restoration Program designated the entire lamprey family as *enhance and/or conserve* (CALFED Bay-Delta Program 2000). This designation indicates that the program will undertake actions to conserve and enhance the abundance and distribution of lamprey and the community diversity in which they live for their long-term stability.

The BDCP conservation strategy for lamprey focuses on one primary stressor to enhance environmental conditions for larval settlement and development in the Plan Area. The protection and improvement of the quality, quantity, and availability of habitat for larval rearing and juvenile migration will be accomplished by implementing conservation actions at the landscape, natural community and species scales that meet the specific habitat requirements for lamprey. The strategy also includes measures to provide bypass flows and other water operations criteria that will increase juvenile outmigration success.

The lamprey conservation strategy will include efforts to expand the scientific knowledge base of Pacific and river lamprey in the Plan Area in order to inform future adaptive management and facilitate achieving BDCP goals and objectives for lamprey. Contributing financial and/or technical

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resources toward implementing regional monitoring programs focused on Pacific and river lamprey is expected to expand the scientific understanding of both of these species and contribute to identifying measures necessary to maintain self-sustaining populations. Data obtained through cooperation in a regional program could be used to assess population trends, refine knowledge of stressors on key life stages, and complement future adaptive management actions. Relevancy of these data for use in the BDCP will be improved if contributions can be linked to conditions in the Plan Area.

The larval form of Pacific lamprey (ammocoete) is common throughout the BDCP Plan Area, although there are no abundance estimates from Bay-Delta sampling programs. There are few status and trend data, and there are no regular monitoring programs with which to assess trends through time. However, anecdotal evidence indicates that populations have been in decline in many California river systems (Moyle 2002).

Ammocoetes live in silty backwaters and eddies with muddy or sandy substrate into which they burrow. Ammocoetes require water temperatures lower than 25°C (76°F) (Moyle et al. 1995). Evaluation of the threats and stressors to Pacific lamprey has been limited. However, the primary threat to Pacific lamprey is thought to be loss or degradation of habitat through dams, diversions, toxics, stream channelization, dredging, and urbanization. Dams have altered flows in channels and limited access to spawning grounds. Toxics may have both lethal and sublethal effects on individuals. Stream channelization, dredging, and diversions have altered flow patterns and rates in channels. Urbanization has degraded habitat by increasing loads of certain toxics, changing runoff patterns, and altering the configuration of some channels. Future climate change is expected to further increase water temperatures and modify the timing of flow-related environmental cues upon which Pacific lamprey depend for life-history events (e.g., outmigration, spawning). Refer to Appendix 2.A, *Covered Species Accounts*, for a full discussion of these stressors.

The Pacific Lamprey Conservation Initiative, led by the USFWS, was initiated in 2007 to "facilitate communication and coordination relative to the conservation of Pacific lampreys throughout their range" (U.S. Fish and Wildlife Service 2007). The goal of the initiative is to restore Pacific lamprey populations and improve their habitat. Anticipated actions from the initiative include development of a Pacific lamprey conservation plan, identification of funding for implementation of the initiative and plan, development of a network of interested parties, funding for immediate conservation actions, and improvements in communication of Pacific lamprey conservation efforts.

No formal evaluations have assessed the threats and stressors to river lamprey. Therefore, much of the following discussion is based on limited information or has been derived from data on the co-occuring Pacific lamprey. The primary threat to river lamprey is thought to be loss or degradation of habitat through dams, diversions, toxics, stream channelization, dredging, and urbanization. Dams have altered flows in channels and limited access to spawning grounds. Toxics may have both lethal and sublethal effects on individuals. Stream channelization, dredging, and diversions have altered flow patterns and rates in channels. Urbanization has degraded habitat by increasing loads of certain toxics, changing runoff patterns, and altering the configuration of some channels. Future climate change is expected to further increase water temperatures and modify the timing of flow-related environmental cues upon which river lamprey depend for life-history events (e.g., outmigration, spawning). Refer to Appendix 2.A, *Covered Species Accounts*, for a full discussion of these stressors.

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The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.10.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for lamprey are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objective L1.3 Benefits: Meeting this objective will enhance the seasonally inundated floodplains and tidally influenced natural communities that are very important for lamprey in terms of primary productivity and food resources. Providing a gradient of floodplain and tidally influenced natural communities will provide a range of conditions suitable for food production and rearing. The BDCP will restore 65,000 acres of tidal wetland in the Delta, approximately 10,000 acres of seasonally inundated floodplain, up to 20 miles of channel margin habitat, and at least 5,000 acres of riparian habitat to benefit covered fish species (in addition to other restoration actions specific to terrestrial species also covered in the BDCP). The habitat restoration actions have two principal objectives: to increase the amount of available habitat for covered fish species, and to enhance the ecological function of the Delta. Although little is known about lamprey use of channel margin habitat, these species may benefit from enhancement that increases the area of substrate into which ammocoetes can bury. Refer to TPANC1.1 for a discussion of these benefits.

Objective L1.4 Benefits: Meeting this objective will make a greater range of habitat conditions, food resources, and habitat complexity available for lamprey. Providing a greater range of potentially suitable habitat conditions for lamprey and the organisms upon which they prey is anticipated to increase the extent of habitats available across a range of conditions (e.g., flow, water temperatures, and turbidity). Close et al. (2003) found that larval Pacific lamprey prefer habitats with soft sediments and low water velocities. Protection and enhancement of suitable larval rearing habitats in the Plan Area is expected to benefit productivity.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.3:** Allow lateral river channel migration. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers. • **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.6:** Maintain or increase life-history diversity of native fish species and a diversity of spawning and rearing conditions for native fish species over time. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.9:** Provide refuge habitat for migrating and resident covered fish species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.2 and L2.3 Benefits: Meeting these objectives will restore natural fluvial processes to improve habitat conditions through floodplain inundation, which can increase sediment inputs and thereby maintain suitable substrate conditions for ammocoete settlement and development in the Plan Area.

Objective L2.4 Benefits: Meeting this objective will increase river-floodplain connectivity to improve hyporheic processes such as groundwater recharge, thereby increasing habitat complexity improving water quality, providing cool water inputs, and maintaining flow inputs to surface waters. Increased connectivity will also increase allochthonous inputs, which will contribute to an increase in productivity in aquatic systems.

Objective L2.5 Benefits: Meeting this objective will reduce the amount of pollution in stormwater runoff entering Delta waterways. This will benefit lamprey by reducing pesticides and herbicides. Ammocoetes spend 5 to 7 years living in silty areas that are known to accumulate high levels of toxins. As a result, lamprey are prone to high body burdens of toxins relative to other fish species (Haas and Ichikawa 2007; Bettaso and Goodman 2008). These water quality improvements will contribute to a reduction in the accumulations of toxins in ammocoetes and contribute to increasing available food resources.

Objective L2.6 Benefits: Meeting this objective will provide a range of environmental gradients to ensure that a diversity of spawning and rearing conditions exists for lamprey within the Plan Area over the life of the BDCP, thereby increasing the diversity and resiliency of the species.

Objective L2.8 Benefits: Meeting this objective will increase natural dendritic channels in tidal marsh habitats to promote food production and transport, which will benefit lamprey rearing in and/or migrating through the Plan Area by providing food resources. This will benefit lamprey rearing in the freshwater and low salinity zones of the Plan Area, as they grow and develop critical osmoregulatory capacities that allow them to enter the ocean.

Objective L2.9 Benefits: Meeting this objective will provide refugia habitat for migrating lamprey, which may reduce potential predation effects.

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Objective L2.10 Benefits: Meeting this objective will increase food resources important to lamprey such as algae, organic material, and microorganisms, which is expected to increase growth rates and subsequently survival. Also see the rationale for Objective TPANC1.1, below.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.2:** Promote connectivity between low salinity zone habitats and upstream freshwater habitats, and availability of spawning habitats for native pelagic fish species. • **Objective L3.3:** Support the movement of larval and juvenile life stages of native fish species to downstream rearing habitats. • **Objective L3.4:** Provide flows that support the movement of adult life stages of native fish species to natal spawning habitats.

Objective L3.2 Benefits: Meeting this objective will increase connectivity between low salinity zone habitat and upstream freshwater spawning habitat, which will benefit lamprey adults by improving access to suitable spawning habitats and providing a range of suitable spawning conditions through a variety of habitat conditions.

Objective L3.3 Benefits: Meeting this objective will provide increased flexibility for water operations of the north diversions, and will allow BDCP to provide flow conditions that can more easily coincide with the timing of juvenile lamprey outmigrations. Enhancing outmigration conditions is expected to reduce predation and improve survival.

Objective L3.4 Benefits: Meeting this objective will provide flow conditions similar to natural flow conditions within the Plan Area, which will provide appropriate cues to lamprey to begin their spawning migration, and provide access to natural spawning habitats.

Goal L4: Reduce mortality of covered species in the Plan Area.
• **Objective L4.1:** Avoid and minimize adverse effects on covered species resulting from BDCP covered activities. • **Objective L4.2:** Manage the distribution and abundance of established nonnative predators in the Delta to reduce predation on native covered fish species. • **Objective L4.3:** Manage the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. • **Objective L4.4:** Reduce entrainment, impingement, and salvage losses of covered fish species.

Objective L4.1 Benefits: Meeting this objective will avoid and minimize direct effects on lamprey resulting from BDCP covered activities. Avoidance and minimization measures will include project planning and site-specific surveys to identify covered species and suitable habitat for which these measures apply, preconstruction surveys if timing restrictions require such surveys in the months or weeks prior to construction, implementation of construction BMPs, and operation and maintenance associated with long-term activities (e.g., operation and maintenance of the water conveyance facilities), and ongoing covered species habitat enhancement and management. These measures are intended to avoid and minimize direct effects on individual covered species and their habitats, as well as natural communities as a result of construction activities and operation and maintenance activities.

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Objective L4.2 Benefits: Meeting this objective will reduce predation on lamprey by nonnative predators. Although predation is a natural part of aquatic community dynamics, excessive predation has been identified as a stressor for BDCP covered fish species, such as lamprey. Mammals, birds, and other fish species consume lamprey at all life stages (Luzier et al. 2009). The diversity and populations of invasive predator species have increased in recent decades, and the targeted harvest, capture, and removal of nonnative predators are expected to reduce population level predation impacts on lamprey. Refer to *CM15 Predator Control* for discussion of the management of predators within the Plan Area.

Objective L4.3 Benefits: Meeting this objective will manage flows to influence the distribution of covered fish species to minimize movements into high predation risk areas of the Delta. Juvenile lamprey may be transported to predator-infested tidal and shallow sub-tidal areas in the Delta where they are vulnerable to predators with greater swimming abilities, particularly when Delta outflow is relatively low (Rosenfield 2010). Therefore, managing for higher flows may result in a wider distribution of lamprey and a reduction in predation and mortality rates.

Objective L4.4 Benefits: Meeting this objective will reduce the entrainment of lamprey. Across the five water-year types, exports from the south Delta decrease from 100% of total exports under the existing biological conditions to an average of about 58% under the BDCP. The proportion of total exports that will come from the south Delta facilities under the BDCP is lowest in wet water years (about 35%) and is highest in critical water years (about 84%). The BDCP will increase total exports over baselines during April, May, and June but will do so largely by taking water from the north Delta intakes. Exports from the south Delta facilities during the spring months are generally similar or reduced relative to the existing biological conditions. With the BDCP, total exports from combined north and south Delta intakes will increase relative to the existing biological conditions in wet, above normal, and below normal water years. Under dry and critical water years, total exports will decrease under the BDCP relative to existing biological conditions. Overall, the BDCP will substantially reduce exports from the south Delta facilities in most months relative to the existing biological conditions. Entrainment is expected to be reduced most in wetter years because a greater percentage of flow will be diverted from the north Delta in wet years than in dry years (Appendix 5.B, *Entrainment*).

3.3.5.10.2 Applicable Natural Community Goals and Objectives

All natural community goals and objectives that provide lamprey habitat (i.e., tidal perennial aquatic, tidal brackish emergent wetland, tidal freshwater emergent wetland and nontidal perennial aquatic) will benefit lamprey. Meeting those objectives that will contribute to an increase in primary productivity and the transport of food resources to deepwater habitats, such as creation, restoration, and enhancement of aquatic natural communities is anticipated to benefit fish species that occur in the Plan Area and thereby contribute to an increase in their abundance. An increase in the abundance of fish species in the Plan Area will provide a greater abundance in the prey available to both Pacific and river lamprey adults. An increase in primary productivity will also benefit ammocoetes. Ammocoetes remain in freshwater for approximately 5 to 7 years, where they bury into silt and mud and feed on algae, organic material, and microorganisms. Ammocoetes change locations during this stage. As discussed below, the BDCP species-specific goal and objective for lamprey is focused on protecting and enhancing habitat suitable for larval settlement and development within the Plan Area. Creating, restoring, and enhancing habitat that will contribute to an increase in primary productivity will also benefit ammocoetes, which are filter feeders for the

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first 5 to 7 years of their lives, before their metamorphosis into macropthalmia (juveniles), in preparation for their predatory life stage in the ocean and estuary.

3.3.5.10.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for lamprey within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale. Species-specific goals and objectives for covered fish also define population performance metrics to be achieved during BDCP implementation.

The BDCP species-specific goals and objectives for Pacific and river lamprey are presented in the context of broader global goals and objectives developed by USFWS (Section 3.3.1, *Framework for the Goals and Objectives*).

The BDCP conservation strategy for lamprey will be achieved via altered flow management and habitat restoration. Altered flow management will be achieved primarily through conservation measures to relocate and operate the primary point of diversion to the north Delta. This change is expected to reduce the spatial overlap of diversion intakes and lamprey occurrence, thereby substantially reducing entrainment.

Global Goals and Objectives Developed by the U.S. Fish and Wildlife Service Independent of BDCP[21]

Global Goal: Manage estuary to improve habitat. Restore/sustain Pacific and River lamprey populations throughout historic range
• **Global Objective 1:** Implement actions known to benefit Pacific and River lamprey, minimize threats, and improve scientific understanding.

As stated previously, the global goals and objectives were developed by USFWS independent of the BDCP and are associated with the USFWS' responsibility to recover species protected under the ESA. The BDCP lamprey goals and objectives presented below have been developed to contribute towards the achievement of the global goals and objectives. The global goals and objectives are provided here for broader context of lamprey recovery.

[21] Citation to be provided.

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

Goal PRL1 (Rearing Habitat): Suitable larval rearing habitat for Pacific and River lamprey within the Plan Area.
• **Objective PRL1.1:** Protect and enhance habitat suitable for larval settlement and development within the Plan Area within 15 years of BDCP implementation.
Assumed Stressors: Lack of suitable rearing habitat. **Stressor Reduction Targets:** • **Larval Habitat.** Baseline monitoring to determine extent of suitable substrates in plan area, extent of use of suitable habitats in the plan area and adoption of guidance on tidal habitat restoration to produce these substrate types as practicable. PHABSIM (Physical Habitat Simulation System) analysis on the Columbia River identified commonly preferred habitat characteristics as (Close et al. 2003): ○ Silt, sand or organic (≥30 mm depth) substrates. ○ Water velocity of 0–19 centimeter per second (cm/s). ○ Avoiding sudden changes in water levels (to reduce stranding).

Objective PRL1.1 (Larval Habitat) Rationale: Meeting this objective will protect and enhance habitat characteristics that support the settlement and development (growth) of Pacific and river lamprey. Ammocoetes remain in freshwater rearing habitats for 5 to 7 years, where they bury into silt and mud and feed on algae, organic material, and microorganisms. Lamprey ammocoetes generally are thought of as occurring upstream of the Plan Area, but there appear also to be appreciable numbers in the Plan Area throughout the year. More than 2,100 Pacific lamprey ammocoetes were collected during electrofishing at bank protection sites (HT Harvey and Associates with PRBO Conservation Science 2010).

Although little is known about Pacific and river lamprey use of channel margin habitat, the species may benefit from enhancement that increases the area of nonrevetted substrate into which ammocoetes can bury. Enhancement of channel margin habitat would increase the amount of ammocoete burial habitat where hardened substrates are removed or covered with soft substrate of a sufficient depth (at least 30 centimeters) (Close et al. 2003). Given the broad distribution and extended period that lamprey occur in the Plan Area, the protection and enhancement of suitable larval rearing habitats is expected to benefit overall productivity.

Using Jacobs' selectivity index, Close et al. (2003) developed habitat suitability index values for Pacific lamprey larvae in the Columbia River basin for use in Physical Habitat Simulation System (PHABSIM). Close et al. (2003) found that larval Pacific lamprey prefer habitats with soft sediments and low water velocities. Similar analysis of Pacific lamprey habitat preference could be used to identify and target areas for larval habitat conservation and enhancement within the Plan Area.

An additional consideration for larval habitat that was not identified by Close et al. (2003) is stranding risk. Fluctuations in reservoir and stream water levels, irrigation diversions, and stream dewatering can strand ammocoetes in the substrate (U.S. Fish and Wildlife Service 2009). A single event can have a significant effect on a local lamprey population, affecting multiple generations (U.S. Fish and Wildlife Service 2009, Luzier et al. 2009). However, there is little data identifying the extent of such occurrences in the Plan Area.

Downstream movement of juvenile lampreys (macropthalmia) happens year round (Luzier et al. 2009). Due to poor swimming ability, movement is probably driven by flow conditions and velocities (Moursund 2009). Juvenile travel time is related to water particle travel time, and increases in freshet flows will likely reduce lamprey travel time (Nez Perce et al. 2008). Downstream

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migrating macropthalmia are often impinged on diversion and intake screens, resulting in death (Luzier et al. 2009). While not part of the species-specific goals and objectives, the management of flows and entrainment for other plan species are expected to also reduce stranding, entrainment and migration impacts on lamprey.

Contributing financial and/or technical resources toward implementing regional monitoring programs (e.g., The Pacific Lamprey Conservation Initiative) focused on Pacific and river lamprey is expected to expand the scientific understanding of both of these species and contribute to identifying measures necessary to maintain self-sustaining populations. Data obtained through cooperation in a regional program could be used to assess population trends, refine knowledge of stressors on key life stages, and complement future adaptive management actions. Relevancy of these data for use in the BDCP will be improved if contributions can be linked to conditions in the Plan Area.

3.3.5.11 Riparian Brush Rabbit

The riparian brush rabbit (*Sylvilagus bachmani riparius*) occupies riparian communities dominated by thickets of willows (*Salix* spp.), wild roses (*Rosa* spp.), blackberries (*Rubus* spp.), and other successional trees and shrubs; and when available, seasonally dense, tall stands of herbaceous plants adjacent to patches of riparian shrubs in the northern San Joaquin Valley. These communities in the San Joaquin Valley have been reduced to less than 11% of their historical extent (Katibah 1984), primarily by the clearing of natural vegetation, irrigated cultivation, river impoundment, and stream channelization.

Populations of riparian brush rabbit are known to have occurred historically in riparian forests along the San Joaquin and Stanislaus Rivers and some tributaries to the San Joaquin River (U.S. Fish and Wildlife Service 1998). Population declines are directly associated with the removal of riparian communities, which accelerated with dams construction on the major rivers of the Central Valley for irrigation and flood control. Construction of levees along major river systems facilitated the conversion of floodplains to croplands and the consequent reduction and fragmentation of remaining riparian communities (U.S. Fish and Wildlife Service 1998).

Today, the only known naturally occurring populations of riparian brush rabbits are confined to Caswell Memorial State Park, a 258-acre park supporting riparian oak woodland on the Stanislaus River immediately southeast of the Plan Area, and in the south Delta southwest of Lathrop, which is within the Plan Area (Williams and Basey 1986; Williams et al. 2002) (Figure 3.3-7). The known distribution of the south Delta population is fragmented into isolated and semi-isolated patches along the San Joaquin River, Paradise Cut, Tom Paine Slough, and railroad rights-of-way in San Joaquin County. The only protected south Delta population segment is in the Oxbow Preserve, a 30-acre riparian forest preserve owned by the Center for Natural Land Management. Paradise Cut is located on private property and the waterway is managed primarily for flood control. Habitat patches are extremely narrow strips—most only a few meters wide—between active farmland and open water (Kelly et al. 2011). Extant populations are small, isolated, may not be self-sustaining, and are under significant, proximate threats of extinction (Williams et al. 2002).

The existing two populations, the Caswell Park and south Delta populations, are under significant, proximate threats of extinction. The population at Caswell Park faces threats from inbreeding (loss of genetic diversity), wildfire, flooding, disease, and predation risk (high numbers of feral cats) (Williams and Basey 1986; U.S. Fish and Wildlife Service 1998). The south Delta population faces

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threats from stochastic demographic and genetic events, flooding, disease, predation, competition, habitat destruction, and urban edge effects. Continued threats to the species from flooding and predation further add to the species' already limited distribution and abundance.

The recovery plan (U.S. Fish and Wildlife Service 1998) for the brush rabbit, and other upland species of the San Joaquin Valley, focuses on riparian restoration and protection, and population reintroductions. This species is covered under the San Joaquin County Multiple Species Conservation Program. Because the extant populations at Caswell Memorial State Park and the south Delta are isolated from other suitable sites that are uninhabited, reintroductions of individuals from existing populations are required to meet the recovery goal of three additional self-sustaining wild populations. To provide a source of animals for reintroduction, a controlled propagation program was undertaken in 1999 by USFWS, DFG, and Reclamation (Williams et al. 2002).

The conservation approach for the riparian brush rabbit is to protect, restore or create, and maintain habitat and corridors near the largest remaining fragments of habitat and extant populations. Riparian habitat for the brush rabbit includes large patches of dense brush composed of riparian vegetation, ecotonal edges of brushy species to grasses and herbaceous forbs, skeletal scaffolding structure, an open tree overstory, and high ground refugia. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.11.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the riparian brush rabbit are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland transitional areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.5 Benefits: This objective will address the need for upland refugia for riparian brush rabbits during flood events. The width of the riparian corridor in otherwise suitable riparian brush rabbit habitat has been greatly reduced as a result of channelization and levee construction, and uplands outside the levees have been leveled for agricultural production. The result has been a lack of the necessary topography and vegetative cover for riparian brush rabbit use during high river flows. Land between the levees can be entirely submerged during these high flow events, with few or no high ground sites where riparian brush rabbits can seek shelter with appropriate cover either inside or outside the levees. In 1995 and 1997, high flow events in the reduced floodplain were catastrophic for the riparian brush rabbit population along the Stanislaus River (River Partners 2008). Floodplain restoration in Conservation Zone 7 will widen the floodplain to increase opportunities for flood refugia. The adjacent upland habitat that seldom floods will further increase these opportunities. Additional provisions for riparian brush rabbit refugia are described under the

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species-specific objectives. Provision of upland transitional areas will also provide riparian buffers to reduce the potential for adverse effects from adjacent urban and agricultural lands, such as noise, lighting, and predation from domestic pets. Additionally, grassland provided adjacent to riparian habitat can provide foraging opportunities for riparian brush rabbit (Kelly et al. 2011). Criteria for upland areas adjacent to restored riparian are provided in CM3 *Natural Communities Protection and Restoration.*

Objective L1.6 Benefits: Increasing the size and connectivity of the reserve system consistent with this objective will minimize the risk of riparian brush rabbit habitat fragmentation and adverse effects of adjacent land uses. Habitat fragmentation results in a small population size, increasing the risk of extirpation as a result of population fluctuations and catastrophic events such as flooding. Small reserves are also vulnerable to effects from such elements of adjacent urban and agricultural lands as noise, lighting, encroachment of dogs and cats that may prey on riparian brush rabbits (Kelly et al. 2011), and disturbance as a result of human encroachment into the habitat. A large, interconnected reserve system that builds on existing protected lands will reduce these effects on riparian brush rabbit.

Existing populations within the Plan Area appear to be taking advantage of railroad right-of-ways that support suitable riparian shrubs (e.g., the corridor north of the intersection of Interstates 5 and 205). These vegetated railroad rights-of-way can provide a linear corridor to connect river systems and large networks of suitable habitat through otherwise unsuitable agricultural zones. The reserve system could take advantage of these railroad rights-of-way through strategic protection and restoration of riparian brush rabbit habitat in proximity to such corridors.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.

Objective L2.1 Benefits: Allowing natural flooding regimes consistent with this objective will provide natural vegetation disturbances to encourage establishment of early to mid-successional riparian vegetation. In the absence of regular flooding or other similar disturbances, the trees mature and form a dense canopy that creates shade and prevents the establishment of shrubby understory vegetation necessary for riparian brush rabbit.

Objective L2.4 Benefits: Connecting rivers and their floodplains consistent with this objective will recharge floodplain groundwater from mainstem channels. Reduced water tables inhibit growth of dense vegetation (Riparian Habitat Joint Venture 2004), which provides cover for riparian brush rabbit. Therefore, recharging floodplain groundwater is expected to benefit this species by providing conditions favorable for establishment of suitable habitat.

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Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: This objective addresses the need to improve riparian connectivity for the riparian brush rabbit. Riparian brush rabbit habitat connectivity is further addressed under Objectives L1.6 and RIBR1.1.

3.3.5.11.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the riparian brush rabbit are included below.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period.

Objectives VFRNC1.1 and VFRNC1.2 Benefits: Riparian protection and restoration consistent with these objectives will provide additional habitat potentially available for riparian brush rabbit population expansion. All the recorded occurrences of riparian brush rabbit in the Plan Area are in Conservation Zone 7, where riparian protection will occur consistent with Objective VFRNC1.2. Additional restoration and creation in this zone, consistent with Objective VFRNC1.2, will benefit riparian brush rabbit by providing additional habitat potentially available for population expansion (see Goal RBR1, below, for additional objectives related to future growth and expansion of populations). However, not all of the 750 acres of protected riparian and 5,000 acres of restored riparian natural community will have suitable structural characteristics necessary for supporting riparian brush rabbit, hence the need for Objective VFRNC2.2 and species-specific goals and objectives described below.

Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.
• **Objective VFRNC2.2:** Maintain at least 1,000 acres of early to mid-successional vegetation with a well-developed understory of dense shrubs.

Objective VFRNC2.2 Benefits: Maintaining early to mid-successional vegetation consistent with this objective will provide additional suitable habitat for the riparian brush rabbit. As described above for Objective L2.1, riparian brush rabbit requires the dense, shrubby vegetation that is typical of younger riparian stands. The restoration of seasonally inundated floodplain (CM5 *Seasonally Inundated Floodplain Restoration*) is expected to provide sufficient fluvial disturbance to maintain at least 1,000 acres of early to mid-successional riparian vegetation in the Plan Area. However, if fluvial disturbance is not sufficient to meet this objective, additional enhancement and management will be implemented as described in CM11 *Natural Communities Enhancement and Management.*

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3.3.5.11.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for riparian brush rabbit within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal RBR1: Suitable habitat available for the future growth and expansion of riparian brush rabbit populations.

- **Objective RBR1.1:** Of the 750 acres of protected valley/foothill riparian natural community, protect at least 200 acres of suitable riparian brush rabbit habitat (defined in CM7 *Riparian Natural Community Restoration*) that is occupied by the species or contiguous with occupied habitat.
- **Objective RBR1.2:** Of the 5,000 acres of riparian restoration, restore/create and maintain at least 300 acres of early- to mid-successional riparian habitat that meets the ecological requirements of the riparian brush rabbit and that is within or adjacent to or that facilitates connectivity with existing occupied or potentially occupied habitat.
- **Objective RBR1.3:** Create and maintain high-water refugia in the 300 acres of restored riparian brush rabbit habitat and additional protected lands occupied or with potential to become occupied by riparian brush rabbit, through the building and/or restoring of high ground habitat on mounds, berms, or levees, so that refugia are no further apart than 20 meters.
- **Objective RBR1.4:** In protected riparian areas, monitor for and control nonnative predators that impede survival and breeding success of riparian brush rabbits.

Objective RBR1.1 Rationale: This objective addresses the need to protect habitat occupied by the riparian brush rabbit. The Plan Area supports one of only two existing populations of riparian brush rabbit. Of the approximately 270 acres of known occupied habitat in the Plan Area (Williams et al. 2008), only 30 acres are protected. The rarity of this species and low proportion of occupied habitat that is protected necessitates additional protection. Protection of habitat occupied by known riparian brush rabbit populations is a guiding conservation principle (Kelly et al. 2011). As described in CM11 *Natural Communities Enhancement and Management,* the 200 acres will be enhanced and managed as necessary to establish and maintain suitable habitat characteristics for riparian brush rabbit.

Objective RBR1.2 Rationale: This objective addresses the need to provide riparian natural community with the specific characteristics that are suitable for the riparian brush rabbit. Suitable habitat for this species is extremely limited in the Plan Area and throughout the species' range. The extent of known occupied habitat in the Plan Area is approximately 270 acres (Williams et al. 2008). These occupied sites occur in isolated or semi-isolated patches separated by poor quality or unsuitable habitat. Restoring 300 acres of suitable riparian brush rabbit habitat will more than double the extent of available riparian brush rabbit habitat in the Plan Area and greatly increase its quality by creating larger, more contiguous patches of interconnected habitat. This will help facilitate expansion of the distribution and increase in abundance of the species. Riparian habitat will be restored according to the specifications in CM7 *Riparian Natural Community Restoration*, which describes the habitat requirements for this species that will be required elements of restoration plans. Additionally, these suitable habitat characteristics will be maintained as described in CM11 *Natural Communities Enhancement and Management.*

The 300 acres of riparian brush rabbit habitat will be restored adjacent to areas where naturally occurring populations are known to exist in Conservation Zone 7 (Figure 3.3-7). Connectivity with

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currently occupied or potentially occupied habitat will be a primary factor in the selection of restoration sites. The establishment of permanent corridors between known populations will facilitate dispersal of the species and genetic interchange between adjacent populations. Focusing restoration efforts on lands adjacent to occupied or potentially occupied sites will increase the extent of available habitat for existing populations and facilitate greater connectivity between them, thereby promoting an expansion of the species' distribution and abundance and contributing to a reduction of the potential extinction threat.

Objective RBR1.3 Rationale: This objective addresses the need to protect the riparian brush rabbit from mortality during flooding. An essential element of riparian brush rabbit habitat is high-water upland refugia, important for survival during flood events. The lack of high-water refugia has been responsible for substantial mortality and population declines during flood events and is considered one of the greatest threats to the Caswell Memorial State Park population (Elsholz 2010). To address this, all riparian brush rabbit restoration projects will be designed to incorporate high-water refugia consisting of building or restoring high ground habitat such as mounds, berms, and levees, no greater than 20 meters apart, and suitable vegetative composition and structure that can provide upland habitat and cover during flood events. Design specifications and vegetation requirements for these refugia are provided in *CM7 Riparian Natural Community Restoration.*

Objective RBR1.4 Rationale: This objective addresses the need to protect the riparian brush rabbit from nonnative feral predators, such as cats and dogs, which can be a threat to the populations, particularly where sufficient cover habitat is not available. Control of predators will be particularly important during restoration and relocation efforts until self-sustaining populations are established. Therefore, predation threats by feral predators will be monitored and minimized at all restoration sites through predator control or other management actions. Predator control will be a key element of the riparian brush rabbit restoration plan (CM11 *Natural Communities Enhancement and Management*).

3.3.5.12 Riparian Woodrat (San Joaquin Valley)

The riparian woodrat (San Joaquin Valley) (*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; U.S. Fish and Wildlife Service 1998).

Before the statewide reduction of riparian communities, the riparian woodrat probably ranged throughout the riparian forests along major streams flowing onto the floor of the northern San Joaquin Valley. There has been a nearly 90% reduction in the extent of riparian communities along these major streams (Katibah 1984). Much of the loss is due to habitat conversion to agricultural lands and the construction of large dams and canals. The riparian woodrat is now confined to the lower portions of the San Joaquin and Stanislaus Rivers in northern San Joaquin County (Williams 1986, 1993; U.S. Fish and Wildlife Service 1998). Habitat loss and fragmentation are considered the main causes of the riparian woodrat's range contraction (Appendix 2.A, *Covered Species Accounts*).

The riparian woodrat is not known to occur in the Plan Area. The only verified extant population of riparian woodrats rangewide is 2 miles east of the Plan Area in Caswell Memorial State Park along the Stanislaus River (Williams 1986, 1993). Riparian woodrat may occur in small patches of valley

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oak riparian forest occur within the Plan Area along the San Joaquin River from the southern tip of the Plan Area north to approximately the Interstate 5 overcrossing near Lathrop (Figure 3.3-8).

The riparian woodrat is included in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (U.S. Fish and Wildlife Service 1998). Habitat protection and, where appropriate, habitat restoration, are the central components of the conservation strategy recommended in the recovery plan for this and other upland species of the San Joaquin Valley (U.S. Fish and Wildlife Service 1998). The recovery plan establishes an overall goal of securing and protecting three riparian woodrat populations by protecting and restoring riparian habitat and reintroducing populations (U.S. Fish and Wildlife Service 1998). The overall BDCP biological goal for the riparian woodrat—to restore suitable habitat in order to conserve the species—is consistent with the recovery plan.

The BDCP conservation approach for the riparian woodrat is to provide opportunities for population expansion into the Plan Area from adjacent lands to the south and southeast. The strategy focuses on restoring and maintaining suitable habitat at the southernmost end of Conservation Zone 7, providing connectivity with existing populations to the south and southeast, and creating and maintaining flood refugia. The conservation measures that will be implemented to achieve these goals and objectives are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.12.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the riparian woodrat are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.5 Benefits: Channelization and levee construction have greatly reduced the width of the riparian corridor in otherwise suitable riparian woodrat habitat, and uplands outside the levees have been leveled for agricultural production. The result has been a lack of the necessary topography and vegetative cover for woodrat use during high river flows. Land between the levees can be entirely submerged during these high flow events, leaving few or no high ground sites where riparian woodrats can seek shelter with appropriate cover either inside or outside the levees. In 1995 and 1997, flood events were catastrophic for the riparian woodrat population along the Stanislaus River (River Partners 2008).

Floodplain restoration in Conservation Zone 7 will widen the floodplains to increase opportunities for flood refugia, and the creation of adjacent upland habitat that seldom floods, consistent with Objective L1.6, will further increase these opportunities. Additional provisions for woodrat refugia are described under the species-specific objectives. The creation of upland transitional areas will also provide riparian buffers to reduce the potential for adverse effects from adjacent urban and agricultural lands, such as noise, lighting, and predation from domestic pets. This objective will be

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achieved through protection of lands adjacent to restored floodplain, as described in CM3 *Natural Communities Protection and Restoration*, and through grassland restoration adjacent to restored riparian natural community, as described in CM11 *Natural Communities Enhancement and Management.*

Objective L1.6 Benefits: Increasing the size and connectivity of the reserve system consistent with this objective will minimize the risk of riparian woodrat habitat fragmentation and adverse effects of adjacent land uses. Habitat fragmentation results in small population size, increasing the risk of extirpation as a result of population fluctuations and catastrophic events such as flooding. Small reserves are also vulnerable to effects from adjacent urban and agricultural lands uses such as noise, lighting, encroachment of dogs and cats that may prey on riparian woodrats (Kelly et al. 2011), and disturbance as a result of human encroachment into the habitat. A large, interconnected reserve system that builds on existing protected lands will reduce these effects on riparian woodrats.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.

Objective L2.4 Benefits: Improved recharge of floodplain groundwater will provide conditions favorable for establishment of dense riparian vegetation communities that riparian woodrats depend on for nesting and cover (Riparian Habitat Joint Venture 2004). This objective will be achieved through floodplain restoration as described in CM5 *Seasonally Inundated Floodplain Restoration.*

Goal L.3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Consistent with this objective, riparian restoration within restored floodplain in Conservation Zone 7 will be designed to improve connectivity with the riparian community south of the Plan Area, where the nearest known riparian woodrat population occurs. This will facilitate dispersal of the species and genetic interchange between populations by establishing permanent habitat corridors between known populations (Kelly et al. 2011). While increased connectivity will not guarantee the northward expansion of riparian woodrats into the Plan Area, it will expand opportunities for riparian woodrat dispersal northward and establishment in the Plan Area. It will also provide continued habitat connectivity between the population to the south and a newly established population, if any, in Conservation Zone 7.

3.3.5.12.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the riparian woodrat are included below.

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Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near term implementation period.

Objectives VFRNC1.1 and VFRNC1.2 Benefits: Riparian restoration and protection consistent with these objectives will benefit riparian woodrat by providing habitat for potential population establishment and expansion in the Plan Area. Some of the 750 acres of protected riparian and 5,000 acres of restored riparian natural community will occur in Conservation Zone 7 and have suitable structural characteristics necessary for supporting riparian woodrats (species-specific goals and objectives below address this uncertainty). These objectives will be achieved through riparian restoration and protection as described in CM3 *Natural Communities Protection and Restoration* and CM7 *Riparian Natural Community Restoration.*

Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.

- **Objective VFRNC2.1:** Restore, maintain and enhance structural heterogeneity with adequate vertical and horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands.

Objective VFRNC2.1 Benefits: Riparian woodrats require a dense shrub understory as well as tall shrubs, small trees or vines to grow above flood levels and provide access to a tree canopy where they forage (Kelly et al. 2011). Riparian woodrats will therefore benefit from the maintenance and enhancement of structural heterogeneity with adequate vertical overlap among vegetation components. This objective will be achieved through riparian restoration as described in CM7 *Riparian Natural Community Restoration* and vegetation management if necessary, as described in CM11 *Natural Communities Enhancement and Management.*

3.3.5.12.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for riparian woodrat within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal RW1: A reserve system that includes suitable habitat available for the future growth and expansion of riparian woodrat populations.

- **Objective RW1.1:** Of the 5,000 acres of riparian restoration, restore/create and maintain at least 300 acres riparian habitat that meets the ecological requirements of the riparian woodrat (e.g., dense willow understory and oak overstory) and that is adjacent to or facilitates connectivity with existing occupied or potentially occupied habitat.
- **Objective RW1.2:** Create high-water refugia in restored sites through the building and/or restoring of high ground habitat on mounds, berms, or levees, so that refugia are no further apart than 20 meters.

Objective RW1.1 Rationale: Restoring 300 acres of suitable riparian habitat in an area that is adjacent to or facilitates connectivity with existing or potential habitat will facilitate an expansion of the distribution and increase in abundance of the species. The objective is necessary to meet specific

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riparian woodrat habitat requirements that would not necessarily be provided through Goal VFRNC1. Riparian habitat will be restored according to provisions in CM7 *Riparian Natural Community Restoration*, which will include site-selection criteria and site-specific restoration guidance to ensure appropriate species composition, density, structure, and other species-specific habitat elements. Management and maintenance of appropriate habitat conditions are further specified in CM11 *Natural Communities Enhancement and Management.* Connectivity with currently occupied or potentially occupied habitat (south of Highway 4) will be the primary factor in the selection of restoration sites to meet this objective.

Objective RW1.2 Rationale: Providing adequate flood refugia will reduce riparian woodrat mortality during flood events (U.S. Fish and Wildlife Service 1998). All riparian woodrat restoration projects will be designed to incorporate high-water refugia, and refugia will be incorporated into protected areas that provide suitable habitat for this species. High-water refugia consist of built or restored high ground habitat such as mounds, berms, and levees, and suitable vegetative composition and structure that can provide upland habitat and cover during flood events. The specifications for these refugia are provided in CM7 *Riparian Natural Community Restoration*.

3.3.5.13 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 (U.S. Fish and Wildlife Service 2001). 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 (Appendix 2.A, *Covered Species Accounts*). Much of the occupied habitat in Suisun Marsh consists of remnant tidal brackish emergent wetlands and artificial nontidal managed and diked wetlands (including adjacent upland grasslands used as refugia during high tide events) (Figure 3.3-9). Despite their artificial nature, the mouse has adapted to nontidal managed and diked wetlands following the reclamation of historical Suisun Bay tidal marshes.

The historical range of the species likely included most of the marshland in the San Francisco Bay Area. Tidal marshes have been reduced by nearly 85% since the 1850s. Today, the species potentially occupies an area representing approximately 15% of the historical salt marsh habitat formerly found in the San Francisco Bay Area (Dedrick 1989). Once a vast tidal marsh, much of the remaining habitat is isolated by dikes and landfill, and remaining populations are small and separated by large areas of unsuitable habitat.

Loss and degradation of tidal marsh habitats continue to be the most significant threat to the salt marsh harvest mouse. The loss and fragmentation of suitable habitats, initially from reclamation for farming and later for commercial and industrial development, has isolated populations and reduced dispersal opportunities. The loss of tidal marsh habitat through filling and diking has largely been curtailed. However, other current factors associated with declining populations include the conversion of salt marshes to brackish marshes due to freshwater discharges from sewage treatment plants; introduction of nonnative cordgrass, saltgrass, and other plant species; predation by nonnative red foxes and feral cats; and input of runoff, industrial discharges, and sewage effluent (Shellhammer et al. 1982; California Department of Fish and Game 2000; LSA 2007). Probably the most significant long-term threat is the predicted sea level rise of up to 1.2 meters within this century.

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The conservation approach for this species is to restore and protect tidal brackish emergent wetland, protect managed wetland, protect adjacent upland, and manage and enhance habitat to provide vegetation structure and composition suitable for sustaining populations of salt marsh harvest mouse, consistent with the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (U.S. Fish and Wildlife Service 2010). However, it may take several decades to achieve the mature tidal marsh conditions preferred by mice. To minimize this temporal effect, the conservation strategy also includes phasing the restoration to spread the initial effects of restoration out over time. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.13.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the salt marsh harvest mouse are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities. • **Objective L1.5:** Include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetland to permit the future upslope establishment of tidal emergent wetland communities with sea level rise, and to provide upland habitat and refugia for native wildlife.

Objective L1.4 Benefits: Providing elevation and hydrological gradients in restored tidal brackish emergent wetland consistent with this objective will contribute to the range of habitat requisites for the salt marsh harvest mouse. This species needs mid to high marsh plain to fulfill vegetation requirements for cover and food, and an adjacent high marsh transition zone to provide refuge during high tide events (U.S. Fish and Wildlife Service 2010).

Objective L1.5 Benefits: Achieving this objective will benefit salt marsh harvest mouse by providing sufficient upland area adjacent to restored habitat to accommodate an upward elevation shift in habitat with sea level rise. Achieving this objective will also provide additional upland areas for salt marsh harvest mice to use as refugia during high tide events. Salt marsh harvest mice generally move into the upper brackish marsh fringe during high tide. However, during prolonged periods of winter high tides mice move into the adjacent upland transition areas. These upland areas are especially important in the winter as many of the plants on the brackish marsh fringe are annuals that do not provide winter cover, and winter tides are often high enough to inundate these higher wetland zones.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

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Objective L2.7 Benefits: This objective will benefit the salt marsh harvest mouse where management efforts reduce invasive nonnative plant species such as perennial pepperweed, which can out-compete the plant species that harvest mice are more dependent upon (e.g., pickleweed). The Implementation Office will also monitor for nonnative predators such as red fox and house cats, and feral hogs, which can destroy habitat, and will implement control measures if needed. This objective will be implemented through actions described in *CM11 Natural Communities Enhancement and Management.*

3.3.5.13.2 Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the salt harvest mouse are included below.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objective TBEWNC1.1 Benefits: Although the restored tidal brackish emergent wetland will provide habitat for salt marsh harvest mouse, it will replace managed wetland natural community that currently provides habitat. However, managed wetland is not a sustainable habitat type because of the potential for catastrophic flooding associated with subsided lands, known levee instability, and projected sea level rise, in addition to the intensive management required of these lands (U.S. Fish and Wildlife 2010). Catastrophic flooding would likely cause mortality of salt marsh harvest mice residing within the confines of a failed levee. Tidal brackish emergent wetland, on the other hand, will stable and persistent habitat in Suisun Marsh (U.S. Fish and Wildlife Service 2010).

The 4,800-acre restoration minimum will ensure a net increase in salt marsh harvest mouse habitat. This will require using cut-and-fill to raise the restoration elevation by 1 foot and will ensure that there isn't a net loss in saltmarsh harvest mouse habitat that would otherwise result from encroachment of tidal perennial aquatic natural community. This will result in a net 500-acre increase in salt marsh harvest mouse habitat in the Plan Area: a 23% increase in wetland habitat for this species in the Plan Area.

Objective TBEWNC1.4 Benefits: Achieving this objective will benefit salt marsh harvest mouse by preventing large short-term habitat losses prior to the successful establishment of replacement habitat. Because this species occupies managed wetlands that would be displaced by tidal brackish emergent wetland, restoration must be carefully phased to allow the Suisun Marsh population to shift its distribution in response to habitat loss and restoration. Conversion of subsided managed wetlands requires sedimentation to restore mature marsh plains, resulting in a prolonged period in which resident salt marsh harvest mouse populations are displaced by uninhabitable aquatic areas (U.S. Fish and Wildlife Service 2010). Adjacent founder populations with adequate genetic diversity and numbers must be protected and sustained until restored tidal marshes are suitable for

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recolonization. In this way, short-term habitat losses will eventually result in net long-term benefits for the salt marsh harvest mouse population and a contribution to recovery of the species.

Phasing of tidal restoration in Suisun Marsh will be implemented as described in *CM4 Tidal Natural Communities Restoration.*

Goal MWNC1: Managed wetland natural community that is managed and enhanced to provide suitable habitat conditions for covered species.
• **Objective MWNC1.1:** Protect and enhance at least 1,500 acres of managed wetlands in the Grizzly Island Marsh Complex consistent with the salt marsh harvest mouse recovery plan.

Objective MWNC1.1 Benefits: Although tidal brackish emergent wetland is believed to have a higher long- term conservation value for salt marsh harvest mouse than managed wetland, as described above, the draft Tidal Marsh Recovery Plan (U.S. Fish and Wildlife Service 2010) recognizes that a large proportion of the salt marsh harvest mouse population in Suisun Marsh is in managed wetlands maintained by dikes. Because of this and because lands in the Grizzly Island Marsh Complex are severely subsided and not readily restorable to tidal conditions, the recovery plan allows managed wetland to count toward the total acreage that must be protected and enhanced to achieve recovery for the salt marsh harvest mouse. Consistent with this objective, the 1,500 acres of protected managed wetlands will be enhanced as described in CM11 *Natural Communities Enhancement and Management,* to provide vegetation with structural diversity and food value for native wildlife. Structural diversity will be provided by management and enhancement actions that promote tall stands of pickleweed, which provide cover for the salt marsh harvest mouse and a substrate on which mice climb for refuge during high tide events.

3.3.5.13.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for salt harvest mouse within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal SMHM1: Suitable habitat and conditions to sustain a population of salt marsh harvest mouse in the reserve system.
• **Objective SMHM1.1:** Of the 4,800 acres of restored tidal brackish emergent wetland, restore and manage at least 1,000 acres in the Western Suisun/Hill Slough Marsh Complex and 1,000 acres in the Suisun Slough/Cutoff Slough Marsh Complex, in 150-acre or greater patches that provide viable habitat areas for salt marsh harvest mouse habitat consistent with the draft tidal marsh recovery plan (U.S. Fish and Wildlife Service 2010).

Objective SMHM1.1 Rationale: Achieving this objective will contribute to recovery of the salt marsh harvest mouse consistent with the draft Tidal Marsh Recovery Plan (U.S. Fish and Wildlife Service 2010). Suisun Marsh comprises the Suisun Bay recovery unit addressed in the recovery plan, which identifies the Western Suisun/Hill Slough and Suisun Slough/Cutoff Slough marsh complexes within the Suisun Bay recovery unit

The recovery plan stipulates that viable habitat areas (defined in CM4 *Tidal Natural Communities Restoration*) must be 150 acres or more, the minimum acreage thought to sustain a healthy salt

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marsh harvest mouse population. Actions to be implemented to achieve this objective are described in CM4 *Tidal Natural Communities Restoration.*

3.3.5.14 San Joaquin Kit Fox

The San Joaquin kit fox is closely associated with arid lands that are sparsely vegetated with shrubs or grasses. The species' natural habitats include valley sink scrub, valley saltbrush scrub, and upper Sonoran subshrub. In the northern portion of its range, it is found primarily in annual grassland (Haight et al. 2004). While some types of agriculture such as dry farming and fallow lands provide marginal habitat for the San Joaquin kit fox, it is rare in intensively irrigated agriculture (Jensen 1972; Morrell 1972; Cypher pers. com.).

Historically, the San Joaquin kit fox was reported to occur throughout the semi-arid habitats of the southern Central Valley and adjacent lowland foothills from Kern County to only as far north as Tracy (Grinnell et al. 1937). By 1937, however, San Joaquin kit fox was presumed to have been extirpated from the Tracy area and to extend only as far north as southern Stanislaus County (Grinnell et al. 1937). When the San Joaquin kit fox was added to the federal endangered species list in 1967, there were no known extant occurrences in San Joaquin County or northward. In the 1970s, however, surveys showed that the range of the kit fox extended northward beyond Tracy to eastern Contra Costa County (Jensen 1972; Clark et al. 2002). Relatively few San Joaquin kit foxes have been found in the northern portion of their range within the last few decades, despite a number of surveys (Hall 1983; California Department of Fish and Game 1983; Bell 1994; Smith et al. 2006; Clark et al. 2007). The northern range of the San Joaquin kit fox (including the Plan Area) was most likely marginal habitat historically and has been further degraded by development pressures, habitat loss, and fragmentation (Clark et al. 2007a). The California Natural Diversity Database (CNDDB) reports eight occurrences of San Joaquin kit fox in the Plan Area, along the extreme western edge of the Plan Area within Conservation Zone 8, south of Brentwood (California Department of Fish and Game 2009) (Figure 3.3-10). However, Clark et al. (2007b) provide evidence that a number of CNDDB occurrences in the northern portion of the species' range may be misidentification of coyote pups. Furthermore, Smith et al. (2006) suggest that the northern range may possibly be an area where the San Joaquin kit fox cannot establish a self-sustaining population (i.e., a population sink).

Habitat loss and fragmentation due to urbanization and agricultural expansion are the principal factors 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 7% of the San Joaquin Valley floor's original native habitat south of Stanislaus County remained untilled and undeveloped (U.S. Fish and Wildlife Service1983). 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 (U.S. Fish and Wildlife Service 1998). A decline in prey abundance associated with ground squirrel poisoning programs has also been identified as a stressor contributing to reduced kit fox abundance (see habitat model in Appendix 2.A, *Covered Species Accounts*).

The Recovery Plan for Upland Species of the San Joaquin Valley, California (U.S. Fish and Wildlife Service 1998) provides a recovery strategy for the San Joaquin kit fox that focuses on conserving a number of kit fox populations and connections between these populations to counteract negative consequences of inbreeding, random stochastic events, and demographic factors. The strategy

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hinges on protecting three geographically distinct core populations: the Carrizo Plain area in San Luis Obispo County, natural lands of western Kern County, and the Ciervo-Panoche area of western Fresno and San Benito Counties. Additionally, the recovery plan calls for protection of several satellite populations[22] (number of populations to be protected dependent on results of research). Nine satellite populations were identified in the recovery plan: the Plan Area includes the northeastern edge of the northernmost kit fox satellite population. A demographic analysis of kit fox populations throughout its range suggested that conservation for the species would be most cost effective farther south in the San Joaquin Valley and Carrizo Plain, outside the Plan Area, where existing populations are established (Haight et al. 2004). The East Contra Costa County and San Joaquin County habitat conservation plans cover San Joaquin kit fox and provide extensive grassland conservation for this species within the Plan Area. The 5-year status review for the kit fox (U.S. Fish and Wildlife Service 2010) indicates that there is currently no known breeding of San Joaquin kit fox in this northernmost extent of the species' range, including the Plan Area.

The BDCP conservation approach for the San Joaquin kit fox is to protect and enhance habitat in the northern extent of the kit fox's range, to increase the likelihood and ability for kit fox to reside and breed in the Plan Area; and to provide connectivity to habitat outside the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.14.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the San Joaquin kit fox are included below.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Consistent with this objective, protecting grasslands in Conservation Zone 8 will contribute to the protection of a San Joaquin kit fox habitat linkage in East Contra Costa County, northeastern Alameda County, and western San Joaquin County, connecting to existing populations farther south in the inner Coast Range. This is further discussed under Objective GNC1.1.

3.3.5.14.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the San Joaquin kit fox are included below.

[22] Core-satellite metapopulations are those having core populations that are stable over time, and peripheral satellite populations that may experience periodic extirpation with subsequent recolonization from the core populations.

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Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.

- **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8 (adjacent to protected lands), at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.
- **Objective GNC1.2:** Restore 2,000 acres of grassland to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia.

Objective GNC1.1Benefits: Because the primary stressor on the kit fox in the northern extent of its range is the loss and fragmentation of grassland habitat through urban and agricultural expansion, protection of grassland habitat is the most effective approach to the kit fox's conservation. In the recovery plan for the San Joaquin kit fox and other San Joaquin Valley upland species (U.S. Fish and Wildlife Service 1998), the recommended conservation strategy is centered on conserving the three core populations and several satellite populations, and providing connectivity between these populations. The Plan Area includes the northeastern edge of the northernmost satellite population: the strategy focuses on protecting the largest remaining contiguous habitat patches in this area and maintaining connectivity with the remainder of the satellite population in Contra Costa County.

Consistent with Objective GNC1.1, the BDCP will protect 1,000 acres of kit fox grassland breeding, foraging, and dispersal habitat in Conservation Zone 8, adjacent to existing protected habitat. Because kit fox home ranges are large (ranging from around 1 to 12 square miles; see Appendix 2.A, *Species Accounts*), habitat connectivity is key to the conservation of the species. 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 in Contra Costa County.

Consistent with Objective L3.1 and Goal GNC1, protection will focus in particular on acquiring the largest remaining contiguous patches of unprotected grassland habitat, which are located south of Highway 4 in Conservation Zone 8 (Appendix 2.A, *Covered Species Accounts*). This area connects to over 620 acres of existing habitat that was protected under the East Contra Costa County HCP/NCCP. Conservation Zone 8 supports 74% of the modeled kit fox grassland habitat in the Plan Area, and the remainder consists of fragmented, isolated patches that are unlikely to support this species. Following BDCP implementation, protected modeled kit fox grassland habitat in Conservation Zone 8 will increase by 19% (from 638 acres to 1,638 acres) and from 12% protected to 31% protected. Conservation areas will be acquired to expand existing protected habitats and provide movement corridors linking kit fox habitats within and adjacent to the Plan Area.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.

- **Objective GNC2.3:** Increase burrow availability for burrow-dependent species.
- **Objective GNC2.4:** Increase prey, especially small mammals and insects, for grassland-foraging species.

Objective GNC2.3 Benefits: Increasing burrow availability consistent with this objective will benefit San Joaquin kit fox by increasing potential den sites on protected grasslands in Conservation Zone 8. Den sites may be a limiting resource for kit foxes (Clark et al. 2005; Spiegel et al. 1996; Orloff

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1986). The San Joaquin kit fox is an obligatory den user: it uses dens for bearing and rearing young, diurnal resting cover, escaping predators, temperature regulation, and avoiding adverse weather conditions (Clark et al. 2005). The kit fox, however, is believed to have weak digging abilities and therefore prefers loose, sandy soils to excavate dens (Jensen 1972). Kit foxes will also use existing burrows constructed by other animals or human-made structures such as culverts or abandoned pipes (Jensen 1972). Competition from coyotes and other carnivores is believed to be especially intense in the northernmost portion of the species' range, and the kit fox therefore likely requires abundant den sites for escape cover (Orloff et al. 1986). Orloff et al. (1986) hypothesized that availability of denning sites may be the major factor limiting the distribution of San Joaquin kit fox in the northern portion of its range.

The kit fox in the northern portion of its range relies on the use of ground squirrel burrows for dens, and maintenance of ground squirrel populations may therefore be an essential factor in providing suitable habitat for kit fox in this region (Orloff et al. 1986). The availability of mammal burrows will therefore be increased on protected grasslands consistent with Objective GNC2.3. Techniques to be implemented to achieve this objective are described under CM11 *Natural Communities Enhancement and Management.*

Objective GNC2.4 Benefits: Declines in prey abundance have been identified as a factor contributing to reduced kit fox population abundance and distribution (see habitat model in Appendix 2.A, *Covered Species Accounts*). Consequently, consistent with Objective GNC2.4, protected and restored grassland will be managed to increase the abundance and distribution of San Joaquin kit fox mammalian prey species (e.g., discontinued use of pesticides, manipulation of topography, mowing for increasing ground squirrel densities) in areas that support kit fox.

3.3.5.14.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve San Joaquin kit fox within the reserve system. Grassland protection in Conservation Zone 8 will protect 31% of the San Joaquin kit fox habitat in the Plan Area, and will provide connectivity to the remainder of the northernmost satellite population. Habitat in the Plan Area has marginal value for the kit fox, and this area is not critical to the long-term survival and recovery of the species (Clark et al. 2007). Additional goals and objectives are not necessary for this species.

3.3.5.15 Suisun Shrew

The Suisun shrew (*Sorex ornatus sinuosus*), one of several subspecies of the ornate shrew, is endemic to the tidal salt and brackish marshes of Solano, Napa, and eastern Sonoma Counties. The species uses a gradient of mature middle and high marsh plain to meet its functional requirements (U.S. Fish and Wildlife Service 2010). Preferred habitats support dense, low-lying vegetation of pickleweed (*Sarcocornia pacifica*), cordgrass (*Spartina foliosa*), and gumplant (*Grindelia cuneifolia*), and contain abundant prey of small insects, crustaceans, and other invertebrates. Upland habitats adjacent to tidal marsh also provide cover and sources of food during prolonged flooding of marshes and dikes (Williams 1983). Suitable habitat for Suisun shrew in the Plan Area is represented by tidal brackish emergent wetland in Suisun Marsh.

While the historical range of the Suisun shrew is not fully known, its current distribution is limited to isolated remnants of natural tidal and brackish marshes along the northern perimeter of San

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Pablo Bay and Suisun Marsh, 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). All reported occurrences of Suisun shrew in the Plan Area are from the Suisun Marsh in Conservation Zone 11, which contains the largest remaining patches of tidal marsh habitat within the species range (Figure 3.3-11). Little information is available on the historical or current abundance of Suisun shrews. Suitable tidal marsh habitat around San Pablo and Suisun Bays that could support the species has declined substantially, from about 100,000 acres to around 12,000 acres (Western Ecological Services 1986).

Degradation of tidal marsh habitats remains the most significant threat to the Suisun shrew. The fragmentation of suitable habitats has isolated Suisun shrew populations, reducing dispersal and gene flow. Small, isolated populations are vulnerable to local extinctions from chance catastrophic events such as extreme tidal flooding or oil spills. While the loss of tidal marsh habitat from filling and diking has largely ceased, other factors may contribute to population declines, including the management of marshes in and around Suisun Marsh (LSA 2007). Contaminants accumulated in the food chain, such as polychlorinated biphenyls, heavy metals, and pesticides, may also degrade habitat and pose a hazard to Suisun shrews (Western Ecological Services 1986).

The conservation strategy for the Suisun shrew involves the protection and restoration of brackish tidal marsh wetland natural communities in the Suisun Marsh (Conservation Zone 11). The restoration of large, interconnected patches of tidal brackish wetland will reduce fragmentation, improve habitat functions, and increase opportunities for species dispersal. These efforts should contribute to the growth and expansion of Suisun shrew populations in the Plan Area. However, it may take several decades for the restoration to achieve the mature tidal marsh conditions preferred by shrews. To minimize this temporal effect, the conservation strategy also includes phasing of the tidal marsh restoration to spread the initial effects of restoration out over time. The conservation measures that will be implemented to achieve these goals and objectives are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.15.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the Suisun shrew are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.7:** To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife. • **Objective L1.8:** To accommodate projected future sea level rise, provide potential tidal marsh plain habitat within the anticipated future eastward position of the low salinity zone of the estuary.

Objective L1.7 Benefits: Including upland areas adjacent to restored brackish and freshwater tidal emergent wetland will benefit Suisun shrew both seasonally and over the long term. During high tides, shrews generally move into the halophyte fringe often dominated by fat hen (a plant).

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However, during prolonged periods of winter high tides, shrews may need to move into the adjacent upland transition areas to avoid drowning (Williams 1983). These upland areas are especially important in the winter as many of the halophyte fringe plants are annuals that do not provide winter cover, and winter tides are often high enough to inundate these higher wetland zones. Suitable upland habitat serves as potential winter refugia for Suisun shrews by providing adequate cover from predators and inclement weather.

Over the long term, low-gradient upland habitat also provides area for the tidal marsh habitats used by Suisun shrews to migrate in the face of rising sea levels. High-gradient transition areas do not allow expansion of shallow waters where emergent wetland habitats important to the shrew can develop. Incorporating the low-gradient upland transition zones adjacent to newly created tidal marsh habitat will provide habitat sustainability as the sea level continues to rise.

Objective L1.8 Benefits: This objective recognizes that, with sea level rise, the brackish/freshwater boundary will move to the east, potentially expanding the brackish marsh conditions Suisun shrews favor deeper into the Delta. This objective will provide additional tidal plain habitat in this region of the Delta, which will allow expansion of shrew habitat as it converts over time from freshwater to brackish.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Achieving this objective will benefit the Suisun shrew where management efforts reduce invasive nonnative plant species such as perennial pepperweed and alkali Russian thistle, which can out-compete the plant communities that shrews naturally inhabit (e.g., pickleweed, cordgrass) and may alter the invertebrate prey community that the shrew is dependent upon. The Implementation Office will also monitor for nonnative predators such as red fox and house cats, and habitat-destroying feral hogs, and will implement control measures if needed. This objective will be met through actions described in CM11 *Natural Communities Enhancement and Management.*

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Consistent with this objective, tidal marsh restoration will take into account the need for movement corridors between large habitat patches, thereby avoiding and minimizing habitat fragmentation for the Suisun shrew. The extent to which habitat fragmentation affects Suisun shrews is unknown, but is probably a concern given that the species uses little, if any, of the managed wetlands that separate and isolate tidal marsh habitat.

3.3.5.15.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the Suisun shrew are included below.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1**: Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.

Objective TBEWNC1.1 Benefits: Restoration of at least 4,800 acres of tidal brackish emergent wetland in the Suisun Marsh will benefit the Suisun shrew by increasing the net extent of habitat available for this species. Approximately 3,600 acres of managed wetland shrew habitat will be replaced with large expanses of tidal brackish emergent wetland that is functioning naturally. Tidal marsh habitat is more important to shrew survival than managed wetlands, and managed wetlands in Suisun Marsh are less sustainable over the long term as they are subject to levee failure and inundation with sea level rise, and require intensive ongoing management (see benefits of this objective to salt marsh harvest mouse for a more detailed discussion regarding the long term conservation value of tidal brackish emergent wetland relative to managed wetlands).

Objective TBEWNC1.2 Benefits: Restoration of tidal brackish emergent wetland connectivity, consistent with this objective, will ensure that the restored tidal habitat is interconnected, thereby reducing fragmentation and isolation and providing opportunities for Suisun shrew dispersal and population expansion. Much of the existing Suisun shrew habitat consists of isolated remnants of natural tidal and brackish marshes along the northern perimeter of Suisun Marsh. Restoring areas adjacent to existing habitat or areas connected by narrow bands (e.g., along channels) will provide pathways for population expansion and refugia from others affected by catastrophic flood events.

3.3.5.15.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve Suisun shrew within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.16 Townsend's Big-Eared Bat

Townsend's big-eared bats can occur in a variety of habitats throughout California, but they are most commonly associated with desert scrub, mixed conifer forest, redwood forest, and piñon-juniper or pine forest habitat. They are roost-limited and locate their maternity colonies and hibernacula in limestone caves, mines, lava tubes, basal hollows, buildings, and bridges (Dalquest 1947, 1948; Graham 1966; Pearson et al. 1952; Kunz and Martin 1982; Pierson et al. 1991; Mazurek 2004; Pierson and Rainey 1998; Dobkin et al. 1995). They are also known to roost in the basal hollows of large trees (Fellers and Pierson 2002). Townsend's western big-eared bats typically hibernate in cold (but above freezing), undisturbed places, such as the deeper, thermally stable portions of caves and mines (Barbour and Davis 1969; Dalquest 1947; Humphrey and Kunz 1976; Pearson et al. 1952; Pierson and Rainey 1998; Zeiner et al. 1990; Pierson and Rainey 1994), although they are also known to use buildings and bridges (Pearson et al. 1952; Kunz and Martin 1982; Pierson and Rainey 1998; Keeley and Tuttle 1999).

Townsend's big-eared bats occur throughout most of western North America from British Columbia to central Mexico, as far east as South Dakota and Texas to the Edwards Plateau (Hall 1981; Kunz

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and Martin 1982). Isolated, remnant populations of this species are found in the southern Great Plains and the Ozark and Appalachian Mountains (Hall 1981; Kunz and Martin 1982). The subspecies *P. t. townsendii* occurs in Washington, Oregon, California, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah (Handley 1959; Hall 1981) from near sea level to over 3,000 meters above sea level (Pearson et al. 1952; Nagorsen and Brigham 1993).

No Townsend's big-eared bats have been documented in the Plan Area. However, the species is known to occur at nearby Central Valley locations and could be present in the Plan Area (Figure 3.3-12) (Appendix 2.A, *Covered Species Accounts*). The nearest recorded occurrences are in northwestern Yolo County, where the species is documented at three mine sites in the Little Blue Ridge and at two sites in Alameda County, and in the hills south of Livermore (California Department of Fish and Game 2008). While no occurrences have been reported in the Plan Area, potential roosting habitat may include old barns and other buildings with suitable interior structure, and possibly bridges and large trees with suitable basal hollows. Considerable foraging habitat is also available, and the species has been documented in the statewide species database west of Conservation Zone 7 in Alameda County (California Department of Fish and Game 2011). To date, very few surveys for roost or nursery sites have been conducted in the Plan Area, and the potential for foraging populations is not well understood. Roost and nursery sites may be absent from the Plan Area because of a lack of mines and suitable rock outcrops.

Disturbance of roosts, including recreational caving and mine exploration and resumed mining, are the primary threats to Townsend's big-eared bats (Piaggio 2005). According to Pierson and Rainey (1998), there has been a 52% decline in the number of maternity colonies during the last 40 years, a 45% decline in the number of available roosts, a 54% decline in the total number of animals, and a 33% 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 the San Francisco Bay Area counties where native habitat and rural land have been converted to agriculture or suburban and urban development. The primary cause of population declines is most likely the disturbance and destruction of roost sites. Pesticide contamination may threaten this species in agricultural areas (Geluso et al. 1976). There is some evidence that predation from rats could be suppressing certain populations (Fellers 2000). Pierson et al. (1999) reported that Townsend's big-eared bats are threatened by the loss of clean water. In addition white-nosed fungus (*Geomyces destructans)* may affect the species: although this disease is currently known only in the eastern United States, it is spreading westward and if it reaches California Townsend's big-eared bat is at risk of infection. Colonies of hibernating bats exposed to the fungus can suffer mortality rates of 90% or more.

Protected and restored natural communities throughout the Plan Area will provide suitable foraging habitat for Townsends' big-eared bat. The conservation approach for this species is to protect roost sites and hibernacula in the reserve system, and replace any roost sites or hibernacula that have to be removed as a result of covered activities. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.16.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for Townsend's western big-eared bat are included below.

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Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.1:** Protect at least 31,000 acres of existing natural communities, focusing on the highest quality natural communities and covered species habitats. • **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objectives L1.1, L1.3, and L1.6 Benefits: Creation and protection of natural communities and establishment of a large, interconnected reserve system will provide potential foraging and roosting habitat, and will maintain suitable habitat for the species in the Plan Area. The BDCP will protect at least 31,000 acres of natural communities in the Plan Area potentially used by Townsend's big-eared bat. Natural communities within the reserve system such as vernal pool complex, alkali seasonal wetland complex, and nontidal perennial aquatic natural communities will provide water sources that may be valuable for Townsend's big-eared bat if the species occurs in the Plan Area. Bats use rivers as flyways to commute to foraging sites, and both streams and wetland complexes can be important sources of water for the species. Additionally, wetland and riparian restoration is expected to increase the invertebrate prey population for this species.

3.3.5.16.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for Townsend's big-eared bat are included below.

Goal CLNC1: Habitat functions for covered and other native species that are supported by cultivated land cover types and management practices.
• **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands in the reserve system. • **Objective CLNC1.4:** 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, ponds, and wetlands.

Objectives CLNC1.1 and CLNC1.4 Benefits: Achievement of these objectives will maintain habitat for Townsend's big-eared bat in cultivated landscapes. This species is known to use cultivated lands for foraging, and thus the management of agricultural lands for foraging habitat can support populations in the Plan Area. Objective CLNC1.4 will maintain and protect isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, and ponds and wetlands, all of which can provide important foraging and watering habitat for the species. Basal hollows of large trees in these areas may also provide roosting habitat for Townsend's big-eared bat.

3.3.5.16.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for Townsend's big-eared within the

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reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal TBEB1: Roosting habitat for Townsend's big-eared bat to protect and promote its distribution in the Plan Area.
• **Objective TBEB1.1:** Offset any unavoidable loss of a maternal roost or hibernaculum resulting from BDCP activities with a functionally equivalent roost or hibernaculum within 10 miles. • **Objective TBEB1.2:** Protect maternity roosts or hibernacula that occur on reserve lands and prohibit recreational or other potentially disruptive activities during periods of seasonal use.

Objectives TBEB1.1 and TBEB1.2 Rationale: The significant decline in Townsend's big-eared bat populations is largely attributed to loss or disturbance of hibernacula and roost sites. Achieving these objectives, in addition to implementing the measures described in CM22 *Avoidance and Minimization Measures* and detailed in Appendix 3.C *Avoidance and Minimization Measures*, will address this primary stressor. Maternal roosts and hibernacula will be identified and kept free from disturbance during critical periods (i.e., maternity colonies in the summer and hibernacula in the winter), and those found on the reserve system will be protected except where they cannot be avoided by restoration activities. Unavoidable disturbance of maternity roosts and hibernacula will only occur when the sites are unoccupied by maternal or hibernating colonies. Maternity roost or hiberacula sites lost will be recreated nearby to offset any losses consistent with Objective TBEB1.2. Criteria for the design and creation of roost sites or hibernacula are provided in CM11 *Natural Communities Enhancement and Management.*

3.3.5.17 California Black Rail

The California black rail is a high marsh species that prefers a dense overhead cover of pickleweed and other saline-tolerant plants. At Suisun Marsh, the species has been negatively associated with hardstem and California bulrush (both low marsh species), and saltgrass (a middle and high marsh species that provides little overhead cover and is difficult to traverse), and positively associated with gumplant, which, like pickleweed, is a high marsh plant that provides overhead cover, yet can be traversed and probably provides nesting cover (Spautz et al. 2006).

The historical range of the California black rail extended from the San Francisco Bay, throughout the Sacramento–San Joaquin Delta, along the coast to northern Baja California, at other southern California locales such as the Salton Sea, and along the lower Colorado River. Breeding records from early in the 20th century indicate that black rail populations were found in coastal marshes in San Diego, Los Angeles, and Santa Barbara Counties. Loss of tidal marsh habitat since the 1950s has extirpated the species from much of its coastal range, particularly in southern California and much of the San Francisco Bay (Manolis 1978; Garrett and Dunn 1981 as cited in California Department of Water Resources 2001).

Declines in populations of the California black rail in California are a result of habitat loss and degradation along with an increase in exotic predators such as black rats and red foxes (Evens et al. 1991). However, because there were no estimates of historical population levels, the extent of population declines is not fully understood. Evens et al. (1991) examined relative abundance of rails at various locations within the species' range and determined that more than 80% of the remaining population is confined to the northern reaches of the San Francisco Bay estuary. They also

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determined that the species was subject to continuing and ongoing population decline resulting from habitat loss and/or degradation.

The species persists in remaining tidal marshes in the northern San Francisco Bay estuary, Tomales Bay, Bolinas Lagoon, the Sacramento–San Joaquin Delta, Morro Bay, the Salton Sea, and the lower Colorado River (Manolis 1978; Evens et al. 1991; Eddleman et al. 1994). Several small, isolated populations still exist in southeastern California and western Arizona (Evens et al. 1991). The species has also been found more recently at several inland freshwater sites in the Sierra Nevada foothills in Butte, Yuba, Placer, San Joaquin, and Nevada Counties (Aigner et al. 1995; Tecklin 1999; Richmond et al. 2008).

Within the San Francisco Bay and Sacramento–San Joaquin River Delta, California black rail populations are restricted primarily to the remaining tidal marshlands of the northern San Francisco Bay estuary, and the vicinity of Suisun and Napa Marshes (Figure 3.3-13). In Suisun Marsh, a high abundance of California black rails has been found at east Mallard Island and moderate abundances at South Joice Island, Pacheco Creek, East Peyton Slough, Cutoff Island, Peytonia Slough, and Southampton Bay (Spautz et al. 2005). A small population may occur in the vicinity of Little Honker Bay and on the north shore of Nurse Slough. California black rails have been found in moderate abundances in the northern reaches of Suisun Bay in undiked marshes along the northern bank of Cutoff Slough from Belden's Landing west to Suisun Slough.

Surveys conducted by DFG in the early 1990s found small numbers of black rails at several locations in the central Delta, including White, Little Potato, Disappointment, and Whiskey sloughs; mid-Channel Islands in Middle and San Joaquin Rivers; Holland and Palm Tracts; and Mildred, Bacon, and Mandeville Islands (California Department of Fish and Game 2011). DWR conducted additional surveys in 2009 and 2010. In 2009, black rails were identified at Peytonia and Cutoff Sloughs (and Point Edith Marsh immediately south of the Plan Area boundary). <placeholder for 2010 update>.

Larger concentrations of California black rail occur in the western portion of the Plan Area in the vicinity of Little Honker Bay and Kimble Island, and smaller concentrations on small in-channel islands, and other wetlands in the central Delta between State Routes 12 and 4. Overall, habitat availability is restricted to remnant wetland sites that are generally unavailable for agricultural uses. Insufficient data have been collected to estimate California black rail populations in the Plan Area; however, the small populations found in the central Delta portion of the Plan Area likely represent a relatively small proportion of the San Francisco Bay and Sacramento–San Joaquin River Delta region. Regardless, these small populations east of the Suisun Marsh are important relative to the overall range and dispersal capabilities of the species.

The primary conservation approach for California black rail is to restore tidal brackish and freshwater marsh habitat lost to development, and to reduce nonnative predator pressure. The California black rail will also benefit from conservation measures designed to benefit other marsh inhabitants, including the listed California clapper rail. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

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3.3.5.17.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the California black rail are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding.

Objective L1.5 Benefits: Achieving this objective will sustain California black rail habitat by protecting upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetland. This will support the future migration of tidal emergent wetland communities in response to sea level rise. As sea level rises and tidal lands are flooded more frequently and with longer duration, there will be a need for freshwater and brackish tidal communities to also shift upward in mean elevation. Without the ability of these habitat types to migrate upward, the existing tidal habitat becomes intertidal and subtidal without being replaced in other, more upland locations.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species. • **Objective L2.8**: Produce sinuous, high-density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.

Objective L2.7 Benefits: Consistent with this objective, measures will be implemented as needed to reduce the introduction and proliferation on nonnative wildlife species that threaten California black rail populations. Elsewhere in the San Francisco Bay area, nonnative red foxes, feral cats, and rats have been identified as a threat to nesting populations of rails (Evens and Page 1986; Wood and Nur 2011). As described in CM11 *Natural Communities Enhancement and Management,* monitoring will be conducted to determine whether these or other nonnative animals pose a significant threat to California black rail populations in Suisun Marsh, followed by the implementation of predator control measures, if needed.

Objective L2.8 Benefits: Achieving this objective will benefit the California black rail by promoting the development of additional channel networks and upper marsh habitat. Spautz et al. (2006) found California black rails in Suisun Marsh to be positively correlated with the number of tidal channels less than 1 meter wide. Networks of small channels are general found in the upper reaches of Suisun Marsh, and often support patches of gumplant nesting cover.

3.3.5.17.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the California black rail are included below.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7. • **Objective TFEWNC1.2:** Restore tidal freshwater emergent wetlands in areas that increase connectivity among protected lands.

Objectives TBEWNC1.1, TBEWNC1.2, TFEWNC1.1, and TFEWNC1.2 Benefits: Achieving this objective will benefit the California black rail by providing additional habitat through restoring at least 18,700 total acres of tidal brackish emergent wetland in Suisun Marsh and tidal freshwater emergent wetland in the Delta region. This will result in a a 70% increase in acres of protected California black rail habitat in the Plan Area from 21,121 acres to 39,821 acres of protected habitat. The restored habitat will consist of large, interconnected patches that will be less vulnerable to habitat edge effects such as encroachment by humans and predators.

3.3.5.17.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the California black rail within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.18 California Clapper Rail

The California clapper rail is found in a range of salt and brackish marshes. Typical habitat consists of dense pickleweed and cordgrass-dominated saline tidal marshes (Zucca 1954; Harvey 1980). There is also reported use of bulrush and cattail-dominated brackish marshes in the north Bay, including Suisun Marsh (U.S. Fish and Wildlife Service 1998). Suitability of habitat may also be dependent on other factors, such as patch size, tidal connectivity (diked marshes), and proximity to other land uses.

The California clapper rail was once very common in the tidal marshes of San Francisco Bay and coastal California. The historical range of this species extended within the coastal California tidal marshes from Humboldt Bay southward to Elkhorn Slough and Morro Bay, and in the estuarine marshes of San Francisco Bay and San Pablo Bay to the Carquinez Strait. Historically, the highest densities of California clapper rails were in south San Francisco Bay (California Department of water Resources 1994; U.S. Fish and Wildlife Service 1998; LSA 2007).

The California clapper rail was a food source in the 1800s, supporting the gold rush population boom. This dramatically reduced the population, resulting in extinction at some locations. Development beginning in the 1800s reduced available tidal marsh habitat by 84% (Dedrick 1989). Degradation of tidal marsh habitat continues to be a threat (Williams 1986; Ohlendorf and Fleming

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1988; Ohlendorf et al. 1989; Harvey 1990; Lonzarich et al. 1990; Foerster and Takekawa 1991; Leipsic-Baron 1992; California Department of Fish and Game 2000 as cited in LSA 2007), primarily as a result of invasive plants such as perennial pepperweed (*Lepidium latifolium*). In the 1980s, predation by red foxes emerged as a population-scale threat, instigating the need for predator control at some locations (Harding et al. 2001). Feral house cats and Norway rats have also been identified as potential threats (Schwarzbach et al. 2006).

The current distribution of California clapper rail is limited to San Francisco Bay, San Pablo Bay, Suisun Bay, and tidal marshes associated with estuarine sloughs draining into these bays (Figure 3.3-14)(Appendix 2.A, *Covered Species Accounts*) (U.S. Fish and Wildlife Service 1998; Albertson and Evens 2000; California Department of Fish and Game 2000; Liu et al. 2009). USFWS reports that there are populations in all of the larger tidal marshes in south San Francisco Bay. The distribution in the north Bay is patchy and discontinuous, primarily in small, isolated habitat fragments (U.S. Fish and Wildlife Service 1998). Small populations are widely distributed throughout San Pablo Bay and at various locations throughout the Suisun Marsh area (Carquinez Strait to Browns Island, including tidal marshes adjacent to Suisun, Honker, and Grizzly Bays) (U.S. Fish and Wildlife Service 1998). There are 21 occurrence records of this species in Suisun Bay dating from 1978, all within tidal brackish marsh habitats. Liu et al. (2009) found low detection rates in Suisun Marsh during surveys between 2005 and 2008, and found the birds to essentially avoid diked and managed wetlands.

The primary conservation approach for the California clapper rail is to restore the tidal brackish marsh habitat that this bird depends upon. The focus of the Tidal Marsh Recovery Plan (U.S. Fish and Wildlife Service 2010) relative to the California clapper rail is to restore and enhance tidal marsh habitat in Suisun Marsh as a means to increase population numbers and expand the distribution of the species. BDCP implementation will integrate with the existing conservation and enhancement efforts for Suisun Marsh, collectively restoring more extensive patches of suitable habitat that should support larger California clapper rail populations. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.18.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the California clapper rail are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L2.8**: Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.

Objective L1.5 Benefits: Achieving this objective will accommodate the upward habitat shift of brackish communities with sea level rise necessary to support the California clapper rail in the Suisun Marsh. The upland transitional areas adjacent to restored brackish and freshwater tidal

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emergent wetland will permit the future migration of tidal emergent wetland communities in response to sea level rise. As sea level rises, and existing tidal lands are flooded more frequently and with longer duration, there will be a need for freshwater and brackish tidal communities to shift upward in mean elevation. Without the ability of these habitat types to migrate upward, the existing tidal habitat will become intertidal and subtidal without being replaced in other, more upland locations. Adjacent upland habitat must transition slowly from low elevations to higher elevations. Adjacent upland areas that transition too quickly from low to high elevations are not suitable for conversion to tidal and freshwater marsh. The California clapper rail recovery plan recognizes the need to protect upland transition lands (U.S. Fish and Wildlife Service 2010).

Objective L2.8 Benefits: Achieving this objective will benefit the California clapper rail by promoting the development of additional channel networks and upper marsh habitat. The presence of intricate networks of tidal channels in marshes is one of the most important characteristics of high-quality rail habitat (Albertson 1996). Muddy channels provide important foraging habitat for California clapper rails during low tides.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Consistent with this objective, measures will be implemented as needed to reduce the introduction and proliferation on nonnative wildlife species that threaten California clapper rail populations. California clapper rails are subject to heavy predation from nonnative species such as red fox (*Vulpes vulpes*), feral cat (*Felis domesticus*), and Norway rat (*Rattus norvegicus*) as well as various native mammals and raptors (Foerster et al. 1990; Albertson 1995 as cited in LSA 2007; U.S. Fish and Wildlife Service 1998; California Department of Fish and Game 2000). The fragmentation of habitat through the construction of dikes and levees has increased and facilitated predation of clapper rails because terrestrial predators use these features as corridors to access clapper rail habitat (Foerster et al. 1990; Burkett and Lewis 1992). The red fox, the predator that may pose the most serious threat to the California clapper rail, has not yet been detected in the Suisun Marsh.

This objective also addresses the threat perennial pepperweed may pose to California clapper rail habitat quality. Perennial pepperweed competes with other native shrubs (e.g., gum plant) that are important winter cover species in the high marsh habitat. Because it is leafless, pepperweed does not provide replacement cover for the species it has outcompeted. The extent to which perennial pepperweed affects the California clapper rail is unknown.

3.3.5.18.2 Applicable Natural Communities Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the California clapper rail are included below.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.

Objectives TBEWNC1.1 and TBEWNC1.2 Benefits: Achieving these objectives will benefit the California clapper rail by restoring 4,800 acres of tidal brackish emergent wetland in Suisun Marsh, reducing habitat fragmentation, and increasing connectivity to provide large, contiguous habitat areas. Restoration of these 4,800 acres will result in will result in a 24% increase in protected California clapper rail habitat in the Plan Area (from 19,595 total acres protected to 24,395 acres protected out of the total 25,245 acres of modeled California clapper rail habitat. Total acres of modeled California clapper rail habitat will increase by 19% (from 25,245 acres to 30,045 acres).

3.3.5.18.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve California clapper rail within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.19 California Least Tern

The California least tern is a small migratory seabird that breeds along the Pacific Coast from San Francisco Bay to Baja California. The species nests in loose colonies on barren or sparsely vegetated sandy or gravelly substrates above the high tide line along the coastline and in lagoons and bays, adjacent to aquatic food sources. Colonies are always located near water that provides foraging opportunities. Foraging typically occurs in shallow estuaries or lagoons (Thompson et al. 1997; U.S. Fish and Wildlife Service 2006).

In the San Francisco Bay Area and Suisun Bay nesting colonies are typically located in abandoned salt ponds and along estuarine shores, often using artificially or incidentally created habitat (Rigney and Granholm 2005; Marschalek 2008). Foraging occurs in the bay or large river estuaries. The historical breeding range of the California least tern was described by Grinnell and Miller (1944) as extending along the Pacific Coast from about Moss Landing to the southern tip of Baja California. Present day, Marschalek (2006) identifies six geographic population clusters along the Pacific Coast and one of which is in San Francisco Bay. These nesting sites are somewhat discontinuous due to the limited availability of suitable estuarine shorelines for nesting.

Historical information on California least tern breeding populations is anecdotal and no historical statewide survey data are available. Statewide surveys in 2010 estimated between 6,437 and 6,699 breeding pairs, with about 85% of the breeding colonies occurring in southern California and only a small percentage (6.3% or 406 breeding pairs) occurring in the San Francisco Bay Area (Marschalek 2011). Of the 406 breeding pairs in the San Francisco Bay Area, 23 (0.036%) were found within the Plan Area at the Montezuma Wetlands site. The Plan Area currently includes three known nesting locations: Montezuma wetlands, Pittsburg Power Plant, and the Bufferlands surrounding the Sacramento Regional Wastewater Treatment Plant (Figure 3.3-15). Two additional nest locations were recently reported just outside the Plan Area at Green Island on the Napa River, and along a

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gravel road at the Sacramento Regional Wastewater Treatment Plant Bufferlands east of Interstate 5 (Marschalek 2008, 2009).

Loss, degradation, and disturbance of suitable coastal strand and estuarine shoreline habitat were the primary causes for the historical decline in California least tern populations. Most existing colonies in the Bay Area are located on small patches of degraded nesting habitat that were incidentally created by development, and are surrounded by human activity. Little suitable natural habitat is available for nesting colony expansion or dispersal in the Bay Area. Human disturbance was a significant factor contributing to colony abandonment and population declines (Schneider 1926 in Rigney and Granholm 2005), and is still a major threat to remaining colonies (Garrett and Dunn 1981; Marschalek 2009). Predation is currently regarded as the most significant threat to existing colonies. Marschalek (2009) reported as many as 45 avian and mammalian predators of California least tern colonies in 2008, including American crow (*Corvus brachyrhynchos*), common raven (*Corvus corax*), and coyote (*Canis latrans*), among numerous other species.

A recovery plan for the California least tern was published in 1980 and revised in 1985 (U.S. Fish and Wildlife Service 1985). The recovery plan identifies 23 coastal management areas within which recovery is to focus. The Plan Area does not overlap with any of these coastal management areas. The most recent 5-year status review conducted by USFWS (2006) indicated that breeding pair numbers were six times that identified in the recovery plan criteria, but this was the only recovery goal that had been fully met. The review recommended a downlisting of federal status from endangered to threatened, although there have been no formal proposals to downlist the species. The Plan Area is not identified as an important breeding center for the recovery of this species.

The conservation strategy for the California least tern involves the restoration and creation of high-value foraging habitat, which includes tidal perennial aquatic habitat that supports small fish such as northern anchovy. Although there are three known nesting locations for this species in the Plan Area, protection and expansion of nesting colonies is not a component of this strategy because the Plan Area currently provides only marginal nesting habitat that may not support viable breeding sites. This situation may not change with restoration. The Plan Area is also not within coastal management areas identified in the recovery plan, nesting sites will not be adversely affected by BDCP activities. For these reasons, active conservation of nesting sites in the Plan Area is unlikely to contribute to species recovery.

These sites have experienced limited nesting success and may constitute known as *population sinks* into which individuals experience excessive mortality or do not successfully reproduce, thus draining the species' population levels. The Montezuma Wetland nesting site is on material excavated for a wetland restoration project on the eastern edge of Suisun Marsh: in 2010 23 pairs were found but only 17 nests were found and 5 young fledged. In comparison, Napa Sonoma Marsh Wildlife Area outside the Plan Area had 47 pairs, 47 nests were found, and 85 young fledged (Laureen Thompson pers. com.). The Bufferlands site in the Plan Area has supported only one nesting pair for three consecutive years, and although this pair successfully produced fledglings for the past two years, the Pittsburg Power Plant site has not produced a nesting pair in three of the last four years (Marschalek 2011). The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

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3.3.5.19.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the California least tern are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.5:** Promote water quality conditions within the Delta that help restore native fish habitat. • **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered species. • **Objective L2.10:** Increase the abundance and productivity of plankton and invertebrate species that provide food production for covered fish species in the Delta waterways.

Objectives L2.5, L2.8, and L2.10 Benefits: Achieving these objectives will result in improved water quality and other conditions that promote the production of fish in the tidal perennial aquatic natural community, and this will increase prey abundance for the California least tern. Restoring tidal marsh will increase production of plankton, invertebrates, and other organic material, and this material will be flushed into open water aquatic areas through tidal action and via a network of tidal channels. This will support the food chain and production of small fish that are California least tern prey.

3.3.5.19.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the California least tern are included below.

The landscape-scale goals and objectives and those provided for covered fish species are sufficient to conserve the tidal perennial aquatic natural community, and provide additional benefits for the California least tern. Those natural community biological goals and objectives that are applicable to the conservation strategy for the California least tern are included below.

Goal TPANC1: Tidal perennial aquatic natural community that supports habitats for covered and other native species and that supports aquatic foodweb processes.
• **Objective TPANC1.1:** Restore or create at least 10,000 acres of tidal perennial aquatic in Conservation Zones 1, 2, 4, 5, 7, and 11) that supports aquatic food production and habitat for covered and other native species.

Objective TPANC1.1 Benefits: Achieving this objective will provide aquatic foraging habitat for California least tern. Restoring or creating at least 10,000 acres of tidal perennial aquatic habitat will substantially increase the primary productivity of fish, increasing the prey base for California least terns. This substantial increase in tidal perennial aquatic foraging habitat will help to offset the historic loss of such habitat within the Plan Area.

3.3.5.19.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve California least tern within the reserve system. Additional goals and objectives are not necessary for this species.

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3.3.5.20 Greater Sandhill Crane

Of the estimated total population of 62,600 greater sandhill cranes, an estimated 8,500 (14%) belong to the Central Valley population (Littlefield and Ivey 2000). The Central Valley population breeds from British Columbia to northern California and winters in the Central Valley, arriving in October and reaching maximum densities in December and January. There are two important greater sandhill crane winter use areas in the Central Valley called Greater Sandhill Crane Winter Use Areas (Figure 3.3-16). One is within the Plan Area and the other is in the Butte Basin in Sutter and Glenn Counties. In the Plan Area, the Winter Use Area includes lands in Conservation Zones 3, 4, 5, and 6, which includes the central Delta and northern Delta east of the Stockton DWSC (Figure 3.3-16).

Greater sandhill cranes occur in the Plan Area during the winter nonbreeding season between October and February. Like many birds, greater sandhill cranes exhibit a high degree of fidelity to their wintering grounds and to specific roosting and foraging habitat areas (Littlefield and Ivey 2000). Wintering habitat for the greater sandhill crane is found almost entirely in cultivated lands, and to a lesser extent in managed wetlands and grasslands. Wintering habitat consists of three primary elements: foraging habitat, loafing habitat, and roosting habitat. There are two principal foraging habitat types used during winter. In the Delta, harvested corn fields are the most commonly used foraging habitat along with winter wheat, alfalfa, pasture, and fallow fields (Pogson and Lindstedt 1988). Use of rice has also been recently documented in the east Delta (Vanklomenpburg pers. comm.). Loafing generally occurs in the middle of the day, when birds loosely congregate along agricultural field borders, levees, rice checks, ditches, managed wetlands, or in alfalfa fields or pastures. During the late afternoon and evening, cranes begin to congregate into large, dense communal groups where they remain until the following morning. Providing protection from predators during the night, roost sites are typically within 2 to 3 miles from foraging and loafing areas (Ivey pers. comm.) and available roosting sites are an essential component of winter habitat. Roosting habitat typically consists of shallowly flooded open fields of variable size (1 to 300 acres) or wetlands interspersed with uplands (Littlefield and Ivey 2000).

Populations of the greater sandhill crane have declined primarily because of effects on their breeding grounds; however, winter habitat in the Central Valley has been reduced because changes in crop patterns have reduced compatible agricultural crop types in traditional Winter Use Areas. The most significant threat to wintering greater sandhill cranes in the Plan Area is the continued 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 disturbance 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. However, the effect of land use changes on the total winter population size is unclear. While portions of the wintering population have been monitored periodically prior to and since the mid-1980s when Littlefield and Ivey (2000) estimated a winter population of 8,500 birds, no other comprehensive survey has been conducted and information has been insufficient to reliably detect trends.

Crane abundance and distribution in the Plan Area depends on three primary factors: the availability and distribution of suitable cultivated land types, food availability in suitable cultivated

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lands, and proximity to nighttime roosting habitat. To maintain the population of cranes in the Plan Area, the conservation strategy focuses on maintaining and enhancing suitable foraging habitats on cultivated lands and maintaining and expanding the distribution of managed roosting habitat in the Winter Use Area.

Conservation of greater sandhill crane will be achieved by acquiring permanent easements and fee-title to target lands that will then be managed according to the specific guidance in CM11 *Natural Communities Enhancement and Management*. Protected lands that support greater sandhill crane habitat in the Winter Use Area will increase 2 to 3% through implementation of the conservation strategy, and will result in protection of at least 22% of modeled crane habitat in the Plan Area. The strategy is expected to help stabilize agricultural patterns in the Winter Use Area and provide additional high-value roosting and foraging habitats. The strategy will also focus, to the extent possible, on shifting the crane distribution onto higher elevation lands not subject to the effects of sea level rise. The creation of new roosting sites is expected to facilitate use of otherwise underused but suitable foraging and loafing habitats that are currently distant from existing roosting sites. The conservation strategy is expected to further facilitate increased use of currently sparsely used areas in the Winter Use Area by coordinating the acquisition of roosting sites with cultivated land conservation easements. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.20.1 Applicable Landscape-Scale Goals and Objectives

While the landscape goals and objectives will provide broad-based benefits to the ecosystems upon which greater sandhill cranes depend, none are integral to the conservation strategy for this species.

3.3.5.20.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the greater sandhill crane are included below.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.
• **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species. • **Objective CLNC1.3**: Target cultivated land conservation to provide connectivity between other protected lands. • **Objective CLNC1.4**: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objective CLNC1.1 Benefits: The key to sustaining greater sandhill crane populations in the Plan Area is the sustainability of an economically viable and compatible cultivated landscape. This objective will protect sufficient suitable habitat in the Plan Area for covered species associated with cultivated lands, including the greater sandhill crane. Achieving this objective will offset the loss of cultivated land values from construction actions and the conversion of cultivated lands to tidal wetland restoration. Combined with other existing protected lands in the Plan Area and assuming

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that cultivated land uses will otherwise continue to provide habitat value to covered species in the Plan Area, achieving this objective will address the effects of the BDCP on cultivated land values and contribute to the recovery of the cultivated land-associated covered species.

Objective CLNC1.3 Benefits: Achieving this objective will promote connectivity of suitable cultivated lands to provide for larger, intact protected landscapes. Because greater sandhill cranes are highly traditional to their wintering habitats and because the proximity of roosting habitat and agricultural foraging habitat is essential to maintain the integrity of traditional crane use areas, this objective will provide an important element of the crane conservation strategy. For example, with the increase in crane use of lands on and surrounding the Stone Lakes National Wildlife Refuge, protecting and managing adjacent lands can help to increase use of this area and expand the winter distribution along the north-south corridor of Conservation Zone 4.

Objective CLNC1.4 Benefits: Achieving this objective will retain existing noncultivated habitat elements on protected agricultural lands. While this objective was developed primarily to retain trees, edges, and other habitat elements to support Swainson's hawk, white-tailed kite, and other agriculture-associated covered species, it could also provide some benefit to greater sandhill crane through the retention of seasonal wetlands and upland edges that sometimes occur in association with agricultural habitats.

Goal MWNC1: Managed wetland natural community that is managed and enhanced to provide suitable habitat conditions for covered species.
• **Objective MWNC1.2:** Create at least 320 acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the greater sandhill crane Winter Use Area in Conservation Zones 3, 4, 5, or 6, with consideration of sea level rise.

Objective MWNC1.2 Benefits: Managed wetlands provide suitable foraging habitat and potential roosting habitat for greater sandhill cranes. Achieving this objective will increase the number and distribution of crane roost sites in the Winter Use Area by creating and managing 320 acres of managed seasonal wetland specifically as greater sandhill crane roosting habitat. Currently there are 196,087 acres of greater sandhill crane habitat in the Plan Area, of which 20% is protected. Creation of at least 320 acres of managed wetland will increase the extent of protected habitat to 21%. At a minimum of 40 acres in size, new crane roosts will be created to supplement the existing network of roosts in the Winter Use Area.

3.3.5.20.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for greater sandhill crane within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

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Goal GSHC1: Protection and expansion of greater sandhill crane winter range.

- **Objective GSHC1.1**: Within the at least 20,000 acres of conserved cultivated lands, protect 5,800–7,100 acres of high [0.75 HSU] to very high [1.0 HSU] value habitat for the greater sandhill crane, with at least 30% maintained in very high [1.0] value types in any given year, as defined by this Plan. This protected area will be within the Winter Use Area, will consider sea level rise, and will be within 2 miles of known roosting sites in Conservation Zones 3, 4, and/or 5. Patch size of cultivated lands will be at least 160 acres.
- **Objective GSHC1.2**: To create additional high value greater sandhill crane winter foraging habitat, 10% of the habitat protected under Objective GSHC1.1 will involve acquiring low value habitat and converting it to high or very high value habitat.
- **Objective GSHC1.3**: If greater sandhill crane habitat is removed from within 2 miles of a roost site, of the total protected acres under Objective GSHC1.1, create 1 acre or protect 2 acres of foraging habitat for every acre removed within 2 miles of that roost site.
- **Objective GSHC1.4:** Within the 320 acres of created managed wetland (Objective MWNC1.2), create at least 40 acres of roosting habitat within 2 miles of Winter Use Areas on the Stone Lakes National Wildlife Refuge, and all other roosts within 2 miles of existing traditional roost sites.
- **Objective GSHC1.5**: If monitoring results indicate that greater sandhill cranes abandon known roost sites as a result of covered activities, create a new roost site of equal size (in addition to the acreage prescribed under Objective MWNC1.1) in the Winter Use Area in Conservation Zones 3, 4, 5, or 6. Create the roost within 2 miles of the affected roost and adjacent to other protected crane foraging habitat.

Objective GSHC1.1 Rationale: While Objective CL1.1 protects cultivated lands throughout the Plan Area to support covered species associated with these lands, Objective GSHC1.1 establishes the proportion of this overall protection that will be applied to the conservation of the greater sandhill crane within the crane Winter Use Area. Since the most important stressor on this species is the conversion of suitable crops in the Winter Use Area to unsuitable crops, the key to long-term protection of the winter population is sustaining sufficient amounts and types of suitable cultivated lands.

The cultivated land base in the crane Winter Use Area has remained relatively stable; however, because crop patterns are subject to agricultural economic influences, the extent of the landscape that provides suitable habitat for the crane is less stable and uncertain over time. Over the last 20 years, cultivated lands compatible with crane winter use have declined primarily as a result of conversion to vineyards. Therefore, the strategy for the greater sandhill crane is focused on protecting cultivated lands to increase the stability and certainty of compatible crops in the crane Winter Use Area.

The strategy involves targeting lands where they are needed most and managing those lands as high-value foraging habitat for cranes. Objective GSHC1.1 requires that protected lands be within 2 miles of known roost sites and that 80% be managed at the highest habitat value in any given year (Table 3.3-6). The remaining 20% will be managed as at least moderate value habitat, which allows for crop rotations and other factors that could influence agricultural productivity. The minimum patch size is relatively large (160 acres) to minimize the potential effects of human-associated visual and noise disturbances. However, there are no restrictions on patch size if it is contiguous with other protected foraging or roosting habitat.

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Table 3.3-6. Assigned Greater Sandhill Crane Foraging Habitat Value Classes for Agricultural Crop Types

Foraging Habitat Value Class	Agricultural Crop Type
Very high	Corn, rice
High	Alfalfa, irrigated pasture, wheat
Moderate	Other grain crops (barley, oats, sorghum)
Low	Other irrigated field and truck crops
None	Orchards, vineyards

This objective will protect cultivated lands sufficient to address the loss of cultivated land habitat value, and additional enhancement provided through GSHC1.2, as described below, will contribute to recovery.

Objectives GSHC1.2 and GSHC1.3 Rationale: Achieving this objective will enhance or create foraging habitat by requiring 10% of the protected lands be converted from an initial low or no value to a high or very high value crop type. Objective GSHC1.3 will protect the integrity of the foraging habitat suitability associated with individual roost sites by requiring conservation to occur where effects are occurring.

Greater sandhill crane winter roosting habitat, an essential element of crane wintering habitat, is limited in the Plan Area. Typical roosting habitat consists of flooded managed wetlands or some shallowly flooded cultivated fields. Crane use of foraging and loafing habitats tends to decrease with distance from roosting sites and therefore the winter distribution of cranes in the Winter Use Area is influenced by the presence and distribution of roosting sites. An appropriate crane management area in the winter use area includes a network of managed seasonal wetland roost sites intermixed with abundant suitable agricultural foraging habitat.

Objective GSHC1.4 Rationale: Achieving this objective will promote continued use and expansion by cranes onto the Stone Lakes National Wildlife Refuge and surrounding lands and will provide additional connectivity between refuge lands and the Cosumnes Preserve. Creating roosting habitat near crane use areas within the refuge will facilitate use of underused cultivated land foraging habitat in that area and expand the winter distribution. The strategy includes using newly created roosting sites as a management tool to attract cranes out of low-elevation zones that have greater uncertainty to exist in the future, due to the potential for levee failure or flooding.

Objective GSHC1.5 Rationale: Achieving this objective will ensure no net loss of roost sites for greater sandhill crane as a result of BDCP construction activities. If cranes abandon a roost as a result of BDCP activities, a new roost of equal or greater size will be established. New roosts created under GSHC1.5 are in addition to the 320 acres of roosting habitat created under GSHC1.4.

3.3.5.21 Least Bell's Vireo

The least Bell's vireo is an obligate riparian breeder that typically inhabits structurally diverse woodlands, including cottonwood-willow woodlands and forests, oak woodlands, and mule fat scrub (U.S. Fish and Wildlife Service 1998). Two features appear to be essential for breeding habitat: the presence of dense cover within 3 to 6 feet (1 to 2 meters) of the ground, where nests are typically sited; and a dense stratified canopy for foraging (Goldwasser 1981; Gray and Greaves 1981; Salata

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1981, 1983; Regional Environmental Consultants 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 to 7.2 acres, but common territory sizes in southern California range from 1.5 to 2.5 acres. Least Bell's vireos exhibit a high degree of site fidelity, sometimes even returning to the same shrub for nesting every year (Riparian Habitat Joint Venture 2004).

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 in California 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 to 80% of the historical population (51 FR 16474). Smaller populations also occurred in the foothill riparian of the Sierra Nevada and Coast Ranges, and in Owens Valley, Death Valley, and scattered locations in the Mojave Desert (Kus 2002). 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 and San Joaquin Valleys, and the species was considered extirpated from the region. By 1986, 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). The population size since increased to an estimated 2000 pairs in 1998 after extensive cowbird trapping efforts in southern California (Kus 2002). Recent occurrences have suggested a range expansion to the northern extent of the species' historical breeding range, including nest sites reported from the San Joaquin River National Wildlife Refuge (Howell et al. 2010) and recent (2010) occurrences from the Yolo Bypass Wildlife Area.

Habitat loss and fragmentation and cowbird parasitism have been the primary factors leading to the decline of least Bell's vireo (Kus 2002). In addition, flood control and channelization are stressors on this species: the riparian system upon which the species depends is adapted to periodic flooding and fluvial disturbances promote the vegetative structural components that are suitable for least Bell's vireo. Additionally, this species is susceptible to nest abandonment resulting from human disturbance (Kus 2002).

Critical habitat for this state and federally endangered species was designated in 1994, although there is no designated critical habitat in the Plan Area. A Draft Recovery Plan emphasizing the need for habitat protection and restoration was published in 1998 (U.S. Fish and Wildlife Service 1998). Least Bell's vireo is also a focal species of the Riparian Bird Conservation Plan (Riparian Habitat Joint Venture 2004), which provides data and recommendations for conservation of riparian birds in California. Riparian habitat creation and restoration are underway throughout California (Riparian Habitat Joint Venture 2004), and the least Bell's vireo is listed as a covered species in at least two northern California HCPs (the Yolo County HCP/NCCP and the Santa Clara Valley HCP/NCCP, both of which are not yet completed). Conservation actions under those HCPs and the BDCP have the potential to act in synergy toward partial recovery of the least Bell's vireo. The recent documentation of the species in the Yolo Bypass and breeding nearby at the San Joaquin National Wildlife Refuge has heightened awareness of the species' conservation potential in the Plan Area (Figure 3.3-17).

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The BDCP conservation approach for least Bell's vireo species involves riparian protection, restoration, and management that promote vegetation structurally suitable for the species, as well as floodplain restoration to reestablish seasonal patterns of fluvial disturbances that promote development of high quality riparian habitat preferred by this species. The conservation measures that will be implemented to achieve these goals and objectives are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.21.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the least Bell's vireo are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland transitional areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.5 Benefits: Least Bell's vireo will benefit from the inclusion of upland areas adjacent to riparian natural community, consistent with this objective. Least Bell's vireos are among many riparian species that commonly use upland habitat adjacent to riparian nesting sites; these upland areas act as both flood refugia and supplemental foraging areas. Additionally, natural uplands adjacent to riparian areas in the reserve system are important for reducing adverse effects of adjacent land use. Vireos with territories bordering on agricultural land and urban areas are significantly less successful in producing young, compared to vireos in territories bordering undeveloped uplands (Riparian Habitat Joint Venture 2004).

Objective L1.6 Benefits: Increasing the size and connectivity of the reserve system, consistent with this objective, will reduce the risk of riparian natural community fragmentation in the Plan Area, which would adversely least Bell's vireo habitat. Habitat fragmentation is a primary stressor for this species. The need for large, unfragmented blocks of least Bell's vireo habitat is further described below, for Goal VFRNC1.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers. • **Objective L2.7:** Increase native biodiversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.1 Benefits: Least Bell's vireo will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early to mid-successional riparian vegetation, consistent

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with this objective. Early- to mid-successional vegetation comprises the dense shrub cover required by least Bell's vireo for nest concealment as well as structurally diverse canopy for foraging (Kus 2002); see also Objective VFRNC2.2, below.

Objective L2.4 Benefits: Improved recharge of floodplain groundwater will provide conditions favorable for establishment of shrubby riparian vegetation favorable for least Bell's vireo (Riparian Habitat Joint Venture 2004). This objective will be achieved through floodplain restoration as described in CM5 *Seasonally Inundated Floodplain Restoration.*

Objective L2.7 Benefits: As described above, least Bell's vireo requires structural diversity in its breeding habitat. Large, monotypic stands of invasive plants can diminish this structural diversity and render habitat unsuitable for the species. Invasive nonnative species that diminish structural diversity and degrade least Bell's vireo habitat conditions include giant reed (*Arundo donax*) and tamarisk (*Tamarix chinensis*) (Riparian Habitat Joint Venture 2004). Invasive plants such as these will be controlled as part of *CM11 Natural Communities Enhancement and Management.* Control of invasive species and maintenance of native vegetation diversity will maintain and enhance vireo habitat.

This objective also addresses the potential need to control nonnative brown-headed cowbird populations. As described in CM11 *Natural Communities Enhancement and Management,* a cowbird control program will be implemented if it is determined through population monitoring that the least Bell's vireo population in the Plan Area is being declining as a result of cowbird parasitism.

3.3.5.21.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the least Bell's vireo are included below.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near term implementation period

Objective VFRNC1.1 Benefits: This objective will increase the likelihood for least Bell's vireo to establish a breeding population in the Plan Area by restoring 5,000 acres of valley/foothill riparian habitat (Figure 3.3-17) in wide bands and large, interconnected patches. Least Bell's vireos occur in disproportionately high frequencies in wider sections (greater than 250 m) of riparian habitat, relative to site availability (Kus 2002). The species is also susceptible to nest abandonment as a result of human disturbance, and habitat fragmentation increases the potential for human disturbance. Most riparian corridors in the Plan Area do not currently support sufficiently large wide bands of habitat for least Bell's vireo breeding, so restoration is needed to increase widths to be suitable for breeding habitat. A reserve system with extensive wide bands or large patches of interconnected valley/foothill riparian natural community (Goal VFRNC1) will reduce loss and fragmentation of least Bell's vireo riparian habitat. A large fraction of the 5,000 acres of restored valley/foothill riparian woodland is expected to provide suitable early- to mid-successional riparian vegetation for this species.

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Objective VFRNC1.2 Benefits: This objective will provide least Bell's vireo with some benefit from the protection of 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 in the near- term implementation period. However, the entire 750 acres of protected riparian will not necessarily provide the vegetative structure necessarily to support this species (see the next objective).

Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.
• **Objective VFRNC2.1:** Restore, maintain and enhance structural heterogeneity with adequate vertical and horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands. • **Objective VFRNC2.2:** Maintain at least 1,000 acres of early to mid-successional vegetation with a well-developed understory of dense shrubs.

Objectives VFRNC2.1 and VFRNC2.2 Benefits: Least Bell's vireo will benefit from the maintenance and enhancement of early to mid-successional riparian vegetation that is structurally diverse. Least Bell's vireo requires riparian habitat with a relatively open canopy and dense understory. Least Bell's vireos favor early- to mid-successional riparian vegetation with a well-developed understory of dense shrubs and relatively open canopy. Their nests are typically located in shrubs approximately 1 meter above the ground, and they often forage in taller trees associated with the shrub layer. Riparian stands between 5 and 10 years of age are most suitable for supporting least Bell's vireo (Riparian Habitat Joint Venture 2004), although vegetation structure more than age appears to be the important determinant of site use. Early successional habitat typically supports the dense shrub cover required for nesting and a structurally diverse canopy for foraging. As stands mature, the tall canopy tends to shade out the shrub layer, making the sites less suitable for nesting; however, least Bell's vireos will continue to use such areas if patches of understory exist (U.S. Fish and Wildlife Service 1998).

Although maintenance of natural or artificial fluvial disturbance consistent with Objective L2.1 will result in a mosaic of different aged habitat patches (including early- to mid-successional and late-successional vegetation) and structural habitat diversity, Goals VFRNC2.1 and VFRNC2.2 will further ensure structural diversity and will maintain a representative amount of vegetation at an appropriate successional stage for least Bell's vireo. However, active management, as described in *CM11 Natural Communities Enhancement and Management,* may be necessary to ensure that sufficient structural diversity is present in the reserve system to support least Bell's vireo and other native species that rely on similar habitat structure.

Although least Bell's vireo is not known to presently breed in the Plan Area, three singing males and one female were detected in the Yolo Bypass Wildlife Area during the 2010 breeding season, two singing males were detected in the Yolo Bypass Wildlife Area in 2011, and a single breeding pair recently nested for multiple years immediately south of the Plan Area along the San Joaquin River. This indicates that the species has potential to reestablish itself in suitable habitat in the Plan Area. Consistent with Objective VFRNC2.2, the reserve system will include suitable habitat for the growth and expansion of a breeding least Bell's vireo population in the Central Valley. Given the relatively small territory size of least Bell's vireo, the large acreage of riparian habitat to be restored, recent breeding records in restored riparian habitat at the nearby San Joaquin River National Wildlife Refuge, and past success in establishing breeding least Bell's vireo pairs in restored habitat (Kus 2002), BDCP

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riparian restoration efforts have the potential to significantly increase the likelihood of population reestablishment and expansion in the Plan Area.

3.3.5.21.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the least Bell's vireo within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.22 Suisun Song Sparrow

The Suisun song sparrow *(Melospiza melodia maxillaris)* is a nonmigratory songbird endemic to the tidal salt marshes of the Suisun Bay. Suitable habitat for Suisun song sparrow within the Plan Area is primarily represented by tidal brackish emergent wetland and tidal freshwater emergent wetland. The species occupies areas dominated by cordgrass, pickleweed, and gum plant in tidal brackish emergent wetlands, and sedges, cattails, and rushes in tidal freshwater emergent wetlands (Spautz and Nur 2008). Song sparrows also inhabit areas dominated by the invasive perennial pepperweed. Dense vegetation is required for nesting sites, song perches, and refuge from predators (Marshall 1948). Exposed ground such as openings in the tidal marsh and slough margins are important for foraging. Highest densities are found adjacent to upland habitat, and upland transition zones are important refugia during high tide events and are used by these sparrows at other times as well.

Suisun song sparrow is confined to tidal salt and brackish marshes extending from the Carquinez Strait east to Antioch at the confluence of the San Joaquin and Sacramento Rivers (Grinnell and Miller 1944; Spautz and Nur 2008). The current range of the species remains relatively unchanged since Grinnel and Miller's (1944) description. However, the current distribution is defined by the extent of remaining tidal marsh habitats, which occur primarily along the fringes of the Carquinez Strait and Suisun Bay. Spautz and Nur (2008), citing unpublished data from the Point Reyes Bird Observatory, estimated the total population of Suisun song sparrows to be 43,000 to 66,000 breeding pairs, approximately one-third of the estimated historical population size (Spautz and Nur 2008). Densities in the tidal marsh of Suisun Bay vary widely based on habitat conditions and suitability (Spautz and Nur 2008). Within the Plan Area, most sightings of Suisun song sparrow are from the Suisun Marsh in Conservation Zone 11 (Figure 3.3-18).

Habitat loss and fragmentation caused by diking, levee construction, channelization, invasive species such as pepperweed, and urbanization remain the primary threats to the Suisun song sparrow (Larsen 1989; Spautz and Nur 2008). Throughout most of the Suisun Marsh, the 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). Small, isolated populations are vulnerable to local extinctions from chance catastrophic events, particularly for highly sedentary species like the Suisun song sparrow. High levels of nest predation may also be a significant threat to the species (Spautz and Nur 2008). Other potential threats include toxins introduced into the system (e.g., oils, sewage) and changes in freshwater outflows that could affect salinity and habitat composition in Suisun Marsh (Larsen 1989).

The conservation approach for this species is to restore, protect, and manage tidal brackish emergent wetlands in the Suisun Marsh. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation*

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Measures, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.22.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the Suisun song sparrow are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetland to permit the future upslope establishment of tidal emergent wetland communities with sea level rise, and to provide upland habitat and refugia for native wildlife.

Objective L1.5 Benefits: Protecting upland areas adjacent to restored brackish and freshwater tidal emergent wetland, consistent with this objective, will benefit Suisun song sparrow in the short term, and in the long term with anticipated sea level rise. As sea level rises and existing tidal lands are flooded more frequently and with longer duration, there will be a need for freshwater and brackish tidal communities to shift upward in mean elevation. Without the ability of these habitat types to migrate upward, the existing tidal habitat will become intertidal and subtidal without being replaced in other, more upland locations. Protecting transitional areas will provide habitat for Suisun song sparrows. Upland transitional habitat in and of itself is a very important component of the suite of habitats used by this bird, especially as refugia during high tide events. Providing additional upland transitional habitat will benefit this species.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species. • **Objective L2.8:** Produce sinuous, high-density, dendritic networks of tidal channels in tidal brackish marsh to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species.

Objective L2.7 Benefits: This objective will address the potential need to control nonnative predators that might be a threat to Suisun song sparrow populations. In at least parts of its range, nonnative red foxes, feral cats, and Norway rats have been identified as a threat to nesting populations of Suisun song sparrows (Spautz and Nur 2008). Suisun Marsh populations, in particular, suffer high rates of nest loss to predators (Greenberg et al. 2006). Under this objective, an assessment will be conducted to determine whether nonnative nest predators pose a significant threat to Suisun song sparrow populations in Suisun Marsh, followed by the implementation predator control measures if needed. Nonnative smooth cordgrass (*Spartina alterniflora*) and peppergrass have been identified as possible threats to Suisun song sparrows. However, *Spartina* invasion is not yet an issue at Suisun Marsh, and peppergrass appears effects appear to be either positive or neutral (Spautz et al. 2006).

Objective L2.8 Benefits: This objective addresses the need for channel habitat throughout the marsh plain. Suisun song sparrows are associated primarily with tidal channels, especially in

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marshes where pickleweed dominates and gumplant lines the channels (Spautz and Nur 2008). Promoting the development of additional channel networks will benefit Suisun song sparrows by creating channel margins that support favorable habitat conditions for this species.

3.3.5.22.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the Suisun song sparrow are included below.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objective TBEWNC1.1 Benefits: This objective addresses the need for restoring tidal brackish emergent wetland in Suisun Marsh and tidal freshwater emergent wetland in the Delta region. The intended restoration for tidal marshes will benefit Suisun song sparrows by providing additional habitat. Restoration of these 4,800 acres in Conservation Zone 11 will result in a 24% increase in protected Suisun song sparrow habitat in the Plan Area (from 19,983 total acres protected to 24,783 acres protected). Total modeled Suiun song sparrow habitat will increase by 19% (from 25,678 acres to 30,478 acres).

Objective TBEWNC1.2 Benefits: This objective addresses the need for connectivity. Suisun song sparrows are highly sedentary and do not readily disperse from occupied areas (Spautz and Nur 2008). Isolated populations are unlikely to disperse across large expanses of unsuitable habitat. Therefore, the lack of sufficient dispersal corridors will impede dispersal following catastrophic disturbance or habitat changes, such as those resulting from rapid salinity changes (Scollon 1993; Cogswell 2000). Restoring connectivity between isolated populations and to newly restored habitat will benefit Suisun song sparrows by providing both avenues of genetic exchange and dispersal pathways following stochastic events.

Objective TBEWNC1.4 Benefits: This objective will benefit Suisun song sparrow by addressing the temporal habitat loss that will occur between the period when managed wetland habitat is initially lost as a result of tidal restoration inundation and when the newly restored tidal brackish marsh finally develops into the habitat structure suitable for Suisun song sparrows. Phasing the restoration activities will ensure that the area affected by restoration at any given time is limited.

3.3.5.22.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the Suisun song sparrow within the reserve system. Additional goals and objectives are not necessary for this species.

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3.3.5.23 Swainson's Hawk

Swainson's hawks nest in the grassland plains and agricultural regions of western North America from southern Canada to northern Mexico. Formerly associated mainly with grassland, desert, and shrub/steppe communities, the conversion of much of the species' range to agriculture has altered the distribution and abundance of the species and changed its key habitat associations throughout much of its range. This species has adapted relatively well to cultivated lands that are compatible with its foraging needs as long as they also provide suitable and secure nesting habitat. Nowhere in the species' range is this exemplified more than in the Central Valley. Almost entirely converted to cultivated lands, the Central Valley currently supports approximately 2,000 nesting pairs of Swainson's hawks (Anderson et al. 2007), and the density of nesting Swainson's hawks in the Yolo, Solano, Sacramento, and San Joaquin County area, considered the core of the Central Valley breeding population, is higher than anywhere else in the species' range. The population in the Plan Area represents an estimated 15 to 20% of the population in the Central Valley, with over 400 nesting records reported since 2000 (Figure 3.3-19). At least 300 of these are considered independent nesting territories that are potentially active in any given year and widely distributed in the Plan Area.

The population in the Plan Area is almost entirely dependent on privately owned cultivated lands. Certain crops such as alfalfa, when combined with shrub cover at field edges, provide relatively high densities of small mammal prey for foraging. Isolated trees and stands of trees on cultivated lands provide important nest sites when they are located in close proximity to suitable foraging habitat. The density of Swainson's hawk populations is largely dependent on the abundance and distribution of these crop types and landscape features. Therefore, management of a compatible agricultural matrix and sustaining other essential habitat elements such as nest trees and habitat edges that support refugia for prey populations are essential to the long-term management and sustainability of the Swainson's hawk population in the Plan Area.

The conservation strategy for the Swainson's hawk focuses on maintaining an agricultural landscape throughout the Plan Area that is compatible with the nesting and foraging needs of the Swainson's hawk and that will sustain the existing population. This will be accomplished by protecting and maintaining high foraging values on cultivated lands, protecting and creating nesting habitats, and protecting and creating habitat edges the provide prey refugia. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.23.1 Applicable Landscape-Scale Goals and Objectives

While the landscape goals and objectives will provide broad-based benefits to the ecosystems upon which Swainson's hawks depend, none are integral to the conservation strategy for this species.

3.3.5.23.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for Swainson's hawk are included below.

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Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zones 7 within the near-term implementation period.

Objectives VFRNC1.1 and VFRNC1.2 Benefits: Protection and restoration of nesting habitat is key to successful Swainson's hawk conservation in the Plan Area. Nesting Swainson's hawks occur in riparian areas and isolated trees throughout the Plan Area, so protecting valley/foothill riparian forest will provide Swainson's hawk with nesting habitat and likely protect traditional nesting territories. The amount and distribution of existing nesting habitat in the Plan Area is likely sufficient to continue to support a large Swainson's hawk nesting population, but the long-term stability of this habitat is uncertain. Many nest sites occur within or adjacent to working cultivated landscapes where trees are regularly trimmed or removed as part of agricultural operations. In addition, trees that die naturally or from disease may not be replaced. Restoration of valley/foothill riparian forest is necessary to replace this community lost to covered activities, and to ensure sufficient valley/foothill riparian forest remains in the Plan Area to offset continued long-term losses expected in unprotected areas. Since restoration of valley/foothill riparian forest under VFRNC1.1 will occur steadily but gradually during the permit period (see Chapter 6, *Plan Implementation*, for the implementation schedule), it will provide future nesting opportunities for Swainson's hawks to ensure that substantial riparian habitat is maintained in the Plan Area through time.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.

- **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.

Objective GNC1.1 Benefits: While the Swainson's hawk population is more closely associated with cultivated lands, grasslands provide suitable foraging habitat for the species. Therefore, while the protection of cultivated lands is the primary focus of the conservation strategy to ensure sufficient Swainson's hawk foraging habitat, the protection of 8,000 acres of grasslands will also contribute to the conservation of the species.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.

- **Objective GNC2.4:** Increase prey, especially small mammals and insects, for grassland-foraging species.

Objective GNC2.4 Benefits: Achieving this objective will benefit the Swainson's hawk by increasing prey density for this species in protected and managed grasslands. Prey density is directly related to the quality of Swainson's hawk foraging habitat. Techniques that will be implemented to achieve this objective, such as grazing practices and avoiding use of pesticides, are described in CM11 *Natural Communities Enhancement and Management.*

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Goal MWNC1: No net loss of habitat functions of managed wetlands in the Plan Area.

- **Objective MWNC1.1:** Protect 1,500 acres of managed wetlands in the Grizzly Island Marsh Complex, consistent with the salt marsh harvest mouse recovery plan.

Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grassland and vernal pool complex.

- **Objective ASWNC1.1:** Protect 150 acres of alkali seasonal wetland in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

Goal VPCNC1: Vernal pool complexes comprised of large, interconnected, or contiguous expanses that represent a range of environmental conditions.

- **Objective VPCNC1.1:** Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005).

Objectives MWNC1.1, ASWNC1.1, and VPCNC1.1 Benefits: Achieving these objectives will protect 1,500 acres, 150 acres, and 600 acres of managed seasonal wetlands, alkali wetland complex, and vernal pool complex, respectively. While also supporting wetland elements either as natural seasonal wetlands within a grassland community or as a result of seasonal flooding to support wintering waterfowl, each of these natural communities also supports Swainson's hawks for foraging habitat and is part of the overall foraging landscape. Alkali wetlands and vernal pool complex are primary grassland habitats with seasonally inundated pools. The grassland component of these communities is always available to Swainson's hawks for foraging, and the wetland component becomes available as it dries during the spring and summer months. Managed wetlands also dry during the spring and become available to foraging Swainson's hawks as prey species recolonize the field. Protection of these communities will contribute to the conservation of Swainson's hawk habitat.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.

- **Objective CLNC1.1**: Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species.
- **Objective CLNC1.4**: Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objective CLNC1.1 Benefits: The Swainson's hawk is a species of large, open landscapes. In the Central Valley, cultivated lands, and to a lesser extent grasslands, are essential communities required for species persistence. Maintaining high-quality cultivated landscapes is therefore the key underlying element of Swainson's hawk conservation in the Central Valley. The quality of cultivated and grassland landscapes, in terms of their compatibility with the foraging habitat requirements of Swainson's hawks, as well as the availability of nesting habitat, influences the distribution and abundance of the species. However, certain crop types will need to be maintained within the cultivated landscapes in the Plan Area in order to maintain the high density of Swainson's hawk found in the Plan Area (see *Species-Specific Goals and Objectives* below).

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Objective CLNC1.4 Benefits: While cultivated landscapes have become essential for the continued survival of Swainson's hawks in the Central Valley, agricultural practices have also historically removed other important habitats such as riparian forest, woodlands, and savannahs that supported nesting habitat for the species. Today, other than narrow riparian corridors, nesting habitat for Swainson's hawks consists of isolated trees, tree rows along field borders or roads, or small clusters of trees in farmyards or at rural residences. Maintaining these small, isolated nesting habitats is also essential to maintaining the distribution and abundance of the species in the Plan Area. This objective is designed in part to provide a means to protect these small but essential habitats that occur within the agricultural matrix. Meeting this objective requires that all cultivated lands protected for Swainson's hawk (i.e., in the reserve system) retain trees, hedgerows, and other edge landscape features that provide habitat for Swainson's hawk and other wildlife.

3.3.5.23.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for Swainson's hawk within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal SH1: Contribute to the sustainability of the Swainson's hawk population by protecting cultivated lands suitable for Swainson's hawk foraging.
• **Objective SH1.1**: Within the at least 20,000 acres of conserved cultivated lands, protect 19,800 to 33,700 acres as a matrix of moderate quality [0.5 HSU] Swainson's hawk foraging habitat, at least 30% of which will be managed as very high [1.0 HSU] quality habitat.

Objective SH1.1 Rationale: This objective addresses the portion of the protected cultivated lands that would be designed to maintain Swainson's hawk in the Plan Area. Achieving this objective will protect between 19,800 and 33,700 acres of cultivated land that provides at least moderate habitat value, as defined by the crop types in Table 3.3-7, which indicates that individual crop types have different habitat values. The extent of conversion from lower to higher value types on protected lands will determine the ultimate number of protected acres within the range (19,800 to 33,700), which was derived by assuming all lands would be converted to high value (low end of the range) and moderate value (high end of the range). The high density populations of nesting Swainson's hawk that occur in the Plan Area and throughout the species' range in the Central Valley are due in part to the relative abundance and distribution of the highest value habitat, alfalfa hay. To ensure that the highest value habitat is part of the conservation strategy, this objective also includes the provision that 25% of the total protected habitat (approximately 4,875–8,425 acres) will be under alfalfa hay production each year. The remaining protected cultivated lands will be maintained as moderate to highest value habitat.

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Table 3.3-7. Foraging Habitat Value Classes for Cultivated Lands for Swainson's Hawk

Foraging Habitat Value Class for Swainson's Hawk	Cultivated Land Type
Very High	Alfalfa hay
High	Irrigated pasture, other hay crops
Moderate	Tomatoes, sugar beets, grain crops (wheat, barley, oats)
Low	Other irrigated field and truck/berry crops
Very Low	Safflower, sunflower, corn, grain sorghum
None	Orchards, vineyards, rice

Goal SH2: Cultivated lands that provide conditions suitable for supporting Swainson's hawk.

- **Objective SH2.1:** Increase distribution and abundance of potential Swainson's hawk nest trees in the Plan Area by planting and maintaining native trees along roadsides and field borders within protected cultivated lands at a rate of 1 tree per 10 acres.
- **Objective SH2.2:** Support the establishment and sustainability of Swainson's hawk prey populations by establishing 20-foot-wide hedgerows along field borders and roadsides within protected cultivated lands at a minimum rate of 400 feet per 100 acres.

Objectives SH2.1 and SH2.2 Rationale: In the absence of a comprehensive effort to maintain habitat diversity, cultivated lands tend to lose diversity over time as trees are lost and not replaced, cultivated fields are extended further into riparian corridors and oak woodlands, wetlands are plowed, and edge habitats are cultivated. Eventually, cultivated lands can become entirely devoid of trees, shrubs, or any uncultivated habitats. As this process continues, nesting opportunities for Swainson's hawks are reduced and the quality of agricultural foraging habitat declines. Where these elements have persisted within the agricultural matrix, Swainson's hawk populations have also persisted. Therefore, to successfully maintain Swainson's hawks in the Plan Area, these essential habitat elements must be maintained on the landscape. These objectives will address this issue by increasing the distribution and abundance of suitable nest trees and creating edge habitat to promote prey populations throughout the protected cultivated lands.

Objective SH2.2 will require planting between approximately 1,500 and 2,700 trees on protected cultivated lands. Trees will be planted according to criteria specified in CM11 *Natural Communities Enhancement and Management*. Trees will be planted in locations that do not interfere with agricultural activities; where they are otherwise limited or in decline; and in numbers and configurations that are appropriate for the location (e.g., linear tree rows, small groves).

Implementing Objective SH2.2 will require a total of approximately 27 to 50 acres of land, or less than 0.1 to 0.2% of the 20,000 acres of protected cultivated lands. At least this amount of land is expected to be unutilized in the protected cultivated lands, so little or no land is expected to be taken out of production to meet this objective. Hedgerows will also be created based on specific criteria in CM11 *Natural Communities Enhancement and Management*. Hedgerows will be created on the edges of cultivated lands in locations that will not interfere with agricultural operations, where they are limited or in decline, and planted with species that best suit the location and provide the highest value.

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3.3.5.24 Tricolored Blackbird

The tricolored blackbird is a colonial nesting passerine that is largely restricted to California. The species typically nests in areas with open accessible water, a nesting substrate that is protected from ground predators (e.g., vegetation that is flooded, thorny, or spiny), and suitable foraging habitat (e.g., pastures, dry seasonal pools, agricultural fields such as alfalfa and sunflower) that provides abundant insect prey within a few miles of the nesting colony (Hamilton et al. 1995; Beedy and Hamilton 1999; University of California Davis nd). Nesting colonies may be located in dense stands of bulrush (*Schoenoplectus* spp.), cattail (*Typha* spp.), Himalayan blackberry (*Rubus armeniacus*), nettle (*Urtica dioica*), willow (*Salix* spp.), silage and grain fields, and weedy stands of thistles (*Circium vulgare*, *Silybum marianum*), mustards (*Brassica* spp.), and mallow (*Malva* spp.) (Neff 1937; Beedy et al. 1991; Hamilton et al. 1995; Hamilton 2000).

Proximity of nesting colonies to suitable foraging habitat appears to be a key factor for high reproductive success by tricolored blackbirds. For purposes of the BDCP, modeled breeding habitat consists of all bulrush, cattail, and blackberry communities, and adjacent high quality foraging areas located within 5 miles of nesting colonies documented in the Plan Area over the last 15 years. Tricolored blackbirds are highly dependent on disturbance events to maintain nesting sites. Older stands of bulrush and cattail with many senescent stems and horizontal dead stems become unattractive to the species for nesting. Breeding season foraging habitat in the Plan Area encompasses grassland, natural seasonal wetlands (e.g., vernal pool complex, alkali seasonal wetland complex), pasturelands (including alfalfa), and sunflower croplands, all habitats known to support abundant insects. During the nonbreeding season, tricolored blackbirds are primarily granivores that forage opportunistically within grasslands, pasturelands, and croplands (University of California Davis nd). Large numbers of tricolored blackbirds are attracted to grains associated with livestock feed lots and dairies. Roosting by nonbreeding tricolored blackbirds occurs in emergent wetlands and shrub stands.

More than 95% of the California breeding population of tricolored blackbird occurs in the Central Valley (Kyle and Kelsey 2011). Breeding also occurs in the foothills of the Sierra Nevada south to Kern County, the coastal slopes from Sonoma County to the Mexican border, and sporadically in the Modoc Plateau. While the overall range of the tricolored blackbirds is largely unchanged since the 1930s (Neff 1937; DeHaven et al. 1975; Beedy et al. 1991; Hamilton 1998), large gaps now exist in the species' former range. Surveys during the 1990s (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000) indicated a significant declining trend in California populations since the 1930s, and a particularly dramatic decline since 1994. Statewide surveys conducted during the 2000s indicated some recovery from the recent (1999) population low; however, the population increases have primarily been limited to the San Joaquin Valley and the Tulare Basin (Kyle and Kelsey 2011).

Scattered nesting colonies of tricolored blackbird are reported for the Plan Area. Colonies identified since 1996 have generally been located along the fringe of the Suisun Marsh, in the Yolo Bypass, and along the southwestern perimeter of the Plan Area (Figure 3.3-20). Tricolored blackbirds may make extensive movements during the breeding season and during winter (Beedy 2008). Wintering tricolored blackbirds often form huge, mixed-species flocks that forage across the landscape. The Delta and central coast are recognized as major wintering areas for tricolored blackbirds (Hamilton 2004; Beedy 2008), with large wintering flocks reported on Sherman Island in the Plan Area.

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The most significant historical and ongoing threat to the tricolored blackbird is habitat loss and alteration (Cook 1999; DeHaven 2000; Hamilton 2004; Yolo Natural Heritage Program 2008; University of California Davis nd). The initial conversion of native landscapes in California to agriculture, which removed vast wetland areas that provided nesting habitat, caused initial declines in populations. The more recent conversion of suitable agricultural lands to urban areas has permanently removed historical breeding and foraging habitat for this species. Taken together, these actions have resulted in a decline in productive foraging habitats near nesting colonies that is contributing to low reproductive success. In urbanizing areas, habitat fragmentation and proximity to human disturbances has also led to abandonment of large historical colonies (Beedy and Hamilton 1999). Other threats to the species include predation, poisoning and contamination, and active colony destruction from agricultural practices, primarily in the San Joaquin Valley where grain and silage fields are used for nesting (Beedy and Hayworth 1992; Hamilton et al. 1995; Beedy and Hamilton 1999; Hamilton 2004; Yolo Natural Heritage Program 2008; University of California Davis nd).

The conservation strategy for the tricolored blackbird involves the protection, restoration, and management of wetland nesting habitat and the protection of high quality foraging habitat. These actions are intended to support existing breeding and wintering populations and provide for future population increases in the Plan Area. Since the Plan Area is a major wintering area but supports only a small number of nesting colonies (largely or mainly in the Yolo Bypass; see Appendix A, *Covered Species Accounts*), the protection, restoration, and management of wetland nesting habitat near suitable foraging habitat has the potential to provide for future increases in the abundance and distribution of tricolored blackbirds. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.24.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the tricolored blackbird are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.1:** Protect at least 31,000 acres of existing natural communities, focusing on the highest quality natural communities and covered species habitats. • **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objectives L1.1, L1.3, and L1.4 Benefits: Restoration of tidal brackish emergent wetlands, tidal freshwater emergent wetlands, and nontidal perennial emergent wetlands natural communities consistent with this objective will provide suitable nonbreeding roosting habitat for tricolored blackbird, particularly portions that support tall or dense vegetation such as cattails and bulrushes. Restoration sites that incorporate hydrologic and elevation gradients will result in a diversity of inundation characteristics and plant composition in the restored wetlands and provide

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opportunities for establishment of suitable vegetation to support nonbreeding roosting tricolored blackbirds. Additionally, the restored valley/foothill riparian natural community is expected to provide nonbreeding roosting opportunities for tricolored blackbird where it occurs in early successional stages. Natural communities that provide nesting habitat for this species are discussed in detail at the natural community level, below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances.

Objective L2.1 Benefits: Because tricolored blackbirds do not tend to nest in older stands of emergent vegetation with many senescent stems and horizontal dead stems, their nesting habitat requires periodic disturbance to regenerate new growth. Under natural conditions, this type of disturbance would normally result from periodic flooding and alluvial scouring; however, the nesting habitat targeted for protection is isolated from the floodplain and unlikely to experience natural disturbances. Therefore, mechanical habitat manipulation, as described in *CM11 Natural Communities Enhancement and Management*, may help to sustain suitable nesting habitat characteristics for tricolored blackbirds in areas targeted to conserve this species.

3.3.5.24.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the tricolored blackbird are included below.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8 (adjacent to protected lands), at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11. • **Objective GNC1.2:** Restore 2,000 acres of grasslands to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.4:** Increase prey, especially small mammals and insects, for grassland-foraging species.

Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex.
• **Objective ASWNC1.1:** Protect 150 acres of alkali seasonal wetland in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

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Goal VPCNC1: Vernal pool complexes comprised of large, interconnected, or contiguous expanses that represent a range of environmental conditions.

- **Objective VPCNC1.1:** Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005).

Objectives GNC1.1, GNC1.2, GNC2.4, ASWNC1.1 and VPCNC1.1 Benefits: The protection and restoration of grassland, alkali seasonal wetlands, and vernal pool complexes will provide improved foraging opportunities for tricolored blackbirds during both the breeding and nonbreeding seasons. Proximity of nesting colonies to suitable foraging habitat appears to be a key factor that contributes to high reproductive success in tricolored blackbirds. All of these communities are known to support large insect populations, a vital food resource for successful rearing and fledging of young. Those conservation lands that lie within a few miles of active nesting colonies will provide high quality foraging areas to support breeding tricolored blackbirds. All of these conservation lands will benefit tricolored blackbirds during the nonbreeding season, when large numbers of wintering tricolored blackbirds forage opportunistically across the Plan Area. The management of protected grasslands to increase insect prey through techniques such as grazing practices and avoiding use of pesticides, as described in CM11 *Natural Communities Enhancement and Management*, will provide further benefits to foraging tricolored blackbirds. Protection and restoration of these communities will offset losses incurred by BDCP actions and will contribute to the conservation of tricolored blackbird habitat.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.

- **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species.
- **Objective CLNC1.4:** Maintain and protect the small patches of important wildlife habitats associated with agricultural lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objective CLNC1.1 Benefits: Achieving this objective will provide foraging habitat for nesting and wintering tricolored blackbirds on cultivated lands in the Plan Area. A key to high reproductive success in tricolor nesting colonies is the presence of nearby foraging habitats that support abundant insect populations. Cultivated lands that meet this criterion include pasturelands, alfalfa and other hay crops, and some croplands such as sunflower, especially when use of insecticides is limited. During the nonbreeding season, large numbers of tricolored blackbirds winter in the Plan Area, feeding opportunistically on a wide variety of plant and animal foods, especially grains. Cultivated lands constitute major foraging sites for nonbreeding tricolored blackbirds, with substantial use associated with a variety of croplands, pasturelands, dairies, and livestock feed lots. Achieving this objective is also expected to benefit tricolored blackbirds by reducing any future losses or changes to suitable foraging habitat on cultivated lands and by minimizing adverse effects caused by habitat fragmentation. The quality of cultivated landscapes, in terms of compatibility with the foraging needs of tricolored blackbirds, and the availability of suitable nesting sites influence the distribution and abundance of the species. Consequently, maintaining high quality cultivated landscapes is an important component of tricolored blackbird conservation in the Plan Area.

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Objective CLNC1.4 Benefits: While cultivated landscapes currently provide important foraging habitat for tricolored blackbirds, agricultural practices have removed emergent wetlands, surrounding grasslands, and other natural communities that historically supported nesting tricolored blackbirds in the Plan Area. This objective is designed, in part, to provide a means to protect small but essential habitats for covered species that occur within the agricultural matrix. Meeting this objective requires that cultivated lands protected for tricolored blackbirds retain residual wetlands, grassland patches, shrub stands, and herbaceous edge habitats, which may provide suitable nesting, foraging or roosting habitat for the species. Maintaining these small areas of high quality habitat interspersed within the cultivated landscape will help maintain the distribution and abundance of the species in the Plan Area.

3.3.5.24.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for tricolored blackbirds within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal TRBL1: Improved nesting, nesting-adjacent foraging, and wintering habitat for tricolored blackbirds in the Plan Area.

- **Objective TRBL1.1:** Protect 50 acres of occupied or recently occupied (within the last 15 years) tricolored blackbird nesting habitat located within 5 miles of high quality foraging habitat in Conservation Zones 1, 2, 8, or 11.
- **Objective TRBL1.2:** Manage protected tricolored blackbird nesting habitat to provide young, lush stands of bulrush/cattail emergent vegetation and prevent vegetation senescence.
- **Objective TRBL1.3:** Of the cultivated lands protected as covered species habitat, protect 11,400 to 19,000 acres of moderate or higher quality cultivated lands as nonbreeding foraging habitat, 50% of which is of high or very high value.
- **Objective TRBL1.4:** Of the cultivated lands protected as covered species habitat, protect 5,100 to 7,600 acres of high to very high quality breeding-foraging habitat within 5 miles of occupied or recently occupied (within the last 15 years) tricolored blackbird nesting habitat in Conservation Zones 1, 2, 3, 4, 7, 8 or 11.

Objectives TRBL1.1 and TRBL1.2 Rationale: Although the natural community objectives described above will benefit tricolored blackbirds by protecting and restoring high value foraging habitat, this species-specific goal is necessary to improve breeding habitat and ensure the species' long-term conservation in the Plan Area. Nesting by tricolored blackbirds in the Plan Area is currently limited by the availability of high quality breeding habitat, which is represented by suitable nesting substrate, such as cattail/bulrush emergent wetland, in close association with highly productive foraging areas that support abundant insect prey, such as grasslands, seasonal wetlands, pasturelands, alfalfa and other hay crops, and some croplands. Proximity to suitable foraging habitat appears to be extremely important in both the establishment of colony sites and overall reproductive success at the colonies (Tricolored Blackbird Working Group 2007; Meese pers. comm. 2011). Most breeding tricolored blackbirds usually forage within 5 miles of their colony sites (Kyle pers. comm. 2011; Meese pers. comm. 2011). Recent banding efforts have demonstrated a strong fidelity to breeding sites by tricolored blackbirds, and a high degree of colony cohesion when birds move to different sites for second breeding attempts (tricolored blackbirds typically nest twice in a breeding season) (University of California Davis nd). Therefore, to successfully manage for

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tricolored blackbirds and maintain or increase breeding in the Plan Area, 50 acres of occupied or recently occupied tricolored blackbird nesting habitat located in close proximity to high quality foraging habitat will be protected and managed.

Tricolored blackbirds are highly dependent on disturbance events to maintain suitable nesting conditions at nesting colony sites. Ideal nesting substrate is represented by young, actively growing stands of bulrush/cattail emergent vegetation. As stands age and develop an abundance of dead and dying stems and leaves, they become less attractive to the species for nesting. Under natural conditions, periodic disturbance from flooding, alluvial scouring, wildfire, and other landscape altering events serve to rejuvenate aging stands. Since much of the Plan Area is isolated from the floodplain and unlikely to experience natural disturbances, active management is needed to sustain suitable nesting habitat characteristics for tricolored blackbirds. Therefore, mechanical habitat manipulation, prescribed fire or other measures, as described in CM11 *Natural Communities Enhancement and Management*, will be used to sustain nesting substrate for tricolored blackbirds in areas targeted to conserve this species.

Objective TRBL1.3 Rationale: Because agriculture is expected to remain the primary land use in the Plan Area, the intent of this objectives is to maintain the habitat values of cultivated land that are most essential to tricolored blackbirds. Objective TRBL1.3 will protect between 11,400 and 19,000 acres of crop types that are of at least moderate value to foraging tricolored blackbirds during the nonbreeding season. The actual amount of protected cultivated lands will be determined during implementation. As cultivated land is lost to BDCP covered activities, its habitat value for tricolored blackbird will be calculated on a per-acre basis according to Table 3.3-8. The amount of protection of cultivated lands depends on the habitat value of affected lands relative to the value of protected lands The low end of the range (11,400 acres) represents the number of protected acres if all protected lands are maintained as the highest value habitat. The high end of the range (19,000 acres) represents the number of protected acres if all protected lands are maintained at the lowest identified habitat value (i.e., moderate for nonbreeding foraging habitat, high for breeding foraging habitat).

To ensure that cultivated lands supporting large insect populations vital to successful rearing of young are available to nesting tricolored blackbirds, Objective TRBL1.4 also includes the provision that the annual protected cultivated land to be maintained in high or very high value crop types for breeding foraging habitat be located within 5 miles of occupied or recently occupied tricolored blackbird nesting colonies. The remaining protected cultivated lands for tricolored blackbirds will be maintained in moderate or higher value crop types distributed across the Plan Area. Through this process, cultivated lands will be protected throughout much of the Plan Area to meet the foraging needs of both breeding and wintering tricolored blackbirds. No additional protection of noncultivated lands that provide high value foraging habitat for tricolored blackbirds (e.g., grasslands, vernal pool complex) is needed, because most of these habitats are protected under the landscape-scale and natural community goals and objectives.

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Table 3.3-8. Tricolored Blackbird Foraging Habitat Value Classes for Cultivated Land Crop Types

Foraging Habitat Value Class/Habitat Suitability Unit	Agricultural Crop Type	
	Breeding Season[1] Foraging Habitat	Non-Breeding Season Foraging Habitat
Very High/1.0	Native pasture, nonirrigated native pasture	Livestock feed lots
High/0.75	Sunflower, alfalfa and mixed alfalfa, mixed pasture, induced high water table native pasture, nonirrigated mixed pasture, livestock feed lots, dairies	Corn, sunflower, millet, alfalfa and mixed alfalfa, mixed pasture, native pasture, induced high water table native pasture, nonirrigated native pasture, rice, dairies
Moderate/0.5	Miscellaneous grass pasture, fallow lands cropped within 3 years, new lands prepped for crop production	Nonirrigated mixed pasture, fallow lands cropped within 3 years, new lands prepped for crop production
Low/0.25	Wheat, mixed grain and hay, farmsteads	Wheat, oats, mixed grain and hay, farmsteads
Marginal/0.1	Rice	None
None	All remaining crop types	All remaining crop types

[1] Generally March through August; occasional breeding in fall (September through November).

3.3.5.25 Western Burrowing Owl

Western burrowing owls are found in open, well-drained grasslands, agricultural and range lands, and desert habitats often associated with burrowing animals (Klute et al. 2003). They also occupy golf courses, airports, road and levee embankments, and other disturbed sites where there is sufficient friable soil for burrows (Haug et al. 1993). Because they typically use the burrows created by other species, particularly the California ground squirrel, presence of these species is usually a key indicator of potential occurrence of the western burrowing owl.

The breeding range of the western burrowing owl extends south from southern Canada throughout most of the western half of the United States and south to central Mexico. The winter range extends from central California southeastward through Arizona, New Mexico, and Texas and south into northern and central Mexico and coincides with southern breeding range where the species is resident year-round (Haug et al. 1993). In California, the species is distributed primarily throughout the lowland portions of the state, including the Central Valley, Imperial Valley, the southern desert region, the southern California coast, and the San Francisco Bay Area.

Reported occurrence data indicate that, within the Plan Area, western burrowing owls are concentrated mostly in the grassland and pastureland areas west of the Sacramento DWSC in Yolo and Solano Counties, and in the grasslands along the western edge of the Plan Area between roughly Brentwood/Antioch and Tracy (Figure 3.3-21). These mostly uncultivated areas support larger and more stable populations of California ground squirrels and are less likely to be disturbed by regular cultivation and other ground disturbances. The species is a year-round resident in the Plan Area; however, local migratory patterns and the extent to which migrants occupy the Plan Area during the nonbreeding season are unclear. Western burrowing owls occur locally in the vicinity of Stockton where they are typically found along levees, canals, field edges, and also in the grasslands in the

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vicinity of Stone Lakes. Few western burrowing owls have been reported from the central portion of the Delta and the northern Delta east of the Sacramento DWSC. Western burrowing owls persist in low numbers in grassland habitats around the perimeter of Suisun Marsh. Gervais et al. (2008) note that populations in the vicinity of Suisun Marsh and San Pablo Bay are declining.

Conversion of grasslands and pasturelands to incompatible crop types and the destruction of ground squirrel colonies have been the main factors causing the decline of the western burrowing owl population (Zarn 1974). Assimilation of poisons applied to ground squirrel colonies may also affect western burrowing owl populations (James et al. 1990). Although California has a significant western burrowing owl population, development pressures and recent population trends suggest that the species may continue to be extirpated from large portions of its range in California during the next decade (DeSante et al. 2007). While western burrowing owls in the Central Valley have exhibited strong site fidelity even with increasing habitat fragmentation, the species has been extirpated from many historically occupied areas due to increasing urbanization and related causes. Populations in the Plan Area face similar threats from land use changes.

Western burrowing owl is covered by the East Contra Costa County HCP/NCCP, San Joaquin County MSCP, Yolo County HCP/NCCP, and Solano County HCP, all of which overlap with the Plan Area. The East Contra Costa County HCP/NCCP is expected to result in substantial conservation for this species in areas near Conservation Zone 8, and will potentially result in conservation for this species within this zone.

The BDCP addresses these threats to western burrowing owl in the Plan Area by protecting and restoring large areas of grassland natural communities, managing cultivated lands to support foraging habitat, and reducing the threat of habitat loss and fragmentation, and managing a landscape that supports ground squirrels, which are critical for creating cover and nesting habitat for western burrowing owls. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.25.1 Applicable Landscape-Scale Goals and Objectives

While the landscape-scale goals and objectives will provide broad-based benefits to the ecosystems upon which western burrowing owls depend, none are integral to the conservation strategy for this species.

3.3.5.25.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the western burrowing owl are included below.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11. • **Objective GNC1.2:** Restore 2,000 acres of grasslands to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia.

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Objective GNC1.1 Benefits: Urbanization, including residential and commercial development and infrastructure development, and conversion of grasslands to incompatible agricultural lands uses are among the principal causes of habitat loss for western burrowing owls and is a continuing threat to remaining northern California populations (see Appendix 2.A, *Covered Species Accounts*). BDCP conservation of western burrowing owl is directed at maintaining a landscape of suitable nesting and foraging habitat across the Plan Area and adjacent lands. However, the protection of grasslands, which occur primarily along the western edge of the Plan Area, are key to protecting high-value burrowing owl habitat and sustaining existing populations in the Plan Area. Objective GNC1.1 will protect a large amount of grassland from any future threats of land conversion and reduce the effects of current levels of habitat fragmentation. This objective will expand the amount of protected high-value habitat in the Plan Area and support existing western burrowing owl populations that occur to the west of Conservation Zone 8 in Contra Costa County and in the areas surrounding Conservation Zones 1 and 11 in Solano County, which would especially benefit declining populations in the vicinity of Suisun Marsh and San Pablo Bay.

Objective GNC1.2 Benefits: Restoration of grasslands will focus on connecting fragmented patches of other protected grasslands, effectively increasing the size of intact grassland landscapes. This will contribute to reducing the effects of habitat fragmentation that have occurred from development impacts and agricultural conversions, and may facilitate movement of burrowing owls into currently unoccupied areas.

Goal GNC2: Biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.3:** Increase burrow availability for burrow-dependent species. • **Objective GNC2.4:** Increase prey, especially small mammals and insects for grassland foraging species.

Objectives GNC2.3 and GNC2.4 Benefits: The distribution of burrowing owls is in part determined by the presence of ground squirrels that initially excavate burrow systems burrowing owls will later inhabit. While grasslands remain relatively abundant along the western edge of the Plan Area and a large amount of grassland will be protected under Objective GNC1.1, most of these grasslands are currently unoccupied by burrowing owls. This is due in part to burrow availability. In order to facilitate expansion of the burrowing owl population in the Plan Area, Objective GNC2.3 will increase burrow availability on protected grasslands by encouraging ground squirrel occupancy and expansion. This will be done through the creation of berms, mounds, edges, and other features designed to attract and encourage burrowing activity and by prohibiting ground squirrel control programs (i.e., poisoning) on BDCP protected lands, as described in CM11 *Natural Communities Enhancement and Management*. Increasing small mammal and insect prey populations on BDCP protected lands will also contribute to the expansion of the existing burrowing owl population.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.
• **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species. • **Objective CLNC1.4:** Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

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Objective CLNC1.1 Benefit: At least 64% of the Plan Area is cultivated land. While relatively few cultivated cover types are suitable as burrowing owl habitat, certain types, such as irrigated pasture, alfalfa and other hay crops, and even some row and grain crops, can provide foraging habitat for burrowing owls, at least some portion of the year. Burrowing owls occur in agricultural habitats in much lower density than in grassland landscapes and only where suitable edge habitats (e.g., levees, roadside berms, edges of permanent water conveyance canals) are available as burrow habitat. Cultivated lands are therefore considered low to moderate value habitat. Still, these habitats, particularly those supporting low vegetation structure and those that are tilled less frequently (e.g., irrigated pastures, alfalfa hay) do support breeding and wintering burrowing owls. Cultivated lands can, therefore, contribute to the conservation of burrowing owls under appropriate management regimes. With the extent of BDCP protected cultivated lands under Objective CLNC1.1, there are likely to be many opportunities to enhance and manage these protected lands to support burrowing owl habitat and encourage burrowing owl occurrence and use. For example, maintaining berms around irrigated pastures, short grasses on levee slopes, and selectively prohibiting ground squirrel control programs can facilitate burrowing owl use of some agricultural lands. An unknown portion of the protected cultivated lands are expected to support burrowing owl habitat that could be further enhanced to expand and support populations in the Plan Area.

Objective CLNC1.4 Benefits: Achieving this objective will support western burrowing owls by maintaining and protecting patches of habitat within cultivated areas that may support western burrowing owl prey species (insects and small mammals) and that may provide suitable burrow habitat, such as berms and other edge habitats. Implementation of this objective may allow western burrowing owls to establish a greater presence in the central portion of the Delta.

3.3.5.25.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for western burrowing owl within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal WBO1: Contribute to the sustainability of the burrowing owl population by protecting cultivated lands suitable for burrowing owl foraging.
• **Objective WBO1.1:** Of the cultivated lands protected under Objective CLNC1.1, protect at least 1,000 acres in Conservation Zones 1 and 11 that support moderate value burrowing owl habitat and are within 1 mile of high value grassland habitat or occupied moderate value habitat.

Objective WBO1.1 Rationale: Western burrowing owls in Conservation Zones 1 and 11 are associated with a landscape that includes a matrix of grasslands and cultivated lands. Much of the cultivated land is moderate value irrigated or nonirrigated pasture or hays. These lands are used for cattle grazing and for production of hay feed and silage. Burrowing owls that occur in these areas use both the grassland and adjacent agricultural lands for foraging and many nesting burrows are in or adjacent to pasturelands, which are uncultivated or infrequently cultivated. In addition to protection of grasslands under Objective GNC1.1, it is important to protect adjacent cultivated lands in this portion of the Plan Area, particularly those that are known to be occupied by nesting and wintering burrowing owls. Protection of 1,000 acres of adjacent agricultural lands will substantially increase the extent of connectivity of protected habitats within Conservation Zones 1 and 11, further protect lands that are occupied by burrowing owls, and maintain the matrix of moderate to high

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value habitats that support this subpopulation. The protection of moderate value burrowing owl habitat in Conservation Zones 1 and 11 is also consistent with cultivated land protection for Swainson's hawk, white-tailed kite, and tricolored blackbird.

The western burrowing owl will be conserved in cooperation and in conjunction with neighboring and overlapping HCP/NCCPs to ensure that conservation actions occur where they most benefit the regional western burrowing owl population and where they are compatible with conservation of other grassland and agricultural-associated species. BDCP's proposed western burrowing owl conservation strategy is expected to sustain the existing population of western burrowing owls and provide for future increases in its abundance and distribution within and adjacent to the Plan Area.

3.3.5.26 Western Yellow-Billed Cuckoo

The western yellow-billed cuckoo (*Coccyzus americanus*) is a neotropical migrant that breeds in North America and winters in South America. The western yellow-billed cuckoo (*C. a. occidentalis*), one of two recognized subspecies, occurs west of the Rocky Mountains. The range of the western subspecies historically extended from southern British Columbia to the Rio Grande River in northern Mexico, and east to the Rocky Mountains (Bent 1940). Based on the historical distribution of the western yellow-billed cuckoo in suitable habitat throughout the Central Valley (Belding 1890), the species presumably nested along the Sacramento, San Joaquin, and Mokelumne Rivers and along smaller tributary drainages such as the Lost Slough, White Slough, and Disappointment Slough. Studies conducted since the 1970s indicate that there may be fewer than 50 breeding pairs of the western yellow-billed cuckoo in California (Gaines 1974; Halterman 1991; Laymon et al. 1997). The only California locations that currently sustain breeding populations include the Colorado River system in southern California, the South Fork Kern River east of Bakersfield, and isolated sites along the Sacramento River in northern California (Laymon and Halterman 1989; Laymon 1998). There are no recent breeding records of western yellow-billed cuckoos in the Plan Area (Figure 3.3-22): scattered sightings of this species in the Plan Area over the last 50 years are presumed to be from migrating birds.

The western yellow-billed cuckoo is an obligate riparian species. The primary habitat association for this species is willow-cottonwood riparian forest, but other species such as alder and box elder may be important habitat elements in some areas (Laymon 1998). Nests are primarily constructed in willow (*Salix* spp.) trees, and cottonwood (*Populus fremontii*) trees which provide important foraging habitat for insect prey.

Historical declines of the western yellow-billed cuckoo have been due primarily to the removal of riparian forests for agricultural and urban expansion. Habitat loss and degradation continues to be the most significant threat to remaining populations, a consequence of bank stabilization and flood control projects, urbanization along edges of watercourses, agricultural activities, and river management that alters flow and sediment regimes. The minimum viable habitat patch size for breeding western yellow-billed cuckoo is approximately 41 hectares (Riparian Habitat Joint Venture 2004), and most existing riparian habitat patches that occur in the Plan Area are too small to support breeding pairs. Additionally, predation can be a significant source of nest failures in some areas (Hughes 1999), exacerbated by habitat fragmentation that makes nest sites more accessible and vulnerable to predation. Pesticide use associated with agricultural practices may also pose a long-term threat to cuckoos (Hughes 1999).

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A recovery plan has not been prepared for the western yellow-billed cuckoo. Howe et al. (2010) suggest that approximately 71% of riparian habitat in the Sacramento Valley is owned by federal and state agencies and nongovernment organizations, and these acquisitions have been aimed at recovery of the western yellow-billed cuckoo. Significant conservation and research efforts have also occurred at Audubon California's Kern River Preserve, and in association with the Lower Colorado River Multi-Species Conservation Program. The western yellow-billed cuckoo is also a focal species of the Riparian Bird Conservation Plan (Riparian Habitat Joint Venture 2004), which provides data and recommendations for conservation of riparian birds in California. Some regional habitat conservation planning efforts may also provide protections, primarily through protection of riparian habitat. The western yellow-billed cuckoo is a covered species under the approved San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, and the in-progress Yolo County Natural Heritage Program Plan and Butte Regional Conservation Plan.

The BDCP conservation approach for this species involves riparian protection, restoration, and management that promote vegetation structurally suitable for the western yellow-billed cuckoo, as well as floodplain restoration to reestablish seasonal patterns of fluvial disturbances that promote development of high quality riparian habitat preferred by this species. Because most riparian corridors in the Plan Area do not support sufficiently large riparian patches for cuckoo breeding (Laymon 1998), conservation will be directed toward restoring suitable riparian forest to provide habitat that could allow for the expansion of the existing western yellow-billed cuckoo population back into its historical range in the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.26.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the western yellow-billed cuckoo] are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland transitional areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.5 Benefits: Including upland areas adjacent to riparian habitat, consistent with this objective, will benefit the western yellow-billed cuckoo where they occur by providing crucial foraging opportunities during flooding events. Because western yellow-billed cuckoo habitat is typically associated with the primary floodplain, floods may regularly reduce the cuckoo's prey base. The western yellow-billed cuckoo prey base, largely katydid and sphinx moth larvae, winters underground. In wet years, cuckoos must forage in upland areas until the prey base in the lower floodplain recovers (Riparian Habitat Joint Venture 2004).

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Objective L1.6 Benefits: Increasing the size and connectivity of the reserve system, consistent with this objective, will benefit the western yellow-billed cuckoo by reducing the threat of habitat fragmentation in the Plan Area. Habitat fragmentation is a primary stressor for this species. The need for large, unfragmented blocks of western yellow-billed cuckoo habitat is further described below for Goal VFRNC1.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances. • **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.1 Benefits: Achieving this objective will provide conditions suitable for establishing western yellow-billed cuckoo habitat by allowing natural fluvial disturbances that will promote regeneration of riparian structural diversity. Breeding habitat for the cuckoo typically has high structural diversity, with closed primary canopy and a dense shrub layer (Hammond 2011). Continuing habitat succession is identified as important in sustaining breeding populations (Laymon 1998). Riparian systems subject to natural erosional and depositional processes provide conditions conducive to the establishment of new stands of willow, which create preferred nesting conditions. Habitat along channelized streams or levied systems that restrict these natural processes may become over-mature and less optimal.

Objective L2.7 Benefits: Increasing native biodiversity and reducing invasive nonnative plant species in the riparian natural community, consistent with this objective, will enhance yellow-billed cuckoo habitat. As described above, this species requires structural diversity in its breeding habitat. Large, monotypic stands of invasive plants can diminish this structural diversity and render habitat unsuitable for the western yellow-billed cuckoo. The nonnative invasive Himalayan blackberry, for example, often invades riparian restoration sites and does not provide the same habitat structural complexity as other riparian plant species: this invasive species may inhibit establishment of other understory species that form important structural components of western yellow-billed cuckoo habitat (Hammond 2011). Reserve management will seek to control invasive plants such as Himalayan blackberry (CM11 *Natural Communities Enhancement and Management*).

3.3.5.26.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the western yellow-billed cuckoo are included below.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near term implementation period.

Objective VFRNC1.1 Benefits: Achieving this objective will increase migratory and breeding opportunities for the western yellow-billed cuckoo to in the Plan Area by restoring 5,000 acres of

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valley/foothill riparian habitat. It is expected that a portion of these 5,000 acres will provide suitable habitat conditions for the western yellow-billed cuckoo because, when combined with existing protected forest stands, the restoration will occur as part of large blocks of valley/foothill riparian forest greater than the minimum required for cuckoo breeding (over 100 acres). The species-specific objectives below will provide additional assurance that riparian vegetation is maintained with suitable habitat conditions for the species.

Objective VFRNC1.2 Benefits: Achieving this objective will provide suitable habitat for the western yellow-billed cuckoo by protecting 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 in the near-term implementation period. By itself, the 750 acres likely does not support suitable habitat for this species because it often occurs in stands smaller than the minimum required for cuckoo breeding. Restoration will be needed to expand existing stands of valley/foothill riparian forest to support the species.

Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.
• **Objective VFRNC2.1:** Restore, maintain and enhance structural heterogeneity with adequate vertical and horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands.

Objective VFRNC2.1 Benefits: Achieving this objective will benefit the western yellow-billed cuckoo by increasing structural diversity of riparian vegetation. This will be achieved through restoration and management actions as described in CM7 *Riparian Natural Community Restoration* and CM11 *Natural Communities Enhancement and Management*.

3.3.5.26.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the western yellow-billed cuckoo within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.27 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). Most white-tailed kites nest in the Sacramento Valley are found in oak and cottonwood riparian forests, valley oak woodlands, or other groups of trees and are usually associated with compatible foraging habitat consisting of low-growing, herbaceous vegetation in patches of greater than 1,500 square meters (Erichsen et al. 1996). Pasture and hay crops, compatible row and grain crops, and natural vegetation such as seasonal wetlands and annual grasslands provide foraging habitat for this species (Erichsen 1995). The white-tailed kite is excluded from narrow bands of riparian vegetation by Swainson's hawks, and therefore requires wide patches of nesting habitat where its range overlaps with the Swainson's hawk (Hansen pers. comm.). For more detail on white-tailed kite habitat requirements, see Appendix A, *Covered Species Accounts.*

In North America, the white-tailed kite is believed to have historically occurred in the southern portions of the United States and Mexico (Dunk 1995). Currently, the species' distribution includes the east coast and southeast United States, the southwest United States from Texas to California, and north to Washington State, and from Mexico to South America (Dunk 1995). California is currently

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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). White-tailed kite is distributed throughout the Plan Area during the breeding and wintering seasons, although relatively few nesting locations have been documented. Most nesting habitat for kites in the Plan Area consists of riparian woodlands and scrub along drainages. Because most of the Plan Area, including grassland, seasonal wetland, and cultivated land natural communities, is potential foraging habitat for kites, the species potentially occurs throughout the Plan Area during winter and in the vicinity of suitable nesting habitat during the breeding season (Figure 3.3-23).

Urbanization, including residential, commercial, and infrastructure development (roads and oil, water, gas, and electrical conveyance facilities), is one of the principal causes of continuing habitat loss for the white-tailed kite and is a continuing threat to remaining populations, particularly in rapidly urbanizing areas in the Sacramento Valley. While there are examples of kites nesting and roosting in urban areas, in general the species is intolerant of noise and human activities and will abandon nesting areas that are subject to increasing levels of human disturbances. Kites are also sensitive to habitat fragmentation. Low density urbanization or isolation of habitats also leads to territory abandonment, even if relatively large patches remain undisturbed.

The conservation approach for the white-tailed kite involves maintaining a landscape of suitable nesting and foraging habitat across the Plan Area. Habitat loss and fragmentation are a primary stressor to white-tailed kite in California. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.27.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the white-tailed kite are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.1:** Protect at least 31,000 acres of existing natural communities, focusing on the highest quality natural communities and covered species habitats. • **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objectives L1.1 and L1.3 Benefits. Many of the natural communities to be protected and restored in the reserve system will provide suitable foraging or nesting habitat for the white-tailed kite. Restored and protected valley/foothill riparian natural community will provide nesting habitat for the species. Restored tidal and nontidal emergent wetlands, restored and protected grasslands and vernal pool complex, and protected alkali seasonal wetlands will provide foraging habitat for the white-tailed kite. Foraging habitat within 5 to 8 miles of nest sites is most likely to be used by white-tailed kites (Hansen pers. comm.), and most of the land in Conservation Zones 1 through 5, 8, and 11,

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where much of the restoration and protection will take place, are within 8 miles of known white-tailed kite occurrences.

Objective L1.6 Benefits: Increasing the size and connectivity of the reserve system will reduce the risk of habitat fragmentation in the Plan Area, which would adversely white-tailed kite habitat. Habitat fragmentation is a primary stressor for this species.

3.3.5.27.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for white-tailed kite are described below.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period.

Objectives VFRNC1.1 and VFRNC1.2 Benefits: These objectives will increase the extent of nesting habitat for the white-tailed kite, and provide for expansion of the species' nesting habitat distribution in the Plan Area. White-tailed kites usually nest in trees within dense canopies, but nest trees can vary from single, isolated trees (although this is rare) to trees in large woodlands. Large patches of riparian habitat provide higher value nesting habitat than narrow bands of trees, where white-tailed kites are often displaced by Swainson's hawks (Hansen pers. comm.). Achieving these objectives will improve white-tailed kite breeding habitat in the Plan Area in the long term by providing large patches of riparian habitat. Suitable foraging habitat for the white-tailed kite (i.e., low, herbaceous vegetation including marshes, grasslands, and many types of cultivated lands) will be present throughout the Plan Area, and most of the riparian restoration will be within 5 to 8 miles of suitable foraging habitat.

Goal GNC1: Extensive grassland comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes and functions.
• **Objective GNC2.4:** Increase prey, especially small mammals and insects, for grassland-foraging species.

Objectives GNC1.1 and GNC2.4 Benefits: Grasslands protected in Conservation Zones 1, 8, and 11 will provide suitable foraging habitat for the white-tailed kite, which is known to occur within or adjacent to each of these three conservation zones. Achieving Objective GNC2.4 will benefit the white-tailed kite by increasing the abundance of voles and other small mammals upon which white-tailed kites prey.

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Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species
• **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species. • **Objective CLNC1.4:** Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objective CLNC1.1 Benefits: Achieving this objective will provide foraging habitat for white-tailed kites on cultivated lands in the reserve system. White-tailed kites prefer alfalfa and other hay crops, irrigated pastures, and some cultivated habitats, particularly sugar beets and tomatoes, both of which can support relatively large populations of voles (Estep 1989) and which have been highly correlated with kite nest site densities (Erichsen et al. 1994). Kites also forage in dry pastures, rice stubble fields, and occasionally in orchards (Erichsen 1995). Achieving this objective will benefit the white-tailed kite by reducing any future losses of or changes to suitable foraging habitat on cultivated lands and reduce current, as well as the threat of, habitat fragmentation.

Objective CLNC1.4 Benefits: Achieving this objective will protect potential nesting habitat for the white-tailed kite, in addition to the nesting habitat provided through riparian restoration and protection. Although white-tailed kites prefer dense riparian forests, they are also known to use isolated trees, especially where they are associated with compatible agricultural foraging habitat, such as pasture and hay crops, and compatible row and grain crops.

Ongoing cultivated lands within and adjacent to the Plan Area will continue to support foraging habitat for white-tailed kite nesting and wintering in the Plan Area. The 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.

3.3.5.27.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve white-tailed kite within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.28 Yellow-Breasted Chat

The yellow-breasted chat nests and forages in streamside, shrubby thickets of willows, vines, and brush (Small 1994). The species uses early- to mid-successional riparian habitat, and is dependent on understory and a well-developed shrub layer as well as taller trees with open canopy for singing perches. The species has been classified as an open-canopy obligatory species (i.e., prefers 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). The yellow-breasted chat nests near the border of streams, creeks, sloughs, and ponds, in low dense shrubs (willows, with brush and vines).

The yellow-breasted chat is a neotropical migrant that breeds throughout much of North America and winters primarily in Mexico and Central America; a few birds also wintering in California (Small 1994). According to Grinnell and Miller (1944), the species' breeding distribution includes the entire length and breadth of California exclusive of the higher mountains and coastal islands. Within the

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Plan Area, Grinnel and Wythe (1927) described the chat as a "fairly common summer visitant to the warm interior valleys." The yellow-breasted chat is still present in most of its historical range except in most of the Central Valley (Comrack 2008); however, 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 (Figure 3.3-24) (Appendix 2.A, *Covered Species Accounts*).

Habitat loss is implicated in yellow-breasted chat population declines throughout much of the species' range (Remsen 1978; Rosenberg et al. 1991). In the San Joaquin and Sacramento Valleys, losses and degradation of riparian habitats have resulted from widespread habitat conversion, water diversion, mining, and the introduction of numerous invasive species. Remaining riparian forests are estimated to cover only about 2% of their original area, and are now mostly small, widely spaced remnants (Katibah 1984). Bank stabilization and flood control activities have rendered a relatively stable system and thus reduced the availability of early successional riparian habitat that chats need for breeding (Ricketts and Kus 2000). Nest parasitism by brown-headed cowbirds has been implicated as a limiting factor in populations outside of California, but research conducted at the Lower Clear Creek Floodway in Shasta County suggest that low nest success is driven by predation rather than nest parasitism and is a likely factor contributing to observed declines (Young and Burnett 2010). Low nest success, especially at restoration sites, may be driven in part by the lack of dense understory, which makes it easier for predators to locate nests.

Species management recommendations include protecting existing, healthy riparian habitat; restoring degraded riparian habitat; maintaining or promoting a dense shrub layer in riparian habitat; and creating a shrub layer in the early stages of restoration projects (Shuford and Gardali 2008). Recommendations for restoration projects include retaining patches of mature riparian habitat with a blackberry understory to provide suitable nesting habitat for this species immediately following restoration, and using supplemental planting of California blackberry (*Rubus ursinus*), wild rose (*Rosa californica*), and vines such as California grape (*Vitis californica*) and pipevine (*Aristolochia californica*) to increase nesting success and territory densities at older restoration sites (Young and Burnett 2010). Zeiner et al. (1990) report that yellow-breasted chat territory size ranges from 0.3 to 3.2 acres (0.1 to 1.3 hectares).

A recovery plan has not been prepared for the yellow-breasted chat, but it is a focal species of the Riparian Bird Conservation Plan (Riparian Habitat Joint Venture 2004), which provides data and recommendations for conservation of riparian birds in California. The BDCP conservation approach for this species involves riparian protection, restoration, and management that expands and promotes vegetation structurally suitable for the species, as well as floodplain restoration to reestablish seasonal patterns of fluvial disturbances that promote new development of high quality riparian habitat preferred by this species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.28.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the yellow-breasted chat are included below.

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Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.5:** Include sufficient noncultivated upland transitional areas adjacent to restored and protected valley/foothill riparian to provide transitional upland habitat values and refugia from flooding. • **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.5 Benefits: Increasing the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands will benefit the yellow-breasted chat by reducing the risks of habitat fragmentation and adverse effects from adjacent lands uses.

Objective L1.6 Benefits: Providing an upland buffer will reduce adverse effects of adjacent land uses. This buffer, which will include transitional uplands adjacent to riparian habitat, will decrease opportunities for encroachment into riparian habitat of domestic pets that are potential predators, and human disturbances such as trampling, nest disturbance, noise and lighting.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances. • **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and to allow input of large woody debris, leaves, and insects to rivers.

Objective L2.1 Benefits: Regenerating riparian structural diversity through floodplain restoration to ensure natural fluvial disturbances will provide suitable habitat conditions for the yellow-breasted chat. Flood control and river channelization are factors leading to the elimination of suitable early successional riparian habitat for the yellow-breasted chat (Riparian Habitat Joint Venture 2004). The yellow-breasted chat requires low, dense shrubs for nesting, and early successional habitat typically supports these shrubs (Riparian Habitat Joint Venture 2004). As stands mature, the tall canopy tends to shade out the shrub layer, making the sites less suitable for the species.

Objective L2.4 Benefits: Floodplain restoration (CM5 *Seasonally Inundated Floodplain Restoration*) will connect rivers and their floodplains and thereby recharge floodplain groundwater from mainstem channels. Reduced water tables inhibit growth of dense, shrubby vegetation preferred by the yellow-breasted chat (Riparian Habitat Joint Venture 2004). Therefore, recharging floodplain groundwater and connecting rivers with their floodplains will promote vegetation growth adjacent to channels, and benefit yellow-breasted chats because they tend to nest in shrubs along channel borders (Riparian Habitat Joint Venture 2004).

3.3.5.28.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the yellow-breasted chat are included below.

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Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.

- **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.
- **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near term implementation period.

Objectives VFRNC1.1 and VFRNC1.2 Benefits: Restoration and protection of riparian natural community consistent with this objective will provide nesting habitat for the yellow-breasted chat in the Plan Area, and reverse habitat loss, one of the species' primary stressors. The small territory size for this species (average 1.25 hectares [Thompson and Nolan 1973]) suggests that large-scale restoration and protection of valley/foothill riparian may promote the establishment of sizeable chat populations. Because of their relatively small territories, small habitat patch size is not, by itself, believed to contribute to the decline of this species (Riparian Habitat Joint Venture 2004), but nest predators such as raccoons, foxes, skunks, opossums, and scrub jays are well adapted to fragmented habitats near human habitation. Large-scale riparian restoration and protection resulting in large, contiguous blocks of vegetation buffered from human development can thus reduce predation risk for this species. However, the yellow-breasted chat has specific structural habitat requirements, so only the early to mid-successional portions of the 5,750 acres of restored and protected riparian natural community (a minimum of 1,000 acres; see below) are expected to provide suitable habitat characteristics for the species.

Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.

- **Objective VFRNC2.1:** Restore, maintain and enhance structural heterogeneity with adequate vertical and horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands.
- **Objective VFRNC2.2:** Maintain at least 1,000 acres of early to mid-successional vegetation with a well-developed understory of dense shrubs.

Objectives VFRNC2.1 and VFRNC2.2 Benefits: These objectives will build on Objective L2.4 to further ensure the structural diversity and maintenance of at least 1,000 acres of riparian natural community at an appropriate early- to mid-successional seral stage. This early- to mid-successional vegetation is essential to yellow-breasted chat habitat. Maintenance of fluvial disturbance consistent with Objective L2.4 is expected to result in a mosaic of different-aged habitat patches and structural habitat diversity of the riparian community in the reserve system. However, if natural fluvial disturbances are not sufficient to maintain at least 1,000 acres of early- to mid-successional seral stage riparian vegetation, active vegetation will be implemented to achieve this objective as part of *CM11 Natural Communities Enhancement and Management.*

3.3.5.28.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the yellow-breasted chat within the reserve system. Additional goals and objectives are not necessary for this species.

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3.3.5.29 Giant Garter Snake

The giant garter snakes uses 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. However, in the Plan Area, reclamation projects, which began in the 1860s, have removed most of the marsh habitat and substantially altered the natural flood regime of the Delta (California Department of Water Resources 1995). By the 1940s, nearly all of the marshland had been reclaimed and the Delta had been transformed from a large tidal marsh to the network of channels and leveed islands that exist today. This has resulted in a substantial loss of giant garter snake habitat in the Plan Area and has restricted the species' range to a few isolated sites around the periphery of the Delta.

The giant garter snake is endemic to the wetlands of the Central Valley and was historically distributed from Butte County in the north to Buena Vista Lake in Kern County (U.S. Fish and Wildlife Service 1999). Wetland habitat for giant garter snakes was once abundant throughout the species' historical range, coinciding with the historical distribution of large flood basins, freshwater marshes, and tributary streams of the Central Valley (Hansen and Brode 1980). The species is considered extirpated in the southern San Joaquin Valley and at remnant levels elsewhere in the San Joaquin Valley due to widespread habitat loss and fragmentation (Sloan 2004; Hansen 1988). With the successful adaptation to rice agriculture and associated irrigation channels, populations in the Sacramento Valley are considered more robust. The current range of the giant garter snake extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County. However, suitable habitat for the species remains highly fragmented and discontinuous throughout most of its range, resulting in both local and regional isolation of occupied areas.

No occurrences of giant garter snakes are known from the northern portion of the San Joaquin Valley north to the eastern fringe of the Sacramento–San Joaquin River Delta, where the floodplain of the San Joaquin River is limited to a relatively narrow trough (Hansen and Brode 1980; 58 FR 54053). The resulting gap of approximately 100 kilometers (62 miles) separates the southern and northern populations, with no giant garter snakes known from the lowland regions of Stanislaus County (Hansen and Brode 1980; California Department of Fish and Game 2009).

Occurrence records indicate that garter snakes are currently distributed in 13 unique population clusters coinciding with historical flood basins, marshes, wetlands, and tributary streams of the Central Valley (Hansen and Brode 1980; Brode and Hansen 1992; U.S. Fish and Wildlife Service 1999). These populations are isolated, without protected dispersal corridors to other adjacent populations, and are threatened by land use practices and other human activities, including conversion of wetlands and suitable cultivated lands. The Plan Area is in the mid-valley recovery unit identified in the draft recovery plan. Three of the 13 giant garter snake populations identified by USFWS occur in the Plan Area in Yolo Basin/Willow Slough, Yolo Basin/Liberty Farms, and Coldani Marsh/White Slough (U.S. Fish and Wildlife Service 1999). While there are several historical occurrences of giant garter snake from elsewhere in the Plan Area, the current distribution is largely limited to the eastern edge of the Plan Area from Coldani Marsh/White Slough northward to approximately Cosumnes River Preserve, and the Yolo Bypass from Fremont Weir to Liberty Farms (Figure 3.3-25).

Giant garter snake is covered by the San Joaquin County MSCP, Yolo County HCP/NCCP, East Contra Costa County HCP/NCCP, and Solano County HCP, all of which overlap with the Plan Area. Of these,

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the San Joaquin County MSCP and Yolo County HCP/NCCP are likely to include significant conservation for giant garter snake, some of which may take place in the Plan Area. Natomas Basin HCP also covers giant garter snake and is adjacent to the Plan Area.

The conservation strategy for the giant garter snake is to protect and restore key habitat and habitat function, expand the species' local range within and adjacent to the Plan Area, and provide increased opportunity for protection and management of the three subpopulations in the Plan Area. The primary stressors on the giant garter snake in the Delta are loss, fragmentation, and degradation of habitat as a result of urban and agricultural expansion. In view of these threats, the focus of this conservation strategy is to provide habitat, provide and enhance connectivity, and enhance habitat function. The actions in this conservation strategy will contribute to the recovery of giant garter snake in the Delta region, particularly in Conservation Zones 2 and 4, which have known populations. Conservation actions outside of these zones will be achieved through restoration of natural communities. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.29.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the giant garter snake are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: While nonnative aquatic plants such as water primrose provide cover for the giant garter snake, they can impede snake movement if they become too dense. Nonnative wildlife species such as bullfrog and largemouth bass prey on young giant garter snakes and may threaten local populations. Consistent with this objective, nonnative invasive plant species that degrade giant garter snake habitat or nonnative wildlife species that prey on the giant garter snake will be controlled if monitoring determines that giant garter snake populations in the reserve system are threatened by these factors.

3.3.5.29.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the giant garter snake are included below.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.

Objective TFEWNC1.1 Benefits: The restoration of the freshwater tidal freshwater marsh natural community in the Plan Area will create or enhance habitat conditions for the giant garter snake and provide potential for dispersal and expansion of populations, although this natural community type

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is only expected to be suitable for the giant garter snake where tidal influence is muted. The role of tidal marsh restoration in the giant garter snake conservation strategy is further described under the species-specific goals and objectives, below.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent perennial wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.

- **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle.
- **Objective NFEW/NPANC1.2:** Of the at least 400 acres of created nontidal freshwater marsh, create at least 200 acres contiguous with habitat occupied by the Coldani Marsh/White Slough garter snake subpopulation in Conservation Zone 2, and at least 200 acres contiguous with habitat occupied by the Yolo Basin/Willow Slough giant garter snake subpopulation in Conservation Zone 4.

Objectives NFEW/NPANC1.1 and NFEW/NPANC1.2 Benefits: Restoration of nontidal freshwater marsh near giant garter snake subpopulations in Conservation Zones 2 and 4 will expand and enhance habitat in these areas to allow for increases in giant garter snake abundance and distribution, and to help meet USFWS recovery goals for these designated subpopulations. The draft giant garter snake recovery plan (U.S. Fish and Wildlife Service 1999) calls for such actions. Nontidal freshwater marsh, consisting of a mosaic of aquatic and emergent wetland natural communities, provides the highest quality aquatic habitat for giant garter snake, with opportunities for foraging and cover. Uplands adjacent to these wetlands are also important, and are addressed under the species-specific objectives, below.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.

- **Objective CLNC1.1:** Protect at least 20,000 acres of cultivated lands that provide suitable habitat for covered and other native wildlife species.
- **Objective CLNC1.2:** Annually maintain 4,600 acres of rice lands or similarly functioning habitat for giant garter snake in Conservation Zone 2.
- **Objective CLNC1.3:** Target cultivated land conservation to provide connectivity between other protected lands.
- **Objective CLNC1.4:** Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objectives CLNC1.1, CLNC1.2, CLNC1.3, and CLNC1.4 Benefits: Although dependent on the aquatic environment, the giant garter snake occurs within the cultivated 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 a matrix of cultivated lands that includes suitable interconnected canals with reliable water, associated emergent vegetation, and adjacent upland habitats is essential for conservation of this species.

Protecting and expanding existing giant garter snake subpopulations is considered the most effective approach to conservation of this species in the Plan Area. The Coldani Marsh/White Slough

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and Yolo-Willow Slough subpopulations support the highest densities of giant garter snakes in the Plan Area. Protection and maintenance of rice lands or similarly functioning habitats in Conservation Zone 2 (Objective CLNC1.2) will help to secure populations from potential threats (e.g., change in land uses).

3.3.5.29.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for giant garter snake within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal GGS1: High quality upland and aquatic giant garter snake habitat with buffers from disturbance.
• **Objective GGS1.1:** Restore or protect existing grasslands adjacent to the 400 acres of restored nontidal marsh to provide sufficient upland refugia and overwintering habitat for giant garter snakes. • **Objective GGS1.2:** Protect giant garter snakes on preserve lands from incidental injury or mortality by establishing 200-foot buffers between protected giant garter snake habitat and roads, and establishing giant garter snake preserves at least 2,500 feet from urban areas or areas zoned for urban development.

Objectives GGS1.1 and GGS1.2 Rationale: Achieving Objective GGS1.1 will provide giant garter snakes with upland areas for refuge and overwintering purposes. Restored or existing protected grasslands will be provided adjacent to restored nontidal marsh consistent with this objective. Consistent with Objective GGS1.2, providing a 200-foot buffer between giant garter snake habitat and roads is expected to substantially reduce mortality caused by vehicle strikes on roads. The buffered zone will be managed to discourage snakes from crossing the buffered area and moving onto the road. This measure will balance the need to reduce the rate of mortality with the need to continue to allow snakes to move throughout the Plan Area to access suitable habitat.

A 2,500-foot buffer between giant garter snake habitat and urban areas is expected to substantially reduce the amount of contact and thus potential mortality caused by domestic cats and other effects from urban areas. Domestic cats have been shown to have a significant impact on populations of various native animal species, including giant garter snakes. Objective GGS1.2 is consistent with the draft giant garter snake recovery plan (U.S. Fish and Wildlife Service 1999), which calls for buffering lands supporting giant garter snake populations from the effects of urbanization and highway expansion.

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Goal GGS2: Expanded range and protected corridors facilitating giant garter snake movement and population connectivity.

- **Objective GGS2.1:** Of the at least 20,000 acres of cultivated lands to be protected, prioritize protection of lands that establish habitat connectivity for giant garter snake between the Coldani Marsh/White Slough and Yolo Basin/Willow Slough subpopulations of the species and the Stones Lakes National Wildlife Refuge.
- **Objective GGS2.2:** Of the 13,900 acres of tidal freshwater emergent wetland restoration, restore at least 1,500 acres in Conservation Zone 4 to facilitate connectivity, dispersal, and movement of giant garter snakes and contribute to a north-south corridor that includes protected cultivated lands and restored tidal and nontidal wetlands between Coldani Marsh/White Slough and the Stones Lakes National Wildlife Refuge.
- **Objective GGS2.3:** In cultivated lands protected for giant garter snake, maintain a water conveyance system that is compatible with giant garter snake foraging, cover, and movement.

Objectives GGS2.1, GGS2.2, and GGS2.3 Rationale: While the conservation strategy emphasizes the establishment and management of two giant garter snake preserves designed to protect and enhance existing subpopulations, a broader goal of the strategy is to facilitate movement and dispersal of snakes into otherwise unoccupied portions of the Plan Area and the Delta, and to provide connectivity between populations to facilitate genetic exchange. 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 climate change or catastrophic events.

A giant garter snake corridor is envisioned along the eastern perimeter of the Plan Area connecting the Coldani Marsh/White Slough subpopulation with the Stone Lakes National Wildlife Refuge. To help achieve this, a portion of the cultivated lands that will be protected for species that use cultivated lands will be acquired in Conservation Zone 4. In addition, at least 1,500 acres of freshwater tidal habitat restoration will occur in Conservation Zone 4. Through a coordinated acquisition and restoration plan, a linear corridor can be established that links Coldani Marsh/White Slough with the Stone Lakes National Wildlife Refuge and provides additional connectivity with the Cosumnes River Preserve, and that facilitates connectivity, dispersal, and movement into unoccupied portions the Delta.

Other cultivated 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 Basin/Willow Slough subpopulation within the Yolo Bypass and for the Coldani Marsh/White Slough subpopulation between Stone Lakes National Wildlife Refuge and the Coldani Marsh/White Slough area.

*[**Note to Reviewers:** We are in the process of refining the giant garter snake model and refining our effects analysis for this species. Once this process is complete, we plan to revisit this conservation strategy in coordination with Eric Hansen to determine whether the conservation is adequate and proportional to impacts.*

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Additionally, the wildlife agencies have raised concern over the strategy's reliance on conservation in Conservation Zone 2, within the Yolo Bypass which is subject to periodic flooding. We are still evaluating several options to resolve this issue, and expect to have a revised strategy for the public review draft.]

3.3.5.30 Western Pond Turtle

The western pond turtle (*Emys marmorata*), although primarily found in natural aquatic habitats, 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 used (Ernst et al. 1994). Historically, western pond turtles inhabited most water bodies throughout their range, but the series of warm, shallow lakes and extensive slough systems that formerly covered most of the floor of the Central Valley represented their optimal habitat (Jennings et al. 1992). Western pond turtle population declines have been mostly attributed to habitat loss and fragmentation with additional effects from the competition from exotic species (bullfrogs, bass, carp, and exotic turtles), flooding and irrigation, and predation. Habitat quality is often positively correlated with the number of available basking sites (Jennings and Hayes 1994). Turtles seem to avoid areas lacking in significant refugia cut banks and large woody debris (Holland 1994). Upland habitats are also important to western pond turtles for nesting, overwintering, and overland dispersal (Holland 1994). Nesting sites may be as far as 400 meters (1,312 feet) or more from the aquatic habitat, although usually the distance is much less and generally around 100 meters (328 feet) (Jennings and Hayes 1994).

The western pond turtle occurs in the Pacific states of North America from Baja California Norte, north through Washington, and possibly into southernmost British Columbia, Canada (Bury and Germano 2008). In California, this species historically occurred in most Pacific slope drainages between the Oregon and Mexican borders and in only two drainages on the desert slope: the Mojave River (San Bernardino County) and Andreas Canyon (Riverside County) (Jennings and Hayes 1994). Occurrences east of the crest of the Sierra Nevada include Susanville in Lassen County (Stebbins 2003). Most populations throughout the range have exhibited some declines. Bury and Germano (2008) report continued declines in the northern and southernmost portions of the range, but not in the core of the range from central California to southern Oregon. Western pond turtle populations in the Central Valley continue to persist in many areas and appear to have sufficient recruitment to maintain numbers (Germano and Bury 2001).

There are relatively few occurrence records from the Plan Area (Figure 3.3-26). The CNDDB reports several occurrences spread throughout the Plan Area in Sacramento, San Joaquin, and Contra Costa Counties (California Department of Fish and Game 2011); however, it is likely that this species is underreported and underrepresented in CNDDB. Western pond turtles are common throughout many parts of the Delta, including island interiors, particularly main irrigation and drainage canals or ditches, including toe drains (Patterson pers. comm.). The species has the potential to occur along most of the slower-moving sloughs and other natural watercourses and in artificial channels and other water bodies in the Plan Area where essential habitat elements (streamside cover, logs and other debris for basking, and adjacent upland habitats) are present.

The conservation approach for western pond turtle involves restoration and protection of aquatic and adjacent upland habitat, and establishment of an interconnected reserve system that provides for western pond turtle dispersal. The habitat protection and restoration needs for this species are

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addressed at the landscape and natural community levels. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.30.1 Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the western pond turtle are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.1:** Protect at least 31,000 acres of existing natural communities, focusing on the highest quality natural communities and covered species habitats. • **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.5:** Include sufficient noncultivated upland areas adjacent to restored and protected valley/foothill riparian to provide upland habitat values and refugia from flooding. • **Objective L1.7:** To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.

Objectives L1.1 and L1.3 Benefits: Protection and restoration of natural communities consistent with these objectives will benefit western pond turtle by providing an interconnected reserve system with a wide variety of aquatic, nesting and overwintering, and dispersal habitat types. Natural communities that are expected to be used by western pond turtle in some capacity (aquatic foraging and movement, upland nesting and overwintering, or dispersal) include tidal perennial aquatic, tidal brackish emergent wetland, tidal freshwater emergent wetland, valley/foothill riparian, grassland, alkali seasonal wetland complex, vernal pool complex, other natural seasonal wetland, nontidal freshwater emergent wetland, nontidal freshwater aquatic, and cultivated lands. However, western pond turtles use only a small portion of each of these natural community types and are most likely to use specific aquatic features within these communities such as drainage ditches, ponds, and agricultural canals as aquatic habitat and adjacent uplands for nesting and overwintering. Most of the upland natural communities protected will provide suitable dispersal habitat for the western pond turtle because turtles have been known to travel over many different land cover types. Those natural communities most likely to benefit western pond turtle are discussed further under Section 3.3.4, *Natural Community Biological Goals and Objectives*.

Objectives L1.5 and L1.7 Benefits: Protection of uplands, consisting primarily of grasslands, adjacent to tidally restored areas and valley-riparian natural community, will benefit the western pond turtle by providing opportunities for nesting and overwintering.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances. • **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.3:** Allow lateral river channel migration.

Objectives L2.1, L2.2, and L2.3 Benefits: Floodplain restoration to achieve these objectives will potentially increase the quantity and quality of aquatic habitat and nesting and overwintering habitat for the western pond turtle. Where the floodplain is widened and restored, this will allow oxbows and slow-moving side channels to form, providing suitable aquatic habitat for this species (Bury and German 2008; Ernst and Lovich 2009). Where riparian vegetation grows adjacent to slower moving channels, sloughs, and ponds, downed trees can provide important basking habitat and cover habitat for turtles.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: The western pond turtle will benefit from the protection of habitat linkages that allow turtles to disperse over land. Dispersal will allow the species to move between habitat areas and promote gene flow between populations. Fragmentation of western pond turtle populations is thought to be a factor contributing to lack of genetic variability for western pond turtles in Oregon and Washington (Gray 1995). Genetic variability is important for maintaining population stability and resilience.

3.3.5.30.2 Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the western pond turtle are included below.

Goal NFEW/NPANC1: Nontidal marsh consisting of a mosaic of nontidal freshwater emergent wetland and nontidal perennial aquatic natural communities, and providing habitat for covered and other native species.
• **Objective NFEW/NPANC1.1:** Create at least 400 acres of nontidal freshwater marsh consisting of a mosaic of nontidal perennial aquatic (at least 250 acres) and nontidal freshwater emergent wetland (at least 100 acres) natural communities, with suitable habitat characteristics for giant garter snake and western pond turtle.

Objective NFEW/NPANC1.1 Benefits: Creation of 400 acres of nontidal freshwater marsh will benefit the western pond turtle by providing high-value aquatic habitat. As described in CM10 *Nontidal Marsh Restoration*, this community will be restored as a combination of emergent wetland and aquatic habitat, with adjacent upland grasslands for basking, nesting, and overwintering. The western pond turtle is known to be present in Conservation Zone 2 in the Yolo Bypass Wildlife Area

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(California Department of Fish and Game 2011), and in Conservation Zone 4 in the White Slough Wildlife Area (Germano and Bury 2001); therefore, this species is expected to benefit from restoration in these areas.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11. • **Objective GNC1.3:** Protect stock ponds and other aquatic features within protected grasslands to provide aquatic breeding habitat for native amphibians and aquatic reptiles.

Objectives GNC1.1 and GNC1.3 Benefits: Achieving this objective will provide high-quality habitat for the western pond turtle in the reserve system. Grasslands provide the highest value habitat for western pond turtle nesting and overwintering. Additionally, grasslands in the Plan Area are interspersed with stock ponds and other aquatic features that provide aquatic habitat for this species.

Goal CLNC1: Cultivated lands that provide habitat connectivity and support habitat for covered and other native wildlife species.
• **Objective CLNC1.2:** Annually maintain 4,600 acres of rice lands or similarly functioning habitat for giant garter snake in Conservation Zone 2. • **Objective CLNC1.4:** Maintain and protect the small patches of important wildlife habitats associated with cultivated lands that occur within BDCP conserved cultivated lands, including isolated valley oak trees, trees and shrubs along field borders and roadsides, remnant groves, riparian corridors, water conveyance channels, grasslands, ponds, and wetlands.

Objectives CLNC1.2 and CLNC1.4 Benefits: Achieving these objectives will benefit the western pond turtle through the protection and management of drainage and irrigation ditches associated with cultivated lands, which provide aquatic habitat for this species. Additionally, ponds and upland areas associated with protected cultivated lands will provide aquatic and nesting and overwintering habitat for the pond turtle.

3.3.5.30.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve western pond turtle within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.31 California Red-Legged Frog

Aquatic breeding habitat requirements for the California red-legged frog are cold water pond habitats (including intermittent and perennial streams) with emergent and submergent vegetation, providing suitable cover for young and adults and ensuring successful reproduction (Storer 1925; Hayes and Jennings 1988). Optimal habitats are described as deep-water ponds or pools at least 2.3 feet (0.7 meter) deep along low-gradient streams with dense stands of overhanging willows and a fringe of cattails between the willow roots and overhanging willow limbs. The California red-legged frog uses a variety of aquatic habitats that meet these requirements, including permanent and ephemeral ponds, perennial and intermittent streams, seasonal wetlands, springs, seeps, marshes,

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dune ponds, lagoons, and human-made aquatic features (U.S. Fish and Wildlife Service 2007). In addition to aquatic breeding habitat, the California red-legged frog also requires upland nonbreeding habitat used for cover, aestivation, and dispersal. Nonbreeding cover habitat may include nearly any areas within 1 to 2 miles of a breeding site. Potential cover and aestivation habitat includes all aquatic, riparian, and upland areas that provide cover (61 FR 25813). Dispersal habitat may include annual grasslands, riparian corridors, woodlands, and sometimes active agricultural lands (Fellers and Kleeman 2007). For more detail, see the species account for California red-legged frog in Appendix 2.A, *Covered Species Accounts.*

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, Marin County, California, and inland from the vicinity of Redding, Shasta County, California, southward along the interior Coast Ranges and Sierra Nevada foothills to northwestern Baja California, Mexico (U.S. Fish and Wildlife Service 2007) (Appendix 2.A, *Covered Species Accounts*). USFWS (2002) estimates that the species has lost suitable habitat in approximately 70% of its former range, with the most severe declines occurring primarily in the Central Valley and southern California (Jennings and Hayes 1994). There have been recent discoveries at isolated locations in the Sierra Nevada (Placer, Nevada, Yuba, and El Dorado Counties) and two populations in the southern Transverse and Peninsular Ranges. Sizable populations continue to exist only in coastal drainages and associated pond habitats between Point Reyes and Santa Barbara (Jennings and Hayes 1994).

Within the Plan Area the California red-legged frog has been detected only in aquatic habitats within the grassland landscape west and southwest of Clifton Court Forebay, in the vicinity of Byron and Brushy Creek along the west-central edge of the Plan Area, and in some upland sites west of Suisun Marsh (Figure 3.3-27) (California Department of Fish and Game 2011) (Appendix 2.A, *Covered Species Accounts*). These areas represent the easternmost edge of the current range of California red-legged frog within the Coast Ranges. The occurrences west of Suisun Marsh are separated from the Plan Area by Interstates 80 and 680, which limit movement into the Plan Area. California red-legged frog is not known to occur in the cultivated lands of the Central Valley. Occupied habitats in the Plan Area are characterized by grassland foothills with stock ponds, intermittent drainages, and slow-moving perennial drainages.

The principal factors contributing to the decline of the California red-legged frog are loss of habitat due to urban development, conversion of native habitats to cultivated lands, introduction of nonnative predators such as bullfrogs, and pesticide use (Fisher and Shaffer 1996; Hobbs and Mooney 1998; Davidson et al. 2002). Habitat loss and fragmentation result in small, isolated populations, which reduce individual movements and genetic exchange between populations.

The recovery plan for the California red-legged frog (U.S. Fish and Wildlife Service 2002) focuses on protection of suitable habitat, in perpetuity, within core areas that are defined in the recovery plan, including protection of upstream areas that if adversely affected could make habitat unsuitable. There are two California red legged frog core recovery areas in the Plan Area, in Conservation Zones 1 and 8 (Figure 3.3-27).

The conservation approach for this species is to protect and manage grasslands to sustain and increase habitat values for this species, and to protect and enhance perennial stream channels and stock ponds in grassland natural communities in Conservation Zone 8 through partial livestock exclusion and predator control. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed

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in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.31.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the California red-legged frog are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7**: Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Consistent with this objective, the introduction and proliferation of nonnative bullfrogs and other nonnative aquatic wildlife that prey on red-legged frogs will be reduced. As described in CM11 *Natural Communities Enhancement and Management*, nonnative aquatic predators that threaten California red-legged frog populations will be removed from ponds and other aquatic habitat, as needed to sustain the red-legged frog population in the reserve system.

3.3.5.31.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the California red-legged frog are included below.

Goal GNC1: Extensive grasslands comprised of large interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11. • **Objective GNC1.3:** Protect stock ponds and other aquatic features within protected grasslands to provide aquatic breeding habitat for native amphibians and aquatic reptiles.

Objectives GNC1.1 and GNC1.3 Benefits: Protection of at least 1,000 acres of grassland in Conservation Zone 8, west of Byron Highway, will benefit California red-legged frog by providing habitat in the portion of the Plan Area with the highest long-term conservation value for the species based on known species occurrences and large, contiguous habitat areas. Consistent with GRNC1.3, ponds and other aquatic features within the grasslands will be protected to provide aquatic habitat for this species, and surrounding grassland will provide dispersal and aestivation habitat. Protected lands in Conservation Zone 8 will connect with the East Contra Costa County HCP/NCCP reserve system and the extensive Los Vaqueros Watershed lands, including grassland areas supporting this species. This objective will ensure that California red-legged frog upland and associated aquatic habitats will be preserved and enhanced in the largest possible patch sizes adjacent to occupied habitat within and adjacent to the Plan Area.

Approximately 3,830 acres of upland cover and dispersal habitat is present in Conservation Zone 8, of which approximately 619 acres (16%) are currently protected. Following BDCP implementation, approximately 11% of modeled California red-legged frog habitat in Conservation Zone 8 that links to occupied habitat outside the Plan Area will be protected. Achieving these objectives will 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-

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legged frogs and to maintain connectivity with occupied core populations adjacent to the Plan Area that are covered under adjacent and overlapping HCP/NCCPs.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.3**: Increase burrow availability for burrow-dependent species. • **Objective GNC2.5:** Maintain and enhance aquatic features in grasslands to provide suitable inundation depth and duration and suitable composition of vegetative cover to support breeding for covered amphibian and aquatic reptile species.

Objectives GNC2.3 and GNC2.5 Benefits: Achieving these objectives will benefit the California red-legged frog by maintaining suitable habitat characteristics for this species in the reserve system. Increasing burrow availability consistent with Objective GRNC2.3 will provide refugia and cover for aestivating and dispersing California red-legged frogs. Maintaining appropriate depth and duration of aquatic features is important for this species, to ensure that conditions are favorable for supporting the entire aquatic life cycle, from breeding through metamorphosis from larval to adult stages. Furthermore, features that are inundated for a sufficient duration to support the red-legged frog lifecycle but are dry in late summer are less likely to support bullfrogs and other aquatic predators. Additionally, livestock exclusion from streams and ponds and other measures will be implemented as described in CM11 *Natural Communities Enhancement and Management* to promote growth of aquatic vegetation with appropriate cover characteristics favorable to California red-legged frogs.

3.3.5.31.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the California red-legged frog within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.32 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, stock ponds, 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% of the species' historical natural aquatic habitat has been lost (Holland 1998), and the species has been eliminated from 55 to 58% of historical breeding sites (Barry and Shaffer 1994).

California tiger salamander has been documented in the past in the Plan Area in Conservations Zones 1, 6, 7, 8, 10, and 11 (Figure 3.3-28)(California Department of Fish and Game 2011). There are several California tiger salamander occurrences in Conservation Zone 1 that is west of Highway 113 and east of Travis Air Force Base (California Department of Fish and Game 2011), an area designated as critical habitat for California tiger salamander by USFWS. There are also several occurrences along the western edge of Conservation Zone 8, just west of Clifton Court Forebay, and several in the Portero Hills just south of Travis Air Force Base in Conservation Zone 11 (California Department of Fish and Game 2011). Potential habitat exists in vernal pool and alkali wetland

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natural communities identified in portions of Conservation Zone 1, primarily within its southwestern portion; Conservation Zone 2, on the west half of the Yolo Bypass north of Liberty Island; Conservation Zone 4, off Interstate 5 west of Elk Grove; Conservation Zone 8, in its western half, east and west of Byron Highway; Conservation Zone 9, scattered areas in its southern half; and Conservation Zone 11, along its eastern and northern boundaries.

There is no recovery plan for the California tiger salamander, but this species relies primarily on vernal pool and pond breeding and grassland cover habitat (Appendix 2.A, *Covered Species Accounts*). The conservation strategy for this species relies primarily on the landscape-scale and natural community goals and objectives for large, interconnected habitat areas, management to promote native vegetation and increase burrows for aestivation, and maintenance of suitable hydrologic conditions. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.32.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the California tiger salamander are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.6 Benefits: One of the primary causes of the decline of California tiger salamander populations is the fragmentation of habitat resulting from urban and agricultural development. This objective will build on the existing reserve system to protect large, interconnected areas. This objective relates to the California tiger salamander habitat and other areas that may not be used by this species, but may serve to buffer California tiger salamanders and their habitat from the effects of anthropogenic stressors (e.g., hydrologic disturbances, pollutants, nonnative species introductions).

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Nonnative invasive plant species will be reduced and native plant species encouraged in vernal pools and other aquatic California tiger salamander habitat features, consistent with this objective and as described in CM11 *Natural Communities Enhancement and Management.* Increasing native vegetative cover has been shown to increase vernal pool hydroperiod (Marty 2004), thus making aquatic habitat more suitable for California tiger salamander breeding.

Consistent with this objective, the introduction and proliferation of nonnative bullfrogs and other nonnative aquatic wildlife that prey on California tiger salamanders will be reduced. Bullfrogs and

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predatory fish are a primary source of mortality for this species (Fisher and Shaffer 1996). As described in CM11 *Natural Communities Enhancement and Management*, nonnative aquatic predators that threaten California tiger salamander populations will be removed from ponds and other aquatic habitat, as needed, to sustain the California tiger salamander population in the reserve system.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Consistent with this objective, measures described in CM11 *Natural Communities Enhancement and Management* such as controlling the height and density of grassland and improvement of culverts will be implemented to facilitate California tiger salamander movement and thus enhance habitat linkages. Increasing opportunities for California tiger salamander to move through grassland habitats will enhance genetic exchange and the ability to recolonize any areas where the species may have been locally extirpated.

3.3.5.32.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the California tiger salamander are included below.

Goal GNC1: Extensive grasslands comprised of large interconnected patches or contiguous expanses.
• **Objective GNC1.1**: Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11. • **Objective GNC1.2:** Restore 2,000 acres of grasslands to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia. • **Objective GNC1.3**: Protect stock ponds and other aquatic features within protected grasslands to provide aquatic breeding habitat for native amphibians and aquatic reptiles.

Objectives GNC1.1, GNC1.2, and GNC1.3 Benefits: Protection of at least 8,000 acres of grasslands in Conservation Zones 1, 8, and 11 will benefit the California tiger salamander by providing habitat in the portions of the Plan Area with the highest-long term conservation value for the species based on known species occurrences and large, contiguous habitat areas. Consistent with GNC1.3, ponds and other aquatic features within the grasslands will be protected to provide aquatic habitat for this species, and surrounding grassland will provide dispersal and aestivation habitat. Protected lands in Conservation Zone 8 will connect with the East Contra Costa County HCP/NCCP reserve system, including grassland areas supporting this species. Protected lands in Conservation Zone 11 will connect with the future Solano County reserve system, including grassland and vernal pool complex areas supporting this species. Protecting seasonal ponds associated with grasslands, consistent with Objective 1.3, will ensure that California tiger salamander aquatic habitat and associated uplands will be preserved and enhanced in the largest possible patch sizes adjacent to occupied habitat within and adjacent to the Plan Area.

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Grassland restoration will focus specifically on connecting fragmented patches of protected grasslands (GNC1.2), thereby increasing dispersal opportunities for the California tiger salamander. The protection and restoration of these natural communities will increase the extent and connectivity of protected habitat in the Plan Area and region. Protection and restoration will build off existing protected lands within and adjacent to the Plan Area. Protected and restored vernal pool complex will be managed in conjunction with protected grassland and alkali seasonal wetland complex natural communities to conserve and promote connectivity. The increased habitat extent and connectivity will increase opportunities for genetic exchange and allow for colonization of extirpated populations and restored habitats.

Goal GNC2: Biologically diverse grassland that are managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.3**: Increase burrow availability for burrow-dependent species. • **Objective GNC2.5**: Maintain and enhance aquatic features in grasslands to provide suitable inundation depth and duration and suitable composition of vegetative cover to support breeding for covered amphibian and aquatic reptile species.

Objectives GNC2.3 and GNC2.5 Benefits: Achieving these objectives will benefit the California tiger salamander by maintaining suitable habitat characteristics for this species in the reserve system. Increasing burrow availability consistent with Objective GRNC2.5 is expected to provide refugia and cover for aestivating and dispersing California tiger salamanders. Maintaining appropriate depth and duration of aquatic features is important for this species, to ensure that conditions are favorable for supporting the entire aquatic life cycle from breeding through metamorphosis from larval to adult stages. Furthermore, features that are inundated for a sufficient duration to support the California tiger salamander lifecycle but are dry in late summer are less likely to support bullfrogs and other aquatic predators (e.g., seasonal ponds and wetlands or stock ponds that can be drained periodically). Additionally, livestock exclusion and other measures will be implemented as described in CM11 *Natural Communities Enhancement and Management* to promote growth of aquatic vegetation with appropriate cover characteristics favorable to the California tiger salamander.

Goal VPCNC1: Vernal pool complexes comprised of large, interconnected, or contiguous expanses that represent a range of environmental conditions.
• **Objective VPCNC1.1**: Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool core recovery plan (U.S. Fish and Wildlife Service 2005). • **Objective VPCNC1.2**: Restore vernal pool complex in Conservation Zones 1, 8, and/or 11 to achieve no net loss of vernal pool acreage. • **Objective VPCNC1.3**: Increase the size and connectivity of protected vernal pool complex within the Plan Area and increase connectivity with protected vernal pool complex adjacent to the Plan Area. • **Objective VPCNC1.4:** Protect the range of inundation characteristics that are currently represented by vernal pools throughout the Plan Area.

Objectives VPCNC1.1, VPCNC1.2, and VPCNC1.3: The protection and restoration of vernal pool complexes within a large, interconnected reserve system in Conservation Zones 1, 8, and 11 will benefit the California tiger salamander by providing suitable aquatic and upland habitat in areas known to support this species. The vernal pool complex natural community will be protected in association with the larger grassland acreage to be protected, as described above, contributing to an extensive interconnected reserve system for this species.

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Consistent with Objectives VPCNC1.1 and VPCNC2.1, vernal pool protection and restoration will occur in Conservation Zones 1, 8, and 11, primarily in areas identified as core recovery areas in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005). Although California tiger salamander is not included in the 2005 vernal pool recovery plan, habitat and occurrences for this species in Conservation Zones 1, 8, and 11 are concentrated primarily in the core recovery areas.

Objective VPCNC1.4: Protecting the range of inundation characteristics that are currently represented by vernal pools in the Plan Area will benefit the California tiger salamander by ensuring that a representative proportion of the protected vernal pools are sufficiently large and deep, with long inundation periods, to support the aquatic life cycle for this species. Optimal California tiger salamander breeding habitat consists of large vernal pools, playa pools, or ephemeral ponds that hold water until at least May. In coastal regions such as the Plan Area, California tiger salamander larvae may not metamorphose until late July, and pools holding water through July often have higher reproductive success for this species (Barry and Shaffer 1994).

Goal VPCNC2: Vernal pool complexes that are managed and enhanced to sustain populations of native vernal pool species.
• **Objective VPCNC2.1**: Maintain or enhance vernal pool complexes to provide the appropriate inundation (ponding) characteristics for supporting and sustaining vernal pool species.

Objective VPNC2.1 Benefits: Achieving this objective will benefit the California tiger salamander because vernal pools will be maintained and enhanced to ensure that they are inundated for a sufficient period to support the species' entire aquatic lifecycle, and will also exhibit seasonal drying to limit the ability of nonnative predators to become established (e.g., bullfrogs and fish).

Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex**.**
• **Objective ASWNC1.1**: Protect 150 acres of alkali seasonal in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

Objective ASWNC1.1 Benefits: Alkali seasonal wetlands will be protected within a mosaic of natural communities that will also include grasslands and vernal pool complex as described above, resulting in a large, interconnected reserve system in Conservation Zones 1, 8, and 11. This will benefit the California tiger salamander by providing suitable aquatic and upland habitat in areas known to support this species.

Goal ASWNC2: Alkali seasonal wetland complexes that are managed and enhanced to sustain populations of native alkali seasonal wetland species.
• **Objective ASWNC2.1**: Provide appropriate seasonal flooding characteristics for supporting and sustaining alkali seasonal wetland species.

Objective ASWNC2.1 Benefits: Maintaining and enhancing appropriate hydrologic characteristics for alkali seasonal wetlands will benefit California tiger salamander in the same manner that hydrologic maintenance and enhancement of vernal pools will benefit the species, as described for Objective VPCNC2.1, above.

The natural community objectives listed above will together protect at a minimum 11,000 acres of lands [10,000 acres of grassland (GNC1.1 and GNC1.2), 600 acres of vernal pool complex (VPCNC1.1

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and VPCNC2.1), and 400 acres of alkali wetland complex (ASWNC1.1)] that currently, or following enhancement or restoration actions, are expected to provide suitable habitat for California tiger salamander.

3.3.5.32.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve the California tiger salamander within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.33 Western Spadefoot

Optimal habitat for the western spadefoot consists of vernal pool breeding habitat surrounded by grassland upland cover habitat. The western spadefoot 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 meters (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. More than 80% of occupied habitat in southern California and more than 30% in northern California have been lost to development or other incompatible land uses (Jennings and Hayes 1994).

The western spadefoot 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 includes portions of the Central Valley and bordering foothills, and the Coast Ranges south of Monterey Bay (Stebbins 2003). The western spadefoot has been extirpated throughout most of the lowlands of southern California (Stebbins 1985) and from many historical locations in the Central Valley (Jennings and Hayes 1994, Fisher and Shaffer 1996). Fisher and Shaffer (1996) state that the western spadefoot populations have declined severely in the Sacramento Valley, and their density has been reduced in eastern San Joaquin Valley.

The western spadefoot has not been documented in the Plan Area (California Department of Fish and Game 2011). The nearest reported occurrences are in the inner Coast Range several miles west of Conservation Zone 7 (California Department of Fish and Game 2011). Potential habitat exists in vernal pool and alkali wetland natural communities identified in portions of Conservation Zone 1, primarily within its southwestern portion; Conservation Zone 2, on the west half of the Yolo Bypass north of Liberty Island; Conservation Zone 4, off of Interstate 5 west of Elk Grove; Conservation Zone 8, in its western half, east and west of Byron Highway; Conservation Zone 9, scattered areas in its southern half; and Conservation Zone 11, along its eastern and northern boundaries (Figure 3.3-29).

The western spadefoot is addressed in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005) and the BDCP is consistent with recovery goals for this species in the Solano-Colusa vernal pool region (Conservation Zones 1 and 11). The BDCP conservation strategy for this species relies on landscape-scale and natural community biological goals and objectives, which direct conservation actions toward establishing a large, interconnected reserve system supporting habitat

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that is managed to optimize native vegetation, shelter, and appropriate hydrologic conditions for aquatic habitat. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.33.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the western spadefoot are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: Nonnative invasive plant species will be reduced and native plant species encouraged in vernal pools, consistent with this objective and as described in CM11 *Natural Communities Enhancement and Management.* Increasing native vegetative cover has been shown to increase the vernal pool hydroperiod (Marty 2004), thus making aquatic habitat more suitable for western spadefoot.

Goal L3: Capacity for movement of native organisms and genetic exchange among populations necessary to sustain native fish and wildlife species in the Plan Area.
• **Objective L3.1:** Protect and improve habitat linkages that allow terrestrial covered and other native species to move between protected habitats within and adjacent to the Plan Area.

Objective L3.1 Benefits: Consistent with this objective, measures described in CM11 *Natural Communities Enhancement and Management* such as controlling the height and density of grassland within vernal pool complexes and improvement of culverts will be implemented to facilitate western spadefoot movement and thus enhance habitat linkages. Increasing opportunities for western spadefoot to move through upland habitat will enhance genetic exchange and the ability to re-colonize any areas where the species may have been locally extirpated.

3.3.5.33.2 Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the western spadefoot are included below.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1**: Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11. • **Objective GNC1.2:** Restore 2,000 acres of grasslands to connect fragmented patches of protected grassland and to provide upland habitat adjacent to riparian and tidal natural communities for wildlife foraging and upland refugia. • **Objective GNC1.3:** Protect stock ponds and other aquatic features within protected grasslands to provide aquatic breeding habitat for native amphibians and aquatic reptiles.

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Objectives GNC1.1, GNC1.2, and GNC1.3 Benefits: Achieving these objectives will benefit the western spadefoot by providing suitable upland dispersal habitat and associated aquatic features potentially suitable for breeding. One of the primary causes of the decline of western spadefoot in California is the loss and fragmentation of habitat from urban and agricultural development. These objectives relate to western spadefoot habitat and other areas that may not be used by western spadefoot, but may serve to buffer their habitat from the effects of anthropogenic stressors (e.g., hydrologic disturbances, pollutants, nonnative species introductions).

Grasslands and associated aquatic features will be protected in association with vernal pool complex and alkali seasonal wetland complex. Grassland restoration will focus specifically on connecting fragmented patches of protected grasslands, thereby increasing dispersal opportunities for western spadefoot. This will result in a large, interconnected reserve system supporting suitable habitat for the species. The increased habitat extent and connectivity will increase opportunities for genetic exchange and allow for colonization of extirpated populations and restored habitats. However, as there no known occurrences of this species in the Plan Area, therefore the extent to which these objectives will benefit the species is unknown.

Goal GNC2: Biologically diverse grassland managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.3**: Increase burrow availability for burrow-dependent species. • **Objective GNC2.5:** Maintain and enhance aquatic features in grasslands to provide suitable inundation depth and duration and suitable composition of vegetative cover to support breeding for covered amphibian and aquatic reptile species.

Objectives GNC2.3 and GNC2.5 Benefits: Maintaining and enhancing aquatic features in grassland is expected to benefit the western spadefoot by maintaining and enhancing suitable aquatic breeding habitat in the reserve system. Increasing burrow availability consistent with Objective GNC2.3 will provide refugia and cover and will potentially be used by aestivating and dispersing western spadefoot.

Goal VPCNC1: Vernal pool complexes comprised of large, interconnected, or contiguous expanses that represent a range of environmental conditions**.**
• **Objective VPCNC1.1:** Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool core recovery plan (U.S. Fish and Wildlife Service 2005). • **Objective VPCNC1.2:** Restore vernal pool complex in Conservation Zones 1, 8, and/or 11 to achieve no net loss of vernal pool acreage. • **Objective VPCNC1.3:** Increase the size and connectivity of protected vernal pool complex within the Plan Area and increase connectivity with protected vernal pool complex adjacent to the Plan Area.

Objectives VPCNC1.1, VPCNC1.2, and VCPNC1.3 Benefits: The protection and restoration of vernal pool complexes within a large, interconnected reserve system in Conservation Zones 1, 8, and 11 will benefit the western spadefoot, if this species occurs in the Plan Area, by providing suitable aquatic and upland habitat. The vernal pool complex natural community will be protected in association with the larger grassland acreage to be protected, as described above, contributing to an extensive interconnected reserve system for this species.

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Goal VPCNC2: Vernal pool complexes that are managed and enhanced to sustain populations of native vernal pool species.
• **Objective VPCNC2.1**: Maintain or enhance vernal pool complexes to provide the appropriate inundation (ponding) characteristics for supporting and sustaining vernal pool species.

Objective VPCNC2.1 Benefits: Achieving this objective will benefit the western spadefoot, if present in protected vernal pools, because these pools will be maintained and enhanced to ensure that they are inundated for a sufficient period to support the species' entire aquatic lifecycle, and will also exhibit seasonal drying to limit the ability of nonnative predators to become established (e.g., bullfrogs and fish).

Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex.
• **Objective ASWNC1.1:** Protect 150 acres of alkali seasonal in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

Objective ASWNC1.1 Benefits: Alkali seasonal wetlands will be protected within a mosaic of natural communities that will also include grasslands and vernal pool complex as described above, resulting in a large, interconnected reserve system in Conservation Zones 1, 8, and 11. This will benefit the western spadefoot, if present, by providing suitable aquatic and upland habitat.

Goal ASWNC2: Alkali seasonal wetland complexes that are managed and enhanced to sustain populations of native alkali seasonal wetland species.
• **Objective ASWNC2.1**: Provide appropriate seasonal flooding characteristics for supporting and sustaining alkali seasonal wetland species.

Objective ASWNC2.1 Benefits: Maintaining and enhancing appropriate hydrologic characteristics for alkali seasonal wetlands will benefit the western spadefoot in the same manner that hydrologic maintenance and enhancement of vernal pools will benefit the species, as described for Objective VPNC2.1, above.

The natural community objectives listed above will together protect at a minimum 10,900 acres of lands (10,000 acres of grassland, 500 acres of vernal pool complex, and 400 acres of alkali wetland complex) that currently, or following restoration actions, provide some level of habitat for the western spadefoot. Following BDCP implementation, approximately 64% of modeled western spadefoot habitat in the Plan Area will be protected, an increase of 30% from existing conditions. The proposed habitat conservation actions are expected to maintain sufficient habitat area to sustain or increase the existing Plan Area population of the western spadefoot and to maintain connectivity with habitat adjacent to the Plan Area.

3.3.5.33.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve western spadefoot within the reserve system. Additional goals and objectives are not necessary for this species.

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3.3.5.34 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 (U.S. Fish and Wildlife Service 1984). The valley elderberry longhorn beetle has a dependent association with elderberry (*Sambucus* spp.) which is an obligate host plant for valley elderberry longhorn beetle larvae and is necessary for the completion of the beetle's life cycle (Linsley and Chemsak 1972, 1997; Eng 1984; Barr 1991; Collinge et al. 2001).

There is little information regarding range-wide population trends for valley elderberry longhorn beetle. At the time of its listing, the beetle was known from less than 10 locations on the American River, Putah Creek, and the Merced River in the Central Valley. Since the time of its listing, surveys have identified approximately 190 locations of the beetle ranging from Shasta County to Fresno County. Loss of riparian habitat has slowed throughout the Central Valley and efforts specific to this species as of 2006 had resulted in protection of 50,000 acres and restoration of over 5,100 acres of valley elderberry longhorn beetle habitat. Based on the number of sightings throughout the Central Valley and the reduction in primary threats to this species (habitat loss), USFWS recommended in a 5-year status review that the species be delisted (U.S. Fish and Wildlife Service 1984, 2006).

The current distribution of valley elderberry longhorn beetle through the Plan Area is largely unknown, but current CNDDB occurrence data are concentrated in the northeastern portion of the Plan Area, specifically Conservation Zone 3 near Sacramento. Three occurrences of the valley elderberry longhorn beetle are documented in the Plan Area, including one along Old River north of Tracy and two recent occurrences along small drainages between the Sacramento River and the Sacramento DWSC in the vicinity of West Sacramento (Figure 3.3-30). (Appendix 2.A, *Covered Species Accounts*) (California Department of Fish and Game 2011). Additional historical occurrences are documented from along the Sacramento River corridor and Putah Creek in Yolo County (Eya 1976; Jones & Stokes 1985, 1986, 1987a, 1987b; U.S. Fish and Wildlife Service 1984; Barr 1991; Collinge et al. 2001). Comprehensive surveys for the species or its host plant, elderberry, have not been conducted and thus the population size and location of the species in the Plan Area is unknown. However, distribution is typically based on the occurrence of elderberry shrubs, which are known to occur along riparian corridors throughout the Plan Area, including the Sacramento River, Stanislaus River, San Joaquin River, and along smaller natural and channelized drainages, as well as in upland habitats. The beetle is considered to potentially occur in all mature elderberry shrubs in the Plan Area.

The riparian zone throughout the Delta has been reduced by agriculture and urban development to thin strips along the levees surrounding the Delta islands and various drainages. These levees have been highly modified for stabilization with riprap and mostly denuded of vegetation to meet coverage criteria under DWR and U.S. Army Corps of Engineers (USACE) levee assurance programs for flood protection and urban safety. This has reduced the capability of the riparian community to support species that rely on this community and significantly reduced the ability of the valley elderberry longhorn beetle to inhabit riparian areas in the Delta. Due to the limited habitat in the riparian community, specifically elderberry shrubs, it is unlikely that the present riparian community within the Delta would be able to sustain a viable long term population of the valley elderberry longhorn beetle.

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Critical habitat has been designated for the valley elderberry longhorn beetle, 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 USFWS in 1999 to mitigate development-related impacts on valley elderberry longhorn beetle habitat (U.S. Fish and Wildlife Service 1999). The 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, Placer County Conservation Plan, and the Butte Regional Conservation Plan. Valley elderberry longhorn beetle conservation under the BDCP will therefore tie in with conservation efforts under those other habitat conservation plans.

The conservation strategy for valley elderberry longhorn beetle will entail floodplain restoration, restoration of 5,000 acres of valley/foothill riparian habitat, and creation of valley elderberry longhorn beetle habitat in the vicinity of existing populations. In all cases, elderberry shrubs would need to be planted or colonize sites naturally in order to provide suitable breeding sites for the species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.34.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the valley elderberry longhorn beetle are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.4:** Connect rivers to their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.

Objective L2.4 Benefits: Achieving this objective will benefit valley elderberry longhorn beetle by providing suitable habitat conditions through floodplain restoration. Flood control efforts, and accompanying reduction in the width of the riparian corridor, has contributed to decreased valley elderberry longhorn beetle occupancy in riparian stretches along the Sacramento River (Lang et al. 1989). Floodplain restoration and associated riparian restoration will increase the width of the riparian corridor, and recharging of floodplain groundwater will promote and sustain riparian vegetation.

Most of the floodplain restoration is planned to occur in Conservation Zone 7. There is one current CNDDB occurrence record (#158) for the valley elderberry longhorn beetle in Conservation Zone 7, which reports one adult captured and beetle exit holes observed[23] in elderberry shrubs near Middle River or Old River in 1984. There is another CNDDB occurrence record (#45) for this species immediately south of Conservation Zone 7, outside the Plan Area at Caswell Memorial State Park.

[23] Valley elderberry longhorn beetle larvae develop in the pith of elderberry stems. Before the larvae pupate they burrow out of the stem, creating an exit hole that is characteristic of the species.

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This record reports two elderberry plants containing beetle exit holes, observed in 1985. It is unknown whether these two valley elderberry longhorn beetle occurrences in and near Conservation Zone 7 are still extant, but these records indicate that the species is potentially present in Conservation Zone 7. This indicates that floodplain restoration in Conservation Zone 7 will potentially benefit the species by providing additional habitat where elderberries are present in the restored riparian areas, and conditions for population expansion in this zone. This objective will be met through floodplain restoration (CM5 *Seasonally Inundated Floodplain Restoration*).

3.3.5.34.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the valley elderberry longhorn beetle are included below.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historic distribution.
• **Objective VFRNC1.2:** Restore or create 5,000 acres of valley/foothill riparian forest.

Objective VFRNC1.2 Benefits: Achieving this objective will improve conditions for the valley elderberry longhorn beetle by restoring or creating at least 5,000 acres of valley/foothill riparian in the Plan Area (CM7 *Riparian Natural Community Restoration*), to contribute to the goal of extensive wide bands or large patches of interconnected valley/foothill riparian forests. While the entire 5,000 acres is not expected to provide suitable habitat conditions for the valley elderberry longhorn beetle, some portion of this acreage will benefit the species where restoration occurs in the vicinity of existing populations and where suitable elderberry shrubs are present. Most of the 5,000 acres of riparian restoration will take place within the restored floodplain.

Goal VFRNC3: Maintain or increase native biodiversity that characterizes the valley/foothill riparian community.
• **Objective VFRNC3.1:** Maintain or increase abundance and distribution of rare and uncommon shrubs characteristic of riparian communities, especially buttonwillow and elderberry bushes.

Objective VFRNC3.1 Benefits: Elderberry plantings will be incorporated into riparian restoration plans consistent with this objective to contribute to riparian plant species diversity. This is expected to directly benefit the valley elderberry longhorn beetle by increasing the abundance and distribution of the host plant species, thereby potentially providing opportunities to expand the distribution and increase the abundance of valley elderberry longhorn beetle populations in the Plan Area.

3.3.5.34.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for the valley elderberry longhorn beetle within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

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Goal VELB1: Promote dispersal and expansion of the valley elderberry longhorn beetle where there are known source populations within the American and Sacramento River systems.

- **Objective VELB1.1:** Mitigate for impacts on elderberry shrubs by creating valley elderberry longhorn beetle habitat consistent with the U.S. Fish and Wildlife Service (1999) valley elderberry longhorn beetle conservation guidelines, and planting elderberry shrubs in high-density clusters.
- **Objective VELB1.2:** Site valley elderberry longhorn beetle habitat restoration within drainages immediately adjacent to or in the vicinity of sites known to be occupied by valley elderberry longhorn beetle.

Objective VELB1.1 Rationale: This objective will increase opportunities for colonization by planting elderberry shrubs in high-density clusters to offset their loss to covered activities. The valley elderberry longhorn beetle is more likely to occupy elderberry shrubs that occur in clumps rather than isolated shrubs, and shrub density is an important factor influencing beetle occupancy (Collinge et al. 2001). To further increase opportunities for colonization by valley elderberry longhorn beetle into restoration sites, any shrubs at impact sites showing evidence of occupation by valley elderberry longhorn beetle will be transplanted to habitat restoration sites. Criteria for valley elderberry longhorn beetle habitat restoration are detailed in CM7 *Riparian Natural Community Restoration*.

Because valley elderberry longhorn beetle habitat is patchily and unpredictably distributed within the riparian natural community, the extent to which elderberry shrubs and occupied valley elderberry longhorn beetle habitat will be lost as a result of BDCP activities cannot be determined at the Plan level. In order to ensure that conservation is roughly proportional to impacts consistent with provisions of the NCCPA, impacts will be determined through site-specific surveys during individual project planning, and mitigated consistent with the Valley Elderberry Longhorn Beetle Conservation Guidelines (U.S. Fish and Wildlife Service 1999). These guidelines require transplanting shrubs from the areas of effect to restoration sites, and planting additional elderberry seedlings at ratios ranging from 1:1 to 8:1 (seedling planted to stems affected) for all stems over 1 inch in diameter. As specified in the 1999 guidelines, the mitigation ratio will depend on the diameter of each stem affected, presence or absence of valley elderberry longhorn beetle exit holes in each shrub, and whether or not each affected shrub is in a riparian area. The landscape and natural community level goals and objectives will likely provide benefits to the valley elderberry longhorn beetle beyond mitigation. Furthermore, the habitat restoration for this species will be designed and configured to optimize opportunities for colonization by the valley elderberry longhorn beetle.

Objective VELB1.2 Rationale: This objective will focus restoration on the drainages close to sites occupied by the valley elderberry longhorn beetle. This species has distinct, relatively isolated populations in individual drainages, likely due to the beetle's limited dispersal capability (Collinge et al. 2001). The species is unlikely to colonize unoccupied drainages, even if suitable habitat is present. This necessitates siting habitat restoration within or in the vicinity of occupied drainages, consistent with Objective VELB1.1. Known occupied habitat in the Plan Area occurs in Conservation Zones 2 and 7 in three occurrences, but additional known occurrences are expected to be found as the reserve system is assembled. Some occurrences are known from agricultural ditches and railroad tracks, and therefore does not provide opportunities restore dense patches of elderberry shrubs within a riparian matrix directly adjacent to occupied areas. In these cases, restoration would be located within reasonable dispersal distance for the valley elderberry longhorn beetle from known occurrences.

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

3.3.5.35 Vernal Pool Crustaceans

The covered crustacean species associated with the vernal pool complex include the California linderiella, conservancy fairy shrimp, longhorn fairy shrimp, midvalley fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. The historic distributions of the covered vernal pool crustaceans are unknown, but probably coincided with the historic distributions of their habitat (U.S. Fish and Wildlife Service 2005). These species occupy vernal pool complexes, which are described in detail in Section 2.3.4.9, *Vernal Pool Complex*, and Section 3.3.4.9, *Managed Wetland,* above.

The primary stressors affecting long-term survival and recovery of the covered vernal pool shrimp are habitat loss and fragmentation, and habitat degradation as a result of changes to natural hydrology, erosion, invasive species, incompatible grazing regimes, and recreational activities (U.S. Fish and Wildlife Service 1994). These stressors will be reduced or eliminated on protected and restored lands in the Plan Area consistent with the biological goals and objectives.

The Plan Area contains a total of 7,908 acres of vernal pool complex and 2,494 acres of degraded vernal pool complex distributed along the margins of the Plan Area, in Conservation Zones 1, 2, 4, 8, 9, and 11.

The current distributions of the covered vernal pool crustacean species occurrences range-wide and in Plan Area are as follows.

- **California linderiella.** This species occurs in the Central Valley from Shasta County south to Fresno County and in the Coast Transverse ranges from Mendocino County south to Ventura County (Eriksen and Belk 1999; Appendix 2.A, *Covered Species Accounts*). Typical habitat for this species includes large, clear pools (Eng et al. 1990), although this species has been found in turbid, tea colored, or small pools (U.S. Fish and Wildlife Service 2007). In the Plan Area, there are records for this species in Conservation Zones 1, 2, 10, and 11, and adjacent to Conservation Zone 4 (Figure 3.3-31) (Appendix 2.A, *Covered Species Accounts*).
- **Conservancy fairy shrimp.** This species is known from a few isolated populations distributed over a large portion of California's Central Valley and in southern California (U.S. Fish and Wildlife Service 2005, p. II-183) (Appendix 2.A, *Covered Species Accounts*). Conservancy fairy shrimp is often found in vernal pools that are relatively large and turbid (U.S. Fish and Wildlife Service 2005, P. II-183). In the Plan Area, there are recorded occurrences of conservancy fairy shrimp in Conservation Zones 1, 2, and 11 (Figure 3.3-32) (Appendix 2.A, *Covered Species Accounts*).
- **Longhorn fairy shrimp.** This species is known from only a small number of widely separated populations (Appendix 2.A, *Covered Species Accounts*). The species has been found in small, clear, sandstone outcrop pools in Contra Costa and Alameda Counties; in a matrix of alkali sink and alkali scrub plant communities near Soda Lake in the Carrizo Plain area; in alkaline grassland pools at the Kesterson National Wildlife Refuge; and in a roadside ditch near Los Banos (U.S. Fish and Wildlife Service 2005). There are no recorded occurrences of longhorn fairy shrimp in the Plan Area (Figure 3.3-33).
- **Midvalley fairy shrimp.** This species is known from a range of vernal pool types, including clear sandstone pools with little alkalinity to turbid vernal pools on clay soils with moderate alkalinity (King et al. 1996; Eriksen and Belk 1999). All known occurrences of midvalley fairy

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shrimp are in California, between central Sacramento County and northern Fresno County (Appendix 2.A, *Covered Species Accounts*). In the Plan Area, there are recorded occurrences for this species in Conservation Zones 1, 2, 8, and 9, and adjacent to Conservation Zone 4 (Figure 3.3-34) (Appendix 2.A, *Covered Species Accounts*).

- **Vernal pool fairy shrimp.** This species occupies a variety of vernal pool habitats and is found in 28 counties across the Central Valley and coastal ranges of California, and in Jackson County of southern Oregon (U.S. Fish and Wildlife Service 2005; Appendix 2.A, *Covered Species Accounts*). In the Plan Area, there are recorded occurrences of vernal pool fairy shrimp in Conservation Zones 1, 2, 4, 8, 9, 10, and 11 (Figure 3.3-35) (Appendix 2.A, *Covered Species Accounts*).

- **Vernal pool tadpole shrimp.** This species occupies a variety of vernal pool habitats across the Central Valley and in the San Francisco Bay area (Appendix 2.A, *Covered Species Accounts*). However, the species is uncommon within its range: Helm (1998) found vernal pool tadpole shrimp in only 17% of vernal pools sampled across 27 counties, and Sugnet (1993, in U.S. Fish and Wildlife Service 2007) found this species at only 11% of 3,092 locations. In the Plan Area, there are recorded vernal pool tadpole shrimp occurrences in Conservation Zones 1, 2, and 11, and adjacent to Conservation Zone 4 (Figure 3.3-36) (Appendix 2.A, *Covered Species Accounts*).

Habitat loss and fragmentation have been identified as the largest threats to the survival and recovery of vernal pool species (U.S. Fish and Wildlife Service 2005, 2007). Habitat loss has generally been the result of urbanization and agricultural conversion, and has also occurred in the form of habitat alteration and degradation as a result of changes to natural hydrology, invasive species, and incompatible grazing regimes.

The conservation approach for vernal pool crustaceans is guided chiefly by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005), an ecosystem-level recovery and conservation strategy for vernal pool species developed by USFWS in collaboration with a team of vernal pool species experts. Key elements of the Vernal Pool Recovery Plan include the establishment of reserves throughout the species' ranges to prevent further habitat loss and fragmentation in areas identified as important for the species (core recovery areas) (Figure 3.3-25 through Figure 3.3-30), the restoration of habitat to achieve no net loss of habitat for vernal pool species, and adaptive habitat management to maintain and enhance habitat values for vernal pool species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.35.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the vernal pool crustaceans are included below.

Goal L1: A large, interconnected reserve system consisting of a landscape-scale mosaic of natural communities.
• **Objective L1.6:** Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

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Objective L1.6 Benefits: This objective will reduce future habitat loss and fragmentation in the Plan Area. The size and connectivity of protected lands, including vernal pool complexes within a matrix of other natural community types, will be increased by building on the existing network of protected lands and applying the conservation land assembly principles described in Section 3.2.4.2.1, *Conservation Land Assembly Principles*. Vernal pool complexes will be protected and restored as components of a large, interconnected reserve system, within a mosaic of grasslands and alkali seasonal wetlands. Large, interconnected reserves are less likely to be adversely affected by adjacent disturbances related to urban development, such as urban run-off and human-related habitat degradation (off-road vehicles, trampling) than small, isolated vernal pool complexes.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7: Benefits: This objective will benefit the covered vernal pool crustacean species by reducing threats to the species' biochemical and hydrologic requirements that result from heavy infestations of invasive plant species. This will be achieved by implementing the *Invasive Species Control Program* section of CM11 *Natural Communities Enhancement and Management.* Invasive plants can increase the production of dense vegetation and thatch that shortens the ponding duration of vernal pools (Marty 2005; Pyke and Marty 2005). Literature also suggests that invasive plants in vernal pools can lead to higher respiratory oxygen consumption relative to photosynthetic oxygen generation (Rogers 1998), and thus low oxygen conditions can stress vernal pool aquatic wildlife.

3.3.5.35.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the vernal pool crustaceans are included below.

Goal VPCNC1: Large, interconnected expanses of vernal pool complex within a reserve system that includes a range of geomorphological, hydrologic, and vegetation characteristics.
• **Objective VPCNC1.1**: Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool core recovery plan (U.S. Fish and Wildlife Service 2005). • **Objective VPCNC1.2**: Restore vernal pool complex in Conservation Zones 1, 8, and 11 to achieve no net loss of vernal pool acreage. • **Objective VPCNC1.3**: Increase the size and connectivity of protected vernal pool complex within the Plan Area and increase connectivity with protected vernal pool complex adjacent to the Plan Area. • **Objective VPCNC1.4**: Protect the range of inundation characteristics that are currently represented by vernal pools throughout the Plan Area.

Objectives VPCNC1.1 and VPCNC1.2 Benefits: Objective VPCNC1.1 will eliminate habitat loss and fragmentation on protected and restored vernal pool complexes on 600 acres in the Plan Area. Objective VPCNC1.2 will benefit vernal pool crustaceans by ensuring no net loss of their habitat.

Consistent with Objectives VPCNC1.1 and VPCNC1.2, vernal pool protection and restoration will occur in Conservation Zones 1, 8, and 11. Although habitat for the vernal pool crustaceans is also

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present in Conservation Zones 2, 4, and 9, the targeted conservation zones (1, 8, and 11) provide the only opportunities for large-scale conservation of vernal pool crustacean habitat within the Plan Area (Figure 3.3-25 through Figure 3.3-30). Conservation Zones 2, 4, and 9 are not targeted under the BDCP conservation strategy because the vernal pool complexes in Conservation Zones 2 and 4 are almost entirely under protected status (99%), and in Conservation Zone 9 (approximately 120 acres) they are largely fragmented by development and cultivated lands.

Objectives VPCNC1.1 and VPCNC1.2 prioritize protection and restoration in core recovery areas (Figure 3.3-25 through Figure 3.3-30) identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). These specific sites are considered necessary to recover the federally endangered or threatened vernal pool species or to conserve sites that are necessary to recover those species. For species of concern that are not federally listed, core recovery areas are the specific sites necessary to prevent these species from being federally listed in the future (U.S. Fish and Wildlife Service 2005). The core recovery areas were developed to include viable populations (in some cases, source populations for larger metapopulations) or to contribute to the connectivity of habitat and thus increase dispersal opportunities between populations. Core recovery areas were established to provide for protection throughout the species' ranges, and to prioritize lands with high concentration of species per unit area. Core recovery area boundaries were established for the Vernal Pool Recovery Plan based on the distributions of species occurrence information, data layers for the proposed critical habitat for vernal pools, vernal pool complex mapping (Holland 1998), watershed boundaries, other hydrographic boundaries, topographic features, roads, and land use designations. Establishment of the core recovery areas assumed that the long-term survival and recovery of species are best achieved through two core conservation actions.

- Protecting multiple populations so that a single or series of catastrophic events cannot cause the extinction of the whole species.
- Increasing the size of the populations in core areas to a level where threats from genetic, demographic, and normal environmental uncertainties or change are diminished.

Objective VPCNC1.3 Benefits: This objective will increase the overall extent and connectivity of the vernal pool reserve system by extending existing protected vernal pool complexes within and adjacent to the Plan Area. Protected and restored vernal pool complex will be incorporated into the reserve system, and protection and management of these lands will prevent habitat degradation that could otherwise result from human activities such as recreation and incompatible grazing regimes. These lands will be enhanced to benefit vernal pool species and managed in conjunction with protected grassland and alkali seasonal wetland complex natural communities to conserve and promote connectivity.

Objective VPCNC1.4 Benefits: This objective will ensure that the inundation characteristics of vernal pool habitat for each of the vernal pool crustacean species will be represented in the reserve system. For example, the proportion of pools in the reserve system that are large or deep, thus providing habitat for vernal pool conservancy fairy shrimp, will be representative of the Plan Area. Protected vernal pool complexes will be maintained or enhanced to provide the appropriate hydrological conditions for sustaining vernal pool species. The conservation of 600 acres of large, interconnected tracts of vernal pool complex consistent with Objectives VPCNC1.1 and VPCNC1.2, and management consistent with VPCNC2.1, will also protect intact vernal pool complexes from further alterations to natural hydrology.

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Goal VPCNC2: Vernal pool complexes that are managed and enhanced to sustain populations of native vernal pool species.
• **Objective VPCNC2.1**: Maintain or enhance vernal pool complexes to provide the appropriate inundation (ponding) characteristics for supporting and sustaining vernal pool species.

Objective VPCNC2.1 Benefits: This objective will provide the appropriate hydrological conditions for sustaining vernal pool species within the reserve system. Altered hydrology of vernal pool complexes can change the timing, frequency, or duration of vernal pool inundation, which can create conditions that render existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005, 2007). For example, vernal pool ecosystems have been altered by hydrologic barriers such as roads or canals. Vernal pool hydrology has also been altered by the diversion of urban runoff and agriculture, both of which increase pond timing and duration, converting vernal pools to perennial ponds that are incapable of supporting The conservation of 600 acres of large, interconnected tracts of vernal pool complex consistent with Objectives VPCNC1.1 and VPCNC1.2, and management consistent with VPCNC2.1, will protect intact vernal pool complexes from further alterations to natural hydrology.

3.3.5.35.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve vernal pool crustaceans within the reserve system.

Additional species-specific goals and objectives are only deemed necessary for the conservancy fairy shrimp because of this species' relative rarity (fewer than 50 occurrences throughout its range). Although longhorn fairy shrimp is also very rare (11 occurrences range-wide), there are no recorded occurrences of longhorn fairy shrimp in the Plan Area and the species is not expected to be affected by BDCP covered activities.

Goal VPC1: Protected occurrences of the rarest covered vernal pool crustacean species.
• **Objective VPC1.1:** Protect at least one currently unprotected occurrence of conservancy fairy shrimp.

Objective VPC1.1 Rationale: This objective will ensure that the rarest vernal pool crustacean species present in the Plan Area, the conservancy fairy shrimp, will be represented in the newly protected lands. As shown in Table 3.3-8, only 34 occurrences of this species are recorded range-wide; 12% of these are in the Plan Area (Figure 3.3-32). Currently 75% of the occurrences in the Plan Area are protected, but because the Plan Area includes a significant proportion of the range-wide occurrences for this rare species, protection of one additional occurrence is warranted. This will result in 100% protection of the known occurrences for Conservancy fairy shrimp. Table 3.3-9 depicts the occurrence of the vernal pool crustaceans in the Plan Area.

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Table 3.3-9. Covered Vernal Pool Crustacean Species Occurrences and Level of Protection

Species	Percentage of Range-Wide Occurrences in Plan Area	Percentage of Plan Area Occurrences Currently Protected	Species-Specific Objectives
California linderiella	3% (11/380)	36% (4/11)	none
Conservancy fairy shrimp	12% (4/34)	75% (3/4)	Protect one additional occurrence
Longhorn fairy shrimp	0% (0/11)	N/A	none
Midvalley fairy shrimp	6% (6/96)	33% (2/6)	none
Vernal pool fairy shrimp	2% (13/605)	85% (11/13)	none
Vernal pool tadpole shrimp	4% (11/252)	36% (4/11)	none

Consistency with Vernal Pool Recovery Plan

This section addresses BDCP consistency with the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2007) for vernal pool crustaceans, because the recovery plan provides very specific guidance for HCPs. All six of the covered vernal pool crustacean species are addressed in the recovery plan, which lists six elements that an HCP must incorporate to support implementation of the recovery plan for the covered area. Meeting these criteria is also expected to meet NCCPA requirements for these species. These six elements are indicated below (*italics*), and described as they relate to the BDCP.

1. *Permanently protected vernal pool preserves within the area covered by the Habitat Conservation Plan in large contiguous blocks of suitable habitat.*

   Consistent with Goal VPCNC1, the BDCP will result in a large, interconnected vernal pool reserve system in the Plan Area. This will be achieved by building off of the existing reserve system in the Plan Area. The Plan will add 600 acres to the 4,536 acres of vernal pool complex that are currently protected. A majority of the 600 acres is expected to be protected adjacent to existing protected land within the Jepson Prairie core recovery area.

2. *Protection of the entire genetic range of each listed species within the area covered by the Habitat Conservation Plan.*

   As described in the Vernal Pool Recovery Plan (page III-5), genetic composition has not been investigated for most of the vernal pool crustacean species; therefore, genetic diversity is assumed to be protected by protecting populations throughout each species' range. The core recovery areas identified in the recovery plan are distinct areas that provide geographic and/or genetic diversity necessary for recovery of the species (Vernal Pool Recovery Plan, page III-18). By focusing 600 acres of vernal pool complex protection within the Jepson Prairie and Altamont Hills core recovery areas, which are ranked as Recovery Zone 1 (highest priority) protection for vernal pool crustaceans, the BDCP will protect areas identified in the recovery plan as important for protecting the full range of genetic diversity throughout the range of those species identified in the recovery plan.

   The BDCP conservation strategy for vernal pool species is based on the assumption that the genetic range of each species in the Plan Area will be protected by protecting lands within different parts of the species' distribution in the Plan Area. The distribution of recorded

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occurrences for each species, in relation to lands that are already protected and are targeted for protection under BDCP, is described below and depicted in Figure 3.3-25 through Figure 3.3-30 and demonstrates that each species' range in the Plan Area will be well represented in the reserve system.

- **California linderiella**. Recorded occurrences for this species in Conservation Zones 1, 2, 10, and 11, and adjacent to Conservation Zone 4. Occurrences and habitat for this species is already protected in Conservation Zones 2 and 4, and the occurrence in Conservation Zone 10 is in a small, isolated habitat patch that is not likely to be viable for long-term protection and management, and is outside core recovery areas. Additional vernal pool complex will be protected within core recovery areas in Conservation Zones 1 and 11.
- **Conservancy fairy shrimp.** Recorded occurrences for this species are in two locations: within the Jepson Prairie core recovery area in Conservation Zones 1 and 11, and at the Tule Ranch unit of the DFG Yolo Basin Wildlife Area in Conservation Zone 2. The location for the Tule Ranch occurrences, and the modeled habitat for conservancy fairy shrimp in Conservation Zone 2, is already protected. Approximately 44% of the modeled habitat and three out of four of the conservancy fairy shrimp occurrences within the Jepson Prairie core recovery area, in Conservation Zones 1 and 11 are protected, and it is expected that the majority of the 600 acres of vernal pool complex protection will be focused in this area.
- **Longhorn fairy shrimp.** There are no recorded occurrences of longhorn fairy shrimp in the Plan Area, although there are occurrences southwest of the Plan Area near Conservation Zone 8. A portion of the 600 acres of vernal pool protection will occur within Conservation Zone 8.
- **Midvalley fairy shrimp.** There are recorded occurrences for this species in Conservation Zones 1, 2, 8, and 9, and adjacent to Conservation Zone 4. Occurrences and habitat for this species are already protected in Conservation Zones 2 and 4, and the occurrence in Conservation Zone 9 is in a small, isolated habitat patch that is not likely to be viable for long-term protection and management, and is outside core recovery areas. Additional vernal pool complex in core recovery areas will be protected in Zones 1 and 8.
- **Vernal pool fairy shrimp.** There are recorded occurrences of vernal pool fairy shrimp in Conservation Zones 1, 2, 4, 8, 9, 10, and 11 (Appendix 2.A, *Covered Species Accounts*). Occurrences in Conservation Zones 2 (Tule Ranch) and 4 (Stone Lakes area) are already protected. Occurrences in Zones 9 and 10 are in small, isolated habitat patches that are not likely viable for long-term protection and management, and are outside core recovery areas. Additional vernal pool complex will be protected in Zones 1, 8, and 11.
- **Vernal pool tadpole shrimp.** There are recorded vernal pool tadpole shrimp occurrences in Conservation Zones 1, 2, and 11, and adjacent to Zone 4. Occurrences and habitat for this species in Zones 2 and 4 are already protected, and the BDCP conservation strategy will protect additional vernal pool complex in Zones 1 and 11.

3. *Protection of all populations of species with 25 or fewer total occurrences addressed in this plan within the area covered by the Habitat Conservation Plan.*

   The only covered vernal pool crustacean species with 25 or fewer total occurrences is the longhorn fairy shrimp, and there are no records for this species in the Plan Area.

4. *Connectivity with other preserves within the area covered by the Habitat Conservation Plan.*

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The newly protected lands will be adjacent to existing protected lands, and will build on the existing reserve system to support recovery of vernal pool crustaceans in the Plan Area.

5. *Adaptive management of the preserves within the area covered by the Habitat Conservation Plan to support the species addressed in this recovery plan.*

   See Section 3.6, Adaptive Management and Monitoring Program.

6. *Sufficient funding for management, maintenance, and monitoring of the preserves in perpetuity.*

   See Chapter 8, Implementation Costs and Funding Sources.

In conclusion, BDCP addresses all of the six elements listed in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2007) for inclusion in HCPs for each of the covered vernal pool crustaceans.

3.3.5.36 Brittlescale and Heartscale

Brittlescale, also an annual herb, is found in alkali meadows and on the margins of scalds, slickspots, and vernal pools with alkaline clay soils (California Native Plant Society 2009). Species associated with brittlescale can include common spikeweed, saltgrass, alkali heath, low barley, Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), western niterwort (*Nitrophila occidentalis*), Parish's pickleweed (*Salicornia subterminalis*), bush seepweed, heartscale, and San Joaquin spearscale (*Atriplex joaquiniana*) (California Department of Fish and Game 2011; California Native Plant Society 2011). The reported CNDDB occurrences in Solano and east Contra Costa Counties are in close proximity to hydrological features such as stream corridors and playa pools. It is not known whether this association with hydrological features is a strict habitat requirement or a legacy of land management practices such as extensive dry-farmed grain and other intensive agriculture that avoid planting and cultivation of hydrological features, continuing to the present (Gerlach pers. comm.).

Brittlescale is endemic to California. The species' range extends from Colusa and Glenn Counties in the north, to Fresno, Merced, and Stanislaus Counties in the south and east, and to Alameda, Contra Costa, Solano, and Yolo Counties in the west (California Department of Fish and Game 2011; California Native Plant Society 2011). It is currently known from 59 occurrences, all of which are presumed to be extant. Some of the reported occurrences of heartscale may be misidentifications of lesser saltscale (*Atriplex minuscula*) (Preston 2003). Brittlescale is present in the Plan Area at three locations in Solano County: at Jepson Prairie, west of Bird's Landing, and near the east end of Hill Slough (Figure 3.3-37) (California Department of Fish and Game 2011).

The primary threat to brittlescale is the loss of suitable habitat within the range of the species (California Department of Fish and Game 2011). Other threats include livestock grazing and trampling (California Department of Fish and Game 2011), invasive species, and the periodic inundation of managed marshes to create habitat for waterfowl (Showers 1996).

Heartscale, an annual herb, is typically found in alkali grassland, alkali meadow, or iodine bush scrub with alkaline soils, usually near or on the margins of scalds, slickspots, and vernal pools. Heartscale is commonly associated with saltgrass (*Distichlis spicata*), low barley (*Hordeum depressum*), common spikeweed (*Hemizonia pungens* ssp. *pungens*), alkali heath (*Frankenia salina*), alkali weed (*Cressa truxillensis*), and bush seepweed (*Suaeda moquinii*) (California Department of Fish and Game 2011; California Native Plant Society 2011). It often co-occurs with other annual *Atriplex* species.

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Heartscale is endemic to California, ranging through the Central Valley from Glenn County in the north to Tulare County in the south (California Native Plant Society 2011). It has also been reported from valleys of the inner Coast Range in Alameda and San Luis Obispo Counties and from Kern County, although these reports are likely to be based on misidentifications (California Department of Fish and Game 2011). It is known from 49 confirmed occurrences (64 total), 13 of which have not been observed for more than 25 years. Ten of the occurrences are presumed to be extirpated, because habitat at the occurrence locations has been converted to intensive agriculture (California Department of Fish and Game 2009). Two occurrences are known from the Plan Area in Solano County: one adjacent to Calhoun Cut, the other near the east end of Hill Slough (Figure 3.3-38).

Reported threats to heartscale include agriculture intensification, development, nonnative plants, overgrazing, and trampling (California Department of Fish and Game 2011; California Native Plant Society 2011).

Because habitat loss and the potential effects of overgrazing are the primary stressors affecting heartscale and brittlescale, the conservation approach includes protecting and managing existing natural alkaline habitats occurrences in the Plan Area. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.36.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for brittlescale and heartscale are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objective L1.4 Benefits: Brittlescale and heartscale are known to occur within the alkaline seasonal wetland natural community. The microhabitat conditions required by heartscale appear to be different than those required by brittlescale. Therefore, preserving potential habitat with a range of environmental gradients would maximize the potential for preserving the soil, hydrologic, and elevational requirements for both species.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: One of the threats to these two plant species is invasive plants. The control and reduction in nonnative species cover on reserve lands are expected to benefit brittlescale and heartscale by increasing the availability of suitable habitat and reducing competition

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Note to Reader: This is a revised working draft prepared by the BDCP consultants. This document is currently undergoing review by the Department of Water Resources with input from the Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and U.S. Bureau of Reclamation and does not necessarily reflect the position of the state or federal agencies. It is expected to go through several more revisions prior to being released for formal public review and comment in 2012. All members of the public will have an opportunity to provide comments on the public draft of a revised version of this document during the formal public review and comment period. Responses will be prepared only on comments submitted in the formal public review and comment period.

3.3.5.36.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for brittlescale and heartscale are included below.

Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex.
• **Objectives ASWNC1.1:** Protect 150 acres of alkali seasonal in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

Goal VPCNC1: Vernal pool complexes comprised of large, interconnected or contiguous expanses that represent a range of environmental conditions.
• **Objective VPCNC1.1:** Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005). • **Objective VPCNC1.2:** Restore vernal pool complex in Conservation Zones 1, 8, and/or 11 to achieve no net loss of vernal pool acreage.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8 (adjacent to protected lands), at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.

Objectives ASWCNC1.1, VPCNC1.1, VPCNC1.2, and GNC1.1 Benefits: Brittlescale and heartscale are found primarily in association with the alkali seasonal wetland natural community. In the Plan Area, alkali seasonal wetland is found in small patches within the larger vernal pool/grassland matrix. Acres of vernal pool or grassland targeted for protection have a high potential to also include patches of alkali seasonal wetland and, therefore, suitable habitat for brittlescale and heartscale. Protecting suitable habitat may also include the protection of known or previously unknown occurrences. Vernal pool restoration also has the potential to protect suitable brittlescale and heartscale habitat, as some of the largest patches of degraded vernal pool habitat (which would be targeted for restoration) occur in Conservation Zone 11 and overlap significantly brittlescale and heartscale modeled habitat.

3.3.5.36.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for brittlescale and heartscale within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal BRIT/HART1: A reserve system that includes habitat and occurrences for brittlescale and heartscale.
• **Objective BRIT/HART1.1:** Of the protected alkali seasonal wetland complex, vernal pool complex, and grassland natural community, protect 150 acres of modeled or otherwise suitable brittlescale and heartscale habitat in Conservation Zones 1, 8, and 11.

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Objective BRIT/HART1.1 Rationale: Brittlescale and heartscale are primarily associated with the alkali seasonal wetland natural community; however, the habitat model for the species includes vernal pool, alkali seasonal wetland, and grassland natural communities. Because the modeled habitat for brittlescale and heartscale does not overlap completely with any one natural community, the targeted protection of modeled or suitable brittlescale and heartscale habitat will insure the protection of the range of habitat requirements that might not be captured in Objectives AWCNC1.1, VPCNC1.1, VPCNC1.2, and GNC1.1.

3.3.5.37 Caper-Fruited Tropidocarpum

The caper-fruited tropidocarpum, an annual herb, is endemic to California and was known historically from the west edge of the San Joaquin Valley near Mount Diablo. It may have been more widespread, based on a specimen from Glenn County and another from Fresno County. It was thought to have been extinct because it had not been observed since the last specimen was collected in 1962. However, recent specimens collected at Fort Hunter Liggett in southern Monterey County, in 2000 and 2001, have been identified as the caper-fruited tropidocarpum (Hickman 1993; Al-Shehbaz 2003; California Department of Fish and Game 2011; California Native Plant Society 2009). The caper-fruited tropidocarpum has been found in valley and foothill grassland habitats in moderately alkaline soils (California Native Plant Society 2009) or, on Fort Hunter Liggett, also in foothill oak woodland habitats on slightly alkaline clay soils (California Department of Fish and Game 2011).

Within the Plan Area, the caper-fruited tropidocarpum was observed historically at six locations between Byron and the City of Tracy (California Department of Fish and Game 2011; Consortium of California Herbaria 2009). Three of these six occurrences are listed as extirpated and the other three occurrences are listed as possibly extirpated. There are also three CNDDB occurrences of the caper-fruited tropidocarpum located just outside the Plan Area, two of which are listed as extirpated and one of which is listed as presumed extant (Figure 3.3-39).

Based on land use patterns in the Plan Area, most historical effects on the caper-fruited tropidocarpum appear to have occurred through intensive agriculture and urbanization or other development activities. Recently reported threats to the caper-fruited tropidocarpum in Monterey County are grazing, military activities, trampling, and nonnative plants (California Native Plant Society 2009).

USFWS has not prepared a recovery plan for this species and no recovery goals have been established. Because habitat loss has been the primary stressor on the caper-fruited tropidocarpum, the conservation approach for this species is to secure potential habitat within the species' known range in anticipation of its future rediscovery. Protected habitat would also provide an opportunity to potentially reintroduce the species from the population in Monterey County. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.37.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the caper-fruited tropidocarpum are included below.

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Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objectives L1.4 and L2.7 Benefits: Because habitat loss has been the primary stressor on the caper-fruited tropidocarpum, protecting large landscapes, particularly those containing the grassland natural community consistent with Objective GNC1.1, is the most important biological goal for this species. Although the general type of habitat is known for this species (i.e., alkaline grasslands), the microhabitat conditions required for this species are unknown. Therefore, preserving grasslands with a range of environmental gradients will maximize the potential for preserving caper-fruited tropidocarpum habitat.

3.3.5.37.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the caper-fruited tropidocarpum are included below.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8, at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.

Objective GNC1.1 Benefits: The western edge of Conservation Zone 8, in the grassland area west of the Byron Highway, includes the majority of historic caper-fruited tropidocarpum occurrences in the Plan Area. The protection of grasslands in alkaline soils in this area is most likely to include suitable habitat for this species.

Goal GNC2: Biologically diverse grasslands that are managed to enhance native species and sustained by natural ecological processes.
• **Objective GNC2.1:** Restore and sustain a mosaic of grassland vegetation alliances, reflecting localized water availability, soil chemistry, soil texture, topography, and disturbance regimes, with consideration of historical states. • **Objective GNC2.2:** Increase the extent, distribution, and density of native perennial grasses intermingled with other native species, including annual grasses, geophytes, and other forbs.

Objectives GNC2.1 and GNC2.2 Benefits: The protected grasslands will be restored, managed and enhanced to increase relative cover of native species, consistent with Objective L4.2. This will involve controlling invasive nonnatives, as described in CM11 *Natural Communities Enhancement and Management*, which is expected to benefit the caper-fruited tropidocarpum by reducing competition for space, nutrients, water, and light.

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3.3.5.37.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for caper-fruited tropidocarpum within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal CFT1: A reserve system that includes suitable habitat for the caper-fruited tropidocarpum.
• **Objective CFT1.1:** Of the grassland acres to be protected in Conservation Zones 7 and 8, include at least 250 acres in moderately alkaline soils with suitable habitat for the caper-fruited tropidocarpum.

Objective CFT1.1 Rationale: Very little suitable habitat for the caper-fruited tropidocarpum remains in the Plan Area, except for some areas in the remaining intact grassland areas along the western border of Conservation Zones 7 and 8, in eastern Contra Costa and Alameda Counties (Figure 3.3-39). If this species can be recovered through protection or possibly reintroduction, then suitable habitat must be secured and managed. Grassland conservation in the southwestern portion of Conservation Zone 8 and the northwestern portion of Conservation Zone 7 will be closest in proximity to the only CNDDB occurrence of the species in or near the Plan Area that is listed as presumed extant. All other occurrences are listed as extirpated or possibly extirpated (California Department of Fish and Game 2011).

3.3.5.38 Carquinez Goldenbush

The Carquinez goldenbush is known only from a very limited geographic range in Solano County, California (Nesom 1991; Hickman 1993; California Department of Fish and Game 2011; California Native Plant Society 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; California Native Plant Society 2009; Natural Resources Conservation Service 2009). This narrowly endemic species is found along seasonal drainages or adjacent to the margins of alkaline playas in association with vegetation that is transitional between the brackish marsh and the grasslands within the 3.4- to 4.3-meter North American Vertical Datum of 1988 (NAVD88) elevation band along the eastern border of Suisun Marsh.

There are 13 presumed extant occurrences of the Carquinez goldenbush found throughout its limited range north and west of the Montezuma Hills in Solano County, nine of which are within the Plan Area. Three of the nine occurrences are in Conservation Zone 1 on the western edge of the Plan Area: two of these are on Jepson Prairie and the third is north of Jepson Prairie. The remaining six occurrences are in Conservation Zone 11, along the northern and eastern edge of the Suisun Marsh area (Figure 3.3-40). Four of the nine occurrences in the Plan Area are protected: one in Conservation Zone 1 and three in Conservation Zone 11.

The continued persistence of the Carquinez goldenbush is threatened by agricultural land conversion, grazing, road widening, and development (California Native Plant Society 2009). The conservation strategy will minimize these threats through the protection of existing or previously undiscovered occurrences of the Carquinez goldenbush and the management of reserve lands to minimize the effects of grazing on ephemeral drainages. The conservation approach for Carquinez goldenbush is to protect grassland, alkali seasonal wetland complex, and vernal pool complex

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natural communities within the narrow geographic, elevation, and edaphic requirements of this species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.38.1 Applicable Landscape-Scale Goals and Objectives

While the landscape goals and objectives will provide broad-based benefits to the ecosystems upon which Carquinez goldenbush depends, none are integral to the conservation strategy for this species.

3.3.5.38.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the Carquinez goldenbush are included below.

Goal GNC1: Extensive grasslands comprised of large, interconnected patches or contiguous expanses.
• **Objective GNC1.1:** Protect a minimum of 8,000 acres of grassland with at least 2,000 acres protected in Conservation Zone 1, at least 1,000 acres in Conservation Zone 8 (adjacent to protected lands), at least 2,000 acres protected in Conservation Zone 11, and the remainder distributed among Conservation Zones 1, 7, 8, and 11.

Goal ASWNC1: A reserve system including alkali seasonal wetland complex within a mosaic of grasslands and vernal pool complex.
• **Objective ASWNC1.1:** Protect 150 acres of alkali seasonal wetland in Conservation Zones 1, 8, and/or 11 among a mosaic of protected grasslands and vernal pool complex.

Goal VPCNC1: Vernal pool complexes comprised of large, interconnected, or contiguous expanses that represent a range of environmental conditions.
• **Objective VPCNC1.1:** Protect 600 acres of existing vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (U.S. Fish and Wildlife Service 2005).

Objectives GNC1.1, ASWNC1.1, and VPCNC1.1 Benefits: Carquinez goldenbush modeled habitat and existing, unprotected occurrences are in the grassland, alkali seasonal wetland, and vernal pool complex natural communities along the northern and eastern border of Suisun Marsh and in the grassland and vernal pool complex natural communities in the Jepson Prairie area of Conservation Zone 1. The protection of these natural communities in Conservation Zones 1 and 11 will benefit the Carquinez goldenbush by removing primary threats and protecting existing, unprotected occurrences or lands that may have undiscovered populations. Improved management on these protected lands will further remove threats of overgrazing. The consideration of grazing control in ephemeral drainages in the grassland matrix is discussed in CM11 *Natural Communities Enhancement and Management*.

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3.3.5.38.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for Carquinez goldenbush within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal CGB1: A reserve system that includes Carquinez goldenbush occurrences and sustains suitable habitat for this species.
• **Objective CGB1.1:** Protect at least three unprotected occurrences of the Carquinez goldenbush in Conservation Zones 1 and/or 11. • **Objective CGB1.2**: Maintain and enhance occupied Carquinez goldenbush habitat to slow erosion and reverse degradation from livestock grazing.

Objective CGB1.1 Rationale: Of the 13 known occurrences in this species' small range, nine are located in Conservation Zones 1 and 11. Of these, four are currently protected and five are currently unprotected. This species is narrowly endemic to areas within and just outside of the Plan Area (Figure 3.3-40); therefore, it is substantially reliant on conservation within the Plan Area to achieve recovery. Although BDCP implementation is not expected to affect extant occurrences of the Carquinez goldenbush, protection efforts will be directed to Carquinez goldenbush occurrences to contribute to species recovery.

Objective CGB1.2 Rationale: The main stressors on the Carquinez goldenbush are overgrazing and trampling by livestock and the erosion of alkaline soils that are critical to the species. The reserve system lands that include grassland, vernal pool complex, and alkali seasonal wetlands will be grazed to maintain their ecological function. While ecologically managed range is correlated with increased densities of most of the covered species dependent on these communities, grazing within and near ephemeral drainages has the potential to degrade habitat for Carquinez goldenbush. Those parts of the reserve that include Carquinez goldenbush will be managed to maintain and enhance the specific soil and hydrologic characteristics that benefit this species; specifically, alkaline soils around ephemeral drainages. Grazing in the grassland, vernal pool, and alkali seasonal wetland matrix will be managed as described in CM11 *Natural Community Enhancement and Management*.

3.3.5.39 Delta Button Celery

Delta button celery, an annual/perennial herb, is found in vernally mesic depressions within floodplains. Soils where this species is found are generally clay, but flood-deposited sand and silt may also be present. The wetland hydrology of delta button celery habitat includes inputs both from precipitation and from overland flood flows during flood events. Delta button celery plants are prostrate and root at the nodes, a unique feature among California button-celery species, and which may be a mechanism for anchoring the plants against the effects of flooding.

Delta button celery is endemic to the San Joaquin Valley (NatureServe 2008) with a historical distribution that includes San Joaquin County to the north, Stanislaus and Merced Counties to the south, Contra Costa County to the west, and Calaveras County to the east. The species is found within the historic floodplain of the San Joaquin River. Delta button celery is still found throughout its historical range, with the greatest density of occurrences in Merced County. There are 26 known, extant occurrences of delta button celery in the state, six of which are "possibly extirpated"

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(California Department of Fish and Game 2011), and two of which may have been incorrectly identified (Preston pers. comm.). San Joaquin County occurrences, which are located within and just outside the Plan Area, represent the northern-most extent of the species range. The two occurrences of the delta button celery in the Plan Area are on the alluvial plain of Kellogg and Marsh Creeks immediately west of Discovery Bay, and along the San Joaquin River northeast of Tracy (Figure 3.3-41); both occurrences are unverified and listed as possibly extirpated in the CNDDB.

Historical stressors and ongoing threats to this species include agricultural habitat conversion, flood control, overgrazing, dredging, and invasion of habitat by nonnative plant species (California Department of Fish and Game 2008; NatureServe 2008).

The conservation strategy for delta button celery includes floodplain restoration and active reestablishment of delta button celery occurrences within floodplain restoration areas of the San Joaquin River (Conservation Zone 7). Any populations that become established in the reserve system will be managed to control invasive, nonnative competitors. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.39.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for delta button celery are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.2:** Allow natural flooding to promote fluvial processes, such that bare mineral soils are available for natural colonization of vegetation, and cause fresh deposits of sediments (i.e., fine sands and silt). • **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.2 Benefits: The delta button celery historically relied on overland river flow, and the resulting mesic depressions, to create the necessary wetland hydrology. Floodplain restoration in Conservation Zone 7, as discussed in CM5 *Seasonally Inundated Floodplain Restoration*, will directly benefit this species. As levees are breached and flood flows are allowed to once again connect with clay depressions within the floodplain, suitable habitat for delta button celery is likely to be created. If delta button celery occurrences are restored within the new floodplain area, the control of nonnative, invasive species will be an important management requirement to maintain and enhance the species.

Objective L2.7 Benefits: Invasion of habitat by nonnative plant species is a stressor for this species (California Department of Fish and Game 2008; NatureServe 2008). Consistent with this objective, and as described in CM11 *Natural Communities Enhancement and Management*, delta button celery populations that become established in the Plan Area will be monitored and invasive species that threaten these populations will be controlled.

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3.3.5.39.2 Applicable Natural Community Goals and Objectives

No natural community biological goals and objectives are integral to the delta button celery conservation strategy.

3.3.5.39.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for delta button celery within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal DBC1: Expand the distribution and increase the abundance of delta button celery populations.
• **Objective DBC1.1:** Establish two occurrences of delta button celery within the restored floodplain habitat on the mainstem of the San Joaquin River in Conservation Zone 7 between Mossdale and Vernalis.

Objective DBC1.1 Rationale: Although delta button celery may be extirpated from the Plan Area, the restoration of floodplain habitat on the main stem of the San Joaquin River provides an opportunity to expand and reestablish suitable habitat for the species. This will provide opportunities to reintroduce occurrences of delta button celery to the Plan Area. If new occurrences are found (or rediscovered), additional floodplain habitat will help to ensure that the species is maintained in the Plan Area. Reestablishment of the species within its historic range in the Plan Area will contribute to the species' recovery.

Germination of delta button celery from a persistent seed bank is also possible in restored areas. Absent natural recruitment, active seeding or transplanting will be necessary to ensure the species' reestablishment in the Plan Area. Although reintroduction of this species in natural habitat is untested, the species was cultivated successfully from seed in a greenhouse as part of a taxonomic study performed in the 1970s (Sheikh 197X).

3.3.5.40 Delta Mudwort and Mason's Lilaeopsis

The delta mudwort, an annual, stoloniferous[24] herb, grows on intertidal flats and muddy banks of watercourses in estuarine areas, surrounded by brackish or freshwater marsh and riparian scrub vegetation. Occasionally, it can be found along the edges of tule marshes (Witham and Kareofelas 1994). It has been observed associated with or near Mason's lilaeopsis, Delta tule pea, and Suisun Marsh aster (Witham and Kareofelas 1994; May & Associates 2005). Salinity of approximately 7 ppt or greater may be unsuitable for delta mudwort: in sites above this salinity threshold, the species exhibits substantially reduced flowering and seed germination rates (Golden and Fiedler 1991; Fiedler and Zebell 1993; Zebell and Fiedler 1996).

In California, the delta mudwort is found only in the Sacramento–San Joaquin Delta region. Its range extends from Solano County in the north, to San Joaquin County in the south, to Contra Costa County in the west, and to Sacramento County in the east. Outside of California, it can be found in British Columbia, on the east coast of North America, and in Europe (Hickman 1993). On the east coast of the United States, it is threatened by habitat destruction (California Native Plant Society 2008).

[24] Having long stems or runners that can become new plants.

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All 56 known occurrences of the delta mudwort in California are located in the Plan Area (Figure 3.3-42). It has been observed in the tidal zone along Calhoun Cut and Barker Slough (Witham and Kareofelas 1994), in the Miner Slough Wildlife Area, along Montezuma Slough, near Three Mile Slough, at Brown's Island, and near Collinsville (California Department of Fish and Game 2011).

Delta mudwort is threatened by habitat destruction, including hydrologic alterations, and recreational activities such as boating, which creates wakes that erode banks and shorelines. Fishing and hunting access also pose a threat to this species (Witham and Kareofelas 1994). Petroleum product spills could have a significant impact on tidal flat biota, and nonbiodegradable litter such as plastics could collect near the tidal drift line, inhibiting plant establishment and growth (Witham and Kareofelas 1994).

Mason's lilaeopsis, a perennial, rhizomatous herb, is found in relatively unvegetated areas in brackish or 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; California Department of Fish and Game 2000; California Native Plant Society 2008). Within the Delta, Mason's lilaeopsis is not found upstream of the extent of active tidal fluctuation (B. Grewell, pers. comm. as cited in Suisun Ecological Workgroup 1997). It is a colonizing species that establishes on newly deposited or exposed sediments (California Native Plant Society 2008). It is occasionally found distributed among riprap-lined levees (Golden and Fiedler 1991) and along the edges of tule marshes (Witham and Kareofelas 1994; May & Associates 2005). Although it is often found on low tidal flats on clayey or silty soils (Witham and Kareofelas 1994), it does not appear to be substrate-specific, as it occurs on a range of substrates, including organic mucks, silty clays, and even pure sand (Golden and Fiedler 1991). It has been found in areas with high soil salinity, but those sites might not be optimum habitat (Fiedler and Zebell 1993). In the sloughs that radiate westward into Solano County at the southern end of the Sacramento River DWSC, it grows in a narrow band between the mudflats and mesic terrestrial vegetation (Meisler 2002). In Suisun Marsh and other places, Mason's lilaeopsis is predominantly associated with California tule, annual tule, and three-ribbed arrowgrass (*Triglochin striata*) (B. Grewell pers. comm. as cited in Suisun Ecological Workgroup 1997; May & Associates 2005; California Department of Fish and Game 2011).

Mason's lilaeopsis is endemic to the Sacramento–San Joaquin Delta, Suisun Marsh, and eastern San Pablo Bay, including the Napa River. Mason's lilaeopsis is found throughout Suisun Marsh, dotting the edges of Suisun, Hill, Duck, Montezuma, and Nurse Sloughs as well as the outer edge of Suisun Marsh, along the edges of tidal habitat that lines Grizzly Bay and Suisun Bay (Figure 3.3-43) (California Department of Fish and Game 2011). Because Mason's lilaeopsis was not described until 1977, (Mathias and Constance 1977), its historical distribution is unknown. Most of the known occurrences have been documented in the last 25 years. The species' current range extends from Napa and Solano Counties in the north, to Contra Costa and Alameda Counties in the south, and Sacramento and San Joaquin Counties in the east (Goals Project 2000; California Department of Fish and Game 2011).

According to the CNPS (2008), occurrences of Mason's lilaeopsis in California are rare and the species is at serious risk throughout its range. Population trends of Mason's lilaeopsis have not been documented. Occurrences are subject to tidal action so the extent of occupied habitat is in constant flux. Therefore, it is difficult to directly assess population trends, and the best approximation is to assess the extent of potential habitat. Surveys in Solano County found that Mason's lilaeopsis had

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declined because its habitat along the margins of small islands in the sloughs had decreased as the islands shrank in size (Meisler 2002).

Threats to Mason's lilaeopsis are varied, but the primary threat is the loss of marsh and floodplain habitat. There are numerous processes and activities that threaten this habitat, including erosion, channel stabilization, levee maintenance and construction, flood-control improvements, dredging, dumping spoils, agriculture, recreation, and water quality changes (California Native Plant Society 2008; California Department of Fish and Game 2011). Bank erosion caused by boat wakes removes habitat for the species, yet measures to limit bank erosion, such as placement of riprap, prevent the species from recolonizing. Other threats include recreational activities (trampling) and invasion by exotic species such as water hyacinth, giant reed, and yellow flag iris (California Department of Fish and Game 2011). A long-term threat is the stabilization of banks and mudflats resulting from highly regulated water flow regimes, which can cause floodplain habitat to be less dynamic (Fiedler and Zebell 1993).

Because habitat loss is the primary stressor on Mason's lilaeopsis and delta mudwort, protecting, enhancing, and restoring natural tidal communities is expected to help maintain and potentially increase the abundance and distribution of these species. Conservation of Mason's lilaeopsis and delta mudwort will rely upon the restoration of a minimum of 4,800 acres of tidal brackish emergent wetland and 13,900 acres of tidal freshwater emergent wetland and associated channel margin habitat in the Plan Area (Figure 3.3-36 and Figure 3.3-37). The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.40.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for Mason's lilaeopsis and delta mudwort are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.8:** Produce sinuous, high density, dendritic networks of tidal channels through tidal areas to promote effective exchange throughout the marsh plain and provide foraging habitat for covered fish species. • **Objective L2.11:** Restore or create at least 20 linear miles of transitional intertidal areas including tidal mudflat natural community and patches of subtidal and lower marsh.

Objectives L1.3, L1.4, and L2.8 Benefits: The primary threat to the Mason's lilaeopsis and delta mudwort is the loss and degradation of tidal marsh and floodplain; in particular, the loss of lower

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marsh areas at the edge of the vegetated marsh plain, between the marsh and the tidal mudflat. The restoration of tidal wetlands will return natural tidal processes to portions of the Delta that had previously been disconnected from tidal flow by levees and tide gates. By opening levees, and in some cases actively restoring natural communities (e.g., grading, introducing sediment, planting native marsh vegetation), a more natural tidal channel form will be returned to large patches of marsh habitat, within the previously disconnected portions of the marsh and along the existing tidal slough. Tidal restoration will result in a net increase in elevation diversity caused by natural scour and erosion processes, which will increase the quantity and the quality of the lower marsh habitat used by Mason's lilaeopsis and delta mudwort. This increase in habitat availability is expected to increase the number of occurrences and the total population sizes of these species, contributing to species recovery.

Objective L2.11 Benefits: The restoration of intertidal habitat along long, linear stretches of channelized river and stream segments is detailed in CM6 *Channel Margin Enhancement.* Restoration includes seeding and out-planting elevated benches on the outboard (stream) side of the existing levees with riparian and marsh vegetation. This vegetation will likely replace riprap or other hardscape features meant to reduce erosion but which have also removed much of the lower marsh niche habitat used by Mason's lilaeopsis and delta mudwort. The placement of vegetation in the stream channel will increase the natural deposition of sediment, thereby restoring the muddy and sandy banks colonized by these two plant species.

3.3.5.40.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for Mason's lilaeopsis and delta mudwort are included below.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.
• **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11. • **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them. • **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition. • **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1, TBEWNC1.2, and TBEWNC1.3 Benefits: While both Mason's lilaeopsis and delta mudwort have known occurrences in or near Suisun Marsh, where the majority of tidal brackish marsh occurs in the Plan Area, Mason's lilaeopsis is by far more common. This is attributed to the suspected low salinity tolerance of the delta mudwort. Most of the tidal brackish marsh habitat in Suisun Marsh is behind tidal gates, cut off from the natural tidal cycle. Former slough habitat has been largely replaced by ditches and canals that have little spatial heterogeneity because the natural sediment scour and depositional process has been lost along with tidal inundation. The restoration of the tidal marsh natural community in Suisun Marsh will reconnect the marsh plain to tidal inundation and restore a more natural tidal slough form. Because of the large number of

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Mason's lilaeopsis occurrences in this area, the species' propagules or floating seed are expected to quickly colonize restored habitats created by more natural inundation patterns. See CM4 *Tidal Natural Communities Restoration* for more information on the process and expected outcomes of tidal restoration in Suisun Marsh.

Objective TBEWNC1.4 Benefits: The benefits of this objective for Mason's lilaeopsis and delta mudwort are expected to be the same as that for Delta tule pea and Suisun Marsh Aster (see Section 3.3.5.41 *Delta Mudwort and Mason's Lilaeopsis*.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.

Objective TFEWNC1.1 Benefits: Mason's lilaeopsis is more abundant in brackish areas while the delta mudwort is more abundant in freshwater areas; however, both have known occurrences within the western, central, and eastern portions of the Delta. As in Suisun Marsh, the reconnection of large portions of leveed marsh to tidal inundation is expected to increase the quantity and quality of tidal slough habitat, where the species colonize the marsh/tidal mudflat edge habitat.

The habitat colonized by Mason's lilaeopsis and delta mudwort—the narrow transition zone between the tidal perennial aquatic natural community and the brackish and freshwater tidal emergent wetland natural communities, and the sediment depositional areas along artificial and natural levees in the valley/foothill riparian natural community—is difficult to accurately model and measure to predict restoration outcomes with any accuracy. However, suitable microhabitat for these two species is expected to be created throughout tidal wetland restoration sites, as well as along the margins of restoration sites where remnant levees remain and become islands. The proposed strategy for these plants capitalizes on multiple restoration types in varied geographic locations throughout the Plan Area to achieve abundant diverse and widely distributed pockets of potential habitat. The rate of plant colonization and succession on these newly restored habitats will depend on the supply of propagules and therefore the distance to parent plants; the more proximate a newly created habitat is to existing occurrences, the more likely that it will be colonized.

3.3.5.40.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for Mason's lilaeopsis and delta mudwort within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal DMW/ML1: A reserve system that supports Mason's lilaeopsis and delta mudwort.
• **Objective DMW/ML1.1:** No net loss of Mason's lilaeopsis and delta mudwort occurrences within the restoration footprint, or the area of affected tidal range, of BDCP restoration projects.

Objective DMW/ML1.1 Rationale: CM4 *Tidal Natural Communities Restoration* and CM6 *Channel Margin Enhancement* will, in the long term, benefit Masons' lilaeopsis and delta mudwort by increasing the quantity and quality of currently degraded habitat. However, during project implementation, individual plants or entire occurrences may be lost because of the placement of sediment or construction materials atop existing occurrences or because of the desiccation caused

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by the localized reduction in tidal range back to historical conditions. The no-net-loss standard is appropriate to apply to these species, because, although they are rare, they are widely distributed throughout the Plan Area and have a reproductive strategy conducive to passive restoration. In other words, although they could experience some short-term habitat or occurrence loss, their distribution and abundance are expected to significantly increase with restoration of tidal and nontidal marsh natural communities. This outcome has a high degree of certainty due to the ease of propagation of these species and the already widespread distribution in similar habitats throughout the Plan Area.

3.3.5.41 Delta Tule Pea and Suisun Marsh Aster

The Delta tule pea, a perennial herb, occurs on the borders of fresh and brackish marshes from zero to 13 feet in elevation (Grewell et al. 2007; California Native Plant Society 2008). It has been observed to co-occur with or near other BDCP covered plant species such as soft bird's-beak, Mason's lilaeopsis, Suisun Marsh aster, and delta mudwort (California Department of Fish and Game 2011).

The range of the Delta tule pea extends 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. The Delta tule pea is endemic to California, and its distribution is based on 207 observations (Calflora 2007). It was reported as common in Suisun Marsh in 1894 and 1911, but today it is considered occasional to rare. It occurs throughout the legal Delta (California Department of Fish and Game 2008) and along the Napa River (Dutchman Slough) (Goals Project 2000).

Within the Plan Area, there are occurrences of Delta tule pea at and immediately above the tidal zone in marshes and along rivers and streams (Figure 3.3-44). It has been observed near Hass Slough, Snodgrass Slough, Lost Slough, on Ryer Island, Staten Island, Andrus Island, Bouldin Island, Rough and Ready Island, Browns Island, Winter Island, on the banks of the Middle River by the Upper and Lower Jones tracts, and near Collinsville and Pittsburgh, among other locations throughout the Delta (California Department of Fish and Game 2011). It also occurs in the tidal zone along Calhoun Cut and Barker Slough (Witham and Kareofelas 1994) in the Cache Slough area and is found throughout all major tidal slough channels in Suisun Marsh (California Department of Fish and Game 2011).

The primary threat to the Delta tule pea is the loss of marsh and floodplain habitat in the species' range. This habitat can be eliminated or degraded by agriculture, water diversions, and erosion (California Native Plant Society 2008). Trampling from fishing and hunting access also pose a threat to this species (Witham and Kareofelas 1994).

The Suisun Marsh aster, a rhizomatous perennial herb, grows on the upper margins of brackish and freshwater marshes in the ecotone with terrestrial habitats (Goals Project 2000) and above erosional cuts and along the banks of sloughs and watercourses, often occurring with common reeds, cattails, bulrushes, and blackberry (Witham and Kareofelas 1994; May & Associates 2005). A 1994 report from the Calhoun Cut Ecological Reserve noted that many occurrences of Suisun Marsh aster were in relatively shaded areas either along north-facing banks or under overhanging trees (Witham and Kareofelas 1994). It has been observed in close proximity to other rare plant species, including Mason's lilaeopsis, Delta tule pea, delta mudwort, and soft bird's-beak (Goals Project 2000; California Native Plant Society 2008; California Department of Fish and Game 2011).

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The range of Suisun Marsh aster extends from Napa and Solano Counties in the north, to San Joaquin County in the south, to Contra Costa County in the west, and Sacramento County in the east. It is endemic to Suisun Marsh and the Sacramento–San Joaquin Delta (California Department of Fish and Game 2011; California Native Plant Society 2008). Historically, it was known from marshes in the East Bay portion of San Francisco Bay (California State Coastal Conservancy 2003) and the Sonoma and Napa Rivers (Goals Project 2000).

Within the Plan Area, the Suisun Marsh aster occurs in tidal areas throughout the west and central Delta and Suisun Marsh with scattered occurrences in the north and south Delta (Figure 3.3-45). Suisun Marsh aster occurs at the upper margin and immediately above the tidal zones of fresh and brackish marshes and along rivers and creeks. It has been observed on Andrus Island, Terminous Tract, Rindge Tract, Bethel Island, Franks Tract, and near Collinsville and Antioch, among other locations in the Plan Area (California Department of Fish and Game 2008). Many small occurrences are known from along Baker Slough and Lindsey Slough on the Calhoun Cut Ecological Reserve (Witham and Kareofelas 1994). The Suisun marsh aster is ubiquitous throughout Suisun Marsh, occurring in all major tidal slough channels (California Department of Fish and Game 2011).

Historically, the marsh habitat suitable for Suisun Marsh aster has been lost mostly through development, dredge disposal, agricultural conversion, and diking. 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 extremes of inundation and dryness in diked wetlands (Goals Project 2000). Such habitat losses from human activities still occur, but many of the large marshes are now protected or are zoned to restrict development. Current threats to Suisun Marsh aster include invasive plants, erosion, creek channelizing, levee maintenance and construction, and possibly herbicide applications (California Department of Fish and Game 2008; California Native Plant Society 2008).

Because habitat loss and exotic species are the primary stressors on the Delta tule pea and Suisun Marsh aster, protecting, enhancing, and restoring tidal natural communities will help maintain and potentially increase the abundance and distribution of these species. Conservation of the Delta tule pea and Suisun Marsh aster is expected to benefit substantially from the restoration of 4,800 acres tidal brackish emergent wetland and 13,900 acres of tidal freshwater emergent wetland and associated channel margins in the Plan Area (Figure 3.3-38 and Figure 3.3-39). The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.41.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for Delta tule pea and Suisun Marsh aster are included below.

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Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.3:** Restore or create at least 72,809 acres of natural communities, including at least 65,000 acres of tidally influenced natural communities. • **Objective L1.4:** Include a variety of environmental gradients (e.g., hydrology, elevation, soils, slope, and aspect) within and across a diversity of protected and restored natural communities.

Objectives L1.3 and L1.4 Benefits: The Delta tule pea and Suisun Marsh aster are found throughout the tidal regions of the Plan Area. Tidal natural community restoration will include breaching previously leveed marsh habitat and restoring the historical tidal connection. By restoring tidal inundation, plant propagules and seeds will be carried into newly restored (and previously inaccessible) areas, thus increasing the potential habitat. In addition, restored natural communities will include topographic heterogeneity, which will diversify inundation patterns and niche habitats for these species. This diversity of environmental conditions is expected to increase the quality of habitat, both within the restored marsh areas, but also in the tidal slough natural communities outside restored areas. Increasing available habitat through Objectives L1.3 and L1.4 will increase opportunities for natural and artificial colonization of Delta tule pea and Suisun Marsh aster and is expected to increase the number of occurrences in the Plan Area, increase the range of the species, and increase total population size, thereby contributing substantially to species recovery.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.11:** Restore or create at least 20 linear miles of transitional intertidal areas including tidal mudflat natural community and patches of subtidal and lower marsh.

Objective L2.11 Benefits: The restoration of intertidal habitat along long, linear stretches of channelized river and stream segments is detailed CM6 *Channel Margin Enhancement.* Restoration will include seeding and out-planting elevated benches on the outboard (stream) side of the existing levees with riparian and marsh vegetation. This vegetation will likely replace riprap or other hardscape features meant to reduce erosion but which have also removed much of the lower marsh habitat used Delta tule pea and Suisun marsh aster. The placement of vegetation on these benches will increase the mudflat and lower and upper marsh areas known to be used by these species. Increasing available habitat through Objective L2.11 will increase opportunities for natural and artificial colonization of Delta tule pea and Suisun Marsh aster and is expected to increase the number of occurrences in the Plan Area, increase the range of the species, and increase total population size, thereby contributing substantially to species recovery.

3.3.5.41.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the Delta tule pea and Suisun Marsh aster are included below.

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Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1, TBEWNC1.2, and TBEWNC1.3 Benefits: Known occurrences of the Delta tule pea and Suisun Marsh aster are widely distributed throughout Suisun Marsh (California Department of Fish and Game 2011). Most of the tidal brackish marsh habitat in Suisun Marsh is behind tidal gates, cut off from the natural tidal cycle. Former slough habitat has been largely replaced by ditches and canals that have low spatial heterogeneity because the natural sediment scour and depositional process has been lost along with tidal inundation. The restoration of tidal brackish emergent wetland natural community will reconnect the marsh plain to tidal inundation and restore a more natural hydrologic regime to tidal sloughs. Because of the abundance of Delta tule pea and Suisun Marsh aster occurrences in Suisun Marsh, and the known propagation success of these two species, it is expected that these newly restored areas will be easily colonized by both species. Therefore, the increase in quantity and quality of tidal brackish marsh in Suisun Marsh is expected to increase the number of occurrences, distribution, and rangewide population of these species in Suisun Marsh. See CM4 *Tidal Natural Communities Restoration* for more information on the process and expected outcomes of tidal natural community restoration in Suisun Marsh.

Objective TBEWNC1.4 Benefits: One of the natural results of restoring tidal inundation to large patches of formerly leveed marsh is the localized muting of the tidal range (elevation range between high and low tide). When the marsh plain was disconnected from tidal inundation, the tidal waters had nowhere to go, so tidal range was artificially increased. When levees are breached and tidal inundation is restored, tidal ranges are expected return to a more natural state. This anticipated, localized effect has the potential to "strand" patches of Delta tule pea and Suisun Marsh aster stands that have adapted to the artificially high tidal range at the margins of tidal restoration areas. When tides return to normal levels following levee breaches, plants above the new tidal range may experience water stress or die. To minimize the effects on the species, phased restoration will limit the effects on certain patches in the marsh, leaving other populations or stands undisturbed. This will create the loss of individuals in some portions of the marsh, leaving occurrences unaffected in others. These unaffected occurrences will be important as parent plants, producing the propagules and seeds needed for recolonization.

Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.

- **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.

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Objective TFEWNC1.1: Delta tule pea and Suisun Marsh aster occur in the western, central, eastern, and, to a lesser extent, southern portions of the Delta. Like restoration in Suisun Marsh, the reconnection of large portions of leveed marsh to tidal inundation will increase the quantity and quality of tidal slough and marsh habitat where these species occur. However, while a significant benefit is anticipated, the acreages of beneficial habitat were not calculated, because microhabitats could not be mapped or estimated. The proposed strategy for these plants capitalizes on multiple restoration types in varied geographic locations throughout the Plan Area to achieve diverse and widely distributed pockets of potential habitat. However, the actual rate of plant colonization and succession on these newly restored habitats will depend on the supply of propagules and therefore the distance to clonal plants; the closer a newly created habitat is to existing occurrences, the more likely it will be to become colonized.

3.3.5.41.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for Delta tule pea and Suisun Marsh aster within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal DTP/SMA1: A reserve system that supports the Delta tule pea and Suisun Marsh aster.
• **Objective DTP/SMA1.1:** No net loss of Delta tule pea and Suisun Marsh aster occurrences within restoration sites.

Objective DTP/SMA1.1 Benefits: CM4 *Tidal Natural Communities Restoration and* CM6 *Channel Margin Enhancement* will, in the long term, benefit the Delta tule pea and Suisun Marsh aster by increasing the quantity and quality of currently degraded habitat. However, during project implementation, individual plants or entire occurrences may be lost because of the placement of sediment or construction materials atop existing occurrences or by the desiccation caused by the localized reduction in tidal range back to historical conditions. The no-net-loss standard is appropriate to apply to these species, because, while rare, they are widely distributed throughout the Plan Area and have a reproductive strategy conducive to passive restoration. In other words, although they may experience some short-term habitat or occurrence loss, the distribution and abundance of these species are expected to significantly increase with restoration of tidal and nontidal marsh natural communities. This outcome has a high degree of certainty due to the ease of propagation of these species and the already widespread distribution in similar habitats throughout the Plan Area.

3.3.5.42 Side-Flowering Skullcap

Side-flowering skullcap is a widespread species of wet meadows, seeps, marshes, swamps and bogs in the central and eastern United States, but rarely is it abundant (Holman et al. 2007; California Department of Fish and Game 2011; California Native Plant Society 2010; E-Flora BC 2010; University of Washington Herbarium 2010; U.S. Department of Agriculture 2010). Side-flowering skullcap is found in freshwater tidal swamps on hummock formed by stumps and downed wood in the higher regions of the tidal range. Historically, side-flowering skullcap 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

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communities. In California, the side-flowing skullcap occurs exclusively within the Plan Area in Conservation Zones 4 and 5 (Figure 3.3-46).

There are a total of 12 CNDDB occurrences of side-flowering skullcap within Conservation Zones 4 and 5 of the Plan Area. Most of these are found within Delta Meadows State Park or directly adjacent in the greater Consumnes-Mokelumne River area. Delta Meadows State Park includes one of the last remaining areas of the northern Delta with large stands of mature valley/foothill riparian vegetation (California State Parks 2010). Other occurrences of side-flowering skullcap in the Plan Area are at Snodgrass Slough, Lost Slough, the Mokelumne River, and Sycamore Slough (California Department of Fish and Game 2011). Of the 12 extant occurrences, two are currently protected: these are located in the vicinity of Delta Meadows State Park in the greater Consumnes-Mokelumne River area.

Side-flowering skullcap inhabits wetland and riparian communities, which have been reduced by 95% (Dahl 1990) and 94 to 98% (Katibah 1984), respectively, primarily by development, intensive agriculture, and exotic plant species. In the Plan Area, in particular, the loss and degradation of riparian natural community has diminished the recruitment of large, mature and decaying riparian vegetation and has resulted in a loss of suitable habitat for this species. The conservation strategy for side-flowering skullcap relies on the restoration of tidal freshwater emergent wetland and valley/foothill riparian natural communities in Conservation Zones 4, 5, and 6. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.42.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for side-flowering skullcap are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.4:** Connect rivers and their floodplains to recharge floodplain groundwater from mainstem channels and allow input of large woody debris, leaves, and insects to rivers.

Objective L2.4 Benefits: One of the results of the loss of floodplain loss and degradation in the Plan Area has been a decrease in woody debris upon which this species depends. Although floodplain restoration to meet Objective L2.4 is expected to result in an increase of woody debris, this restoration will occur primarily in Conservation Zone 7, while the species occurs in Conservation Zones 4 and 5. However, if the side-flowering skullcap distribution expands into this Conservation Zone 7, or if the species is currently present in this zone but has not been detected, the recruitment of woody debris in this area is expected to benefit the species.

3.3.5.42.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for side-flowering skullcap are included below.

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Goal TFEWNC1: Large, interconnected patches of tidal freshwater emergent wetland natural community.
• **Objective TFEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 13,900 acres of tidal freshwater emergent wetland in Conservation Zones 1, 2, 4, 5, 6, and/or 7.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest.

Objectives TFEWNC1.1 and VFRNC1.1 Benefits: Tidal restoration in the Cosumnes-Mokelumne area of Conservation Zone 4, which includes the greatest concentrations of side-flowering skullcap in California, will provide tidal freshwater emergent wetland with riparian vegetation along the edges of the restored areas. Restored tidal emergent wetland will provide additional habitat for this species, and restoration of riparian vegetation along the marsh fringes will increase potential source material for woody debris. Tidal restoration will reestablish the inundation and tidal flow patterns that transport the woody debris throughout the wetlands. Because known occurrences are concentrated in this area, this restoration effort is expected to result in a large increase in the quantity and quality of potential habitat for side-flowering skullcap.

3.3.5.42.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to conserve side-flowering skullcap within the reserve system. Additional goals and objectives are not necessary for this species.

3.3.5.43 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 (California Native Plant Society 2009). Slough thistle occurs in freshwater marshes and swamps, and in chenopod scrub and riparian scrub habitats (California Native Plant Society 2009). It is generally found in the portions of channels that flood at high water and on the banks of floodwater conveyance canals and drains (Griggs pers. comm.; Hansen pers. comm.). In the southern San Joaquin Valley, reported occurrences are located along or adjacent to high flood flow areas (California Department of Fish and Game 2011). In the Plan Area, slough thistle habitat is in Conservation Zone 7 along the San Joaquin River (Figure 3.3-47).

There are 19 slough thistle occurrences in California, two of which are in the southern part of the Plan Area. Of these two, one is believed to be extirpated. The other extant occurrence is approximately 6 miles east of Lyon, on the east side of the San Joaquin River.

Slough thistle populations are declining throughout the San Joaquin Valley (Griggs pers. comm.; Hansen pers. comm.). Conversion of suitable habitat to agricultural uses and competition from nonnative plant species are considered the primary threats to this species (California Native Plant Society 2009). Other threats include vegetation clearing along channel banks and weed control efforts (Griggs pers. comm.; Hansen pers. comm.).

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The conservation strategy for slough thistle relies primarily on landscape and natural community level biological goals and objectives to protect and restore floodplain-related wetland habitat. The strategy also involves reestablishment of occurrences along the San Joaquin River from the Mossdale to Vernalis. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.43.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for slough thistle are included below.

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.1:** Allow natural flooding regimes to promote regeneration of desirable natural community vegetation and structural diversity, or implement management actions that mimic those natural disturbances.

Objective L2.2 Benefits: Slough thistle habitat in the Plan Area has largely been lost to flood control activities such as the creation of levees, channel straightening, and vegetation control within levees. *CM5 Seasonally Inundated Floodplain Restoration* provides restoration of up to 10,000 acres of seasonally inundated floodplain, primarily in the Old, Middle, and San Joaquin Rivers in Conservation Zone 7. Floodplain restoration in Conservation Zone 7 will increase the amount of slough thistle suitable habitat in the Plan Area and provide opportunities for population expansion and the introduction of new populations, both of which will contribute to species recovery.

3.3.5.43.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for slough thistle are included below.

Goal VFRNC1: Extensive wide bands or large patches of interconnected valley/foothill riparian forests, with locations informed by both existing and historical distribution.
• **Objective VFRNC1.1:** Restore or create 5,000 acres of valley/foothill riparian forest. • **Objective VFRNC1.2:** Protect 750 acres of existing valley/foothill riparian forest in Conservation Zone 7 within the near-term implementation period.

Objective VFRNC1.1 Benefits: There are two occurrences of slough thistle in the Plan Area, both of which are within the footprint of the historic floodplain of the San Joaquin River between Mossdale and Vernalis in Conservation Zone 7. While one of these occurrences are listed as "possibly extirpated", the other is listed "extant" (California Department of Fish and Game 2011). The preservation of 750 acres of existing riparian habitat in Conservation Zone 7 will protect any remaining pockets of suitable slough thistle habitat between the levees. Preservation in this area has the potential to protect the remaining, extant occurrence as well as discover formerly undiscovered occurrences.

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Goal VFRNC2: Increase structural diversity to include a mosaic of seral stages, age classes, plant zonation, and plant heights and layers characteristic of valley/foothill riparian community.
• **Objective VFRNC2.2:** Maintain at least 1,000 acres of early- to mid-successional vegetation with a well-developed understory of dense shrubs.

Objective VFRNC1.2 Benefits: Slough thistle grows in openings in riparian vegetation within floodplains. Riparian restoration will involve establishment of vegetation that is expected to form the matrix within which these openings will occur, and shelter populations from various types of disturbance such as trampling and excessive scouring during flood events.

3.3.5.43.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for slough thistle within the reserve system. The goals and objectives below are driven by additional species-specific needs that will not be met at the landscape or natural community scale.

Goal ST1: Expand the distribution and increase the abundance of slough thistle populations.
• **Objective ST1.1:** Establish two occurrences of slough thistle within the restored floodplain habitat on the main stem of the San Joaquin River in Conservation Zone 7 between Mossdale and Vernalis.

Objective ST1.1 Rationale: Slough thistle has two known occurrences within the Plan Area, one possibly extirpated and one presumed extant (California Department of Fish and Game 2011). These two occurrences represent the northern-most extent of the species distribution, with the bulk of the extant occurrences in Kings and Kern Counties. The restoration of floodplain habitat for this species on the San Joaquin River in Conservation Zone 7 presents an opportunity to reestablish occurrences within large, connected patches of suitable habitat. Increasing the number of occurrences in this area has potential to increase the genetic diversity of the local population and decrease the risk of extirpation of the species in this part of its range due to random fluctuations in environmental conditions.

3.3.5.44 Soft Bird's-Beak and Suisun Thistle

Within the Plan Area, soft bird's-beak and Suisun thistle co-occur in Suisun Marsh in similar natural communities and microhabitats and, therefore, are treated together in this section.

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 (California Department of Fish and Game 2011).

Soft bird's-beak occurs in high salt and brackish tidal marsh of northern San Pablo Bay and the Suisun Marsh area, and in some diked brackish marshes with limited tidal circulation. It has an affinity for the higher well-drained portions of the marsh and the edges of salt pans. It occurs primarily in portions of the upper-middle to high marsh zones where the vegetation is often interspersed with bare ground or sparse vegetative cover, often in association with pickleweed (*Sarcocornia pacifica*) and saltgrass (*Distichlis spicata*). Soft bird's-beak decreases in abundance or is

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absent with dense, tall grass-like vegetation and dense or tall nonnative brackish marsh vegetation. Populations of soft bird's-beak and Suisun thistle are isolated from tidal inundation by dikes, tidal gates, and pumps; this limits the potential for seed dispersal by water as tidal action is significantly muted or nonexistent.

Soft bird's-beak is hemiparasitic and in the wild requires a host plant for survival and reproduction. Pickleweed and saltgrass are known host species; dodder (*Cuscuta* spp.) may be a host plant because of its close association with soft bird's-beak (Grewell et al. 2003).

There are 12 extant occurrences of soft bird's-beak in the Plan Area, the majority of which are in and around the northern edge of Suisun Marsh (Figure 3.3-48) (U.S. Fish and Wildlife Service 2009; California Department of Fish and Game 2011). A single occurrence has been reported in Sacramento County along the north bank of the San Joaquin River immediately west of the Antioch Bridge (California Department of Fish and Game 2011). This occurrence was last observed in 1972 and may have been extirpated (the site is now a rip-rapped shoreline). The species is threatened by low population numbers, severely reduced habitat area, and reduced habitat quality, all of which contribute to the species being susceptible to loss by chance events. Invasion by nonnative tidal marsh vegetation and hydrologic alterations to tidal sloughs are also significant stressors (U.S. Fish and Wildlife Service 2010).

Suisun thistle is endemic to a few areas in the northern portion of the Suisun Marsh in Solano County, California (U.S. Fish and Wildlife Service 2009). It is found in the upper-middle and high marsh, usually associated with small tidal creek banks that locally drain the marsh peat surface (U.S. Fish and Wildlife Service 2009). Its occurrence along tidal creek channels appears to be related to salinity in soil pores (Culberson 2001; Culberson et al. 2004), not marsh plain elevation.

In 1975, Suisun thistle was presumed to be extinct because it had not been observed for 15 years (62 FR 61916; U.S. Fish and Wildlife Service 2003, 2009); however, extensive surveys conducted at Suisun Marsh in 1989 rediscovered this species at two locations (62 FR 61916; U.S. Fish and Wildlife Service 2003, 2009). More recent surveys have found Suisun thistle within relict undiked high tidal marshes at Rush Ranch, the Joice Island portion of the Grizzly Island Wildlife Area, and the Peytonia Slough Ecological Reserve (U.S. Fish and Wildlife Service 2003). Thousands of plants were observed at Rush Ranch, much smaller numbers were observed at Grizzly Island Wildlife Area, and the population at the Peytonia Slough Ecological Reserve had declined to a single plant in 1996 (U.S. Fish and Wildlife Service 2003, 2009). Currently, CNDDB (2011) has four extant occurrences listed as being present in Suisun Marsh (Figure 3.3-49). All four of these occurrences are currently protected lands owned by DFG or the Solano County Land Trust.

Immediate threats to Suisun thistle include precariously low numbers and few populations, confined dispersal of its seeds in limited habitat, introduced nonnative insect seed predators, and interference with its regeneration caused by nonnative invasive marsh vegetation, including perennial pepperweed (*Lepidium latifolium*). Other threats include disturbance, salinity changes, and genetic swamping by nonnative thistle species (U.S. Fish and Wildlife Service 2009). To address these threats, the BDCP conservation strategy for soft bird's-beak and Suisun thistle focuses on expanding occurrences by restoring and enhancing suitable habitat and increasing connectivity between suitable habitat patches to promote seed dispersal and colonization of new sites. The conservation strategy also establishes a conservation seed bank that will serve as a source population for restoration efforts. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and

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listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.44.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for soft bird's-beak and Suisun thistle are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.7:** To accommodate projected future sea level rise, within the 65,000 acres of tidal restoration include sufficient upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetlands to permit the future upslope establishment of tidal emergent wetland communities; also include additional noncultivated upland to provide habitat and high-tide refugia for native wildlife.

Objective L1.7 Benefits: Upland transitional areas adjacent to restored brackish and freshwater tidal emergent wetland are needed to allow tidal emergent wetland communities to migrate in response to future expected sea level rise. As sea level rises and existing tidal lands are flooded more frequently and for longer duration, freshwater and brackish tidal communities also will need to "rise" or shift upwards in mean elevation. Without the ability of these habitat types to migrate upwards, the existing tidal habitat becomes intertidal and subtidal without being replaced in other, more upland locations. For this to occur, adjacent upland habitat needs to transition slowly from low elevations to higher elevations. Adjacent upland areas that transition too quickly from low to high elevations (i.e., have slopes that are too steep), will preclude this gradual conversion to tidal and freshwater marsh. Without the ability of upward habitat shift for brackish marsh communities in Suisun Marsh, the long-term persistence of upper-middle and high marsh species like Suisun thistle and soft bird's-beak would not be possible. Achieving this objective will protect enough suitable upland areas to allow the community to shift in response to climate change and therefore continue to provide suitable habitat for Suisun thistle and soft bird's-beak. The need for the protection of upland transition lands is recognized in the recovery plan as a prerequisite to delisting both species (U.S. Fish and Wildlife Service 2009).

Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species.
• **Objective L2.7:** Increase native plant and wildlife biodiversity, and relative cover of native plant species and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: The aggressive invasive perennial pepperweed poses a serious threat to soft bird's-beak and Suisun thistle. Perennial pepperweed can permanently establish a continuous leaf canopy, eliminating the vegetation gaps that may be essential for seedling establishment, juvenile growth, or adult reproduction (U.S. Fish and Wildlife Service 2009). Neither colonies of Suisun thistle nor soft bird's-beak have been observed to persist in and amongst colonies of perennial pepperweed (U.S. Fish and Wildlife Service 2009). The need for aggressive control measures of perennial pepperweed is consistent with the recovery plan for both soft bird's-beak and Suisun thistle (U.S. Fish and Wildlife Service 2009).

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In addition to the threat posed by perennial pepperweed, soft bird's-beak is threatened by the invasion of nonnative, perennial and winter annual grass species, the two greatest threats being barbgrass (*Hainardia cylindrical*) and annual beard grass (*Polypogon monspeliensis*). These species are incompatible host plants for soft bird's-beak in that they do not allow full completion of the species' life cycle. The control of incompatible invasive host plants for soft bird's-beak will also be very important.

The population growth of both species appears to be limited, in part, by substantial seed predation from both native and introduced insects. Suisun thistle seeds have potential to be predated upon, at least in some years, by the introduced thistle weevil (*Rhinocyllus conicus*) (U.S. Fish and Wildlife Servie 2009). Soft bird's-beak seeds are known to be predated upon by the native salt marsh snout moth (*Lipographis fenestrella:* Pyralidae) and a *Saphenista* [Tortricidae] moth (Ruygt 1994 as cited in U.S. Fish and Wildlife Service 2009). The control of seed predators consistent with this objective is part of the recovery plan for both species (U.S. Fish and Wildlife Service 2009).

3.3.5.44.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for soft bird's-beak and Suisun thistle are included below.

Goal TBEWNC1: Large expanses and interconnected patches of tidal brackish emergent wetland natural community.

- **Objective TBEWNC1.1:** Within the 65,000 acres of tidal restoration, restore or create at least 4,800 acres of tidal brackish emergent wetland in Conservation Zone 11.
- **Objective TBEWNC1.2:** Restore connectivity to isolated patches of tidal brackish emergent marsh where isolation has reduced effective use of these marshes by the species that depend on them.
- **Objective TBEWNC1.3:** Create topographic heterogeneity in restored tidal brackish emergent wetland to provide variation in inundation characteristics and vegetative composition.
- **Objective TBEWNC1.4:** Phase the restoration of tidal brackish emergent wetland over time to offset adverse effects of tidal perennial aquatic restoration as it occurs, minimize temporal effects on covered species populations from conversion of managed wetlands, and maintain local source populations to recolonize newly restored areas.

Objectives TBEWNC1.1 and TBEWNC1.3 Benefits: The restoration of 4,800 acres of tidal brackish emergent wetland will substantially increase the area in Suisun Marsh that is tidally inundated, thereby increasing the quantity of available of habitat for colonization by these two species. Tidal restoration will involve the breaching of levees and the active and passive restoration of previously diked land to achieve a diversity of inundation patterns and vegetation structure that will resemble a more natural condition. Perennial pepperweed poses a serious threat to the distribution and abundance of both species by colonizing bare sites that are important for their germination and seedling establishment. Restoration of tidal brackish emergent wetland will provide effective control of perennial pepperweed, which will likely improve seed dispersal of Suisun thistle and soft bird's-beak and increase opportunities for germination and colonization of new sites.

Both species occupy specific microhabitats in the upper-middle and high marsh. Restoration will target the creation of these and other tidal elevations to support the species. Restored or improved tidal inundation and an increase in tidal inundation diversity will provide the necessary soil salinities to maintain existing occurrences and the disturbance necessary to create unvegetated patches required for germination and colonization of new sites. Soft bird's-beak seeds float and

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Suisun thistle seeds are expected to float (72 FR 18517), so improved tidal inundation in occupied areas is expected to increase the potential for successful seed dispersal to expand existing occurrences and create new ones. The restoration of tidal inundation is consistent with the recovery plan and delisting criteria for both species.

Objectives TBEWNC1.2 Benefits: Connectivity within Suisun Marsh will be restored through the protection and enhancement of corridors between marsh and upland habitats and the protection and restoration of adjacent upland habitat. These connections with upland habitat will allow for soft bird's-beak and Suisun thistle to shift upward in tidal marsh elevation in response to sea level rise as describe above for Objective L1.7. Management of reserve lands consistent with CM3 *Natural Communities Protection and Restoration* will remove invasive species where they may block or impede species dispersal by tides or wind. For example, the restoration of tidal inundation is expected to convert large stands of cattails (*Typha* spp.) into more heterogeneous marsh communities, reducing the average height of vegetation (and the potential barrier it poses to wind dispersal of seeds) and increasing the occurrence of bare ground important for seed germination. Restoring connectivity within tidal brackish emergent wetland will also promote genetic exchange among the limited number of populations of both species, helping to minimize deleterious effects inherent to small populations.

Objective TBEWNC1.4 Benefits: Restoration phasing will prevent the loss of soft bird's-beak and Suisun thistle populations in areas to be tidally restored. Tidal restoration has the potential to increase tidal flow and scour and displace habitat and species occurrences. Because of the extreme rarity of these species, especially Suisun thistle, all occurrences of these plants in Suisun Marsh will need to be protected and sustained throughout the restoration process. Phasing of tidal restoration in Suisun Marsh, and measures to ensure against loss of this species in restoration areas, will be implemented as described in CM4 *Tidal Natural Communities Restoration*.

3.3.5.44.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and associated conservation measures are expected to protect, restore, and enhance suitable habitat for soft bird's-beak and Suisun thistle within the reserve system. The goals and objectives below are driven by additional needs that will not be met at the landscape or natural community scale.

Goal SBB/ST1: Protected and expanded soft bird's-beak and Suisun thistle populations.
• **Objective SBB/ST1.1:** Restore tidal inundation to wetlands in the Hill Slough Ecological Reserve and to the ponded area at Rush Ranch. • **Objective SBB/ST1.2:** Complete seed banking of all existing Suisun Marsh populations and the representative genetic diversity using accepted seed banking protocols.

Objective SBB/ST1.1 Rationale: Suisun thistle is known to exist as three distinct populations in the following three locations: Peytonia Slough Ecological Reserve, the fully tidal portion of upper Hill Slough, and Rush Ranch and Joice Island (considered one population) (U.S. Fish and Wildlife Service 2010). In Suisun Marsh, soft bird's-beak occurs in Hill Slough, Rush Ranch, and Joice Island (Figure 3.3-48). Although Peytonia Slough and portions of Hill Slough have been restored to the full range of tidal inundation, other portions of Hill Slough and the ponded area at Rush Ranch remain unrestored. The restoration of tidal inundation and the subsequent management and enhancement of Suisun thistle and soft bird's-beak occurrences in these areas are essential to the persistence and

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recovery of these species and is consistent with delisting criterion for Suisun thistle and soft bird's-beak in the recovery plan (U. S. Fish and Wildlife Service 2009).

Objective SBB/ST1.2 Rationale: Because of the limited number of occurrences and extreme endemism of soft bird's-beak and Suisun thistle, the collection and storage of seeds is important to protect the current range of genetic diversity from catastrophic loss caused by a chance event or unintended effects of restoration actions. Collected and stored seeds can be used to establish new occurrences in suitable protected habitat or to restore an occurrence degraded or lost to restoration. Conservation seed banking is an action recommended for both soft bird's-beak and Suisun thistle in their recovery plan (U.S. Fish and Wildlife Service 2009).

3.3.5.45 Vernal Pool Plants

The covered plant species associated with the vernal pool complex include alkali milk-vetch, Boggs Lake hedge-hyssop, dwarf downingia, Heckard's peppergrass, legenere, and San Joaquin spearscale. The historic distributions of these covered vernal pool plants are unknown, but probably coincided with the historic distributions of their habitat (U.S. Fish and Wildlife Service 2005). These species occupy vernal pool complexes, which are described in detail in Section 2.3.4.9, *Vernal Pool Complex*, and Section 3.3.4.8, *Vernal Pool Complex*, above. (San Joaquin spearscale also occupies alkali seasonal wetlands.) Vernal pool complexes in the western United States are distributed from eastern Washington to northern Baja California, Mexico (Moran 1984), and within this range, the remaining vernal pool acreage represents less than 10% of that prior to anthropogenic alteration of these landscapes since the 1800s (Keeley and Zedler 1998).

The primary stressors affecting long-term survival and recovery of the covered vernal pool plants include habitat loss and fragmentation, altered hydrology, and invasive plant species (U.S. Fish and Wildlife Service 2005, 2007). These stressors will be reduced or eliminated on protected and restored lands in the Plan Area consistent with the biological goals and objectives.

The Plan Area contains 7,908 acres of vernal pool complex and 2,494 acres of degraded vernal pool complex distributed along the margins of the Plan Area, in Conservation Zones 1, 2, 4, 8, 9, and 11 (Figure 3.2-9). The range-wide and Plan-wide distributions for each covered plant species are described below, as are the known historic extent and decline of each species.

Alkali milk-vetch. This species was historically known Sonoma, Napa, Solano, and Yolo Counties in the north, to Monterey and San Benito Counties in the south, to San Francisco, Contra Costa, Alameda, and Santa Clara Counties in the west, and San Joaquin, Stanislaus, and Merced Counties in the east. The majority of extant occurrences are in Solano-Colusa vernal pool recovery region, which overlaps considerably with the Plan Area, but there are also presumed extant occurrences in the Central Coast, Lake-Napa, and San Joaquin Valley vernal pool recovery regions (U.S. Fish and Wildlife Service 2005). There are 55 extant occurrences of alkali milk-vetch range-wide[25], 33 of which (44%) are within the Plan Area (Figure 3.3-50). Occurrences in the Plan Area are widely distributed throughout the vernal pool complex natural community in Conservation Zones 1, 2, 6, 8, and 11, but are most dense in the Jepson Prairie and Putah Creek areas (Conservation Zones 1 and 2,

[25] Range-wide occurrences described for all species include CNDDB occurrences, as well as non-CNDDB occurrences mapped for BDCP. See Chapter 2, *Existing Conditions*, for a description of all species occurrence data sources.

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respectively). Of the 33 occurrences in the Plan Area, 81% (27 of 33) are protected in the Cache Slough, Suisun Marsh, and Tule Ranch areas (Figure 3.3-50).

Boggs Lake hedge hyssop. The historic range for this species included the Lake-Napa, Modoc Plateau, southeastern Sacramento Valley, and southern Sierra Nevada foothills vernal pool regions. Only one of the historic occurrences is believed to have been extirpated, and the species has since been found in four additional vernal pool regions: northeastern Sacramento Valley, northwestern Sacramento Valley, and Solano-Colusa (U.S. Fish and Wildlife Service 2005). There are presently 89 extant occurrences of Boggs Lake hedge-hyssop in the state, only one of which occurs in the Plan Area (Figure 3.3-51) and is protected; this occurrence is at the very western edge of Conservation Zone 1 near the Jepson Prairie conservation area (several occurrences are immediately outside the Plan Area in the Jepson Prairie area).

Dwarf downingia. Extant occurrences range from southern Tehama County to Fresno County and from Sonoma County to Placer County. The species is also found in Chile. The population trend for this species is not known but is presumed to be declining due to a loss of suitable habitat. There are 112 occurrences state-wide, of which 10 are in the Plan Area and 90% (9 of 10) of these are currently protected (Figure 3.3-52).

Heckard's peppergrass. Extant occurrences are limited to Glenn, Solano, and Yolo Counties in California. The population trend for this species is unknown but is presumed to be declining due to a loss of suitable habitat. There are 22 extant occurrences of Heckards' peppergrass in the state, 13 of which (59%) occur in Plan Area, and 77% (10 of 13) of these are currently protected (Figure 3.3-53). Occurrences are clustered primarily in the vernal pool complex areas just south of Putah Creek (Tule Ranch area) and in the greater Jepson Prairie area (Wilcox and Gridley Ranches), both of which are in Conservation Zone 1.

Legenere. Between 1890 and 1984, this species had been observed at 12 sites in Solano, Lake, Sacramento, Napa, Placer, San Mateo, Sonoma, and Stanislaus Counties. As of 1984, only three populations were believed to remain extant, but since 1984 the species has been found at several historic sites and numerous new locations. The historic occurrences for legenere were in the Central Coast, Lake-Napa, Santa Rosa, Solano-Colusa, southeastern Sacramento Valley, and southern Sierra Nevada foothills vernal pools regions. The species has since been extirpated from the southern Sierra Nevada foothills region and the one historic occurrence from the Central Coast region has not been rediscovered since 1906 but is presumed extant because suitable habitat remains (U.S. Fish and Wildlife Service 2005). There are 65 extant occurrences of legenere in the state, six of which (9%) are in the Plan Area; these occurrences are all within the Jepson Prairie core recovery area on protected lands (Figure 3.3-54).

San Joaquin spearscale. Extant occurrences of San Joaquin spearscale are distributed through nine counties in the San Francisco Bay area and Central Valley. The population trend for this species is unknown but presumed to be declining due to a loss of suitable habitat. There are presently 104 extant occurrences of San Joaquin spearscale in the state, 15 of which (14%) occur within Plan Area, and 13% (2 of 15) of these are currently protected (Figure 3.3-55). Extant occurrences are found in the western portion of the Plan Area, primarily along the west side of the Sacramento Valley and Inner Coast Range foothills in Conservation Zones 1, 8, 9, and 11.

Habitat loss and fragmentation have been identified as the largest threats to the survival and recovery of vernal pool species (U.S. Fish and Wildlife Service 2005, 2007). Habitat loss has

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generally been the result of urbanization and agricultural conversion, and has also occurred in the form of habitat alteration and degradation as a result of changes to natural hydrology, invasive species, and incompatible grazing regimes.

The conservation approach for vernal pool plants is guided chiefly by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Vernal Pool Recovery Plan) (U.S. Fish and Wildlife Service 2005), an ecosystem-level recovery and conservation strategy for vernal pool species developed by USFWS in collaboration with a team of vernal pool species experts. Key goals of the Vernal Pool Recovery Plan include the establishment of reserves throughout the species' ranges to prevent further habitat loss and fragmentation in areas identified as important for the species (called "core recovery areas"), restoration of vernal pools to achieve no net loss of habitat for vernal pool species (assuming reintroduction into restored areas); and adaptive habitat management to maintain and enhance habitat values for vernal pool species. While only three of six covered vernal pool plant species are included in the Vernal Pool Recovery Plan (alkali milk-vetch, legenere, and Boggs Lake hedge-hyssop), the ecosystem approach of the recovery plan provides a conservation strategy that can appropriately be applied to all the vernal pool plant species covered under the BDCP, although species-specific objectives are also necessary for some of the species. The conservation measures that will be implemented to achieve the goals and objectives described below are discussed in Section 3.4, *Conservation Measures*, and listed in Table 3.3-1. Applicable avoidance and minimization measures are provided in Appendix 3.C, *Avoidance and Minimization Measures*.

3.3.5.45.1 Applicable Landscape-Scale Goals and Objectives

Those landscape-scale biological goals and objectives that are integral to the conservation strategy for the vernal pool plant species are included below.

Goal L1: A reserve system with representative natural and semi-natural landscapes consisting of a mosaic of natural communities that is adaptable to changing conditions to sustain populations of covered species and maintain or increase native biodiversity.
• **Objective L1.6**: Increase the size and connectivity of the reserve system by acquiring lands adjacent to and between existing protected lands.

Objective L1.6 Benefits: This objective will reduce future habitat loss and fragmentation in the Plan Area by protecting lands in perpetuity and reducing threats to vernal pools. The size and connectivity of protected lands, including vernal pool complexes within a matrix of other natural community types, will be increased by building on the existing reserve system and applying the conservation land assembly principles described in Section 3.2.4.2.1, *Conservation Land Assembly Principles*. Vernal pool complexes will be protected and restored as components of a large, interconnected reserve system, within a mosaic of grasslands and alkali seasonal wetlands. A large size and the connectivity of reserves, including vernal pool complex and other associated natural communities, will provide sufficient upland habitat to protect plant pollinators, and to sustain important predators of herbivores such as rodents and rabbits (U.S. Fish and Wildlife Service 2005). Large, interconnected reserves are also less likely to be adversely affected by adjacent disturbances related to urban development, such as urban runoff or the invasion of exotic plant species.

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Goal L2: Ecological processes and conditions that sustain and reestablish natural communities and native species
• **Objective L2.7:** Increase native species diversity and relative cover of native plant species, and reduce the introduction and proliferation of nonnative species.

Objective L2.7 Benefits: This objective will benefit the covered vernal pool plant species by reducing threats to the species' habitat requirements that result from heavy infestations of invasive plant species. Invasive species threaten the abundance and diversity of vernal pool plants and have contributed to the decline of native vernal pool plant populations in general, but disproportionately affect a number of covered plant species, including alkali milk-vetch (U.S. Fish and Wildlife Service 2005). Consistent with Objective L2.7, all vernal pool complex natural community acquired as protected lands will be monitored and adaptively managed for potential effects of invasive plant species on native plant abundance and distribution, as described in the *Invasive Species Control Program* section of *CM11 Natural Communities Enhancement and Management.*

3.3.5.45.2 Applicable Natural Community Goals and Objectives

Those natural community biological goals and objectives that are integral to the conservation strategy for the vernal pool plant species are included below.

Goal VPCNC1: Large, interconnected expanses of vernal pool complex within a reserve system that includes a range of geomorphological, hydrologic, and vegetation characteristics.
• **Objective VPCNC1.1**: Protect 600 acres of vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool recovery plan (USFWS 2005). • **Objective VPCNC1.2**: Restore vernal pool complex in Conservation Zones 1, 8, and 11, primarily in core vernal pool recovery areas identified in the vernal pool core recovery plan (USFWS 2005), to achieve no net loss of vernal pool acreage. • **Objective VPCNC1.3**: Increase the size and connectivity of protected vernal pool complex within the Plan Area and increase connectivity with protected vernal pool complex adjacent to the Plan Area.

Objectives VPCNC1.1, VPCNC1.2, and VPCNC1.3 Benefits: Objective VPCNC1.1 will eliminate habitat loss and fragmentation on protected and restored vernal pool complexes on 600 acres in the Plan Area. Objective VPCNC1.2 will ensure no net loss of habitat for vernal pool plant species, and VPCNC1.3 will build on existing protected vernal pool complexes within and adjacent to the Plan Area to increase the overall extent and connectivity of the vernal pool reserve system. The permanent preservation of existing vernal pool complexes, in perpetuity, from further habitat loss and fragmentation is the best strategy for ensuring continued survival of vernal pool-dependent plant species (U.S. Fish and Wildlife Service 2005).

The vernal pool complex natural community supports vernal pool plant species habitat in Conservation Zones 1, 2, 4, 8, 9, and 11 along the margins of the Delta. Conservation Zones 1, 8, and 11 include core recovery areas for these species, as described in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). Conservation Zones 1, 8, and 11 also provide the greatest opportunities for the large-scale conservation of vernal pool plant species within the Plan Area. The vernal pool complex natural community in Conservation Zones 2 and 4 is almost entirely under protected status (99%) and the 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.

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The 600 acres of vernal pool preservation will occur in Conservation Zones 1, 8, and 11. Consistent with objectives VPCNC1.1, VPCNC1.2, and VPCNC1.3, and as described in Section 2.3.4.9 *Vernal Pool Complex,* protected areas will capture the diversity of vernal pool types in the Plan Area and conserve the largest possible contiguous areas of vernal pool complex. Protected and restored vernal pool complex will be enhanced to benefit vernal pool species and managed in conjunction with protected grassland and alkali seasonal wetland complex natural communities to conserve and promote connectivity within vernal pool complexes as well as with other natural communities. CM3 *Natural Communities Protection and Restoration* and CM9 *Vernal Pool Complex Restoration* detail the specific methods necessary to successfully achieve the vernal pool complex natural community objectives.

Objective VPCNC1.1 and VPCNC1.2 prioritize protection and restoration in core recovery areas (Figure 3.3-44 through Figure 3.3-49) identified in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). These specific sites are considered necessary to recover the federally endangered or threatened vernal pool species or to conserve sites that are necessary to recover those species. For species of concern that are not federally listed, core recovery areas are the specific sites necessary to prevent these species from being federally listed in the future (U.S. Fish and Wildlife Service 2005). The core recovery areas were developed to include viable populations (in some cases, source populations for larger metapopulations) or to contribute to the connectivity of habitat and thus increase dispersal opportunities between populations. Core recovery areas were established to provide for protection throughout the species' ranges, and to prioritize lands with high concentration of species per unit area. Core recovery area boundaries were established for the Vernal Pool Recovery Plan based on data from distributions of species occurrence information, data layers for the proposed critical habitat for vernal pools, vernal pool complex mapping (Holland 1998), watershed boundaries, other hydrographic boundaries, topographic features, roads, and land use designations. Establishment of the core recovery areas assumed that the long-term survival and recovery of species are best achieved through two core conservation actions.

- Protecting multiple populations so that a single or series of catastrophic events cannot cause the extinction of the whole species.
- Increasing the size of the populations in core areas to a level where threats from genetic, demographic, and normal environmental uncertainties or change are diminished.

Objectives VPCNC1.1, VPCNC1.2, and VPCNC1.3 will be advanced through prioritization, selection, acquisition and protection of lands under *CM3 Natural Communities Protection and Restoration*. Objective VPCNC1.2 will be further advanced through restoration activities under *CM11 Natural Communities Enhancement and Management.*

Goal VPCNC2: Vernal pool complexes that are managed and enhanced to sustain populations of native vernal pool species.
• **Objective VPCNC2.1**: Maintain or enhance vernal pool complexes to provide the appropriate inundation (ponding) characteristics for supporting and sustaining vernal pool species. • **Objective VPCNC2.2**: Maintain and enhance pollination service in the vernal pool complex, especially by native invertebrates including native solitary bees.

Objective VPCNC2.1 Benefits: This objective will provide the appropriate hydrological conditions for sustaining vernal pool species. Altered hydrology of vernal pool complexes can change the timing, frequency, or duration of vernal pool inundation, which can create conditions that render

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existing vernal pools unsuitable for vernal pool species (U.S. Fish and Wildlife Service 2005, 2007). For example, vernal pool ecosystems have been altered by hydrologic barriers such as roads or canals. Vernal pool hydrology has also been altered by the diversion of urban runoff and agriculture, both of which increase pond timing and duration, converting vernal pools to perennial ponds that are incapable of supporting vernal pool plant species. The conservation of 600 acres of large, interconnected tracts of vernal pool complex consistent with Objectives VPCNC1.1 and VPCNC1.2, and management consistent with VPCNC2.1, will protect intact vernal pool complexes from further alterations to natural hydrology.

Objective VPCNC2.2 Benefits: Many rare and endemic vernal pool plant species depend on native invertebrates for pollination (Eaton 2001). Legenere is pollinated by native bees (Buchman et al. 2010), while alkali milkvetch is likely pollinated by butterflies (Liston 1992). San Joaquin spearscale is wind pollinated and pollination mechanisms for Heckard's peppergrass and alkali milk-vetch are unknown (Hoffman Black 2010).

Assembling a large, interconnected reserve system consistent with Goal VPCNC1, including optimization of connectivity between upland and lower portions of the watersheds within vernal pool complexes, will contribute to native pollinator conservation by reducing fragmentation effects. This large reserve system will be assembled using the acquisition criteria described in CM3 *Natural Communities Protection and Restoration*, and vernal pool complexes will be managed and enhanced as described in CM11 *Natural Communities Enhancement and Management*, and monitored and adaptively managed as described in Section3.6, *Adaptive Management and Monitoring Program*, to achieve Objective VPC2.2.

3.3.5.45.3 Species-Specific Goals and Objectives

The landscape-scale and natural community goals, objectives, and actions are expected to protect, restore, and enhance suitable habitat for the covered vernal pool plant species in the reserve system. Covered plant species for which less than 10% of state-wide occurrences are in the Plan Area and over 80% of occurrences in the Plan Area are currently protected are sufficiently conserved by the landscape-scale and natural community biological goals and objectives (i.e., Boggs Lake hedge-hyssop, dwarf downingia, and legenere). Alkali milk-vetch, Heckard's peppergrass, and San Joaquin spearscale have additional species-specific occurrence requirements, as described below.

Goal VPP1: A reserve system that protects vernal pool plant populations.
• **Objective VPP1.1:** Protect at least two currently unprotected occurrences of alkali milk-vetch in the Altamont Hills or Jepson Prairie Core Recovery Areas (Conservation Zones 1, 8, or 11). • **Objective VPP1.2:** Protect and/or establish at least two currently unprotected occurrences of Heckard's peppergrass in Conservation Zones 1, 8, or 11. • **Objective VPP1.3:** Protect at least two currently unprotected occurrences of San Joaquin spearscale in Conservation Zones 1, 8, or 11.

Objectives VPP1.1, VPP1.2, and VPP1.3 Rationale: These objectives will ensure that the rarest covered vernal pool plant species affected by the Plan, the alkali milk-vetch, Heckard's peppergrass, and San Joaquin spearscale, will be represented in the newly protected lands, as follows. Table 3.3-10 presents the occurrence of the vernal pool plant species in the Plan Area.

- **Alkali milk-vetch.** A large proportion (60%) of the statewide alkali milk-vetch occurrences are in the Plan Area (Figure 3.3-50). Alkali milk-vetch is the only plant species included in the Vernal

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Pool Recovery Plan (also included are legenere and Bogg's Lake hedge-hyssop) that has extant, unprotected occurrences within the Plan Area. The protection of two unprotected occurrences of alkali milk-vetch will contribute to achieving the 80% occurrence protection goal for alkali milk-vetch in the Verrnal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005). With the protection of two additional occurrences, 82% (27 of 33) of the alkali milk-vetch occurrences in the Plan Area will be protected.

- **Heckard's peppergrass.** A large proportion (59%) of the statewide Heckard's peppergrass occurrences are in the Plan Area (Figure 3.3-53). With the protection or establishment of two additional occurrences[26], 80% (12 of 15) to 92% (12 of 13) of the Heckard's peppergrass occurrences in the Plan Area will be protected. Establishing an occurrence is allowed for this species as an alternative to protecting existing occurrences because of the relatively few occurrences known statewide and the relatively low likelihood of finding undiscovered occurrences within areas suitable for the reserve system.
- **San Joaquin spearscale.** A relatively small proportion (14%) of the statewide occurrences are in the Plan Area (Figure 3.3-55). With the protection or establishment of two additional occurrences, 26% (4 of 17) to 31% (4 of 15) of the San Joaquin spearscale occurrences in the Plan Area will be protected. Establishing an occurrence is allowed for this species as an alternative to protecting existing occurrences because of the relatively few occurrences known in the Plan Area available for protection.

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[26] This objective allows protection of two occurrences, protection of one occurrence and establishment of one occurrence in the reserve system, or establishment of two occurrences in the reserve system.

Table 3.3-10. Level of Conservation for Covered Vernal Pool Plant Species

Species	Percent of State-Wide Occurrences in Plan Area	Percent of Plan Area Occurrences Currently Protected	Number of Occurrences that Overlap with Hypothetical Tidal Restoration Footprints[1]	Species-Specific Objectives
Alkali milkvetch	60% (33/55)	75% (25/33)	0	Protect two additional occurrences
Boggs Lake hedge-hyssop	1% (1/89)	100% (1/1)	0	none
Dwarf downingia	9% (10/112)	90% (9/10)	0	none
Heckard's peppergrass	59% (13/22)	77% (10/13)	1	Protect and/or establish two additional occurrences
Legenere	6% (4/65)	100% (4/4)	0	none
San Joaquin spearscale	14% (15/104)	13% (2/15)	1	Protect and/or establish two additional occurrences

[1] Tidal restoration impacts on natural communities and species modeled habitat, as well as to species occurrences, were determined by choosing "hypothetical" restoration footprints. While it remains possible that impacts on these vernal pool plant species might occur, the potential is believed to be very low and full avoidance of impacts on species occurrences is expected.

Consistency with Vernal Pool Recovery Plan

The Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2005) lists six elements that an HCP must incorporate to be deemed equivalent to implementation of the recovery plan for the covered area. These six elements are indicated below (*italics*) and described below as they relate to the BDCP and the three covered plant species addressed in the Vernal Pool Recovery Plan (alkali milk-vetch, Bogg's Lake hedge-hyssop, and San Joaquin spearscale).

1. *Permanently protected vernal pool preserves within the area covered by the Habitat Conservation Plan in large contiguous blocks of suitable habitat.*

   Consistent with Goal VPCNC1, the BDCP will result in a large, interconnected vernal pool reserve system in the Plan Area. This will be achieved by building on the existing reserve system in the Plan Area. The Plan will add 600 acres to the 4,536 acres of vernal pool complex that are currently protected. A majority of the 600 acres is expected to be protected adjacent to existing protected land within the Jepson Prairie core recovery area.

2. *Protection of the entire genetic range of each listed species within the area covered by the Habitat Conservation Plan.*

   As described in the Vernal Pool Recovery Plan (page III-5), genetic composition has not been investigated for most of the vernal pool crustacean species; therefore, genetic diversity is assumed to be protected by protecting populations throughout each species' range. The core recovery areas identified in the recovery plan are distinct areas that provide geographic and/or

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genetic diversity necessary for recovery of the species (Vernal Pool Recovery Plan, page III-18). By focusing 600 acres of vernal pool complex protection within the Jepson Prairie and Altamont Hills core recovery areas, which are ranked as Recovery Zone 1 (highest priority) protection for vernal pool crustaceans, the BDCP will protect areas identified in the recovery plan as important for protecting the full range of genetic diversity throughout the range of those species identified in the recovery plan.

The BDCP conservation strategy for vernal pool species is based on the assumption that the genetic range of each species in the Plan Area is protected by protecting lands that represent the species' distribution throughout the Plan Area. The distribution of recorded occurrences for each of the three species in the recovery plan, in relation lands that are already protected and are targeted for protection under BDCP, is described below.

- **Alkali milk-vetch.** Recorded occurrences of this species are in Conservation Zones 1, 2, and 11 (Figure 3.3-50) (Appendix 2.A, *Covered Species Accounts*). Most of the occurrences in Conservation Zones 2 are already protected (Tule Ranch), and the three unprotected occurrences are in small, isolated habitat areas that are not likely viable for long-term protection and management, and are outside core recovery areas. Additional vernal pool complex will be protected in Zones 1, and 11; therefore, the species' range within the Plan Area will be well represented in the reserve system.
- **Bogg's Lake hedge-hyssop.** There are no unprotected occurrences of this species in the Plan Area (Figure 3.3-51). A majority of the 600 acres of vernal pool protection is expected to occur in Conservation Zone 1, where additional occurrences of the species are most likely to be found based on its distribution in and near the Plan Area (Figure 3.3-51). Therefore, the natural community objectives for vernal pools will address the conservation of this species and no additional species-specific objectives are needed.
- **San Joaquin spearscale.** Recorded occurrences of this species are in Conservation Zones 1, 2, 8, and 11 (Figure 3.3-55) (Appendix 2.A, *Covered Species Accounts*). The occurrences in Conservation Zone 2 is within a small, isolated habitat area that is not likely viable for long-term protection and management, and is outside core vernal pool recovery areas. Additional vernal pool complex will be protected in Zones 1, 8, and 11; therefore, the species' range within the Plan Area will be well represented in the reserve system.

3. *Protection of all populations of species with 25 or fewer total occurrences addressed in this plan within the area covered by the Habitat Conservation Plan.*

The only covered vernal pool plant species with 25 or fewer total occurrences is Heckard's peppergrass. There are 22 occurrences of this species range-wide. With full implementation of the BDCP, 80% (12 of 15) to 92% (12 of 13) of the Heckard's peppergrass occurrences in the Plan Area will be protected. Therefore, BDCP will contribute to the recovery of this species but will not, on its own, fully meet this element for Heckard's peppergrass.

4. *Connectivity with other preserves within the area covered by the Habitat Conservation Plan.*

The newly protected lands will be adjacent to existing protected lands, and will build on the existing reserve system to support recovery of vernal pool crustaceans in the Plan Area.

5. *Adaptive management of the preserves within the area covered by the Habitat Conservation Plan to support the species addressed in this recovery plan.*

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See Section 3.6, Adaptive Management and Monitoring Program.

6. *Sufficient funding for management, maintenance, and monitoring of the preserves in perpetuity.*

   See Chapter 8, Implementation Costs and Funding Sources.

In conclusion, with respect to the covered vernal pool plants, the BDCP includes all of the five elements listed in the Vernal Pool Recovery Plan (U.S. Fish and Wildlife Service 2007) for an HCP to be deemed equivalent to recovery, except for element #3 for Heckard's peppergrass. However, the protection or establishment of two additional Heckard's peppergrass occurrences will contribute to the recovery of this species.

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