Appendix L. Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
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1.0 Overview

This appendix summarizes the conservation needs and opportunities that were considered during development of measureable objectives for the Central Valley Flood Protection Plan (CVFPP) Conservation Strategy (Conservation Strategy or Strategy). The summary of conservation needs is based on the needs identified in existing conservation plans for species of riverine and floodplain habitats, as further described below. The summary of conservation opportunities is based on the opportunities identified during the California Department of Water Resources (DWR's) preliminary planning of multi-benefit flood risk reduction projects (multi-benefit projects) for the 2017 update of the CVFPP.

A Technical Advisory Workgroup (Workgroup) was convened to help DWR evaluate conservation needs and opportunities and apply this evaluation to the development of long-term measurable objectives for the Conservation Strategy. The members of the Workgroup included flood planners and managers (including the Central Valley Flood Protection Board), and biologists from resource agencies and nongovernmental organizations (NGOs). Its members provided guidance regarding the methods used to create these summaries and reviewed the preliminary results based on them.

The following sections of this appendix describe the methods used to summarize conservation needs and opportunities to, in turn, develop the measurable objectives. They also discuss the results of using those methods and provide the Workgroup's recommendations regarding measurable objectives for the Conservation Strategy. The results are provided in Attachments 1, 2, and 3.

2.0 Introduction

As required by the Central Valley Flood Protection Act of 2008 (Act), DWR developed the CVFPP and will provide updates to the plan at 5-year intervals. The Act requires DWR to achieve the following environmental objectives as part of the CVFPP to the extent feasible:

- Promote natural dynamic hydrologic and geomorphic processes
- Increase and improve the quantity, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine aquatic habitats
- Promote the recovery and stability of native species populations and overall biotic diversity

To achieve these objectives, DWR has developed the Conservation Strategy as an integral component of the CVFPP. An administrative draft of the Strategy was prepared by DWR and

released for limited stakeholder review in July 2014. Stakeholder review of the administrative draft was intended to further development of a subsequent public draft.

During the review period for the administrative draft Strategy, DWR received both written feedback and comments at public meetings regarding the importance of including conservation-based measurable objectives for improving ecosystem processes and habitats.

In response to those comments and with the understanding that the measurable objectives identified in the Strategy are not obligations or commitments, DWR has proceeded with developing measurable objectives based on both conservation needs and opportunities for multi-benefit projects to contribute to those needs. The intent of these objectives is to inform planning and project formulation, create synergies among separate efforts, and serve as a yardstick for measuring progress in implementing the Conservation Strategy.

DWR is basing the measurable objectives on a synthesis of applicable conservation needs identified in existing and draft conservation plans and on a summary of conservation opportunities identified during preliminary planning of multi-benefit flood risk reduction projects (multi-benefit projects). These conservation plans are the products of extensive planning processes by resource agencies that were based on the best available science and multiple supporting studies. Therefore, in the opinion of DWR, they provide a relevant and scientifically defensible basis for the measurable objectives. The summary of conservation opportunities consists of initial concepts developed for DWR's planning of multi-benefit projects. The feasibility of these concepts has not been fully evaluated, nor have their relative costs and benefits been evaluated. They are preliminary concepts that indicate the type and scale of potential opportunities.

The following sections of this appendix further describe the methods used to determine conservation needs and estimate the size of opportunities for multi-benefit projects to contribute to meeting those needs. They also summarize and discuss the results of those methods and provide recommendations.

3.0 Methods

The methods consisted of three main components:

- Identifying conservation needs (and summarizing related historical and existing conditions as a frame of reference)
- Estimating conservation opportunities
- Engaging Workgroup members in the process of creating the measurable objectives of the Conservation Strategy

The following sections describe these components of the methods.

3.1 Identification of Conservation Needs

The Conservation Strategy focuses on the ecosystem processes, habitats, and species with the greatest potential to benefit from integrating conservation into the improvement, operation, and maintenance of the State Plan of Flood Control (SPFC). It also focuses on related environmental stressors that could be addressed by flood risk management. Collectively, these ecosystem processes, habitats, species, and stressors are considered "targets" for the purpose of this Strategy and are further described in Table 3-1.

To meet the needs of target species, measurable objectives have been developed for the ecosystem process and habitat targets, and the fish passage barrier and invasive plant targets (both of which are stressors affecting target species, ecosystem processes, and habitats). These objectives consist of one or more metrics (specific, measurable attributes, such as the acreage of riparian vegetation), and for each metric, an amount of change (a magnitude of ecosystem enhancement) resulting from multi-benefit flood projects has been identified. The Conservation Strategy's metrics for targeted ecosystem processes, habitats, species, and stressors are described in Table 3-1.

Table 3-1. Ecological Goals and Targeted Ecosystem Processes, Habitats, Species, and Stressors

Targeted Process, Habitat, Species, or Stressor	Metric
Ecosystem processes	
Floodplain inundation	Inundated Floodplain—total amount at several selected flows, including sustained spring flows (acres, floodplain expected annual habitat)
Riverine geomorphic processes	Natural Bank—total length (miles) River Meander Potential—total amount (acres)
Habitats	
SRA cover	Natural Bank and Vegetation (Riparian-Lined) Attributes of SRA Cover—total length (miles)
Riparian	Habitat Amount—total amount on active floodplain (acres)
Marsh (and other wetlands)	Habitat Amount— total amount on active floodplain (acres)
Species	
Targeted species	Restored Habitat—total area (acres) with attributes (as specified) for threatened and endangered target species (Other targets selected in part because of importance to target species.)
Stressors	
Revetment	Revetment Removed to Increase Meander Potential and/or Natural Bank—total length (miles)

Table 3-1. Ecological Goals and Targeted Ecosystem Processes, Habitats, Species, and Stressors

Targeted Process, Habitat, Species, or Stressor	Metric
Levees[1]	Levees Relocated to Reconnect Floodplain or Improved to Eliminate Hydraulic Constraints on Restoration—total length (miles)
Fish passage barriers	Fish Passage Barriers—priority barriers modified or removed
Invasive plants	Invasive Plant–Dominated Vegetation—total area reduced (acres) on DWR-maintained land/facilities

Key: SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.
Note:
[1] In particular, levees are a stressor where located within river meander zones or if their design does not provide sufficient capacity for riparian habitat throughout the floodway.

Conservation needs related to the targets listed in Table 3-1 were identified through a two-step process:

- Relevant goals, objectives, criteria, and actions were compiled from existing and draft or developing conservation plans and programs.
- Changes to existing conditions needed to attain these goals and objectives were estimated.

The Strategy provides a review of relevant conservation plans in Appendix J, "Existing Conservation Objectives from Other Plans." Thirty-five plans were reviewed because they include objectives that apply to part or all of the main stems of the Sacramento and San Joaquin Rivers and their major tributaries. These plans have three main purposes:

- Managing land and water for biodiversity (which is the purpose of land management plans such as those for California Department of Fish and Wildlife [CDFW] wildlife areas, which are intended to protect native species, natural communities, ecological processes, and habitat connectivity for wildlife)
- Conserving species, particularly those that are threatened or endangered (which is the purpose of agency plans for recovering species listed under the Endangered Species Act and several other plans)
- Supporting incidental take authorizations and permits (which is the primary purpose of habitat conservation plans)

Some plans serve two or all three of these purposes. The following plans, however, are more overarching in that they are focused on and have systemwide goals for conserving species that are targets of the Strategy, and most of the other plans have been developed to be consistent with and contribute to them:

- Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California (U.S. Fish and Wildlife Service [USFWS] 2001)

- San Joaquin River Restoration Settlement Act (Public Law 111-11, Omnibus Public Land Management Act of 2009, Title X, Subtitle A, Part I, San Joaquin River Restoration Settlement Act [123 Stat. 1349]); the related San Joaquin River Restoration Program Draft Environmental Impact Statement/Environmental Impact Report (San Joaquin River Restoration Program [SJRRP] 2011); and the related Revised Framework for Implementation (SJRRP 2015).

- Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead (National Marine Fisheries Service [NMFS] 2014)

- Endangered and Threatened Wildlife and Plants: 12-Month Finding on a Petition to Reclassify the Delta Smelt from Threatened to Endangered throughout Its Range (USFWS 2010a)

- Central Valley Joint Venture 2006 Implementation Plan—Conserving Bird Habitat (Central Valley Joint Venture [CVJV] 2006) (which addresses guilds that include the western yellow-billed cuckoo, least Bell's vireo, greater sandhill crane, and California black rail) with more recent, related content in the proposed designation of critical habitat for the western yellow-billed cuckoo (USFWS 2014)

- The Riparian Bird Conservation Plan: A Strategy for Reversing the Decline of Riparian Associated Birds in California (Riparian Habitat Joint Venture [RHJV] 2004) (which addresses riparian-associated birds, including the Swainson's hawk, least Bell's vireo, and western yellow-billed cuckoo)

- Bank Swallow *(Riparia riparia)* Conservation Strategy for the Sacramento River Watershed, California (Bank Swallow Technical Advisory Committee [BANS-TAC] 2013)

- Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) (USFWS 1998a) and more recent, related information in Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review: Summary and Evaluation (USFWS 2006a)

- Valley Elderberry Longhorn Beetle Recovery Plan (USFWS 1984), with related, more recent content in Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) 5-Year Review: Summary and Evaluation (USFWS 2006b)

- Revised Draft Recovery Plan for Giant Garter Snake (*Thamnophis gigas*) (USFWS 2015), and the prior Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (USFWS

1999) and Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation (USFWS 2006c)

- Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998b) (which addresses riparian brush rabbit [*Silvilagus bachmani riparius*] and riparian woodrat [*Neotoma fucipes riparia*]), with related, more recent content in Final Rule to List the Riparian Brush Rabbit, and the Riparian, or San Joaquin Valley, Woodrat as Endangered (USFWS 2010b)

These plans are hereafter referred to as "conservation plans."

The set of conservation needs related to the Strategy's target processes, habitats, and stressors was drawn from the content of these plans. These plans were developed by resource agencies and scientific advisory committees through extensive planning processes based on the best available science and multiple supporting studies. Conservation plans use various terms for plan content to describe changes to existing conditions necessary for conserving species and the means used to accomplish those changes. These terms include "goals," "objectives," "targets," "actions," and "delisting criteria." In this appendix, this conservation plan content is referred to as identified needs.

For each ecosystem process and habitat objective, the size of the overall need was determined. The overall need is the amount of change necessary to meet all the needs of the target species identified in the selected conservation plans that are related to the ecosystem process or habitat. This usually corresponded to the largest identified need of a target species. In some instances, however, where two species' needs did not overlap geographically, the overall need was their sum. For each targeted ecosystem process and habitat, graphs are presented that compare the overall need with historical and existing conditions. This need was graphed along with historical and existing conditions to illustrate the relative amount of change it represents. Changes from existing conditions necessary to meet these conservation needs were identified by:

- Compiling changes specifically stated in the plans and available supporting information

- Quantifying more generally stated needs (such as creating a continuous corridor of habitat between two locations) using the existing geographic information system (GIS) data summarized in the Conservation Strategy's Appendix F, "Existing Conditions," and the information regarding the ecology of target species provided in Appendix G, "Identification of Target Species and Focused Conservation Plans"

- Incorporating an estimate of fish rearing habitat needed to achieve the objectives of the Anadromous Fish Restoration Program (estimate provided in Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal")

- Incorporating available information from ongoing conservation planning by CVJV and USFWS

Where generally stated needs were quantified, the estimated size was generally the midpoint of a range of likely values, with the range displayed as an error bar on accompanying graphs and with its basis explained in the text. The midpoint was considered the best estimate of the actual value. That is, all values in the range were considered equally likely; thus, the midpoint is the value that on average would be closest to the actual value. Ranges of likely values were estimated because in general, the size of a conservation need is not precisely known. For example, the amount of riparian vegetation required by a viable population of a bird that nests in riparian habitat is a product of the size of that population, the amount of habitat required by a nesting pair of birds, and the portion of riparian vegetation that is suitable as habitat for the species. All these factors vary, and none are known precisely. Thus, there exists a reasonably likely range for the size of the conservation need.

Information from Appendix F, "Existing Conditions," and Appendix G, "Identification of Target Species and Focused Conservation Plans," was used in generating ranges of likely values for conservation needs. In particular, existing bank lengths (natural, revetted, and total) and acres of meander potential (constrained by revetment and unconstrained) were used to generate a number of estimates. Appendix G, "Identification of Target Species and Focused Conservation Plans," provides habitat requirements of target species—in particular, home range and territory sizes that were used to generate several estimates.

Estimates of fish-rearing habitat needs provided in Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal," were determined by converting acres of rearing habitat needed to the acres of inundated floodplain that would be required to provide the needed rearing habitat. Only a portion of inundated floodplain would be suitable rearing habitat. This fraction was considered to range from 10 to 25 percent based on the information provided in Appendix H and Minimum Floodplain Habitat Area for Spring and Fall-Run Chinook Salmon (SJRRP 2012).

In addition, needs identified in the CVJV's implementation plan (CVJV 2006) were scaled (multiplied by) the portion of the CVJV basins included in each conservation planning area (CPA). This was done because the needs identified in the CVJV's implementation plan were for areas larger than the CPAs of the Conservation Strategy. GIS data layers of the CVJV basins and Conservation Strategy CPAs were used to quantify the portion of the CVJV basins, and thus of the needs identified in the CVJV implementation plan, included in each CPA.

For each targeted ecosystem process and habitat, data on existing and historical conditions were provided. These data provide a frame of reference for the size of needs and opportunities. Data on existing conditions were derived from Appendix F, "Existing Conditions." Data on historical conditions were derived from Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal," and from mapping of historical vegetation (The Bay Institute 2003), or historical conditions were estimated from existing conditions (for example, historical natural bank length was estimated from total existing bank length).

Conservation needs were synthesized by applying the approach of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) for describing the level of understanding, importance, and predictability of needs. The DRERIP approach defines low, moderate, and high categories so that these modifiers are used consistently. Table 3-2 provides the adapted terminology. In this context, "outcomes" are population responses, and "drivers" are attributes of ecosystem processes, habitats, or stressors.

Table 3-2. Definitions of Levels of Understanding, Importance, and Predictability

Understanding	
A description of the known, established, and/or generally agreed upon scientific understanding of the cause-effect relationship between a single driver and a single outcome.	
High	Understanding is based on peer-reviewed studies from within system and scientific reasoning supported by most experts within system.
Moderate	Understanding based on peer-reviewed studies from outside system and corroborated by studies within system that have not been peer reviewed.
Low	Understanding based on research within system or elsewhere that has not been peer reviewed.
No	Lack of understanding. Scientific basis unknown or not widely accepted.
Importance	
The degree to which a linkage controls the outcome *relative to* other drivers and linkages affecting that same outcome.	
High	Expected sustained major population level effect. For example, the outcome addresses a key limiting factor or contributes substantially to a species population's natural productivity, abundance, spatial distribution, and/or diversity (both genetic and life history diversity) or has a landscape-scale habitat effect, including effects on habitat quality, spatial configuration, and/or dynamics.
Moderate	Expected sustained minor population effect or effect on large area or multiple patches of habitat.
Low	Expected sustained effect limited to small fraction of population, addresses productivity and diversity in a minor way, or limited to spatial or temporal habitat effects.
No	Current understanding indicates little or no effect.
Predictability	
The degree to which the performance or the nature of the outcome can be predicted from the driver.	
High	Understanding is high, and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors or is expected to confer benefits under conditions or times when model indicates greatest importance.
Moderate	Understanding is high, but nature of outcome is dependent on other highly variable ecosystem processes or uncertain external factors, or understanding is moderate and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors.
Low	Understanding is moderate, and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors, or understanding is low and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors.
No	Understanding is lacking, or understanding is low and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors.

Additional information regarding the needs of target species also was compiled from other appendices to the Conservation Strategy. Appendix G, "Identification of Target Species and

Focused Conservation Plans," identifies conservation needs for target species specific to CVFPP activities, including for target species not addressed by conservation plans.

Conservation needs related to target stressors are compiled in Attachment 1 but are not synthesized separately in Attachment 2. Needs related to revetment and levees were considered in the syntheses of related ecosystem process and habitat needs (inundated floodplain, river meander potential, and natural bank). Appendix E, "Invasive Plant Management Plan," and Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System," provide summaries of invasive plant management and fish passage improvement needs, respectively. (Although only sporadically mentioned in conservation plans, control of invasive species is important for species conservation and environmental stewardship in general.)

3.2 Estimation of Conservation Opportunities

In the context of this appendix, "opportunities" and "conservation opportunities" refer to opportunities for multi-benefit flood projects to contribute to the conservation needs identified for each target ecosystem process and habitat of the Conservation Strategy. (The preceding section describes the identification of these needs.) Opportunities were evaluated through a systematic spatial analysis of data from CVFPP planning studies. ArcMap 10.2.1 was used to measure the size of opportunities at each location included in these studies. Additionally, analyses assessing bank restoration opportunities, and several proposed projects identified by NGOs were included in the analysis. For each CPA, results were reported for each ecosystem process and habitat targeted by the Conservation Strategy.

The sizes of opportunities to reduce invasive plant infestations and improve fish passage were not addressed by this evaluation. Rather, these opportunities were identified through the evaluations provided in Appendix E, "Invasive Plant Management Plan," and Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System."

The analysis summarized in this appendix was based primarily on two groups of existing system-wide evaluations which were aimed at achieving improvements in ecosystem, flood risk reduction, and maintenance efficiency:

- GIS data generated by the Basin-Wide Feasibility Studies (BWFSs) and Floodplain Restoration Opportunity Analysis (FROA) conducted by DWR
- Preliminary analyses conducted by DWR that evaluate the potential for bank restoration on the Sacramento, Feather, and San Joaquin Rivers

Additionally, projects proposed by NGO's for inclusion in the San Joaquin BWFS evaluations were included in this analysis, but not in the development of objectives, to provide an understanding of their potential contribution to the conservation needs of species.

Data from the BWFSs and FROA were used to estimate the overall extent of each type of opportunity in each CPA. The additional evaluations were more limited in geographic scope and were used to supplement these estimates, primarily through notes describing additional opportunities that were provided in the results with the estimates based on BWFS and FROA data.

These data sources and the estimates based on them are described further below.

3.2.1 Central Valley Flood Protection Plan Planning Studies

The potential extent of opportunities was estimated from the following evaluations and supplemental GIS data:

- BWFS evaluations that are under development. The Sacramento and San Joaquin BWFSs are being conducted by DWR. System elements have been grouped to form system configurations for the Sacramento and San Joaquin Basins. System configurations are being evaluated for their potential to provide multi-benefits, including reduced flood risk. Many system elements have large and small geographic areas under evaluation. System elements being evaluated for ecosystem opportunities by the BWFSs (data version from July 2014) were included in this conservation opportunities estimation analysis.

- FROA included in Appendix I, "Floodplain Restoration Opportunity Analysis." FROA conducted by DWR identified potential levee setback locations based on levee condition, opportunities to reduce levee length (and thus maintenance), and infrastructure and development constraints, and it prioritized the potential ecological benefits (see Appendix I). Unlike the BWFS elements, these footprints have not undergone further study that evaluates their potential to reduce flood risk.

The BWFSs and FROA identify locations where ecosystem improvements could be integrated into flood improvement projects and indicate the maximum extent of such opportunities being evaluated by the State. These evaluations considered some major constraints (e.g., topography, development, and major infrastructure) but not all factors affecting feasibility because they represent only the initial phase planning and design. Also, the identification of opportunities was limited by data availability and methods. For example, in identifying potential setback locations, the FROA minimized the length of new levee required, which reduced the size and number of identified opportunities. Thus, not all identified opportunities are feasible, nor are all feasible opportunities included. Collectively, however, these evaluations indicate the scale of ecosystem improvement that is feasible and thus provide a basis for long-term ecological objectives.

Both BWFS and FROA data sets identify areas where modifications to the SPFC could provide ecosystem improvements—in particular, by relocating levees to expand bypasses or the area of floodplain connected to rivers. (These evaluations do not capture the potential of smaller modifications to the SPFC, nor do they evaluate the full set of system elements currently under evaluation by the BWFSs.) During the FROA, these areas (footprints) were digitized as described in Appendix I. BWFS system element locations (footprints) were digitized at the 1:4,000 scale. Where BWFS and FROA footprints overlapped, FROA footprints were excluded.

Two sets of these footprints, representing the range from the likely minimum to the likely maximum combined area of potential modifications, were evaluated. This range exists because of differences between alternatives for improvements at individual sites and because of differences among alternative groups of modifications. For many potential modifications identified through the BWFSs and FROA, those efforts delineated alternative footprints. Also, those planning efforts categorized sites based on their potential benefits (in the FROA) or combined the system elements in sets (configurations) that serve as alternatives for systemwide improvements (in the BWFSs). Therefore, on the basis of the footprints developed during the BWFSs and FROA, this evaluation quantified a range of potential opportunities corresponding to the minimum and maximum areas delineated for footprints and included in different priority categories and configurations by the BWFSs and FROA.

The following data sets for existing conditions also were used to estimate the potential size of opportunities:

- California Levee Database (DWR 2011a)
- Fine-Scale Central Valley Riparian Vegetation Map (DWR 2011b, CDFW Vegetation Classification and Mapping Program and Geographical Information Center California State University Chico 2013)
- A revetment catalog for the lower Sacramento River that was developed by the U.S. Army Corps of Engineers (USACE) (USACE 2007)
- Unpublished GIS data files of revetment locations along the Feather and lower San Joaquin Rivers developed by DWR

As described below, these datasets were used to estimate the potential size of contributions to the Strategy's ecosystem process and habitat objectives from opportunities in BWFS and FROA footprints.

Floodplain Inundation

The area of floodplain that could be potentially reconnected was estimated in acres using the calculate area tool in ArcGIS for the footprints of BWFS system elements that involved levee relocation and for FROA footprints. The portion of reconnected floodplain that could meet the inundation timing, frequency, and duration criteria of the Strategy's floodplain inundation objective was not estimated because this area could be substantially changed through project design (e.g., weir design and operation or floodplain topographic modifications). These design decisions would be made on the basis of multiple considerations, such as cost, magnitude of flood risk reduction, and effects on existing land uses, not simply to maximize ecosystem improvements; thus, estimating inundated areas based on assumptions regarding design decisions would underestimate the potential for ecosystem improvements.

River Meander Potential

Increases in river meander potential were estimated by multiplying the miles of additional natural bank by an acreage of meander potential per mile. Natural bank would be created by removing revetment (as described under "Natural Bank," below), which would remove a constraint on meander potential. The average acreage of meander potential per mile of channel bank was based on the meander potential and channel bank data provided in Appendix F, "Existing Conditions." This approach to estimating meander potential assumes that all the reconnected floodplain is within the river's potential meander zone; thus, this approach may overestimate the opportunities for meander potential.

Natural Bank

The revetment inventories described above were used to identify and sum the length of revetment within the delineated BWFS and FROA footprints. Additional locations where revetment could potentially be removed to improve ecosystems were identified. In some cases, both authorized and unauthorized rock revetment was placed on riverbanks within setback levee reaches to halt channel migration and erosion rather than protect structures or SPFC facilities. At many of these locations, there may be an opportunity to restore banks and increase shaded riverine aquatic habitat and meander potential. To identify locations where revetment is not protecting structures or SPFC facilities, and where meander potential could be increased, an analysis was conducted based on three criteria:

1. Revetment located more than 75 meters from SPFC levees and thus much less likely to be protecting SPFC levees than revetment in closer proximity

2. Revetment located more than 25 meters from geologic substrates resistant to erosion and thus in settings where channel meander could be restored

3. Revetment not protecting nonflood infrastructure visible on 2012 National Agriculture Imagery Program imagery (e.g., bridges, buildings, structures)

These three criteria were selected because they are indicators of potential opportunities that could be assessed system-wide on the basis of existing data and because this preliminary assessment could be conducted rapidly in a cost-effective manner. The location of revetment on nonresistant substrates was included as a criterion because natural banks on these substrates provide greater nearshore and bank habitat values and allow for greater meander migration that increases the quality of floodplain habitats.

Riparian-Lined Bank

Opportunities to increase riparian-lined banks (the vegetation attribute of shaded riverine aquatic cover) were identified using the Fine-Scale Central Valley Riparian Vegetation Map GIS data layer (DWR 2011b). The potential increase in riparian-lined banks was calculated as the length of revetment that was identified as potentially removable and that was not located adjacent to the vegetation group coded "RWF" (Southwestern North American riparian evergreen and deciduous woodland). This analysis assumed that riparian forest and riparian-lined banks could

be restored at all such locations that lacked riparian-lined banks and that where riparian vegetation was mapped adjacent to banks, the banks were already lined with riparian vegetation.

Riparian Habitat

The area with riparian habitat potential was assumed to be half of the total area of footprints that were along river reaches. Opportunities for riparian restoration are widespread and extensive, but multiple physical and societal factors constrain the potential area of riparian vegetation on most sites. Thus, an average of 50-percent suitability was used for estimates. This assumption is conservative (i.e., it likely underestimates the potential for riparian restoration where the flood system footprint would be increased by levee relocation).

Marsh and Other Wetland Habitat

The area with wetland habitat potential was estimated to be 25 percent of the area of footprints located in bypasses or transient storage areas. The assumption of 25-percent suitability was made to be consistent with the assumption in the CVFPP that 25 percent of the area of bypass expansions would be restored to natural vegetation.

Stressors

Opportunities for revetment and levee modification to reduce stress on processes and habitats were also identified. However, the Strategy treats changes to these stressors as means to accomplishing process and habitat improvements, not desired ends in themselves. Because the needed extent of these modifications is determined through the development of specific projects, the Strategy does not include objectives for these stressors.

Opportunities related to stressors were not identified through evaluation of BWFS and FROA data. Rather, they are based on Conservation Strategy Appendix E, “Invasive Plant Management Plan,” and Appendix K, “Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System,” respectively.

3.2.2 Additional Existing Evaluations of Conservation Opportunities

In addition to BWFSs and FROA, three other sources identifying opportunities were also considered:

- **Projects identified in the Lower Feather River Corridor Management Plan (DWR 2014).** This corridor management plan identifies specific restoration projects for the active floodplain that have been developed by DWR in coordination with local maintaining agencies and State and federal resource agencies. The potential contributions of these projects to target species conservation needs were identified.

- **Additional multi-benefit projects in the San Joaquin Valley.** A group of conservation NGOs (American Rivers, The Nature Conservancy, National Audubon Society, Point Blue Conservation Science, and Natural Resources Defense Council) identified ten project locations in the San Joaquin Valley, six of which were not included in the BWFS and FROA evaluations. Several of these project footprints overlap with SPFC facilities, including those

at Paradise Cut, East Side Bypass, and Reach 2A San Joaquin River. These project concepts were evaluated for their potential to contribute to the conservation needs of target species.

- **Additional potential revetment removal opportunities in the Upper and Lower Sacramento River, Feather River, and Lower San Joaquin River CPAs.** DWR has been conducting a preliminary evaluation of potential revetment removal opportunities. Preliminary GIS data files from this evaluation were reviewed, and the size of these potential opportunities was noted.

These project concepts were evaluated for their potential contributions to the conservation needs of target species, and their potential contributions were identified in the "Notes" column of summary tables (in Attachment 3) but not included in the estimates of total opportunities provided in those tables.

3.3 Participation of Technical Advisory Workgroup

DWR convened a Workgroup to engage natural resource agencies, environmental interests, and flood managers in DWR's development of the long-term measurable objectives. The Workgroup consisted of representatives from the following organizations:

- American Rivers
- Central Valley Flood Protection Board
- CDFW
- NMFS
- Point Blue Conservation Science
- River Partners
- Sacramento Area Flood Control Agency
- The Nature Conservancy
- Trout Unlimited
- USFWS

Staff members of DWR's Division of Flood Management and FloodSAFE Environmental Stewardship and Statewide Resources Office worked with committee members, and the committee's work was supported by staff members from two consulting firms: Kearns & West and H. T. Harvey & Associates.

Workgroup members were asked to review and provide advice on DWR's proposed methods and results for summarizing conservation needs and estimating the extent of opportunities to provide needed conservation through multi-benefit flood projects. Workgroup members were not expected to make consensus recommendations to DWR's staff. Rather, members were encouraged to provide advice as individuals. DWR took this advice into consideration in developing measurable objectives for inclusion in the Conservation Strategy. The Workgroup met four times between 18 September and 16 October 2014 to discuss the preliminary work products and provide recommendations.

Recommendations of Workgroup members were applied to the methods described above and to the presentation of results. The major comments of Workgroup members regarding the results have been included in the "Discussion" section, below.

4.0 Results and Discussion

4.1 Conservation Needs

4.1.1 Results

Results of the evaluation of conservation needs are provided in Attachments 1–3. In Tables L1-1 through L1-5, Attachment 1 lists relevant content of the reviewed conservation plans. This content is organized by the Strategy's CPAs and, within each CPA, by the Strategy's objectives. Notes are included in the tables regarding interpretation of conservation plan content.

For each ecosystem process and habitat objective of the Strategy, Attachment 2 provides a one-page summary of the overall need based on the conservation plan content summarized in Attachment 1.

As described above, invasive plant objectives have been developed in the Strategy's Invasive Plant Management Plan (Appendix E), and fish passage objectives are based on the opportunities prioritized through the Strategy's assessment of fish migration opportunities (Appendix K).

4.1.2 Discussion

Three characteristics of the available conservation plans analyzed in this appendix have significance for the size of identified conservation needs. The first is the uneven representation of the target species by existing conservation plans. Three of the 10 reviewed plans address the conservation of salmonids, whereas target plant species are not addressed by any of the conservation plans. This uneven representation could cause the overall needs for ecosystem processes or habitats identified in Attachment 2 to be insufficient for meeting the needs of unrepresented or underrepresented species. Similarly, additional native species have conservation needs that may not be fully represented by the needs of target species.

Second, the effects of actions identified through conservation plans have a low level of predictability, which could result in much less efficient and effective conservation than if outcomes of actions were known more precisely. There are several causes of this low predictability:

- Ambiguity in the content of conservation plans, particularly recovery plans, requiring additional interpretation (e.g., "several hundred pairs" could refer to a number between 300 and 900, which is a wide range)
- Scientific uncertainty (e.g., regarding the area of habitat required by an individual or pair and the location, width, and other attributes of corridors providing habitat connectivity)
- Lack of complete inventory data (e.g., regarding the distribution of revetment in the San Joaquin River Basin)
- Complex environmental relationships among objectives (e.g., the need for riparian-lined bank is related to vegetation management, management of large woody material, access to and operation of bypasses, and modification of floodplain topography and restoration of natural bank)

Third, the age of some conservation plans adds inaccuracy to the conservation needs that they identify. The existing conservation plans were developed over a period of approximately 30 years. The older plans are qualitatively different from newer plans, being shorter and less specific. Also, during this 30-year span, scientific understanding has increased, and environmental conditions have changed. (As an example of change in both understanding and circumstances, most existing plans do not address the effects of climate change, which is a major consideration for recently developed plans.)

Members of the Workgroup emphasized the value of relying on regularly updated assessments of conservation needs, such as the Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat (CVJV 2006), as opposed to conservation plans for particular species that incrementally become out of date. Similarly, members advocated the standardized description of needs using metrics that could readily be adjusted in response to changes in water management, such as expected annual habitat units meeting standardized requirements for flow timing, duration, and frequency.

4.2 Conservation Opportunities

4.2.1 Results

The tables in Attachment 3 summarize for each objective the opportunities for ecosystem improvements. These opportunities are based on BWFS planning and the analysis of floodplain restoration opportunities conducted for the Strategy (Appendix I).

4.2.2 Discussion

Several limitations of this evaluation's data sources and methods affected the estimated extent of opportunities and the accuracy of the estimates:

- Restriction to multi-benefit projects. Only opportunities to achieve conservation through multi-benefit projects were evaluated. However, single-purpose restoration actions would also provide additional ecosystem improvements.

- Focus of evaluation on CVFPP analyses. The estimated extent of opportunities generally does not include potential projects not evaluated as part of developing the Conservation Strategy and BWFSs (e.g., additional projects identified in Regional Flood Management Plans). Thus, multi-benefit projects overall could make greater contributions than estimated.

- Reliance on planning-level data. The planning-level data used for this evaluation did not account for a number of constraints on the potential extent of ecosystem improvements. Thus, more detailed hydraulic modeling and feasibility analyses will likely reduce the amount of conservation incorporated into the evaluated footprints.

For these and other reasons, members of the Workgroup argued that potential opportunities may be underestimated by this evaluation's methods or that this evaluation's results should be considered the current set of opportunities and not the full set of opportunities that will be available during implementation of the CVFPP.

5.0 Recommendations

The following recommendations are based on interpretation of the results and input from members of the Workgroup:

- **Scale objectives to realize opportunities if they are smaller than needs.** The Strategy targets ecosystem processes, habitats, species, and stressors closely associated with the SPFC, and some of the related conservation needs cannot be met without modification of the SPFC (e.g., substantial increases in natural bank require modification of revetment and/or levees). These related conservation needs are extensive, and in general, the potential opportunities identified through CVFPP planning are not sufficient to meet them. Although not sufficient to meet conservation needs entirely, fully realizing opportunities for multi-benefit flood projects is necessary for species' conservation, and greater contributions from multi-benefit flood projects are unlikely to be achievable.

- **Complete inventories of existing conditions, and conduct focused studies to increase the predictability of conservation needs.** A number of conservation needs have low levels of predictability; thus, the size of the need is imprecisely estimated and may be inaccurate. The two primary causes of poor predictability are incomplete inventories of existing conditions

and limited scientific understanding. Inventories and scientific studies that increase the precision and accuracy of these estimates could increase the Strategy's effectiveness by allowing for better resource allocation.

- **Identify important projects for meeting conservation needs.** The ability to meet some conservation needs depends on the implementation of specific projects. Identifying these projects would aid conservation planning.

- **Revise objectives during implementation to account for changes in opportunities.** The objectives are based in part on opportunities, which in turn are strongly influenced by recent conditions and needs. During the long period of CVFPP implementation, conditions and needs will change and, consequently, so will the nature and scale of opportunities. Therefore, the objectives should be revised during implementation to account for this change in their basis.

- **Revise objectives when the accuracy or predictability of conservation needs is improved.** During implementation of the Strategy, the results of focused studies and other increases in scientific understanding will become available and likely will increase the predictability of or otherwise refine some conservation needs. As part of adaptive management, the objectives should be revised to be consistent with the more precise estimates of conservation needs that result

- **Base revised objectives on regularly updated assessments of conservation needs wherever possible.** Periodically updated assessments, such as the Central Valley Joint Venture Implementation Plan—Conserving Bird Habitat (CVJV 2006), apply the best available science and address current conditions, unlike recovery plans for particular species, which incrementally become out of date.

- **Use metrics that can be readily adjusted in response to changes in water management.** Target fish species (and, to a lesser extent, other target species) require habitats that are the product of both land use and water management. Therefore, objectives could better reflect species' needs if the metrics used in objectives could be adjusted readily in response to changes in water management, such as habitat metrics based on specified requirements for flow timing, duration, and frequency (e.g., expected annual habitat units).

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L1. Recovery Plan Content Related to Conservation Strategy Objectives

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Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Floodplain Inundation		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal," presents estimates of the amount of rearing habitat required to meet this plan's population doubling goal. The results of the modeling indicate that an additional 18,300–22,100 acres of suitable rearing habitat would be needed in this CPA (Table 6-1 in Appendix H: average required habitat acreage minus estimates of existing habitat acreage at high to low suitability). Portions of the bypass system were excluded from this evaluation because they did not meet the minimum inundation frequency requirements that this analysis established for rearing habitat. (Most of the Sutter Bypass was included; the Butte Basin was not.) Most inundated floodplain (75–90%) would not be suitable as rearing habitat. Thus, this estimate corresponds to a much greater area of additional inundated floodplain.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-1.13:** Identify management targets for Yolo and Sutter bypass inundation timing, frequency, magnitude, and duration that will maximize the growth and survival of juvenile Chinook salmon and spring-run Chinook salmon; and then manage the bypasses to those targets.	—

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo	**Minimum Management Goals for Western Yellow-Billed Cuckoos:** Reforestation of 9,140 acres of suitable habitat [along Sacramento River]. (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 150 pairs of birds in the Sacramento Valley (part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%). Based on western yellow-billed cuckoo critical habitat, all of the Sacramento River acreage identified in the CVJVIP would be included in the Upper Sacramento River CPA.
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 6:** Construct setback levees to expand the meander belt by reconnecting floodplains to the river channel. **Recommendation 6.1:** Construct setback levees to restore 4,500 acres of connected floodplain to the Sacramento River between Chico Landing and Colusa by 2050. **Recommendation 6.2:** Construct setback levees to restore 7,000 acres of connected floodplain on the Sacramento River between Colusa and Verona by 2050.	—
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs of would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species' habitat requirements, see Appendix G, "Identification of Target Species and Focused Conservation Plans.")
Riverine Geomorphic Processes		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]**: Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-1.2:** Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars, and bare cut banks, shady vegetated banks, side channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook.	See the note related to this threat abatement criterion under "SRA Cover."
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for Western Yellow-Billed Cuckoos:** Reforestation of 9,140 acres of suitable habitat [along Sacramento River]. (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration.

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		The acreage identified in the minimum management goals for western yellow-billed cuckoo is based on 150 pairs of birds in the Sacramento Valley (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%). Based on western yellow-billed cuckoo critical habitat all of the Sacramento River acreage identified in the CVJVIP would be included in the Upper Sacramento River CPA.
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 5:** Remove revetment to restore habitat and meander potential. **Recommendation 5.1:** Remove 19 miles of rock revetment on the Sacramento River between Red Bluff and Chico Landing by 2050. **Recommendation 5.2.:** Remove 10 miles of revetment between Chico Landing and Colusa by 2050. **Recommendation 5.3:** Remove 25 miles of rock revetment between Colusa and Verona by 2050. **Recommendation 5.5:** Remove revetment where possible from other tributaries [besides Feather River].	This amount of revetment removal is based both on conservation needs and on the results of a preliminary evaluation of the amount of revetment that may feasibly be removed. The amounts of revetment that would be removed to conserve bank swallow were based on the goal of doubling the bank swallow population compared to the size of the population when the species was proposed for listing and the argument that an increase in nesting habitat would result in a proportional increase in population. The removal recommendation for the Red Bluff–Chico Landing reach includes 10 miles of revetment upstream of the SPA. Thus, the combined total for Recommendations 5.1, 5.2, and 5.3 is 44 miles of revetment removal in the SPA.

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")
SRA Cover		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-1.2:** Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars, and bare cut banks, shady vegetated banks, side channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook.	Multiple plans (including this one) identify improved nearshore habitat quality as a conservation need but do not specify the amount of improvement needed or explicitly state the factors determining the amount needed. In large part, this is because SRA cover and the nearshore environment in general have a complex relationship to the ecology of salmonids and the demography of their populations. The value of SRA cover is related to predation, flow, and temperature effects on the activities, growth, and survival

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	Action ID SAR-2.11: Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators. **Action ID SAR-2.18:** Using an adaptive approach and pilot studies determine if instream habitat for juvenile rearing is limiting salmonid populations, by placing juvenile-rearing-enhancement structures in the Sacramento River. If found to be limiting, add large woody debris/coarse organic material to the upper, middle, and lower reaches of Sacramento River to increase the quantity and quality of juvenile rearing habitat.	of salmonids. It is also related to the management of woody vegetation and the availability of inundated floodplain.
Riparian Habitat		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **Sacramento River Action 5:** Identify opportunities for restoring riparian forests in channelized sections of the upper mainstem Sacramento River that are appropriate with flood control and other water management constraints.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SAR-1.2:** Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars, and bare cut banks, shady vegetated banks, side channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook. **Action ID SAR-2.15:** Restore the current Lake Red Bluff footprint to riparian habitat, consistent with flood control needs. **Action ID SAR-2.8:** Implement projects that promote native riparian species (e.g., willows) including eradication projects for non-native species (e.g., arundo, tamarisk).	—

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred of more breeding pairs, have become established and are protected and managed at the following sites: a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for Western Yellow-Billed Cuckoos:** Reforestation of 9,140 acres of suitable habitat [along Sacramento River]. (CVJVIP) **5-Year Riparian Restoration Objectives:** Butte Basin 1,125 acres, Colusa Basin 1,350 acres, and Sutter Basin 675 acres (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 150 pairs of birds in the Sacramento Valley (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%). Based on western yellow-billed cuckoo critical habitat all of the Sacramento River acreage identified in the CVJVIP would be included in the Upper Sacramento River CPA. The SPA in this CPA does not include all the basin land area identified in the CVJVIP

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		objectives but does include most of the restorable land. (Long-term CVJV objectives are being developed and will be included in the updated CVJVIP.)
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 8:** Restore and manage floodplain vegetation to provide bank swallow nesting and foraging habitat. **Recommendation 8.1:** Continue to restore floodplain habitats on the Sacramento River through: 8.1.1 Implementation of the USFWS Sacramento River NWR riparian and floodplain habitat restoration program 8.1.2 Implementation of the CDFW Comprehensive Management Plan for the Sacramento River Wildlife Area 8.1.3 Implementation of the California State Parks Central Valley Vision Implementation Plan 8.1.4 Continued support of agency efforts through the Sacramento River Project partnership to restore additional acreage	Implementation of the USFWS Sacramento River NWR riparian and floodplain habitat restoration program would restore 3,255 acres of riparian habitat (USFWS 2005). Implementation of the CDFW Comprehensive Management Plan for the Sacramento River Wildlife Area could restore 432 acres of riparian vegetation through planting and potentially more through natural processes (Table 5 in CDFG 2004). Implementation of the *California State Parks Central Valley Vision Implementation Plan* would restore 320 acres of riparian vegetation (CDPR 2009). The additional acreage that could be restored through implementation of the Sacramento River Project has not been determined.
Marsh/Other Wetland Habitat		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SAR-1.2.**:Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars, and bare cut banks, shady vegetated banks, side channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook.	—
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat	**5-Year Semi-Permanent Wetland Restoration Objective for Waterbirds:** 1,000 acres in American, Butte, Colusa, and Sutter Basins combined.	This CPA does not include all the land area of the CVJVIP basins, and opportunities to

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	5-Year Seasonal Wetland Restoration Objective for Waterbirds: 43,000 acres in American, Butte, Colusa, and Sutter Basins combined.	restore semipermanent and seasonal wetlands are widespread in the CVJV basins.
Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation	**Recovery Criterion A1. Butte Basin Recovery Unit: Minimum of six habitat block pairs** with no less than two block pairs per management unit in the Butte Basin Recovery Unit. **Recovery Criterion A2.** Colusa Basin Recovery Unit: Minimum of six habitat block pairs with no less than two block pairs per management unit in the Colusa Basin Recovery Unit. **Recovery Criterion A3.** Sutter Basin Recovery Unit: Minimum of four habitat block pairs with no less than one block pair per management unit in the Sutter Basin Recovery Unit (areas with high flooding flows within the Sutter Bypass should be considered as unsuitable habitat).	Paired habitat blocks would be a block of existing, enhanced, or restored perennial wetland (240 hectares [539 acres] in size) connected by half-mile-wide corridors of suitable habitat to a block of rice agriculture (639 hectares [1,578 acres] in size). In this CPA, these recovery criteria total preservation of 5,390 acres of existing, enhanced, or restored perennial wetland. (All Colusa Basin, two of the three Butte Basin, and two of the four Sutter Basin management units are in this CPA.)
Revetment		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-1.2:** Restore and maintain riparian and floodplain ecosystems along both banks of the Sacramento River to provide a diversity of habitat types including riparian forest, gravel bars, and bare cut banks, shady vegetated banks, side channels, and sheltered wetlands, such as sloughs and oxbow lakes following the guidance of the Sacramento River Conservation Area Handbook. **Action ID SAR-2.1:** Ensure that river stabilization projects along the Sacramento River utilize biotechnical techniques that restore riparian habitat, rather than solely using the conventional technique of adding riprap. **Action ID SAR-2.11:** Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators.	See the note regarding this threat abatement criterion under “SRA Cover.”
Bank Swallow (*Riparia riparia*) Conservation Strategy for the	**Goal 5:** Remove revetment to restore habitat and meander potential. **Recommendation 5.1:** Remove 19 miles of rock revetment on the Sacramento River between Red Bluff and Chico Landing by 2050.	This amount of revetment removal is based both on conservation needs and on the results of a preliminary evaluation of the

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Sacramento River Watershed, California	**Recommendation 5.2:** Remove 10 miles of revetment between Chico Landing and Colusa by 2050. **Recommendation 5.3:** Remove 25 miles of rock revetment between Colusa and Verona by 2050. **Recommendation 5.5:** Remove revetment where possible from other tributaries [besides Feather River].	amount of revetment that may feasibly be removed. The amounts of revetment that would be removed to conserve bank swallow were based on the goal of doubling the bank swallow population compared to the size of the population when the species was proposed for listing and the argument that an increase in nesting habitat would result in a proportional increase in population. The removal recommendation for the Red Bluff–Chico Landing reach includes 10 miles of revetment upstream of the SPA. Thus, the combined total for Recommendations 5.1, 5.2, and 5.3 is 44 miles of revetment removal within the SPA.
Levees		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 6:** Construct setback levees to expand the meander belt by reconnecting floodplains to the river channel. **Recommendation 6.1:** Construct setback levees to restore 4,500 acres of connected floodplain to the Sacramento River between Chico Landing and Colusa by 2050. **Recommendation 6.2:** Construct setback levees to restore 7,000 acres of connected floodplain on the Sacramento River between Colusa and Verona by 2050.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.

Table L1-1. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Fish Passage Barriers		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [1]:** Populations have unobstructed access to Core 1, 2, and 3 watersheds… **Action ID SAR-1.12:** In an adaptive management context, implement short- and long-term solutions to minimize the loss of adult chinook salmon and steelhead in the Yolo Bypass, and Colusa and Sutter-Butte basins. … Providing and/or improving fish passage through the Yolo Bypass and Sutter Bypass allowing for improved adult salmonid re-entry into the Sacramento River (long-term) **Action ID SAR-2.10:** Implement projects to minimize predation at weirs, diversions, and related structures in the Sacramento River.	Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System," describes and prioritizes 12 channel-wide structural barriers that have been identified in this CPA.
Invasive Plants		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SAR-2.8:** Implement projects that promote native riparian species (e.g., willows) including eradication projects for non-native species (e.g., arundo, tamarisk).	—
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Recovery Action 1.7:** Control nonnative plant species.	This action specifically refers to tamarisk (*Tamarix* species) and giant reed (*Arundo donax*), two species identified as high-priority invasive plants in the Conservation Strategy.

Sources: BANS-TAC 2013; CVJV 2006; NMFS 2014; RHJV 2004; USFWS 1984, 1998a, 2001, 2006a, 2006b, 2014

Key: CDFG = California Department of Fish and Game, CDPR = California Department of Parks and Recreation, CPA = conservation planning area, CVJVIP = Central Valley Joint Venture Implementation Plan, DFW = California Department of Fish and Wildlife, DWR = California Department of Water Resources, ID = identifier, LWM = large woody material, NWR = national wildlife refuge, SAR = Sacramento River, SPA = Systemwide Planning Area, SPFC = State Plan of Flood Control, SRA = shaded riverine aquatic, USFWS = U.S. Fish and Wildlife Service

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Floodplain Inundation		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal," presents modeling results that estimates the amount of rearing habitat required to meet this plan's population doubling goal. The results of that modeling indicate that an additional 9,700–9,900 acres of suitable rearing habitat would be needed in this CPA (Table 6-1 in Appendix H: average required habitat acreage minus estimates of existing habitat acreage at high to low suitability). Most inundated floodplain (75–90%) would not be suitable as rearing habitat. Thus, this estimate corresponds to a much greater area of additional inundated floodplain.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID FER-18:** Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed. **Action ID YUR-1.3:** Develop programs and implement projects that promote natural river processes, including projects that add riparian habitat and instream cover. **Action ID YUR-2.2:** Increase floodplain habitat availability in the lower Yuba River.	Implementation of the Lower Feather River Corridor Management Plan would increase by 73 acres the amount of floodplain frequently inundated by sustained springs flows and would increase by 162 acres the area inundated by a 2-year event (Table 5-19 in DWR 2014).

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	Action ID YUR-2.4: Create and restore side channel habitats to increase the quantity and quality of off-channel rearing and spawning areas in the Yuba River.	
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for Western Yellow-Billed Cuckoos:** Reforestation of 770 acres of suitable habitat [along Feather River].	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is based on 25 pairs of birds along the Feather River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%).
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 6:** Construct setback levees to expand the meander belt by reconnecting floodplains to the river channel. **Recommendation 6.3:** Construct setback levees to restore 500 acres of connected floodplain on the Feather River by 2050.	—
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs of would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		G, "Identification of Target Species and Focused Conservation Plans.")
Riverine Geomorphic Processes		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations **Action ID FER-18:** Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed. **Action ID YUR-1.3:** Develop programs and implement projects that promote natural river processes, including projects that add riparian habitat and instream cover.	See the note related to this threat abatement criterion under "SRA Cover."
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for …Western Yellow-Billed Cuckoos:** Reforestation of 1,900 acres of suitable habitat [along Feather River].	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration.

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 25 pairs of birds along the Feather River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat. A large portion of restored riparian vegetation could provide suitable habitat (60–100%).
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 5:** Remove revetment to restore habitat and meander potential. **Recommendation 5.4:** Remove 2 miles of rock revetment from the Feather River by 2050. **Recommendation 5.5:** Remove revetment where possible from other [Sacramento and Feather River] tributaries.	This amount of revetment removal is based both on conservation needs and on the results of a preliminary evaluation of the amount of revetment that may feasibly be removed. The amounts of revetment that would be removed to conserve bank swallow were based on the goal of doubling the bank swallow population compared to the size of the population when the species was proposed for listing and the argument that an increase in nesting habitat would result in a proportional increase in population.
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
SRA Cover		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **Yuba River Action 8:** Purchase streambank conservation easements to improve salmonid habitat and instream cover.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID FER-18:** Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed. **Action ID FER-1.9:** Implement projects to improve near shore refuge cover for salmonids in the Feather River to minimize predatory opportunities for striped bass and other non-native predators. **Action ID YUR-1.3:** Develop programs and implement projects that promote natural river processes, including projects that add riparian habitat and instream cover. **Action ID YUR-2.1:** Develop and implement a large woody material restoration program along the lower Yuba River utilizing sources of wood that enter upstream reservoirs.	The Draft Lower Feather River Corridor Management Plan (DWR 2014) does not state the length of SRA cover that would be restored. However, the plan's project descriptions indicate that more than 1 mile of SRA cover would be restored. Multiple plans (including this one) identify improved near-shore habitat quality as a conservation need, but do not specify the amount of improvement needed or explicitly state the factors determining the amount needed. In large part, this is because SRA cover and the nearshore environment in general, have a complex relationship to the ecology of salmonids and the demography of their populations. The value of SRA cover is related to predation, flow, and temperature effects on the activities, growth, and survival of salmonids. It is also related to the management of woody vegetation and the availability of inundated floodplain.

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Riparian Habitat		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID FER-18:** Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed. **Action ID YUR-1.3:** Develop programs and implement projects that promote natural river processes, including projects that add riparian habitat and instream cover. **Action ID YUR-2.5:** Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating river riparian corridors within their jurisdiction in the Yuba River watershed.	Implementation of the Lower Feather River Corridor Management Plan would restore 718 acres of riparian forest and scrub (Table 5-15 in DWR 2014)
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred of more breeding pairs, have become established and are protected and managed at the following sites: a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs of would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		G, "Identification of Target Species and Focused Conservation Plans.")
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for Western Yellow-Billed Cuckoos:** Reforestation of 1,900 acres of suitable habitat [along Feather River]. **5-Year Riparian Restoration Objectives:** American Basin 675 acres, Butte Basin 1,125 acres, and Sutter Basin 675 acres (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 25 pairs of birds along the Feather River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%). (Long-term CVJV objectives are being developed and will be included in the updated CVJVIP [Seavy pers. comm.].)
Marsh/Other Wetland Habitat		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID FER-18:** Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed.	Implementation of the Lower Feather River Corridor Management Plan would restore 15 acres of marsh (Table 5-15 in DWR 2014)
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat	**5-Year Semi-Permanent Wetland Restoration Objective for Waterbirds:** 1,000 acres in American, Butte, Colusa, and Sutter Basins combined. **5-Year Seasonal Wetland Restoration Objective for Waterbirds:** 43,000 acres in American, Butte, Colusa, and Sutter Basins combined.	The SPA in this CPA does not include all the land area of the CVJVIP basins, and opportunities to restore semi-permanent and

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		seasonal wetlands are widespread in the CVJV basins. Long-term CVJV objectives are being developed and will be included in the updated CVJVIP (Seavy pers. comm.).
Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation	**Recovery Criterion A1.** Butte Basin Recovery Unit: Minimum of six habitat block pairs with no less than two block pairs per management unit in the Butte Basin Recovery Unit. **Recovery Criterion A3.** Sutter Basin Recovery Unit: Minimum of four habitat block pairs with no less than one block pair per management unit in the Sutter Basin Recovery Unit (areas with high flooding flows within the Sutter Bypass should be considered as unsuitable habitat). **Recovery Criterion A4.** American Basin Recovery Unit: Minimum of eight habitat block pairs with no less than one block pair per management unit in the American Basin Recovery Unit.	Paired habitat blocks would be a block of existing, enhanced, or restored perennial wetland (240 hectares [539 acres] in size) connected by half-mile-wide corridors of suitable habitat to a block of rice agriculture (639 hectares [1,578 acres] in size). In this CPA, these recovery criteria total preservation of 5,390 acres of existing, enhanced, or restored perennial wetland. (One of the three Butte Basin, two of the four Sutter Basin, and three of the four American Basin management units are in this CPA.)
Revetment		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations **Action ID FER-1.9:** Implement projects to improve near shore refuge cover for salmonids in the Feather River to minimize predatory opportunities for striped bass and other non-native predators. **Action ID YUR-3.2:** Utilize biotechnical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap in the Yuba River.	See discussion related to this threat abatement criterion under “SRA Cover:”
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 5:** Remove revetment to restore habitat and meander potential. **Recommendation 5.4:** Remove 2 miles of rock revetment from the Feather River by 2050. **Recommendation 5.5:** Remove revetment where possible from other [Sacramento and Feather River] tributaries.	This amount of revetment removal is based both on conservation needs and on the results of a preliminary evaluation of the amount of revetment that may feasibly be removed.

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		The amounts of revetment that would be removed to conserve bank swallow were based on the goal of doubling the bank swallow population compared to the size of the population when the species was proposed for listing and the argument that an increase in nesting habitat would result in a proportional increase in population.
Levees		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID FER-2.6:** Utilize fish-friendly designs (e.g., levee setbacks, inclusion of riparian vegetation) for levee construction and maintenance. A**ction ID YUR-2.2:** Increase floodplain habitat availability in the lower Yuba River.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.
Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California	**Goal 6:** Construct setback levees to expand the meander belt by reconnecting floodplains to the river channel. **Recommendation 6.3:** Construct setback levees to restore 500 acres of connected floodplain on the Feather River by 2050.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.
Fish Passage Barriers		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct	**Threat Abatement Criterion [1]:** Populations have unobstructed access to Core 1, 2, and 3 watersheds… **Action ID FER-1.7:** Implement projects to minimize predation at weirs, diversion dams, and related structures in the Feather River.	Appendix K, “Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System,” describes and prioritizes 4 channel-wide structural barriers that have been identified in this CPA.

Table L1-2. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Feather River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Population Segment of California Central Valley Steelhead	**Action ID FER-2.13:** Modify Sunset Pumps to provide unimpeded upstream passage of adult steelhead and Chinook salmon (and sturgeon) and to minimize predation of juveniles moving downstream.	
Invasive Plants		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID FER-18:** Implement the lower Feather River Corridor Management Plan and other projects that promote natural river processes (e.g., floodplain and riparian restoration). Federal, State, and local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating active floodplain and riparian corridors within their jurisdiction in the Feather River watershed.	Implementation of the Lower Feather River Corridor Management Plan would eradicate 6 acres of Himalayan blackberry infestations and eliminate 620 acres of grassland dominated by nonnative grasses (Table 5-15 in DWR 2014)
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Recovery Action 1.7:** Control nonnative plant species.	Action specifically refers to tamarisk (*Tamarix* species) and giant reed (*Arundo donax*), two of the Conservation Strategy's priority invasive plants.

Sources: BANS-TAC 2013; CVJV 2006; NMFS 2014; RHJV 2004; USFWS 1984, 1998a, 2001, 2006a, 2006b, 2014

Key: CPA = conservation planning area, CVJVIP = Central Valley Joint Venture Implementation Plan, DWR = California Department of Water Resources, FER = Feather River, ID = identifier, LWM = large woody material, SPA = Systemwide Planning Area, SPFC = State Plan of Flood Control, SRA = shaded riverine aquatic, USFWS = U.S. Fish and Wildlife Service, YUR = Yuba River

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Floodplain Inundation		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal," presents estimates of the amount of rearing habitat required to meet this plan's population doubling goal. The results of that modeling indicate that an additional 8,100–10,200 acres of suitable rearing habitat would be needed in this CPA (Table 6-1 in Appendix H: average required habitat acreage minus estimates of existing habitat acreage at high to low suitability). The bypass system was excluded from this evaluation because it did not meet the minimum inundation frequency requirements that this analysis established for rearing habitat. Suitability as rearing habitat is related to water depth and velocity and amount of cover. Most inundated floodplain (75–90%) would not be suitable as rearing habitat. Thus, this estimate corresponds to a much greater area of additional inundated floodplain.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-1.13.** Identify management targets for Yolo and Sutter bypass inundation timing, frequency, magnitude, and duration that will maximize the growth and survival of juvenile Chinook salmon and spring-run Chinook salmon; and then manage the bypasses to those targets.	DEL-1.8 also includes Lower San Joaquin River CPA. DEL-1.8 acreage assumed to include the results of DEL-2.3, DEL-2-5, DEL-1.16, DEL-1.9, DEL-1.10, DEL-1.13, DEL-1.6, and DEL-1.7.

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	Action ID AMR-2.9: Inventory locations on the American River for creating shallow inundated floodplain habitat for multi-species benefits and implement where suitable opportunities are available. **Action ID DEL-2.3:** Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding. **Action ID DEL-1.16:** Implement the Southport Floodplain Restoration Project. **Action ID DEL-1.7:** Restore, improve, and maintain salmonid rearing and migratory habitats in the Delta and Yolo Bypass to improve juvenile salmonid survival and promote population diversity. **Action ID DEL-1.8:** Restore 17,000 to 20,000 acres of floodplain habitat.	
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs of would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")
Riverine Geomorphic Processes		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991.	—

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Production of Anadromous Fish in the Central Valley of California	**Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID DEL-2.3:** Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding.	See the note related to this threat abatement criterion under “SRA Cover.”
Draft Recovery Plan for the Least Bell’s Vireo (*Vireo bellii pusillus*) Least Bell’s Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell’s vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a Sacramento Valley metapopulation.	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, “Identification of Target Species and Focused Conservation Plans.”)
SRA Cover		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural	**Program Goal:** to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991.	—

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Production of Anadromous Fish in the Central Valley of California	**Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **American River Action 9:** Terminate current programs that remove woody debris form the river channel. **American River Action 8.** Develop a riparian corridor management plan to improve and protect riparian habitat and instream cover.	
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-2.11:** Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators. **Action ID SAR-2.18:** Using an adaptive approach and pilot studies determine if instream habitat for juvenile rearing is limiting salmonid populations, by placing juvenile-rearing-enhancement structures in the Sacramento River. If found to be limiting, add large woody debris/coarse organic material to the upper, middle, and lower reaches of Sacramento River to increase the quantity and quality of juvenile rearing habitat. **Action ID AMR-1.6:** Implement a long-term wood management program to provide habitat complexity and predator refuge habitat. **Action ID DEL-2.3:** Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.4:** Improve habitat for juvenile salmonids in Elk, Sutter, and Steamboat sloughs. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding.	Multiple plans (including this one) identify improved near-shore habitat quality as a conservation need, but do not specify the amount of improvement needed or explicitly state the factors determining the amount needed. In large part, this is because SRA cover and the nearshore environment in general, have a complex relationship to the ecology of salmonids and the demography of their populations. The value of SRA cover is related to predation, flow, and temperature effects on the activities, growth, and survival of salmonids. It is also related to the management of woody vegetation and the availability of inundated floodplain.

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Riparian Habitat		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **American River Action 8:** Develop a riparian corridor management plan to improve and protect riparian habitat and instream cover.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SAR-2.8:** Implement projects that promote native riparian species (e.g., willows) including eradication projects for non-native species (e.g., arundo, tamarisk). **Action ID AMR-2.5:** Develop and implement programs and projects that focus on retaining, restoring, and creating river riparian corridors within their jurisdiction in the American River Watershed. **Action ID DEL-2.3:** Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding. **Action ID DEL-1.16:** Implement the Southport Floodplain Restoration Project. **Action ID DEL-1.10:** Enhance floodplain habitat in lower Putah Creek and along the toe drain.	—
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*)	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred of more breeding pairs, have become established and are protected and managed at the following sites:…a Sacramento Valley metapopulation:…	

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation		
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**5-Year Riparian Restoration Objectives:** Butte Basin 1,125 acres, Colusa Basin 1,350 acres, Delta Basin 1,500 acres, and Yolo Basin 675 acres (CVJVIP)	The SPA in this CPA does not include all the land area of the CVJVIP basins, but does include most of the restorable land. Long-term CVJV objectives are being developed and will be included in the updated CVJVIP (Seavy pers. comm.).
Valley Elderberry Longhorn Beetle Recovery Plan Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) 5-Year Review: Summary and Evaluation	**Objective 5-3-1:** Rehabilitate selected riparian forest habitat sites. 5-3-1-1: Remove exotic flora, fauna, or other deleterious materials. 5-3-1-2: Introduce necessary biological components of VELB habitat as identified by autecological and synecological studies.	—
Marsh/Other Wetland Habitat		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID DEL-2.3:** Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding. **Action ID DEL-1.9:** Restore Liberty Island, Cache Slough, and the lower Yolo Bypass. **Action ID DEL-1.13:** Implement the Prospect Island Tidal Habitat Restoration Project. **Action ID DEL-1.8:** Restore 17,000 to 20,000 acres of floodplain habitat.	DEL-1.8 also includes Lower San Joaquin River CPA. DEL-1.8 acreage assumed to include the results of DEL-2.3, DEL-2-5, DEL-1.16, DEL-1.9, DEL-1.10, DEL-1.13, DEL-1.6, and DEL-1.7.
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat	**5-Year Semi-Permanent Wetland Restoration Objective for Waterbirds:** 1,000 acres in American, Butte, Colusa, and Sutter Basins combined; 1,000 acres in Yolo, Delta, and Suisun Basins combined.	The SPA in this CPA does not include all the land area of the CVJVIP basins, and opportunities to restore semi-permanent and

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	5-Year Seasonal Wetland Restoration Objective for Waterbirds: 43,000 acres in American, Butte, Colusa, and Sutter Basins combined; 22,000 acres in Yolo, Delta, and Suisun Basins combined.	seasonal wetlands are widespread in the CVJV basins. Long-term CVJV objectives are being developed and will be included in the updated CVJVIP (Seavy pers. comm.).
Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation	**Recovery Criterion A4.** American Basin Recovery Unit: Minimum of eight habitat block pairs with no less than one block pair per management unit in the American Basin Recovery Unit. **Recovery Criterion A5.** Yolo Basin Recovery Unit: Minimum of five habitat block pairs with no less than one block pair per management unit in the Yolo Basin Recovery Unit (areas with high flooding flows within the Yolo Bypass should be considered as unsuitable habitat). **Recovery Criterion A6.** Cosumnes-Mokelumne Basin Recovery Unit: Minimum of two pairs of habitat blocks in the Cosumnes-Mokelumne Basin Recovery Unit. **Recovery Criterion A7.** Delta Basin Recovery Unit: Minimum of ten habitat block pairs with no less than two block pairs per management unit in the Delta Basin Recovery Unit.	Paired habitat blocks would be a block of existing, enhanced, or restored perennial wetland (240 hectares [539 acres] in size) connected by half-mile-wide corridors of suitable habitat to a block of rice agriculture (639 hectares [1,578 acres] in size). In this CPA, these recovery criteria total preservation of 5,390 acres of existing, enhanced, or restored perennial wetland. (One of the four American Basin, one of the four Delta Basin, half of the one Cosumnes-Mokelumne, and both Yolo Basin management units are in this CPA.)
Revetment		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SAR-2.1:** Ensure that river stabilization projects along the Sacramento River utilize biotechnical techniques that restore riparian habitat, rather than solely using the conventional technique of adding riprap. **Action ID SAR-2.11:** Improve instream refuge cover in the Sacramento River for salmonids to minimize predatory opportunities for striped bass and other non-native predators. **Action ID AMR-2.7:** Utilize biotechnical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip-rap in the American River. **Action ID DEL-2.15:** Utilize biotechnical techniques that integrate riparian restoration for river bank stabilization instead of conventional rip rap.	See the note related to this threat abatement criterion under “SRA Cover.”

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	Action ID DEL-2.3: Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.4:** Improve habitat for juvenile salmonids in Elk, Sutter, and Steamboat sloughs. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding.	
Levees		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID DEL-2.14:** Modify Reclamation District 2068 levees to provide rearing and predator refuge habitat for juvenile salmonids. **Action ID DEL-2.3:** Evaluate the potential effects of reconnecting Elk Slough to the Sacramento River, and if evaluation suggests that habitat conditions for salmonids would improve, then implement a project to carry out the reconnection. **Action ID DEL-2.5:** Re-establish hydrologic connectivity between historical Stone Lakes floodplain and the Sacramento River with a design that minimizes juvenile stranding. **Action ID DEL-1.16:** Implement the Southport Floodplain Restoration Project.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.
Fish Passage Barriers		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [1]:** Populations have unobstructed access to Core 1, 2, and 3 watersheds… **Action ID SAR-1.12:** In an adaptive management context, implement short- and long-term solutions to minimize the loss of adult chinook salmon and steelhead in the Yolo Bypass, and Colusa and Sutter-Butte basins. … Providing and/or improving fish passage through the Yolo Bypass and Sutter	Appendix K, “Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System,” describes and prioritizes 10 channel-wide structural barriers that have been identified in this CPA.

Table L1-3. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower Sacramento River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
	Bypass allowing for improved adult salmonid re-entry into the Sacramento River (long-term) **Action ID SAR-2.10:** Implement projects to minimize predation at weirs, diversions, and related structures in the Sacramento River. **Action ID DEL-2.13:** Modify existing water control structures to maintain flows through isolated ponds in the Yolo Bypass to minimize fish stranding, particularly following the cessation of flood flows over the Fremont Weir. **Action DEL-1.12:** Implement the Lisbon Weir Fish Passage Enhancement Project.	
Invasive Plants		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SAR-2.8:** Implement projects that promote native riparian species (e.g., willows) including eradication projects for non-native species (e.g., arundo, tamarisk).	—
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Recovery Action 1.7:** Control nonnative plant species.	Action specifically refers to tamarisk (*Tamarix* species) and giant reed (*Arundo donax*), two of the Conservation Strategy's priority invasive plants.
Valley Elderberry Longhorn Beetle Recovery Plan Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) 5-Year Review: Summary and Evaluation	**Objective 1-1-3:** Remove selected exotic plants [from occupied sites]. **Objective 5-3-1:** Rehabilitate selected riparian forest habitat sites. 5-3-1-1: Remove exotic flora, fauna, or other deleterious materials.	—

Sources: CVJV 2006; NMFS 2014; RHJV 2004; SJRRP 2011; USFWS 1984, 1998a, 2001, 2006a, 2006b, 2014

Key: AMR = American River, CPA = conservation planning area, CVJVIP = Central Valley Joint Venture Implementation Plan, DEL = Delta, ID = identifier, LWM = large woody material, SAR = Sacramento River, SPA = Systemwide Planning Area, SPFC = State Plan of Flood Control, SRA = shaded riverine aquatic, USFWS = U.S. Fish and Wildlife Service

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Floodplain Inundation		
San Joaquin River Restoration Settlement Act (Public Law 111-11) Draft Program Environmental Impact Statement/Environmental Impact Report San Joaquin River Restoration Program Revised Framework for Implementation	**Phase 1 Improvement 1:** Construct Mendota Pool Bypass and modify Reach 2B to convey at least 4,500 cfs **Phase 1 Improvement 2:** Modify San Joaquin River channel capacity to the extent necessary to ensure conveyance of 500 cfs through Reach 4B **Phase 1 Improvement 3:** Modify Reach 4B1 to convey 475–4,500 cfs **Phase 2 Improvement 4:** Modify Sand Slough Control Structure to ensure conveyance of 4,500 cfs to Reach 4B **Phase 2 Improvement 1:** Modify San Joaquin River channel capacity to the extent necessary to ensure conveyance of 500 cfs through Reach 4B **Phase 2 Improvement 3:** Fill or isolate highest priority gravel pits **Potential Phase 2 Actions:** Modify in-channel, side-channel, and floodplain habitat	Flow and floodplain inundation improvements are to support program's goal of reintroducing salmon. Additional rearing habitat necessary to support goal has been estimated at approximately 500 acres (SJRRP 2012). Most inundated floodplain (75–90%) would not be suitable as rearing habitat. Thus, this estimate corresponds to a much greater area of additional inundated floodplain (see Table 28 in SJRRP 2012). Phase 1 actions are those stipulated in Paragraph 11(a) of the Settlement as having the highest priority. Phase 2 actions, as stipulated in Paragraph 11(b) of the Settlement, have a high priority, but their completion cannot delay completion of Phase 1 actions.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SJR-1.6:** Manage juvenile salmonid predation risk by filling and/or isolating high priority gravel pits as identified in Paragraph 11(b) of the San Joaquin River Stipulation of Settlement. **Action ID SJR-2.5:** Implement projects to protect and restore riparian and floodplain habitats along the San Joaquin River, such as projects underway at the San Joaquin River National Wildlife Refuge to restore riparian habitat, expand the refuge, and breach deauthorized levees in order to increase floodplain habitat.	—

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a San Joaquin Valley metapopulation…	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the San Joaquin River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")
Riverine Geomorphic Processes		
San Joaquin River Restoration Settlement Act (Public Law 111-11) Draft Program Environmental Impact Statement/Environmental Impact Report San Joaquin River Restoration Program Revised Framework for Implementation	**Phase 2 Improvement 3:** Fill or isolate highest priority gravel pits	Phase 2 actions, as stipulated in Paragraph 11(b) of the Settlement, have a high priority, but their completion cannot delay completion of Phase 1 actions.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SJR-1.6:** Manage juvenile salmonid predation risk by filling and/or isolating high priority gravel pits as identified in Paragraph 11(b) of the San Joaquin River Stipulation of Settlement.	See the note related to this threat abatement criterion under "SRA Cover."
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a San Joaquin Valley metapopulation…	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the San Joaquin River Basin. Suitable habitat (early successional vegetation) may account for

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")
SRA Cover		
San Joaquin River Restoration Settlement Act (Public Law 111-11) Draft Program Environmental Impact Statement/Environmental Impact Report San Joaquin River Restoration Program Revised Framework for Implementation	**Potential Phase 2 Action:** Modify in-channel, side-channel, and floodplain habitat	Phase 2 actions, as stipulated in Paragraph 11(b) of the Settlement, have a high priority, but their completion cannot delay completion of Phase 1 actions.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SJR-2.8:** Compile available data and/or conduct new habitat analyses to determine if instream cover is lacking in the San Joaquin River, and add instream cover as necessary.	Multiple plans (including this one) identify improved near-shore habitat quality as a conservation need, but do not specify the amount of improvement needed or explicitly state the factors determining the amount needed. In large part, this is because SRA cover and the nearshore environment in general, have a complex relationship to the ecology of salmonids and the demography of their populations. The value of SRA cover is related to predation, flow, and temperature effects on the activities, growth, and survival of salmonids. It is also related to the management of woody vegetation and the availability of inundated floodplain.

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Riparian Habitat		
San Joaquin River Restoration Settlement Act (Public Law 111-11) Draft Program Environmental Impact Statement/Environmental Impact Report San Joaquin River Restoration Program Revised Framework for Implementation	**Potential Phase 2 Action:** Modify in-channel, side-channel, and floodplain habitat	Phase 2 actions, as stipulated in Paragraph 11(b) of the Settlement, have a high priority, but their completion cannot delay completion of Phase 1 actions.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SJR-2.5:** Implement projects to protect and restore riparian and floodplain habitats along the San Joaquin River, such as projects underway at the San Joaquin River National Wildlife Refuge to restore riparian habitat, expand the refuge, and breach deauthorized levees in order to increase floodplain habitat.	—
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat [CVJVIP] The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**5-Year Riparian Restoration Objectives:** San Joaquin Basin 2,500 acres (CVJVIP)	The SPA in this CPA does not include all the land area of the CVJVIP basins, but does include most of the restorable land. Long-term CVJV objectives are being developed and will be included in the updated CVJVIP.
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred of more breeding pairs, have become established and are protected and managed at the following sites:…a San Joaquin Valley metapopulation…	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the San Joaquin River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		G, "Identification of Target Species and Focused Conservation Plans.")
Marsh/Other Wetland Habitat		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID SJR-2.5:** Implement projects to protect and restore riparian and floodplain habitats along the San Joaquin River, such as projects underway at the San Joaquin River National Wildlife Refuge to restore riparian habitat, expand the refuge, and breach deauthorized levees in order to increase floodplain habitat.	—
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat	**5-Year Semi-Permanent Wetland Restoration Objective for Waterbirds:** 1,500 acres in San Joaquin Basin. **5-Year Seasonal Wetland Restoration Objective for Waterbirds:** 20,000 acres in San Joaquin Basin.	The SPA in this CPA does not include all the land area of the CVJVIP basins, and opportunities to restore semi-permanent and seasonal wetlands are widespread in the CVJV basins. Long-term CVJV objectives are being developed and will be included in the updated CVJVIP (Seavy pers. comm.).
Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation	**Recovery Criterion A8.** San Joaquin Basin Recovery Unit: Minimum of ten habitat block pairs with no less than two block pairs per management unit in the San Joaquin Basin Recovery Unit. **Recovery Criterion A8.** Tulare Basin Recovery Unit: Minimum of two habitat block pairs in the Mendota management unit in the Tulare Basin Recovery Unit.	Paired habitat blocks would be a block of existing, enhanced, or restored perennial wetland (240 hectares [539 acres] in size) connected by half-mile-wide corridors of suitable habitat to a block of rice agriculture (639 hectares [1,578 acres] in size). In this CPA, these recovery criteria total preservation of 5,121 acres of existing, enhanced, or restored perennial wetland. (Three of the four San Joaquin Basin management units and part of the Tulare Basin's Mendota Management Unit are in this CPA; one of the two paired habitat blocks in the Tulare Basin is included in the preceding acreage total.)

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Revetment		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations.	See the note related to this threat abatement criterion under "SRA Cover."
Levees		
San Joaquin River Restoration Settlement Act (Public Law 111-11) Draft Program Environmental Impact Statement/Environmental Impact Report San Joaquin River Restoration Program Revised Framework for Implementation	**Phase 1 Improvement 1:** Construct Mendota Pool Bypass and modify Reach 2B to convey at least 4,500 cfs **Phase 1 Improvement 2:** Modify San Joaquin River channel capacity to the extent necessary to ensure conveyance of 500 cfs through Reach 4B **Phase 1 Improvement 3:** Modify Reach 4B1 to convey 475–4,500 cfs **Phase 2 Improvement 1:** Modify San Joaquin River channel capacity to the extent necessary to ensure conveyance of 500 cfs through Reach 4B **Phase 2 Improvement 3:** Fill or isolate highest priority gravel pits.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SJR-1.6:** Manage juvenile salmonid predation risk by filling and/or isolating high priority gravel pits as identified in Paragraph 11(b) of the San Joaquin River Stipulation of Settlement. **Action ID SJR-2.5:** Implement projects to protect and restore riparian and floodplain habitats along the San Joaquin River, such as projects underway at the San Joaquin River National Wildlife Refuge to restore riparian habitat, expand the refuge, and breach deauthorized levees in order to increase floodplain habitat.	—

Table L1-4. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Upper San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Fish Passage Barriers		
San Joaquin River Restoration Settlement Act (Public Law 111-11) Draft Program Environmental Impact Statement/Environmental Impact Report San Joaquin River Restoration Program Revised Framework for Implementation	**Phase 1 Improvement 4:** Modify Reach 4B Headgate Structure to enable fish passage and flow routing of 500–4,500 cfs **Phase 1 Improvement 5:** Modify Sand Slough Control Structure to ensure fish passage **Phase 1 Improvement 7:** Modify Sack Dam adequate to provide fish passage **Phase 1 Improvement 8:** Modify Eastside and Mariposa Bypasses for fish passage **Phase 1 Improvement 9:** Modify Eastside and Mariposa Bypasses to establish suitable low-flow channel, if necessary. **Phase 1 Improvement 10:** Enable deployment of seasonal barriers at Mud and Salt sloughs **Phase 2 Improvement 2:** Modify Chowchilla Bypass Structure to provide fish passage	Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System," describes 20 channel-wide structural barriers that have been identified in this CPA.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [1]:** Populations have unobstructed access to Core 1, 2, and 3 watersheds… **Action ID SJR-2.12:** Develop and implement design criteria and projects to minimize predation at weirs, diversion dams, and related structures in the San Joaquin River.	—
Invasive Plants		
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Recovery Action 1.7:** Control nonnative plant species.	Action specifically refers to tamarisk (*Tamarix* species) and giant reed (*Arundo donax*), two of the Conservation Strategy's priority invasive plants.

Sources: CVJV 2006; NMFS 2014; SJRRP 2011, 2012; RHJV 2004; USFWS 1984, 1998a, 2001, 2006a, 2006b, 2014

Key: CPA = conservation planning area, CVJVIP = Central Valley Joint Venture Implementation Plan, ID = identifier, LWM = large woody material, SJR = San Joaquin River, SPA = Systemwide Planning Area, SRA = shaded riverine aquatic, USFWS = U.S. Fish and Wildlife Service

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Floodplain Inundation		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries.	Modeling results presented in Appendix H, "Central Valley Chinook Salmon Rearing Habitat Needed to Satisfy the Anadromous Fish Restoration Program Doubling Goal," presents estimates of the amount of rearing habitat required to meet this plan's population doubling goal. The results of that modeling indicate that an additional 3,100–4,100 acres of suitable rearing habitat would be needed in this CPA (Table 6-1 in Appendix H: average required habitat acreage minus estimates of existing habitat acreage at high to low suitability). Most inundated floodplain (75–90%) would not be suitable as rearing habitat. Thus, this estimate corresponds to a much greater area of additional inundated floodplain.
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID DEL-1.6:** Provide access to new floodplain habitat in the South Delta for migrating salmonids from the San Joaquin system. **Action ID DEL-1.8:** Restore 17,000 to 20,000 acres of floodplain habitat. **Action ID STR-2:** Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Stanislaus River. **Action ID MER-1.6:** Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Merced River. **Action ID TUR-2.7:** Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Tuolumne River.	DEL-1.8 also includes Lower Sacramento River CPA. DEL-1.8 acreage assumed to include the results of DEL-2.3, DEL-2-5, DEL-1.16, DEL-1.9, DEL-1.10, DEL-1.13, DEL-1.6, and DEL-1.7.

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for …Western Yellow-Billed Cuckoos:** Reforestation of 4,400 acres of suitable habitat [along Stanislaus River (1,900 acres) and Merced River (2,500 acres)]. (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 25 pairs of birds along the Stanislaus River and 25 pairs along the Merced River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%).
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a San Joaquin Valley metapopulation…	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Riverine Geomorphic Processes		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **Merced River Action 3:** Improve watershed management to restore and protect instream and riparian habitat, including restoring and replenishing spawning gravel. **Stanislaus River Action 2:** Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel. **Tuolumne River Action 2:** Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel and performing an integrated evaluation of biological and geomorphic processes.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID STR-2:** Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Stanislaus River. **Action ID MER-1.6:** Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Merced River. **Action ID TUR-2.7:** Identify and implement floodplain and side channel projects to improve river function and increase habitat diversity in the Tuolumne River.	See discussion related to this threat abatement criterion under “SRA Cover.”

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for …Western Yellow-Billed Cuckoos.** Reforestation of 4,400 acres of suitable habitat [along Stanislaus River (1,900 acres) and Merced River (2,500 acres)]. (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 25 pairs of birds along the Stanislaus River and 25 pairs along the Merced River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%).
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred or more breeding pairs, have become established and are protected and managed at the following sites:...and a San Joaquin Valley metapopulation…	With 2–10 acres required per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the Sacramento River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G, "Identification of Target Species and Focused Conservation Plans.")

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
SRA Cover		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **Merced River Action 3:** Improve watershed management to restore and protect instream and riparian habitat, including restoring and replenishing spawning gravel. **Stanislaus River Action 2:** Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel. **Tuolumne River Action 2:** Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel and performing an integrated evaluation of biological and geomorphic processes.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID SJR-2.8:** Compile available data and/or conduct new habitat analyses to determine if instream cover is lacking in the San Joaquin River, and add instream cover as necessary. **Action ID STR-2.14:** Implement projects to increase instream habitat complexity and predator refuge cover in the Stanislaus River, including the addition of large woody material. **Action ID TUR-2.11:** Improve instream refuge cover for salmonids in the Tuolumne River to minimize predatory opportunities for striped bass and other non-native fish.	Multiple plans (including this one) identify improved near-shore habitat quality as a conservation need, but do not specify the amount of improvement needed or explicitly state the factors determining the amount needed. In large part, this is because SRA cover and the nearshore environment in general, have a complex relationship to the ecology of salmonids and the demography of their populations. The value of SRA cover is related to predation, flow, and temperature effects on the activities, growth, and survival of salmonids. It is also related to the management of woody

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		vegetation and the availability of inundated floodplain.
Riparian Habitat		
Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California	**Program Goal:** …to ensure that…natural production of anadromous fish in Central Valley rivers and streams will be sustainable…at levels not less than twice the average levels attained during the period of 1967–1991. **Objective [1]:** Improve habitat for all life stages of anadromous fish through provision of flows…and improved physical habitat. **Implementation Principle [3]:** Protecting and restoring natural channel and riparian habitat values promotes natural processes that regulate geomorphic characteristics, nutrient dynamics, and production capabilities of streams, rivers, and estuaries. **Merced River Action 3:** Improve watershed management to restore and protect instream and riparian habitat, including restoring and replenishing spawning gravel. **Stanislaus River Action 2:** Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel. **Tuolumne River Action 2:** Improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel and performing an integrated evaluation of biological and geomorphic processes.	—
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID STR-2.7:** Work with local land owners to restore riparian habitats along the Stanislaus River. **Action ID MER-2.6:** Federal, State, and Local agencies should use their authorities to develop and implement programs and projects that focus on retaining, restoring, and creating riparian corridors within their jurisdiction in the Merced River watershed. **Action ID TUR-2.9:** Restore riparian habitat to promote shading and habitat diversity in the Tuolumne River.	—

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for …Western Yellow-Billed Cuckoos:** Reforestation of 4,400 acres of suitable habitat [along Stanislaus River (1,900 acres) and Merced River (2,500 acres)]. (CVJVIP) **5-Year Riparian Restoration Objectives:** Delta Basin 1,500 acres, San Joaquin Basin 2,500 acres (CVJVIP)	The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 25 pairs of birds along the Stanislaus River and 25 pairs along the Merced River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%). Suitable habitat for the western yellow-billed cuckoo requires "dynamic riverine processes," and thus these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The SPA in this CPA does not include all the land area of the CVJVIP basins, but does include most of the land restorable to riparian vegetation. Long-term CVJV objectives are being developed and will be included in an updated CVJVIP.
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Delisting Criterion 2:** Stable or increasing least Bell's vireo populations/metapopulations, each consisting of several hundred of more breeding pairs, have become established and are protected and managed at the following sites:…a San Joaquin Valley metapopulation…	With 2–10 acres per pair (Appendix G), supporting 300–500 pairs would require 600–5,000 acres of suitable habitat in the San Joaquin River Basin. Suitable habitat (early successional vegetation) may account for only a small portion (15–30%) of riparian vegetation. This habitat is sustained by floodplain inundation and riverine geomorphic processes. (For more information on the species habitat requirements see Appendix G,

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
		"Identification of Target Species and Focused Conservation Plans.")
Recovery Plan for Upland Species of the San Joaquin Valley, California Final Rule to List the Riparian Brush Rabbit, and the Riparian, or San Joaquin Valley, Woodrat as Endangered	**Conservation Action 2c:** Establishment of at least three additional wild populations in the San Joaquin Valley in restored and expanded suitable habitat within the rabbit's historical range. **Conservation Action 3:** Develop a plan for the restoration of riparian habitat, the establishment of riparian corridors, and the reintroduction, if necessary, of riparian woodrats to suitable habitat. **Conservation Action 6:** Begin efforts to restore and link riparian habitat, and reintroduce woodrats, as appropriate.	Historical range of these species is not well documented but may have extended along the San Joaquin River from the Delta to the Tuolumne River, and up the Stanislaus and Tuolumne Rivers on the valley floor. (See also focused species plans in Appendix G.) 5,000–6,600 acres of additional riparian vegetation would be required to restore corridors of riparian vegetation throughout this range that were approximately 300–400 feet wide (see Appendix F, "Existing Conditions").
Marsh/Other Wetland Habitat		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Action ID DEL-1.8:** Restore 17,000 to 20,000 acres of floodplain habitat.	DEL-1.8 also includes Lower Sacramento River CPA. DEL-1.8 acreage assumed to include the results of DEL-2.3, DEL-2-5, DEL-1.16, DEL-1.9, DEL-1.10, DEL-1.13, DEL-1.6, and DEL-1.7.
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat	**5-Year Semi-Permanent Wetland Restoration Objective for Waterbirds:** 1,000 acres in Yolo, Delta, and Suisun Basins combined; 1,500 acres in San Joaquin Basin. **5-Year Seasonal Wetland Restoration Objective for Waterbirds:** 20,000 acres in San Joaquin Basin.	The SPA in this CPA does not include all the land area of the CVJVIP basins, and opportunities to restore semi-permanent and seasonal wetlands are widespread in the CVJV basins. Long-term CVJV objectives are being developed and will be included in the updated CVJVIP (Seavy pers. comm.).
Revised Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*)	**Recovery Criterion A6.** Cosumnes-Mokelumne Basin Recovery Unit: Minimum of two pairs of habitat blocks in the Cosumnes-Mokelumne Basin Recovery Unit.	Paired habitat blocks would be a block of existing, enhanced, or restored perennial wetland (240 hectares [539 acres] in size) connected by half-mile-wide corridors of

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation	**Recovery Criterion A7.** Delta Basin Recovery Unit: Minimum of ten habitat block pairs with no less than two block pairs per management unit in the Delta Basin Recovery Unit. **Recovery Criterion A8.** San Joaquin Basin Recovery Unit: Minimum of ten habitat block pairs with no less than two block pairs per management unit in the San Joaquin Basin Recovery Unit.	suitable habitat to a block of rice agriculture (639 hectares [1,578 acres] in size). In this CPA, these recovery criteria total preservation of 5,121 acres of existing, enhanced, or restored perennial wetland. (Half of the one Cosumnes-Mokelumne Basin, one of the four San Joaquin, and three of the four Delta Basin, management units are in this CPA.)
Revetment		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations. **Action ID STR-2.13:** Implement projects to minimize predation in the Stanislaus River at mine pits and deep pools caused by bank stabilization projects.	See the note related to this threat abatement criterion under “SRA Cover.”
Central Valley Joint Venture Implementation Plan – Conserving Bird Habitat The Riparian Bird Conservation Plan: a Strategy for Reversing the Decline of Riparian Associated Birds in California	**Minimum Management Goals for Western Yellow-Billed Cuckoos:** Reforestation of 4,400 acres of suitable habitat [along Stanislaus River (1,900 acres) and Merced River (2,500 acres)]. (CVJVIP)	Suitable habitat for the western yellow-billed cuckoo requires “dynamic riverine processes,” and these processes are a primary constituent element of its proposed critical habitat (USFWS 2014). Therefore, restored western yellow-billed cuckoo habitat would need to be periodically inundated and be subject to channel meander migration. The acreage identified in the minimum management goals for western yellow-billed cuckoo is for 25 pairs of birds along the Stanislaus River and 25 pairs along the Merced River (as part of a 300-pair Central Valley population), with each pair requiring 40 hectares of suitable habitat (CVJVIP). A large portion of restored riparian vegetation could provide suitable habitat (60–100%).

Table L1-5. Identified Conservation Needs for Target Species Related to Conservation Strategy Objectives in the Lower San Joaquin River Conservation Planning Area

Objective Topic/Plan	Conservation Need as Identified in Plan	Notes
Levees		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [4]:** Migratory and rearing corridors meet the life-history, water quality, and habitat requirements of the listed species, such that the corridor supports multiple viable populations.	Although the Conservation Strategy includes levees as a target stressor but does not include objectives for changes to levees, changes to levees were considered a means for restoring ecosystem process and habitat needs, not as objectives in and of themselves. Thus, Attachment 2 does not include boxes synthesizing needs for levee modification.
Fish Passage Barriers		
Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead	**Threat Abatement Criterion [1]:** Populations have unobstructed access to Core 1, 2, and 3 watersheds… **Action ID SJR-2.12:** Develop and implement design criteria and projects to minimize predation at weirs, diversion dams, and related structures in the San Joaquin River. **Action ID TUR-2.10:** Implement projects to minimize predation at weirs, diversions, dams, and related structures in the Tuolumne River.	—
Invasive Plants		
Draft Recovery Plan for the Least Bell's Vireo (*Vireo bellii pusillus*) Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation	**Recovery Action 1.7:** Control nonnative plant species.	Action specifically refers to tamarisk (*Tamarix* species) and giant reed (*Arundo donax*), two of the Conservation Strategy's priority invasive plants.

Sources: CVJV 2006; NMFS 2014; RHJV 2004; USFWS 1984, 1998a, 1998b, 1999, 2001, 2006a, 2006b, 2010, 2014

Key: CPA = conservation planning area, CVJVIP = Central Valley Joint Venture Implementation Plan, DEL = Delta, ID = identifier, LWM = large woody material, MER = Merced River, SAR = Sacramento River, SPA = Systemwide Planning Area, SRA = shaded riverine aquatic, STR = Stanislaus River, TUR = Tuolumne River, USFWS = U.S. Fish and Wildlife Service

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L2. Synthesis of Identified Conservation Needs

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For each targeted ecosystem processes and habitats of the Conservation Strategy, this attachment synthesizes the conservation needs identified in Attachment 1 to determine the overall amount of improvement needed to support the recovery of target species (i.e., the overall need). The summaries are organized first by Conservation Planning Area (CPA), and then by the six habitats and processes targeted by the Conservation Strategy. These metrics (in the order presented) are riparian habitat, marsh and other wetland habitat, riparian-lined bank, natural bank, river meander potential, and inundated floodplain.

Each summary page describes the informational basis in conservation plans for the identified conservation need, the importance of an increase in that metric for species' conservation, the level of scientific understanding of the role of the process or habitat in the species' ecology, and lastly, the level of predictability of the size of the identified need. Whereas some needs are clearly quantified in conservation plans and usually are based on a higher level of understanding and are more predictable, others are qualitatively stated and typically are less well understood and less predictable.

On most summary pages, a graph illustrates the historical size of the area of habitat or process (a gray bar), in comparison to the existing area (a black bar) and the additional need (outlined by a dashed line). Notes below the graph provide further guidance on interpretation of the graph.

Error bars representing the likely range magnitude are provided for some needs. These are primarily instances where additional interpretation of a need involved a calculation with a variable that had a likely range of values. (Conservation plans did not provide error terms or ranges for the size of identified needs.) Where generally stated needs were quantified, the estimated size was generally the midpoint of a range of likely values, which was considered the best estimate of the actual value. That is, all values in range were considered equally likely; thus, the midpoint is the value that on average would be closest to the actual value.

In the interest of brevity, the following conventions have been observed in this attachment:

- Abbreviations and acronyms are not defined in the text; please refer to the following page for a list of definitions.

- Specific Conservation plans are frequently discussed; these are listed in the main body of this appendix, and the conservation needs referred to in this attachment are all listed by CPA and process/habitat in Attachment 1. References for all other citations are provided at the end of this attachment.

- Cross references to other summary pages apply to pages within the same CPA. For example, if a summary refers the reader to "River Meander Potential," it is referring to the discussion of that metric within the same CPA.

- Summaries are numbered as Boxes 1 through 6. The numbering repeats for each CPA, allowing for easy comparison of a single metric among the five CPAs. The title of each box is color-coded to visually distinguish the CPA to which it belongs.

Acronyms and Other Abbreviations

AFRP ..... Anadromous Fish Restoration Program

BANS-TAC ..... Bank Swallow Technical Advisory Committee

cfs ..... cubic feet per second

CMP ..... Corridor Management Plan

CPA ..... Conservation Planning Area

CVJV ..... Central Valley Joint Venture

ESHE..... Emigrating Salmonid Habitat Estimation

NWR ..... National Wildlife Refuge

SJRRP..... San Joaquin River Restoration Program

SPA ..... Systemwide Planning Area

SPFC ..... State Plan of Flood Control

SRA ..... shaded riverine aquatic

USFWS..... U.S. Fish and Wildlife Service

VELB ..... valley elderberry longhorn beetle

Upper Sacramento River Conservation Planning Area

Upper Sacramento River CPA
Box 1. Riparian Habitat

Summary of Conservation Need

11,400 additional acres of riparian habitat on the active floodplain may be needed to recover western yellow-billed cuckoo and other target species. This amount is based on a need quantified in a conservation plan. There is a moderate level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify riparian habitat needs for anadromous fish, western yellow-billed cuckoo, least Bell's vireo, and bank swallow. Swainson's hawk also requires riparian habitat for nesting but is not addressed by conservation plans. Riparian vegetation provides habitat for bird reproduction, foraging, and cover (as described in Appendix G). Riparian vegetation also increases the quality of inundated floodplain and nearshore habitat for fish, which is not discussed further here (see "Riparian-Lined Bank" and "Inundated Floodplain").

Specific identified actions include (1) restoring 9,140 acres of habitat for western yellow-billed cuckoo along the Sacramento River; (2) 5-year CVJV objectives for restoring 3,150 acres of riparian habitat in the Butte, Colusa, and Sutter Basins; (3) restoring 7,000 acres at the Sacramento River National Wildlife Refuge, Sacramento River Wildlife Area, state parks, and elsewhere through the Sacramento River Project Partnership; and (4) restoring riparian habitat at Lake Red Bluff.

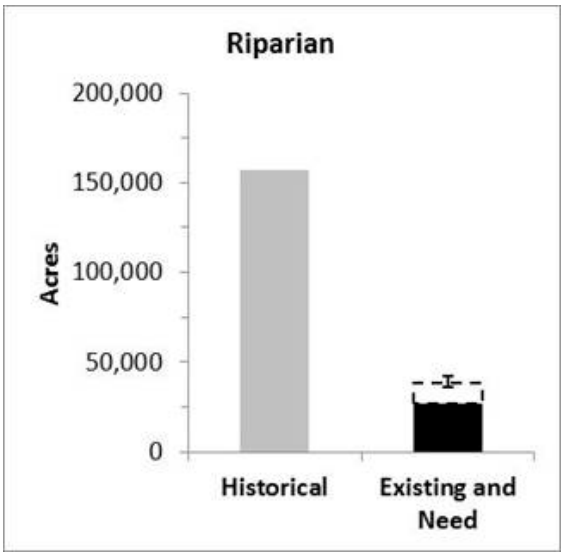
Interpretation of Conservation Plans

The need for riparian habitat on active floodplain has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). However, this need is only moderately predictable because the portion of existing habitat suitable for these species is not known precisely, and there is a several-fold range in population sizes that may be viable.

Attaining the minimum restoration acreages for yellow-billed cuckoo would require the greatest increase in riparian habitat in this CPA. Assuming 80% of restored riparian vegetation is suitable for yellow-billed cuckoo (for which a wide range of riparian vegetation is suitable), approximately 11,400 additional acres of riparian vegetation would be required to meet the minimum habitat acreages identified in the CVJV Implementation Plan.

Conservation of other target species (e.g., giant garter snake) would not require a greater amount of riparian habitat restoration.

The short-term CVJV objectives used as the basis for this need are being reassessed in the context of long-term conservation needs (Seavy pers. comm.). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs.



Sources: Appendix F; The Bay Institute 2003.

Historical and Existing Riparian Habitat and Amount Needed to Conserve Species

Notes: The need for riparian habitat consists of existing habitat (shown in black) and additional restoration (outlined with a dashed line) to meet the CVJV objective for western yellow-billed cuckoo, the largest riparian need identified. The amount displayed assumes that the CVJV acreage for along the Sacramento River would be entirely in this CPA. This assumption is based on the location of existing populations and the USFWS-proposed critical habitat (see Appendix G and USFWS 2014). The amount also assumes that 80% of restored habitat would be suitable for western yellow-billed cuckoo (as a wide range of riparian structure is suitable). The error bar corresponds to 60–100% of riparian vegetation being suitable. The portion of riparian vegetation that is suitable for western yellow-billed cuckoo is unlikely to fall outside of this range.

Upper Sacramento River CPA
Box 2. Marsh and Other Wetland Habitat

Summary of Conservation Need

12,900 additional acres of marsh and other wetlands may be required to recover greater sandhill crane and other target species. This amount is based on a need quantified in a conservation plan. However, there is a low level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify marsh and other wetland needs for anadromous fish, giant garter snake, and greater sandhill crane.

Marsh and other wetlands can provide inundated floodplain habitat for fish, a need that also may be met by other vegetation; thus, fish needs are not discussed further here for related fish needs, see "Inundated Floodplain").

For giant garter snake, marsh provides foraging habitat, cover, hibernacula, and corridors for dispersal and other movements. For greater sandhill crane, marsh and other wetlands can provide foraging, loafing, and roosting habitat.

The CVJV implementation plan includes short-term objectives that specify restoration of 1,000 acres of semi-permanent wetlands and 43,000 acres of seasonal wetlands in the Sacramento Valley to provide habitat for water birds, including greater sandhill crane.

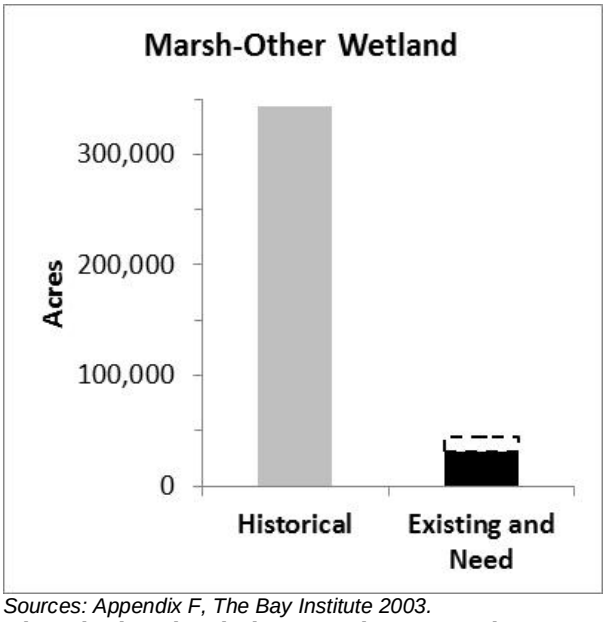
The revised draft recovery plan for giant garter snake specifies preservation of at least 5,390 acres of existing, enhanced, or preserved perennial wetlands in this CPA, in blocks 539 acres in size.

Interpretation of Conservation Plans

The need for marsh and other wetland habitat is of high importance for these species. These species' needs are moderately well understood (see Appendix G).

The predictability of this need is moderate and low for giant garter snake and greater sandhill crane, respectively. In addition to habitat amount, the required density of giant garter snakes in preserved habitat, and related habitat connectivity and location requirements have been identified. For greater sandhill crane, the desired population size and locations where it would benefit from additional wetland have not been identified.

CVJV short-term objectives were used as the basis for this need. These objectives are being reassessed in the context of habitat need and the restoration that has been achieved to date (Seavy pers. comm. 2014). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs. Because wetland restoration opportunities are widespread within the CVJV basins, these proxies for long-term CVJV objectives were scaled to the portion of the CVJV basins accounted for by the SPA in this CPA.



Sources: Appendix F, The Bay Institute 2003.

Historical and Existing Marsh Area and Amount Needed to Conserve Species

Notes: The need for marsh and other wetlands consists of existing habitat (shown in black) and additional restoration (shown by a dashed outline) to meet CVJV objectives. Because the plan area of the CVJV is larger than the SPA, and wetland restoration opportunities are extensive both in and outside the SPA, the need shown here has been scaled to the portion of the CVJV basins that this CPA accounts for. There is no error bar because the CVJV implementation plan specified the amount of restoration required.

Upper Sacramento River CPA
Box 3. Riparian-Lined Bank
[Major Predictability Limitation]

Summary of Conservation Need

85 additional miles of riparian-lined bank may be required to recover target fish species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need.

Conservation Plan Content

Anadromous fish conservation plans identify needs for riparian-lined bank, which is a component of SRA cover.

However, conservation plans have not quantified the need for additional riparian-lined bank or identified specific actions for meeting this need.

Conservation of other target species does not require riparian-lined bank.

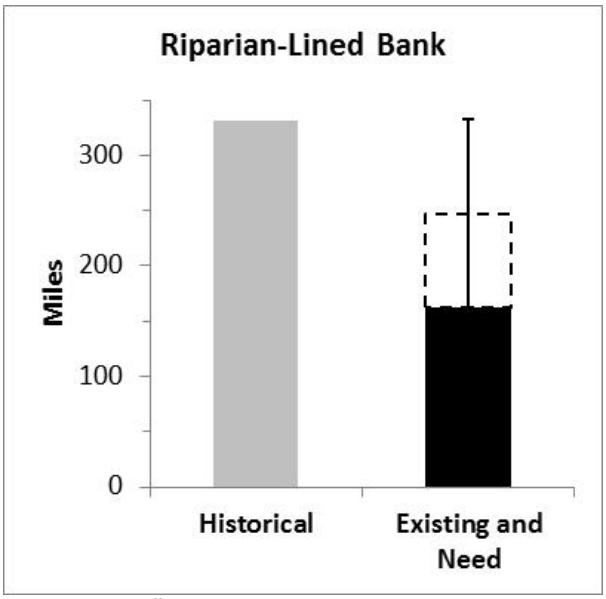
Interpretation of Conservation Plans

Riparian vegetation shades and adds woody material to the nearshore environment, which increases the quality of migration and rearing habitat, and provides refuge from predators. The need for the resulting high-quality nearshore habitat has high importance. It is based on a moderate level of understanding of the species' ecology: habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G). This need has a low level of predictability in part because it is strongly affected by changes to bank revetment and floodplain inundation, and by management of dying and fallen trees and instream woody material.

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in riparian-lined bank. Although this plan does not quantify the need, its size could entail woody vegetation along nearly all bank length.

Only in-channel habitat is available for outmigration and rearing when the Butte Basin and Sutter Bypass are not inundated. Fish require suitable depth, velocity, and cover to be available throughout the river system at a fine scale (i.e., every few feet). These conditions are provided only by a narrow zone along each bank, and riparian-lined banks may support the growth and survival of several times more fish in this zone than banks lacking woody plants (see SJRRP 2012).

Doubling salmonid populations (per the AFRP) could depend on at least doubling the ability of nearshore habitats to support fish, particularly in the absence of large increases in inundated floodplain. However, riparian-lined banks already account for 49% of bank length. Thus, substantial improvements to nearshore habitats would also require other related actions. Related actions include increasing the length of natural banks, increasing the area of the shallow nearshore environment, increasing the frequency and duration of floodplain inundation, and changing vegetation management to increase inputs and retention of woody material.



Source: Appendix F.

Historical and Existing Riparian-Lined Bank and Amount Needed to Conserve Species

Notes: Total bank length is used for historical riparian-lined bank length. It is an overestimate. Existing habitat is shown in black. Additional needed riparian-lined bank is outlined with a dashed line. It is the midpoint of existing and maximal values. The error bar spans this range, because this need has low predictability and may in part be met by other changes.

Upper Sacramento River CPA
Box 4. Natural Bank

Summary of Conservation Need

44 additional miles of natural bank may be required to recover bank swallow, western yellow-billed cuckoo, and other target species. This need is quantified in a conservation plan. There is a high level of certainty regarding the size of this need for bank swallow; there is less certainty regarding the size of this need for other species.

Conservation Plan Content

Conservation plans identify natural bank needs for anadromous fish, bank swallow, western yellow-billed cuckoo, and least Bell's vireo. Natural bank provides fish with migration and rearing habitat and refuge from predators, and provides bank swallows with cut banks to nest in. Natural bank also allows for channel meander, which sustains the early successional habitats used by western yellow-billed cuckoo and least Bell's vireo. Conservation of other target species does not require natural bank.

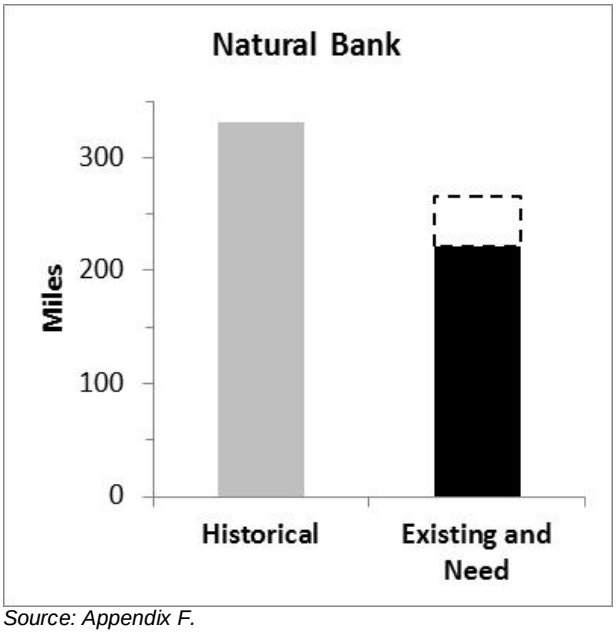
Specific identified actions include (1) removing 44 miles of revetment, and (2) restoring 9,140 acres of riparian habitat exposed to river meander (and thus bordered by natural banks).

Interpretation of Conservation Plans

The need for natural banks and high-quality nearshore habitat dependent on natural banks has high importance. It is based on a high level of understanding of the ecology of bank swallow, western yellow-billed cuckoo, and least Bell's vireo. For target fish, habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G).

This need has a high level of predictability for bank swallow, moderate predictability for other target birds, and a low level of predictability for target fish. For the fish, predictability is low in part because it is strongly affected by management of channel bank vegetation and instream woody material (see "Riparian-Lined Bank"), and inundation of floodplains.

The overall need for natural bank is based on the need identified for bank swallow. Bank swallow has the largest specified and most predictable need for natural bank. The need is quantified in a conservation plan: 54 miles of additional natural bank in this CPA (BANS-TAC 2013), of which 10 miles is upstream of the SPFC and thus excluded from the need here. Western yellow-billed cuckoo has a need that is likely greater, but that is less predictable, and the least Bell's vireo need is likely smaller. Anadromous fish may have a comparable or larger need, but that need is much less predictable than the bank swallow or western yellow-billed cuckoo needs.



Source: Appendix F.

Historical and Existing Natural Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical natural bank length. It is an underestimate because of channel simplification over time. The need for natural bank consists of the existing length (shown in black) plus the additional length (shown by a dashed outline) resulting from revetment removal identified in BANS-TAC 2013 (excluding revetment removal upstream of the SPFC). This graph has no error bar because the need was quantified in the conservation plan without an error term.

Upper Sacramento River CPA
Box 5. River Meander Potential

Summary of Conservation Need

9,500 additional acres of river meander potential may be required to recover bank swallow, western yellow-billed cuckoo, least Bell's vireo, and anadromous fish. This need is not quantified in conservation plans, but is based on another quantified need (for natural bank), as described below. There is a high level of certainty regarding the size of the need for bank swallow, and less certainty regarding the size of this need for other species.

Conservation Plan Content

Conservation plans identify river meander needs for anadromous fish, bank swallow, western yellow-billed cuckoo, and least Bell's vireo. River meander sustains cut banks that are nesting habitat for bank swallows, and provides fish with migration and rearing habitat and refuge from predators. River meander also sustains the early successional riparian habitat used by least Bell's vireo and the diverse riparian habitat of western yellow-billed cuckoo. Conservation of target species not addressed by conservation plans does not require an increase in river meander.

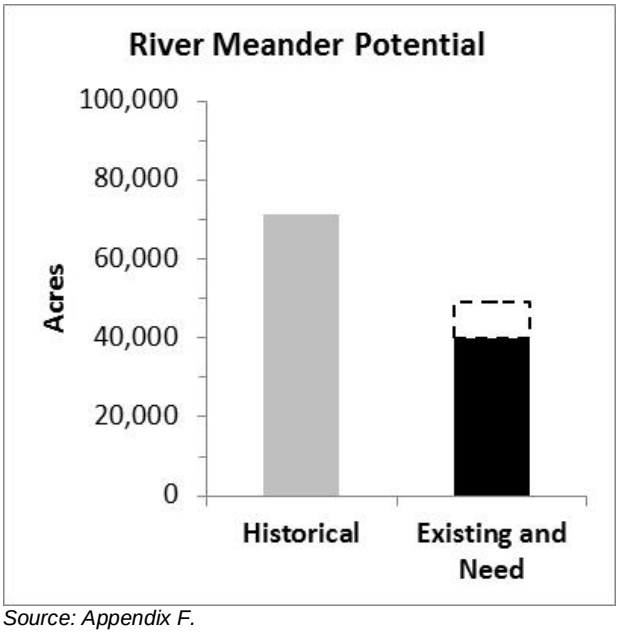
Specific identified actions include (1) removing 44 miles of revetment, and (2) restoring 9,140 acres of riparian vegetation, suitable for western yellow-billed cuckoo, that is exposed to river meander.

Interpretation of Conservation Plans

Increases in meander potential have high importance for sustaining the quality of nearshore habitat, natural bank, and early successional riparian habitat. The physical process of meander migration and how it sustains habitats is well understood.

The need for additional meander potential in this CPA is based on the conservation needs of bank swallow, and has a high level of predictability. Of target species, bank swallow has the most predictable need, which is to sustain the additional 44 miles of natural bank specified in a conservation plan (BANS-TAC 2013). Fish and western yellow-billed cuckoo needs could be much greater but are less predictable. Yellow-billed cuckoo's need depends on the portion of additional riparian habitat that can be restored at sites where river meander is not already constrained. Fish needs are affected by multiple factors (as discussed for riparian-lined bank).

The need for additional meander potential has been calculated as the product of the length of additional natural bank required by bank swallow and the average area of floodplain with river meander constrained only by revetment or levees per mile of bank.



Source: Appendix F.

Historical and Existing River Meander Potential and Amount Needed to Conserve Species

Notes: Historical meander potential is based on the area in the meander zone not constrained by geology (see Appendix F). Existing meander potential (shown in black) is the area in the meander zone not constrained by geology, revetment, or levees. The need is the sum of the existing area (shown in black) and additional area (shown by a dashed outline) that would result from meeting bank swallow's need for additional natural bank. This additional amount is the product of the length of additional natural bank and the average area of floodplain with river meander constrained only by revetment or levees per mile of bank. This graph has no error bar because the need for natural bank was quantified in the conservation plan.

Upper Sacramento River CPA
Box 6. Inundated Floodplain

Summary of Conservation Need

Conservation of target species may require 106,500 additional acres of floodplain inundated by flows of a timing, duration, and frequency adequate for fish rearing. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a moderate level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify inundated floodplain needs for anadromous fish, western yellow-billed cuckoo, least Bell's vireo, and bank swallow. Fish needs are for providing migration and rearing habitat. Bird needs are for sustaining riparian habitat.

Specific identified actions include (1) managing the timing, frequency, magnitude, and duration of Sutter Bypass inundation to maximize growth and survival of juvenile salmonids and (2) constructing setback levees to restore 11,500 acres of inundated floodplain along the Sacramento River.

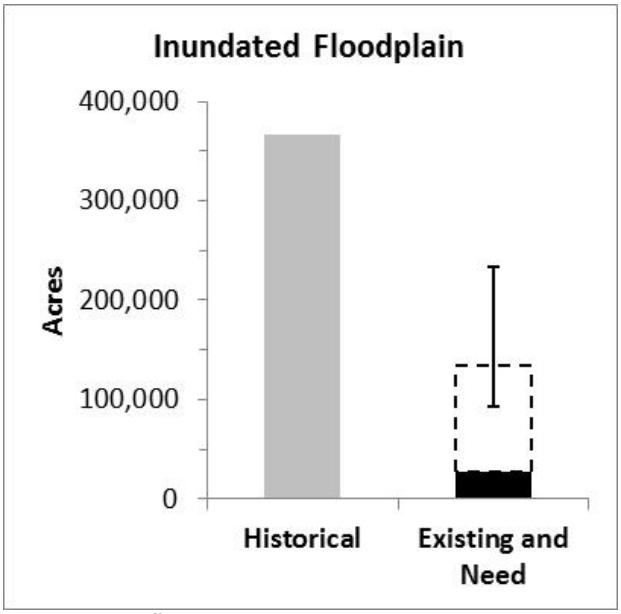
Interpretation of Conservation Plans

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in inundated floodplain; perhaps an order of magnitude more land than needed to meet the needs identified for target bird species, or of target species not addressed by conservation plans.

The need for rearing habitat on inundated floodplains has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). This need has a moderate level of predictability; predictability is limited by variability in the suitability of floodplain as rearing habitat.

As described in Appendix H, the ESHE model was used to estimate the amount of rearing habitat required to support the AFRP doubling goal. Appendix H also provides an estimate of existing rearing habitat. Amount of inundated floodplain is a product of both floodplain area and management of water flows. The estimate provided by Appendix H is for existing hydrology.

Suitability of floodplains as rearing habitat is affected by other variables besides inundation, and consequently, only a fraction of the inundated area provides rearing habitat. This fraction can range from less than 10% to more than 25%. Assuming 17.5% suitability on average, an additional 106,500 acres of inundated floodplain would be needed to provide habitat required for doubling salmonid populations under current hydrology.



Source: Appendix H.

Historical and Existing Inundated Floodplain Area and Amount Needed to Conserve Species

Notes: Acreages are for areas inundated for at least 14 days during December–May by a flood with a recurrence interval of 2years or less. Only a small portion of the active floodplain along major river reaches meets these criteria; as currently operated, much of the Sutter Bypass also meets these criteria (and is included in the acreage). The need is the sum of the existing area (shown in black) and the additional area (shown by a dashed outline) needed to provide rearing habitat for the AFRP goal to double salmonid populations. This amount is based on floodplains providing rearing habitat of intermediate suitability (17.5%). The error bar denotes the range from low to high floodplain suitability as rearing habitat (10–25%). The range is large because suitability can have a several-fold effect on the number of fish supported per unit area. These data are results of the analysis presented in Appendix H, and the model used to generate these estimates is further described in SJRRP 2012. The amount of habitat required to double salmonid populations is more than twice existing habitat because existing populations are supported by both natural production and fish hatcheries. Consequently, because existing habitat supports only a portion of the existing population, habitat for 100% more fish would require more than a 100% increase in habitat.

Feather River Conservation Planning Area

Feather River CPA
Box 1. Riparian Habitat

Summary of Conservation Need

2,400 additional acres of riparian habitat on the active floodplain may be needed to recover western yellow-billed cuckoo and other target species. This amount is based on a need quantified in a conservation plan. There is a moderate level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify riparian habitat needs for anadromous fish, western yellow-billed cuckoo, least Bell's vireo, and bank swallow. Swainson's hawk also requires riparian habitat for nesting but is not addressed by conservation plans. Riparian vegetation provides habitat for bird reproduction, foraging, and cover (as described in Appendix G). Riparian vegetation also increases the quality of inundated floodplain and nearshore habitat for fish, which is not discussed further here (see "Riparian-Lined Bank" and "Inundated Floodplain").

Specific identified actions include (1) restoring 1,900 acres of habitat for western yellow-billed cuckoo along the Feather River; (2) 5-year CVJV objectives for restoring 2,475 acres of riparian habitat in the American, Butte, and Sutter Basins; and (3) implementing the projects identified in the Lower Feather River CMP, which include establishing 718 acres of riparian forest and scrub.

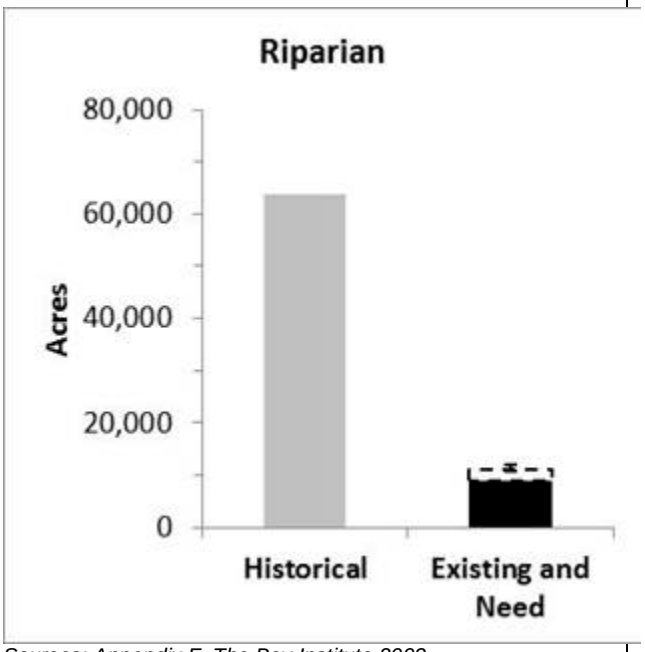
Interpretation of Conservation Plans

The need for riparian habitat on active floodplain has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). However, this need is only moderately predictable because the portion of existing habitat suitable for these species is not known precisely, and there is a several-fold range in population sizes that may be viable.

Attaining the minimum restoration acreages for western yellow-billed cuckoo would require the greatest increase in riparian habitat in this CPA. Assuming 80% of restored riparian habitat is suitable for yellow-billed cuckoo (for which a wide range of riparian vegetation is suitable), approximately 2,400 additional acres of riparian vegetation would be required to meet the minimum habitat acreages identified in the CVJV Implementation Plan.

Conservation of other target species is unlikely to require a greater amount of riparian habitat restoration.

The short-term CVJV objectives used as the basis for this need are being reassessed in the context of long-term conservation needs (Seavy pers. comm.). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs.



Sources: Appendix F, The Bay Institute 2003.

Historical and Existing Riparian Habitat and Amount Needed to Conserve Species

Notes: The need for riparian habitat consists of existing habitat (shown in black) and additional restoration (shown by a dashed outline) to meet CVJV minimum objective for western yellow-billed cuckoo, which was the largest riparian need identified in conservation plans The need assumes 80% of restored riparian vegetation would be suitable for western yellow-billed cuckoo (for which a wide range of riparian vegetation is suitable). The error bar denotes the range corresponding to 60–100% of restored riparian vegetation being suitable as habitat. The portion of riparian vegetation that is suitable for western yellow-billed cuckoo is unlikely to fall outside of this range.

Feather River CPA
Box 2. Marsh and Other Wetland Habitat

Summary of Conservation Need

6,900 additional acres of marsh and other wetlands may be required to recover greater sandhill crane and other target species. This amount is based on a need quantified in a conservation plan. However, there is a low level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify marsh and other wetland needs for anadromous fish, giant garter snake, and greater sandhill crane.

Marsh and other wetlands can provide inundated floodplain habitat for fish, a need that also may be met by other vegetation; thus, fish needs are not discussed further here (for related fish needs, see "Inundated Floodplain").

For giant garter snake, marsh provides foraging habitat, cover, hibernacula, and corridors for dispersal and other movements. For greater sandhill crane, marsh and other wetlands can provide foraging, loafing, and roosting habitat.

Specific identified actions include: (1) implementing the projects identified in the Lower Feather River CMP, which would restore 15 acres of marsh; and (2) CVJV 5-year objectives for restoration of 1,000 acres of semi-permanent wetlands and 43,000 acres of seasonal wetlands in the Sacramento Valley to benefit waterbirds (including greater sandhill crane).

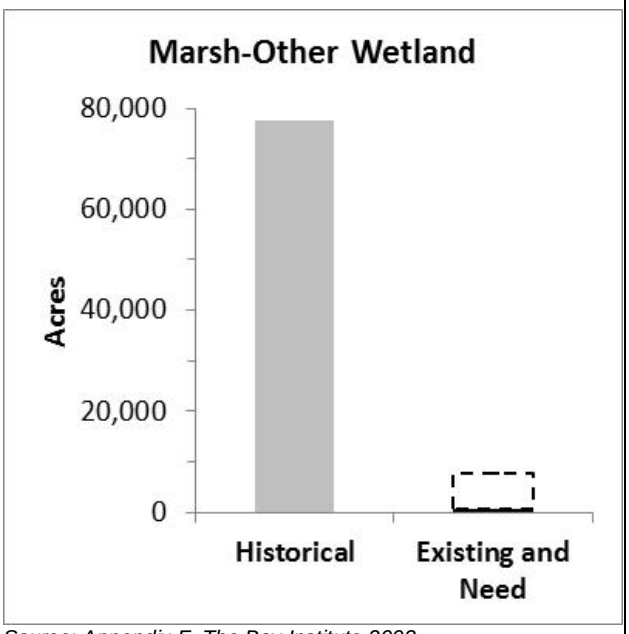
The revised draft recovery plan for giant garter snake specifies preservation of at least 5,390 acres of existing, enhanced, or preserved perennial wetlands in this CPA, in blocks 539 acres in size.

Interpretation of Conservation Plans

The need for marsh and other wetland habitat is of high importance for these species. These species' needs are moderately well understood (see Appendix G).

The level of predictability of this need is moderate and low for giant garter snake and greater sandhill crane, respectively. In addition to habitat amount, the required density of giant garter snakes in preserved habitat, and related habitat connectivity and location requirements have been identified. For greater sandhill crane, the desired population size and locations where it would benefit from additional wetland have not been identified.

CVJV short-term objectives were used as the basis for this need. These objectives are being reassessed in the context of habitat need and the restoration that has been achieved to date (Seavy pers. comm. 2014). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs. Because wetland restoration opportunities are widespread within the CVJV basins, these proxies for long-term CVJV objectives were scaled to the portion of the CVJV basins accounted for by the SPA in this CPA.



Source: Appendix F, The Bay Institute 2003

Historical and Existing Marsh Area and Amount Needed to Conserve Species

Notes: The need for marsh and other wetlands (outlined with a dashed line) consists of existing habitat (shown in black) and additional restoration to meet CVJV objectives. Because the plan area of the CVJV is much larger than the SPA, and wetland restoration opportunities are extensive both in and outside the SPA, the need shown here has been scaled to the portion of the CVJV basins that the SPA accounts for in this CPA. There is no error bar because the CVJV implementation plan specified the amount of restoration required.

Feather River CPA
Box 3. Riparian-Lined Bank
[Major Predictability Limitation]

Summary of Conservation Need

33 additional miles of riparian-lined bank may be required to recover target fish species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need.

Conservation Plan Content

Anadromous fish conservation plans identify needs for riparian-lined bank, which is a component of SRA cover.

However, conservation plans have not quantified the need for additional riparian-lined bank.

Specific identified actions include (1) implementing the projects identified in the Lower feather River CMP, and (2) restoring instream cover and large woody material along the Yuba River.

Conservation of other target species does not require riparian-lined bank.

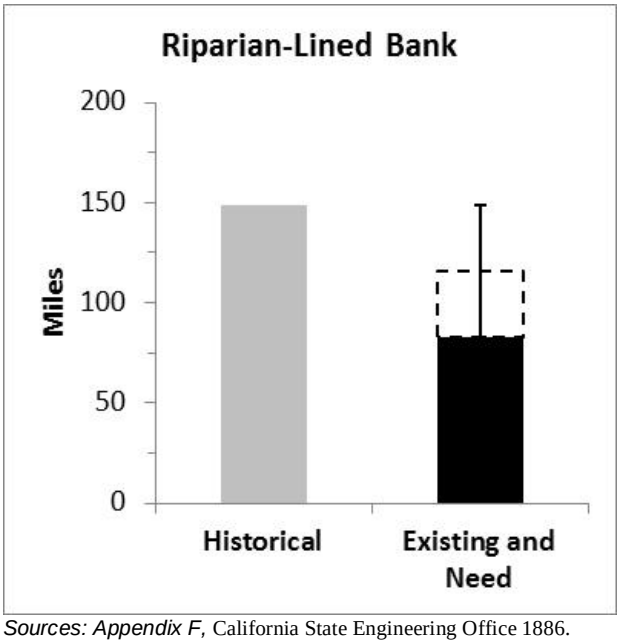
Interpretation of Conservation Plans

Riparian vegetation shades and adds woody material to the nearshore environment, which increases the quality of migration and rearing habitat, and provides refuge from predators. The need for the resulting high-quality nearshore habitat has high importance. It is based on a moderate level of understanding of the species' ecology: habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G). This need has a low level of predictability in part because it is strongly affected by changes to bank revetment and inundated floodplain, and by management of dying and fallen trees and instream woody material.

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in riparian-lined bank. Although this plan does not quantify this need, its size could entail woody vegetation along nearly all bank length.

Fish require suitable depth, velocity, and cover to be available throughout the river system at a fine scale (i.e., every few feet). These are provided only by a narrow zone along each bank, and riparian-lined banks may support the growth and survival of several times more fish in this zone than banks lacking woody plants (see SJRRP 2012).

Doubling salmonid populations (per the AFRP) could depend on at least doubling the ability of nearshore habitats to support fish, particularly in the absence of large increases in inundated floodplain. However, riparian-lined banks already account for 61% of bank length. Thus, substantial improvements to nearshore habitats could also require other related actions. Related actions include increasing the length of natural banks, increasing the area of the shallow nearshore environment, increasing the frequency and duration of floodplain inundation, and changing management to increase inputs and retention of woody material.



Sources: Appendix F, California State Engineering Office 1886.

Historical and Existing Riparian-Lined Bank and Amount Needed to Conserve Species

Notes: Total historical bank length is used as a proxy for riparian-lined bank length. It is an overestimate. Existing habitat is shown in black. Additional needed riparian-lined bank (outlined with a dashed line) is the midpoint of existing and maximal values. The error bar spans this range, because the need is uncertain, and the need also may in part be met by other changes.

Feather River CPA
Box 4. Natural Bank

Summary of Conservation Need

2 additional miles of natural bank may be needed to recover bank swallow, western yellow-billed cuckoo, and other target species. This need is quantified in a conservation plan. There is a high level of certainty regarding the size of this need for bank swallow; there is less certainty regarding the size of this need for other species.

Conservation Plan Content

Conservation plans identify natural bank needs for anadromous fish, bank swallow, western yellow-billed cuckoo, and least Bell's vireo. Natural bank provides fish with migration and rearing habitat, and refuge from predators; and provides bank swallows with cut banks to nest in. Natural bank also allows for channel migration, which sustains the early successional habitats used by yellow-billed cuckoo and least Bell's vireo.

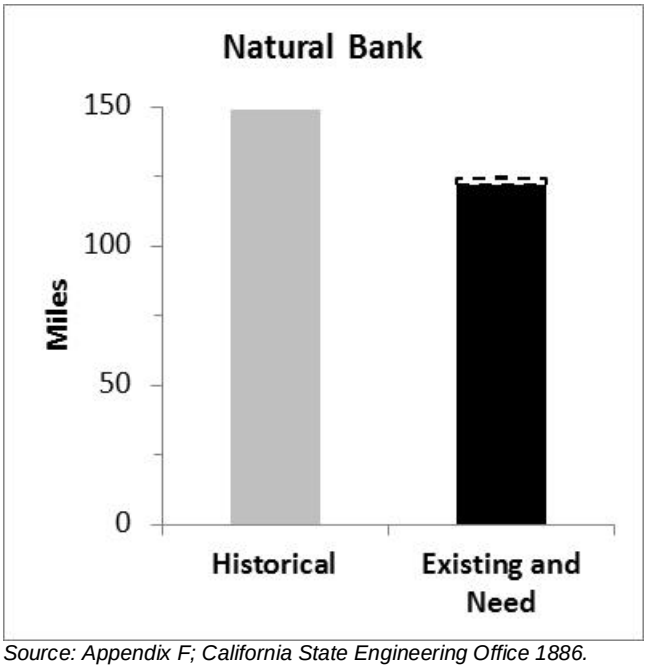
Specific identified actions include (1) removing 2 miles of revetment from the Feather River, (2) implementing the projects identified in the Lower Feather River CMP, and (3) restoring 1,900 acres of riparian habitat exposed to river meander (and thus bordered by natural banks).

Interpretation of Conservation Plans

The need for natural banks and high-quality nearshore habitat dependent on natural banks has high importance. It is based on a high level of understanding of the ecology of bank swallow, western yellow-billed cuckoo, and least Bell's vireo. For target fish, habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G).

This need has a high level of predictability for bank swallow, moderate predictability for other target birds, and a low level of predictability for target fish. For the fish, predictability is low in part because it is strongly affected by management of channel bank vegetation and instream woody material (see "Riparian-Lined Bank"), and by inundation of floodplains.

The overall need for natural bank is based on the need identified for bank swallow. Bank swallow has the largest specified and most predictable need for natural bank. The need is quantified in a conservation plan: 2 additional miles of natural bank (BANS-TAC 2013). Western yellow-billed cuckoo may have a comparable sized need, and anadromous fish may have a comparable or larger need, but those needs are less certain than the bank swallow need.



Source: Appendix F; California State Engineering Office 1886.

Historical and Existing Natural Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical natural bank length. It is an underestimate because of channel simplification over time. The need for natural bank consists of the existing length (shown in black) plus the additional length (shown by a dashed outline) resulting from revetment removal identified in BANS-TAC 2013. This graph has no error bar because the amount was provided in the conservation plan without an error term (CVJV 2006).

Feather River CPA
Box 5. River Meander Potential

Summary of Conservation Need

400 additional acres of river meander potential may be required to recover bank swallow, western yellow-billed cuckoo, least Bell's vireo, and anadromous fish. This need is not quantified in conservation plans, but is based on another quantified need (for natural bank), as described below. There is a high level of certainty regarding the size of the need for bank swallow, and less certainty regarding the size of this need for other species.

Conservation Plan Content

Conservation plans identify river meander needs for anadromous fish, bank swallow, yellow-billed cuckoo, and least Bell's vireo. River meander sustains cut banks that are nesting habitat for bank swallows, and provides fish with migration and rearing habitat and refuge from predators. River meander also sustains the early successional riparian habitat used by least Bell's vireo, and the diverse riparian habitat of yellow-billed cuckoo.

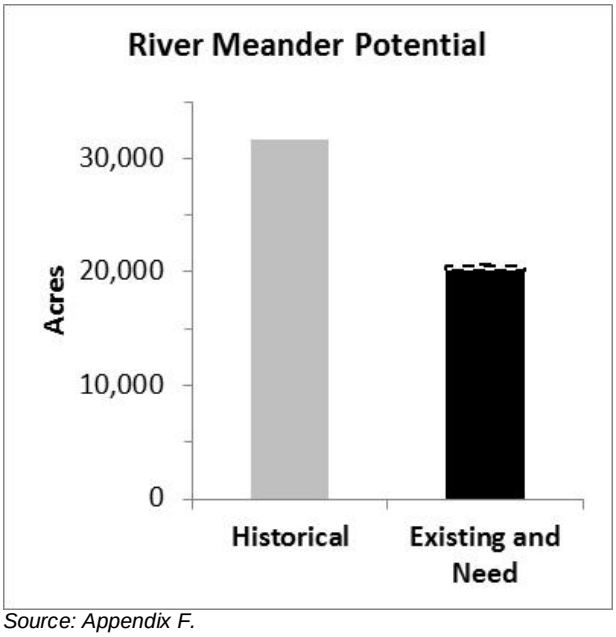
Specific identified actions include (1) removing 2 miles of revetment from the Feather River, and (2) restoring 1,900 acres of riparian habitat exposed to river meander.

Interpretation of Conservation Plans

Increases in meander potential have high importance for sustaining the quality of nearshore habitat, natural bank, and early successional riparian habitat. The physical process of meander migration and how it sustains habitats is well understood.

The need for additional meander potential in this CPA is based on the conservation needs of bank swallow, and has a high level of predictability. Of target species, bank swallow has the most predictable need, which is to sustain the additional 2 miles of natural bank specified in a conservation plan (BANS-TAC 2013). Fish and western yellow-billed cuckoo needs could be much greater but are less predictable. Yellow-billed cuckoo's need depends on the portion of additional riparian habitat that can be restored at sites where river meander is not already constrained. Fish needs are affected by multiple factors (as discussed for riparian-lined bank).

The need for additional meander potential has been calculated as the product of the length of additional natural bank required by bank swallow and the average area of floodplain with river meander constrained only by revetment or levees per mile of revetted bank.



Source: Appendix F.

Historical and Existing River Meander Potential and Amount Needed to Conserve Species

Notes: Historical meander potential is based on the area in the meander zone not constrained by geology (see Appendix F). Existing meander potential (shown in black) is the area in the meander zone not constrained by geology, revetment, or levees. The need is the sum of the existing area (shown in black) and additional area (shown by a dashed outline) that would result from meeting bank swallow's need for additional natural bank. This additional amount is the product of the length of additional natural bank and the average area of floodplain with river meander constrained only by revetment or levees per mile of revetted bank. This graph has no error bar because the need was quantified in a conservation plan, and the plan provided no error term.

Feather River CPA
Box 6. Inundated Floodplain

Summary of Conservation Need

Conservation of target species may require 53,000 additional acres of floodplain inundated by flows of a timing, duration, and frequency adequate for fish rearing. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a moderate level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify inundated floodplain needs for anadromous fish, western yellow-billed cuckoo, least Bell's vireo, and bank swallow. Fish needs are for providing migration and rearing habitat. Bird needs are for sustaining riparian habitat.

Specific identified actions include (1) implementing the projects identified in the Lower Feather River CMP, (2) constructing setback levees to reconnect 500 acres of floodplain to the Feather River, and (3) increasing floodplain habitat availability and restoring side channel habitats in the lower Yuba River.

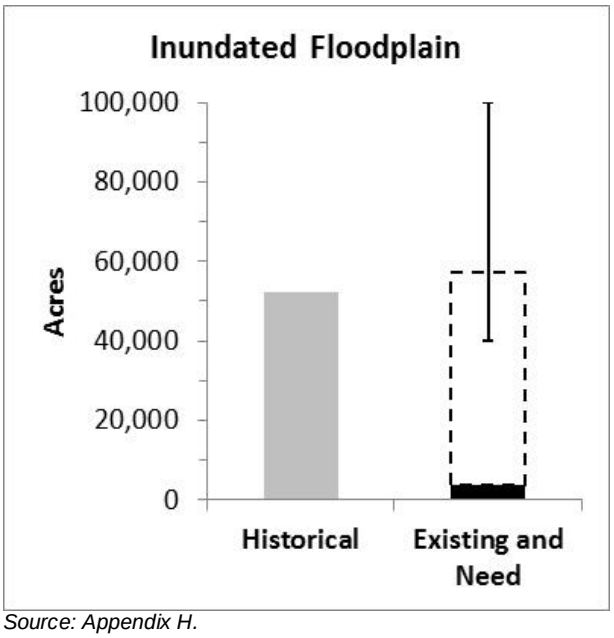
Interpretation of Conservation Plans

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in inundated floodplain; perhaps an order of magnitude more land than needed to meet the needs identified for target bird species, or of target species not addressed by conservation plans.

The need for rearing habitat on inundated floodplains has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). This need has a moderate level of predictability; predictability is limited by variability in floodplain suitability as rearing habitat.

As described in Appendix H, the ESHE model was used to estimate the amount of rearing habitat required to support the AFRP doubling goal. Appendix H also provides an estimate of existing rearing habitat. Amount of inundated floodplain is a product of both floodplain area and management of water flows. The estimate provided by Appendix H is for existing hydrology.

Suitability of floodplains as rearing habitat is affected by other variables besides inundation, and consequently, only a fraction of the inundated area provides rearing habitat. This fraction can range from less than 10% to more than 25%. Assuming 17.5% suitability on average, an additional 106,400 acres of inundated floodplain would be needed to provide habitat required for doubling salmonid populations under current hydrology.



Source: Appendix H.

Historical and Existing Inundated Floodplain Area and Amount Needed to Conserve Species

Notes: Acreages are for areas inundated for at least 14 days during December–May by a flood with a recurrence interval of 2 years or less. Only a small portion of the active floodplain along major river reaches meets these criteria. The need is the sum of the existing area (shown in black) and the additional area (shown by a dashed outline) needed to provide rearing habitat for the AFRP goal to double salmonid populations. This amount is based on floodplains providing rearing habitat of intermediate suitability (17.5%). The error bar denotes the range from low to high floodplain suitability as rearing habitat (10–25%). The range is large because suitability can have a several-fold effect on the number of fish supported per unit area. These data are results of the analysis presented in Appendix H, and the model used to generate these estimates is further described in SJRRP 2012.

The amount of habitat required to double salmonid populations is more than twice existing habitat because existing populations are supported by both natural production and fish hatcheries. Consequently, because existing habitat supports only a portion of the existing population, habitat for 100% more fish would require more than a 100% increase in habitat.

Lower Sacramento River Conservation Planning Area

Lower Sacramento River CPA
Box 1. Riparian Habitat

Summary of Conservation Need

1,500 additional acres of riparian habitat on the active floodplain may be needed to recover target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a moderate level of uncertainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify riparian habitat needs for anadromous fish, VELB, and least Bell's vireo. Riparian vegetation increases the quality of inundated floodplain and nearshore habitats for fish rearing and migration. These needs are not discussed further here (see "Riparian-Lined Bank" and "Inundated Floodplain"). Riparian vegetation provides reproduction and foraging habitat for least Bell's vireo (as described in Appendix G). Swainson's hawk also requires riparian habitat for nesting but is not addressed by conservation plans.

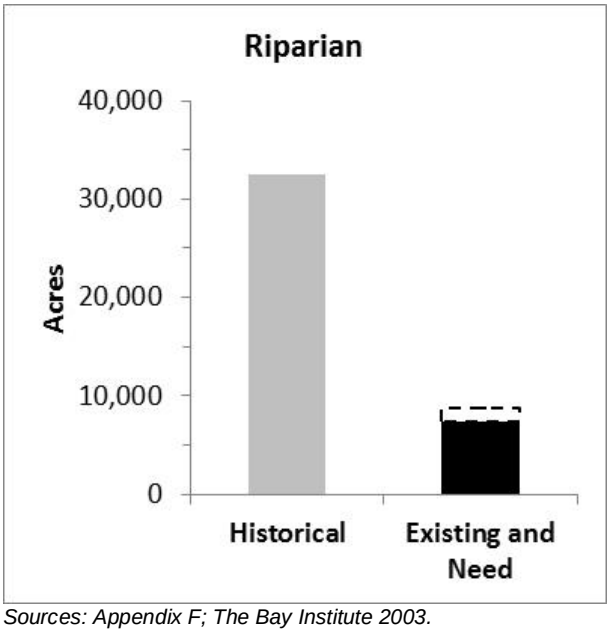
Specific identified actions include (1) 5-year CVJV objectives for restoring 4,200 acres of riparian habitat in the American, Colusa, Delta, Sutter, and Yolo Basins; (2) implementing the Southport Floodplain Restoration Project; and (3) reconnecting Stone Lakes, and potentially Elk Slough, to the Sacramento River.

Interpretation of Conservation Plans

The need for riparian habitat on active floodplain has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). However, this need is only moderately predictable because the portion of existing habitat suitable for these species is not known precisely, and there is a several-fold range in population sizes for least Bell's vireo that may be viable.

CVJV riparian objectives are the largest identified need for additional riparian vegetation. These objectives have not been reduced to account for CVJV basins being larger than the SPA, because most opportunities for riparian restoration are along major river reaches in the SPA. Rather, total objective acreages have been distributed among Sacramento Valley CPAs in proportion to their relative overlap with CVJV basins.

The short-term CVJV objectives used as the basis for this need are being reassessed in the context of long-term conservation needs (Seavy pers. comm.). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs.



Sources: Appendix F; The Bay Institute 2003.

Historical and Existing Riparian Habitat and Amount Needed to Conserve Species

Notes: The need for riparian vegetation consists of existing habitat (shown in black) and additional restoration (shown by a dashed outline) to meet CVJV objectives. Total objective acreages were distributed among CPAs in proportion to their relative overlap with CVJV basins. There is no error bar because the CVJV implementation plan specified the amount of restoration required.

Lower Sacramento River CPA
Box 2. Marsh and Other Wetland Habitat

Summary of Conservation Need

6,600 additional acres of marsh and other wetlands may be required to recover greater sandhill crane, California black rail, and other target species. This amount is based on a need quantified in a conservation plan. However, there is a low level of certainty regarding its size.

Conservation Plan Content

Conservation plans identify marsh and other wetland needs for anadromous fish, giant garter snake, California black rail, and greater sandhill crane.

Marsh and other wetlands can provide inundated floodplain habitat for fish, a need that also may be met by other vegetation; fish needs are not discussed further here.

For giant garter snake, marsh provides foraging habitat, cover, hibernacula, and corridors for dispersal and other movements. For greater sandhill crane, marsh and other wetlands can provide foraging, loafing, and roosting habitat. For California black rail, marsh provides cover and habitat for foraging and reproduction.

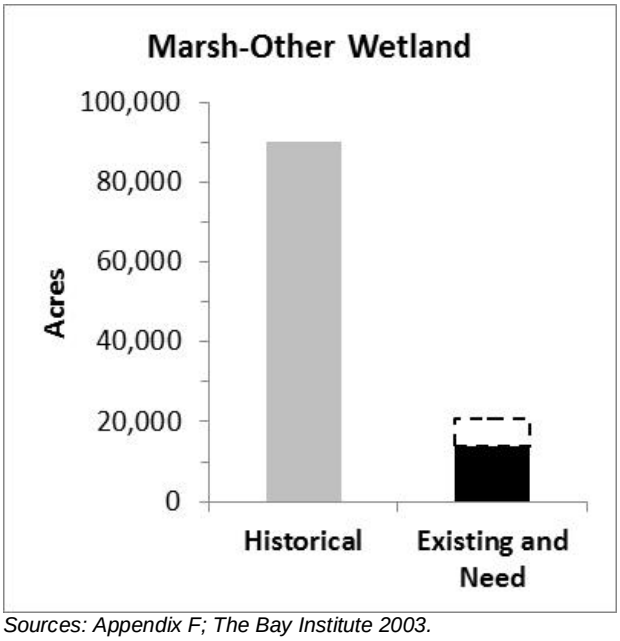
Specific identified actions include (1) several floodplain restoration projects that could include marsh and seasonal wetland restoration; and (2) CVJV short-term objectives for restoration of 1,000 acres of semi-permanent wetlands in the Sacramento Valley, and 43,000 and 22,000 acres of seasonal wetlands in the Sacramento Valley and Delta, respectively. The revised draft recovery plan for giant garter snake specifies preservation of at least 5,390 acres of existing, enhanced, or preserved perennial wetlands in this CPA, in blocks 539 acres in size.

Interpretation of Conservation Plans

The need for marsh and other wetland habitat is of high importance for these species. These species' needs are moderately well understood (see Appendix G).

However, the need has a low level of predictability because of significant data gaps. In this CPA, the size and location of California black rail populations are not known, and the suitable portion of existing marsh is only imprecisely known. Similarly, for greater sandhill crane, the desired population size and locations where it would benefit from additional wetland have not been identified.

CVJV objectives were used as the basis for this need. These objectives are being reassessed in the context of habitat need and the restoration that has been achieved to date (Seavy pers. comm. 2014). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs. These proxies for long-term CVJV objectives were scaled to the portion of the CVJV basins accounted for by this CPA.



Sources: Appendix F; The Bay Institute 2003.

Historical and Existing Marsh Area and Amount Needed to Conserve Species

Notes: The need for marsh and other wetlands consists of existing habitat (shown in black) and additional restoration (shown by a dashed outline) to meet CVJV objectives. Because the plan area of the CVJV is much larger than the SPA, and wetland restoration opportunities are extensive both in and outside the SPA, the need shown here has been scaled to the portion of the CVJV basins that the SPA accounts for in this CPA. There is no error bar because the CVJV implementation plan specified the amount of restoration required.

Lower Sacramento River CPA
Box 3. Riparian-Lined Bank [Major Predictability Limitation]

Summary of Conservation Need

57 additional miles of riparian-lined bank may be required to recover target fish species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need.

Conservation Plan Content

Anadromous fish conservation plans identify needs for riparian-lined bank, which is a component of Shaded Riverine Aquatic (SRA) cover.

However, conservation plans have not quantified the need for additional riparian-lined bank.

Specific identified actions include (1) terminating removal of woody debris and implementing programs to manage riparian corridors and wood, and to improve instream cover; (2) reconnecting Stone Lakes, and potentially Elk Slough, to the Sacramento River; and (3) improving habitat for juvenile salmonids in Elk, Sutter, and Steamboat Sloughs.

Interpretation of Conservation Plans

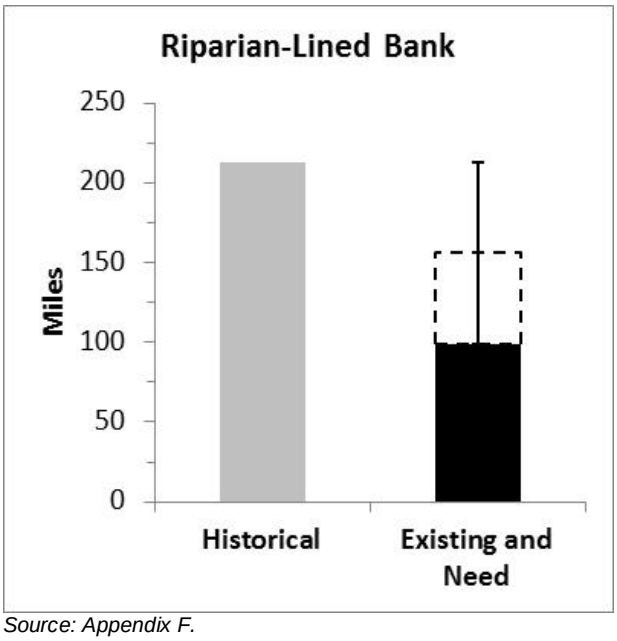
Riparian vegetation shades and adds woody material to the nearshore environment, which increases the quality of migration and rearing habitat, and provides refuge from predators. The need for the resulting high-quality nearshore habitat has high importance. It is based on a moderate level of understanding of the species' ecology: habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G). This need has a low level of predictability in part because it is strongly affected by changes to bank revetment and inundated floodplain, and by management of dying and fallen trees and instream woody material.

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in riparian-lined bank. Although this plan does not quantify this need, its size could entail woody vegetation along nearly all bank length.

Only in-channel habitat is available for outmigration and rearing when the Yolo Bypass is not inundated.

Fish require suitable depth, velocity, and cover to be available throughout the river system at a fine scale (i.e., every few feet). These are provided only by a narrow zone along each bank, and riparian-lined banks may support the growth and survival of several times more fish than banks lacking woody plants (see SJRRP 2012).

Doubling salmonid populations (per the AFRP) could depend on at least doubling the ability of nearshore habitats to support fish, particularly without large increases in inundated floodplain. However, riparian-lined banks already account for 46% of bank length. Thus, substantial improvements to nearshore habitats would also require other related actions. Related actions include increasing the length of natural banks, increasing the area of the shallow nearshore environment, increasing the frequency and duration of floodplain inundation, and changing management to increase inputs and retention of woody material.



Source: Appendix F.

Historical and Existing Riparian-Lined Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical riparian-lined bank length. It is an overestimate. Existing bank length is shown in black. Additional needed riparian-lined bank (outlined with a dashed line) is the midpoint between existing and maximal values. The error bar spans this range because the need is uncertain, and may in part be met by other changes.

Lower Sacramento River CPA
Box 4. Natural Bank
[Major Predictability Limitation]

Summary of Conservation Need

4 additional miles of natural bank may be required to recover target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify natural bank needs for anadromous fish and least Bell's vireo. Natural bank provides fish with migration and rearing habitat, and refuge from predators; and allows for the river meander that sustains the early successional habitats used by least Bell's vireo.

Specific identified actions include (1) terminating removal of woody debris and implementing programs to improve and protect instream cover; (2) reconnecting Stone Lakes, and potentially Elk Slough, to the Sacramento River; and (3) improving habitat for juvenile salmonids in Elk, Sutter, and Steamboat Sloughs.

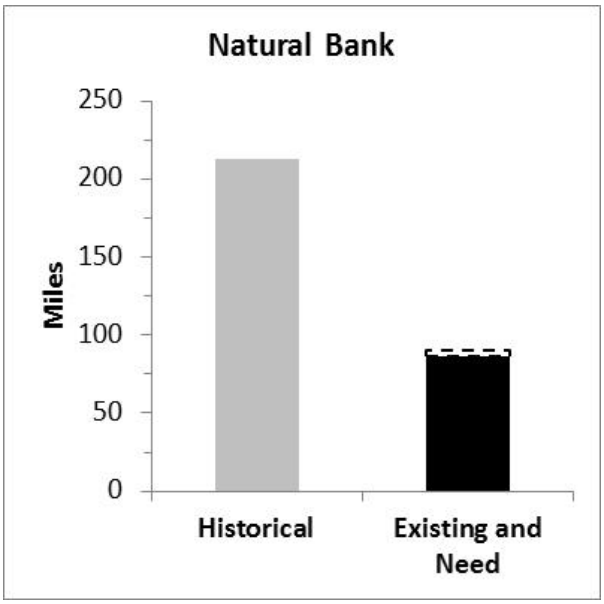
Interpretation of Conservation Plans

The need for natural banks and high-quality nearshore habitat dependent on natural banks has high importance. It is based on a high level of understanding of the ecology of least Bell's vireo. For target fish, habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G).

In general, this need has a moderate level of predictability for least Bell's vireo, and a low level of predictability for target fish. For the fish, predictability is low in part because it is strongly affected by management of channel bank vegetation and instream woody material (see "Riparian-Lined Bank"), and by inundation of floodplains.

The overall need for natural bank given here (6 additional miles) is based on the additional river meander (and thus natural bank) required to sustain additional riparian habitat. Anadromous fish may have a much larger need for additional natural bank to improve nearshore habitats, but that need is less certain than the need for sustaining riparian habitat. (See "Riparian-Lined Bank" for description of the nearshore habitat needs of target fish species.)

This overall need was calculated by dividing the acres of additional needed riparian habitat by the average acres of floodplain in the river meander zone per mile of bank, and then multiplying that result by the percentage of banks with revetment in this CPA.



Source: Appendix F.

Historical and Existing Natural Bank and Amount Needed to Conserve Species

Notes: Total bank length is displayed as historical natural bank length. It is an underestimate because of channel simplification over time. The need for natural bank consists of the existing area (shown in black) and the additional area (shown by a dashed outline) needed to sustain restored riparian habitat (as described for Riparian Habitat). It was calculated by dividing the acres of additional riparian habitat by the average acres of river meander per mile of bank, and then multiplying that result by the percentage of banks with revetment in this CPA. The need is uncertain because anadromous fish needs could be much greater than shown, but those needs also may in part be met by other changes (see "Riparian-Lined Bank" for more information). This graph has no error bar because the amount was provided in the conservation plan without an error term (CVJV 2006).

Lower Sacramento River CPA
Box 5. River Meander Potential
[Major Predictability Limitation]

Summary of Conservation Need

1,300 additional acres of river meander potential may be needed to sustain nearshore and riparian habitats to recover target species. This need is not quantified in conservation plans; it is based on the interpretation below. There is a low level of certainty regarding this need.

Conservation Plan Content

Conservation plans identify river meander needs for anadromous fish and least Bell's vireo. These needs are often described in other terms, such as geomorphic processes or conditions, or natural processes. River meander sustains nearshore environments for fish (see "Riparian-Lined Bank"). River meander also sustains early successional riparian habitat for least Bell's vireo and the diversity of riparian habitats in general.

Specific identified actions include two projects or locations in need of improvements that could involve restoration of meander potential: (1) reconnecting Stone Lakes, and potentially Elk Slough, to the Sacramento River and (2) improving habitat for juvenile salmonids in Elk, Sutter, and Steamboat Sloughs.

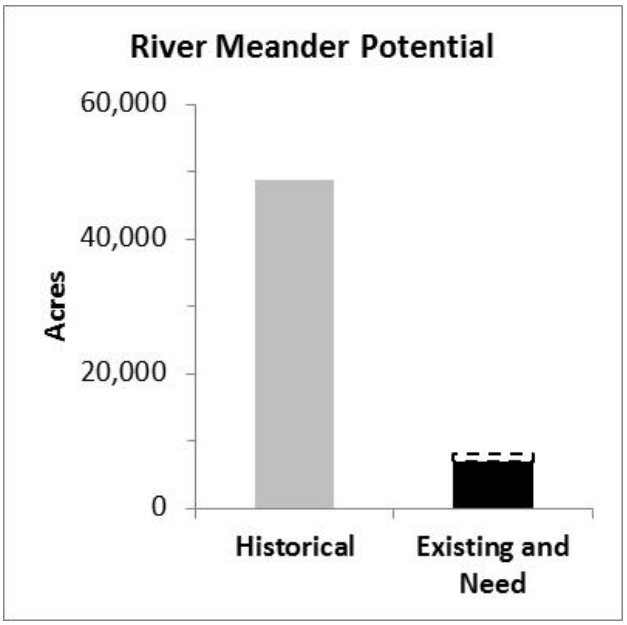
Interpretation of Conservation Plans

Increases in meander potential have high importance for sustaining early successional and diverse riparian habitat, and the quality of nearshore habitat. The physical process of meander migration and how it sustains habitats is well understood.

However, the needs for additional riparian habitats and improved nearshore habitats have moderate and low levels of predictability, respectively. Thus, the need for additional meander potential to sustain additional riparian vegetation has a moderate level of predictability, and the amount needed to sustain nearshore habitats has a low level of predictability.

Because of its greater level of predictability, the overall need presented here (1,300 additional acres with meander potential) is based on the need to sustain additional riparian habitat. However, because anadromous fish needs for improved nearshore habitat may require a much larger increase in meander potential, the overall need is considered to have a low level of certainty.

The need for additional meander potential has been calculated as the product of the area of additional riparian vegetation and the average percentage of floodplain with river meander constrained only by revetment or levees.



Source: Appendix F.

Historical and Existing River Meander Potential and Amount Needed to Conserve Species

Notes: Historical meander potential is based on the area in the meander zone not constrained by geology (see Appendix F). Existing meander potential (shown in black) is the area in the meander zone not constrained by geology, revetment, or levees. The need is the sum of the existing area and additional area (shown by a dashed outline) required to sustain additional riparian habitat needed in this CPA. This additional amount is the product of the area of additional riparian habitat and the average percentage of floodplain with river meander constrained only by revetment or levees.

Lower Sacramento River CPA
Box 6. Inundated Floodplain

Summary of Conservation Need

Conservation of target species may require 50,500 acres of additional floodplain inundated by flows of a timing, duration, and frequency adequate for fish rearing. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a moderate level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify inundated floodplain needs for anadromous fish and least Bell's vireo, and sustaining the diversity of riparian habitats in general. Fish needs are for providing migration and rearing habitat. Least Bell's vireo's needs are for sustaining early successional riparian habitat.

Specific identified actions include (1) managing the timing, frequency, magnitude, and duration of Yolo Bypass inundation to maximize growth/survival of juvenile salmonids; (2) identifying lower American River locations to create inundated floodplain, (3) implementing the Southport Floodplain Restoration Project; (4) reconnecting Stone Lakes, and potentially Elk Slough, to the Sacramento River; and (5) improving juvenile salmonid habitat in Elk, Sutter, and Steamboat Sloughs.

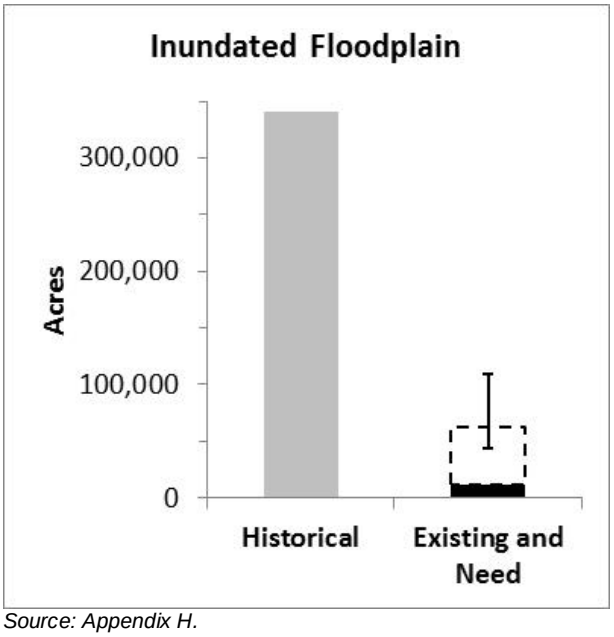
Interpretation of Conservation Plans

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in inundated floodplain; perhaps an order of magnitude more land than needed to meet the needs of other target species.

The need for rearing habitat on inundated floodplains has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). This need has a moderate level of predictability; predictability is limited by variability in the suitability of floodplain as rearing habitat.

As described in Appendix H, the ESHE model was used to estimate the amount of rearing habitat required to support the AFRP doubling goal. Appendix H also provides an estimate of existing rearing habitat. Amount of inundated floodplain is a product of both floodplain area and water flows. The estimate provided by Appendix H is for existing hydrology. Most rearing habitat provided by the Yolo Bypass when inundated is not included in that estimate because the frequency of inundation did not meet minimum requirements.

Suitability of floodplains as rearing habitat is affected by other variables besides inundation, and consequently, only a fraction of the inundated area provides rearing habitat. This fraction can range from less than 10% to more than 25%. Assuming 17.5% suitability on average, an additional 50,500 acres of inundated floodplain would be needed to provide habitat required for doubling salmonid populations under current hydrology.



Source: Appendix H.

Historical and Existing Inundated Floodplain Area and Amount Needed to Conserve Species

Notes: Acreages are for areas inundated for at least 14 days during December–May by a flood with a recurrence interval of 2 years or less. Only a small portion of the active floodplain along major river reaches meets these criteria; as currently operated, the Yolo Bypass does not meet these criteria. The need is the sum of the existing area (shown in black) and the additional area (shown by a dashed outline) needed to provide rearing habitat for the AFRP goal to double salmonid populations. This amount is based on floodplains providing rearing habitat of intermediate suitability (17.5%). The error bar denotes the range from low to high floodplain suitability as rearing habitat (10–25%). The range is large because suitability can have a several-fold effect on the number of fish supported per unit area. These data are results of the analysis presented in Appendix H, and the model used to generate these estimates is further described in SJRRP 2012. The amount of habitat required to double salmonid populations is more than twice existing habitat because existing populations are supported by both natural production and fish hatcheries. Consequently, because existing habitat supports only a portion of the existing population, habitat for 100% more fish would require more than a 100% increase in habitat.

Upper San Joaquin River Conservation Planning Area

Upper San Joaquin River CPA
Box 1. Riparian Habitat

Summary of Conservation Need

2,100 additional acres of riparian habitat on the active floodplain may be needed to recover target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a moderate level of uncertainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify riparian habitat needs for anadromous fish and least Bell's vireo. Riparian vegetation increases the quality of inundated floodplain and nearshore habitats for fish rearing and migration. These needs are not discussed further here (see "Riparian-Lined Bank" and "Inundated Floodplain"). Riparian vegetation provides reproduction and foraging habitat for least Bell's vireo (as described in Appendix G). Swainson's hawk also requires riparian habitat for nesting but is not addressed by conservation plans.

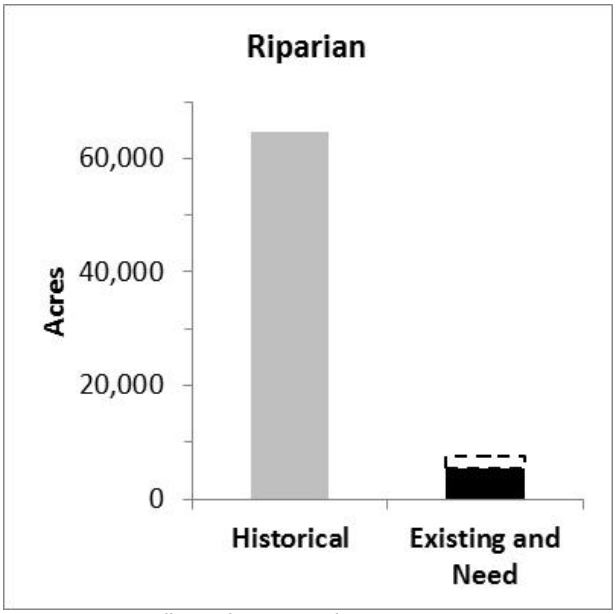
Specific identified actions include (1) restoration of riparian habitat at the San Joaquin NWR, and (2) 5-year CVJV objectives for restoring 2,500 acres of riparian habitat in the San Joaquin Basin.

Interpretation of Conservation Plans

The need for riparian habitat on active floodplain has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). However, this need is only moderately predictable because the portion of existing habitat suitable for these species is not known precisely, and there is a several-fold range in population sizes for least Bell's vireo that may be viable.

CVJV riparian objectives are the largest identified need for additional riparian vegetation. These objectives have not been reduced to account for CVJV basins being larger than the SPA, because most opportunities for riparian restoration are along major river reaches in the SPA. Rather, total objective acreages have been distributed among San Joaquin Valley CPAs in proportion to their relative overlap with CVJV basins.

The short-term CVJV objectives used as the basis for this need are being reassessed in the context of long-term conservation needs (Seavy pers. comm.). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs.



Sources: Appendix F; The Bay Institute 2003.

Historical and Existing Riparian Habitat and Amount Needed to Conserve Species

Notes: The need for riparian vegetation consists of existing habitat (shown in black) and additional restoration (shown by a dashed outline) to meet CVJV objectives. Rather, total objective acreages were distributed among CPAs in proportion to their relative overlap with CVJV basins. There is no error bar because the CVJV Implementation Plan specified the amount of restoration required.

Upper San Joaquin River CPA
Box 2. Marsh and Other Wetland Habitat

Summary of Conservation Need

5,200 additional acres of marsh and other wetlands may be required to recover greater sandhill crane and other target species. This amount is based on a need quantified in a conservation plan. However, there is a low level of certainty regarding the size of the overall need.

Conservation Plan Content

Conservation plans identify marsh and other wetland needs for anadromous fish, giant garter snake, and greater sandhill crane. Conservation of Delta-button celery, which is not addressed by conservation plans, may also require additional wetland habitat in this CPA (i.e., seasonal wetlands in Reaches 4 and 5 and Eastside Bypass).

Marsh and other wetlands can provide inundated floodplain habitat for fish, a need that also may be met by other vegetation; thus, fish needs are not discussed further here (for related fish needs, see "Inundated Floodplain").

For giant garter snake, marsh provides foraging habitat, cover, hibernacula, and corridors for dispersal and other movements. For greater sandhill crane, marsh and other wetlands can provide foraging, loafing, and roosting habitat.

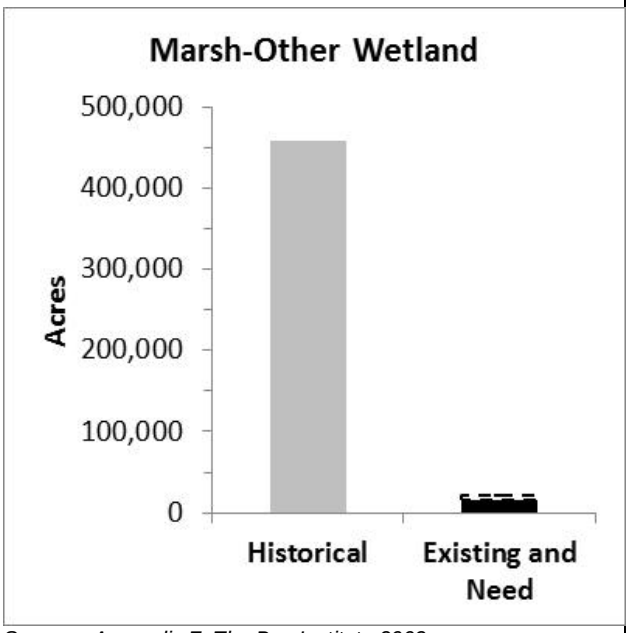
Specific identified actions include (1) restoring 1,500 and 20,000 acres of semi-permanent and seasonal wetlands, respectively, in the San Joaquin Basin, and (2) restoring floodplain habitat at the San Joaquin River National Wildlife Refuge. Also, the revised draft recovery plan for giant garter snake specifies preservation of at least 5,121 acres of existing, enhanced, or preserved perennial wetlands in this CPA, in blocks 539 acres in size.

Interpretation of Conservation Plans

The need for marsh and other wetland habitat is of high importance for these species. These species' needs are moderately well understood (see Appendix G).

The predictability of this need, however, is low: habitat needs and desired population size for Delta button-celery have not been determined, and for greater sandhill crane, the desired population size and locations where it would benefit from additional wetland have not been identified.

CVJV objectives were used as the basis for this need. These objectives are being reassessed in the context of habitat need and the restoration that has been achieved to date (Seavy pers. comm. 2014). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs. These proxies for long-term CVJV objectives were scaled to the portion of the CVJV basins accounted for by this CPA.



Sources: Appendix F; The Bay Institute 2003.

Historical and Existing Marsh Area and Amount Needed to Conserve Species

Notes: The need for marsh and other wetlands consists of existing habitat (shown in black) and additional restoration (shown by a dashed outline) to meet CVJV objectives. Because the plan area of the CVJV is much larger than the SPA, and wetland restoration opportunities are extensive both in and outside the SPA, the need shown here has been scaled to the portion of the CVJV basins that the SPA accounts for in this CPA. There is no error bar because the CVJV implementation plan specified the amount of restoration required.

Upper San Joaquin River CPA
Box 3. Riparian-Lined Bank
[Major Predictability Limitation]

Summary of Conservation Need

114 additional miles of riparian-lined bank may be required to recover target fish species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need.

Conservation Plan Content

Anadromous fish conservation plans identify needs for riparian-lined bank, which is a component of SRA cover.

Conservation plans have not quantified the need for additional riparian-lined bank or identified specific actions for meeting this need.

Only one, nonspecific action has been identified related to riparian-lined banks: add instream cover if determined to be lacking (based on available data and new analyses). This action acknowledges the uncertainty regarding this need.

Conservation of other target species does not require riparian-lined bank.

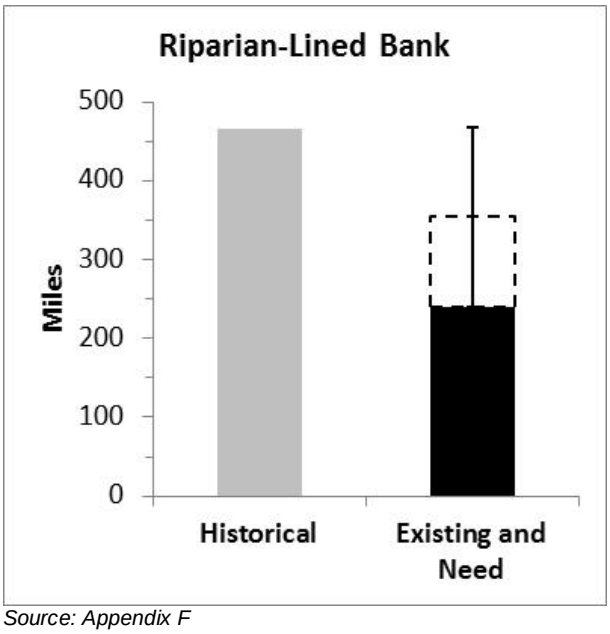
Interpretation of Conservation Plans

Riparian vegetation shades and adds woody material to the nearshore environment, which increases the quality of migration and rearing habitat, and provides refuge from predators. The need for the resulting high-quality nearshore habitat has high importance. It is based on a moderate level of understanding of the species' ecology: habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G). This need has a low level of predictability in part because it is strongly affected by changes to bank revetment and inundated floodplain, and by management of dying and fallen trees and instream woody material.

Conservation plans do not quantify the need for additional riparian-lined bank, but its size could entail woody vegetation along nearly all bank length.

Fish require suitable depth, velocity, and cover to be available throughout the river system at a fine scale (i.e., every few feet). These are provided only by a narrow zone along each bank, and riparian-lined banks may support the growth and survival of several times more fish than banks lacking woody plants (see SJRRP 2012).

Reintroduced salmonids may require substantially improved nearshore habitat. However, riparian-lined banks already account for 65% of bank length. Thus, substantial improvements to nearshore habitats may also require other related actions. Related actions include increasing the length of natural banks, increasing the area of the shallow nearshore environment, and changing management to increase inputs and retention of woody material.



Source: Appendix F

Historical and Existing Riparian-Lined Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical riparian-lined bank length. It is an overestimate. Existing bank length is shown in black. Additional needed bank (outlined with a dashed line) is the midpoint of existing and maximal values. The error bar spans this range, because the need is uncertain, and may in part be met by other changes.

Upper San Joaquin River CPA
Box 4. Natural Bank
[Major Predictability Limitation]

Summary of Conservation Need

0–23 additional miles of natural bank may be required to recover target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need, in part because of a data gap regarding the location and extent of revetted bank.

Conservation Plan Content

Conservation plans identify natural bank needs for anadromous fish and least Bell's vireo. Natural bank provides fish with migration and rearing habitat and refuge from predators, and allows for the river meander that sustains the early successional habitats used by least Bell's vireo. Conservation of other target species does not require natural bank.

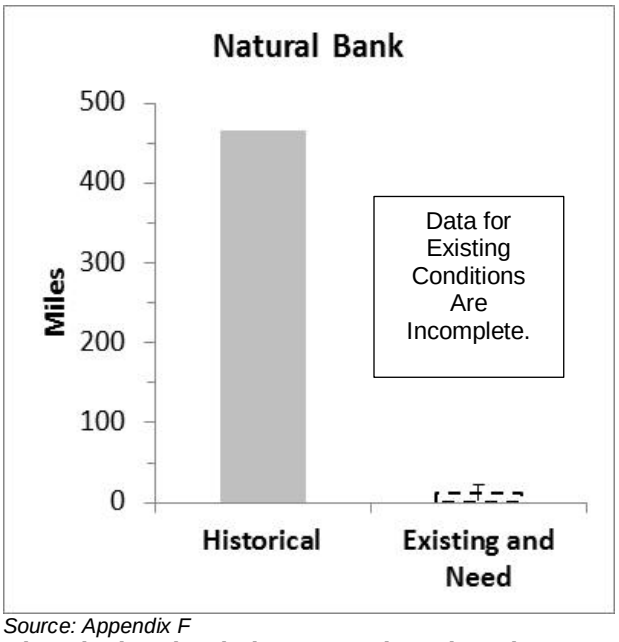
No specific actions have been identified. More generally, there are references to modifying in-channel, side-channel, and floodplain habitat, which likely includes natural bank.

Interpretation of Conservation Plans

The need for natural banks and high-quality nearshore habitat dependent on natural banks has high importance. It is based on a high level of understanding of the ecology of least Bell's vireo. For target fish, habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G).

In general, the need for sustaining riparian habitat has a moderate level of predictability, and the need for higher quality nearshore habitats has a low level of predictability for target fish. For the fish, predictability is low in part because it is strongly affected by management of channel bank vegetation and instream woody material (see "Riparian-Lined Bank"), and by inundation of floodplains. (See "Riparian Habitat" for a description of riparian habitat needs.)

Because of its greater predictability, the overall need given here is for sustaining additional riparian habitat. However, because the inventory of bank revetment is incomplete in this CPA, the need for additional natural bank may range from none, if all additional riparian habitat could be sustained by meander migration associated with existing natural banks, to 23 miles, if all additional riparian habitat had to be restored at locations currently constrained by revetted banks. (The 23-mile maximum is based on the acreage of additional needed riparian habitat divided by the mean acres of meander potential per mile of bank.) Provisionally, the midpoint of this range (11.5 miles) has been identified as the need.



Source: Appendix F

Historical and Existing Natural Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical natural bank length. It is an underestimate. Insufficient data exist for existing amounts: inventory of revetted banks is incomplete, with documented revetment accounting for only 1% of river banks. The additional amount of natural bank needed to sustain riparian habitats is outlined with a dashed line.

Upper San Joaquin River CPA
Box 5. River Meander Potential
[Major Predictability Limitation]

Summary of Conservation Need

1,050 additional acres of river meander potential may be needed to sustain nearshore and riparian habitats to recover target species. There is a low level of certainty regarding this need, in part because of a data gap regarding the location and extent of revetted bank.

Conservation Plan Content

Conservation plans identify river meander needs for anadromous fish and least Bell's vireo. These needs are often described in other terms, such as geomorphic processes or conditions, or natural processes. River meander sustains nearshore environments for fish (see "Riparian-Lined Bank"). River meander also sustains early successional riparian habitat for least Bell's vireo and the diversity of riparian habitats in general.

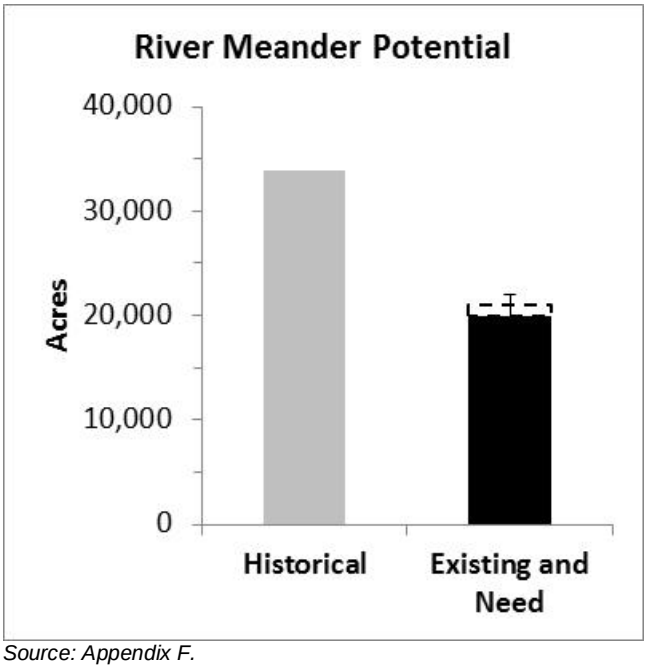
The only specific identified action is to fill or isolate the highest-priority gravel pits (in Reach 1A). More generally, plans refer to modifying in-channel, side-channel, and floodplain habitat, which may include increasing river meander.

Interpretation of Conservation Plans

Increases in meander potential have high importance for sustaining early successional and diverse riparian habitat, and the quality of nearshore habitat. The physical process of meander migration and how it sustains habitats is well understood.

In general, the needs for additional riparian habitats and improved nearshore habitats have moderate and low levels of predictability, respectively, and thus so does the associated needs for river meander potential. Because of its greater predictability, the overall need has been estimated based on sustaining additional riparian vegetation.

However, because the inventory of bank revetment is incomplete in this CPA, the need for additional meander potential may range from none, if all additional riparian habitat is restored at unconstrained locations, to 2,100 acres, if all additional riparian habitat had to be restored at locations currently constrained by revetted banks and/or levees. Provisionally, the midpoint of this range (1,050 acres) has been identified as the need.



Source: Appendix F.

Historical and Existing River Meander Potential and Amount Needed to Conserve Species

Notes: Historical meander potential is based on the area in the meander zone not constrained by geology (see Appendix F). Existing meander potential is the area in the meander zone not constrained by geology, revetment, or levees. The locations of revetted banks have not been completely inventoried; thus, the graph displays an overestimate of existing meander potential. The need is the sum of the existing area (shown in black) and an estimate of the additional area (shown by a dashed outline) required to sustain additional riparian vegetation. The error bar spans the range from all habitat restored in unconstrained locations (and thus no additional meander potential) to all habitat restored in currently constrained locations. The estimated need is the midpoint of this range.

Upper San Joaquin River CPA
Box 6. Inundated Floodplain

Summary of Conservation Need

Conservation of target species may require 2,800 acres of additional floodplain inundated by flows of a timing, duration, and frequency adequate for fish rearing. There is a moderate level of certainty regarding the size of this need. This need is not quantified in conservation plans; but the amount required to sustain reintroduced salmon runs has been quantified by the SJRRP (SJRRP 2012) as described below.

Conservation Plan Content

Conservation plans identify inundated floodplain needs for anadromous fish and least Bell's vireo. Inundated floodplain provides migration and rearing habitat for fish, and sustains early successional riparian habitat for least Bell's vireo.

Specific identified actions include: (1) constructing the Mendota Pool Bypass and modifying Reach 2B and Sand Slough Control Structure to convey 4,500 cfs, (2) modifying Reach 4B1 to convey 475–4,500 cfs, and (3) breaching deauthorized levees at the San Joaquin River NWR.

Conservation of Delta button-celery, which is not addressed by conservation plans, may also require additional floodplain inundation.

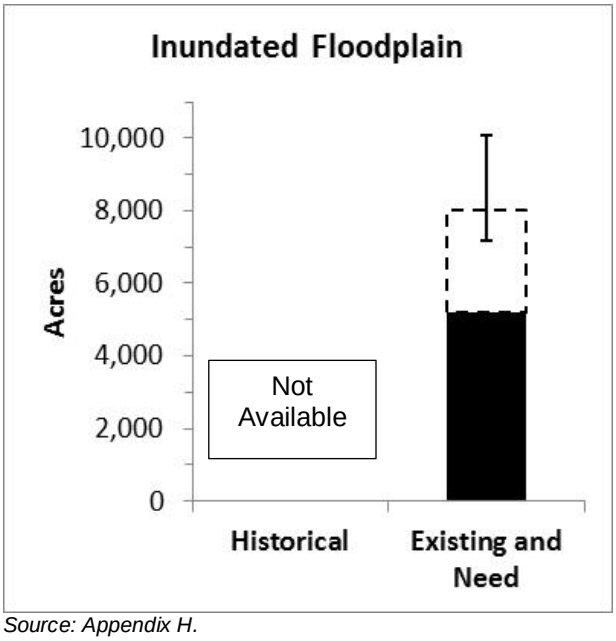
Interpretation of Conservation Plans

Supporting the reintroduction of salmon populations by the SJRRP likely would require a greater increase in floodplain inundation than required to sustain riparian habitat for least Bell's vireo. (For interpretation of least Bell's vireo needs see "Riparian Habitat.") It is not likely that conservation of Delta button-celery would require a greater increase in floodplain inundation.

The need for rearing habitat on inundated floodplains has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). This need has a moderate level of predictability.

The ESHE model was used to estimate amount of rearing habitat and inundated floodplain required to support salmon populations reintroduced by USBR (see SJRRP 2012). Amount of inundated floodplain is a product of both floodplain area and management of water flows. The estimate is for the planned flow regime being implemented through the SJRRP (SJRRP 2011).

Suitability of floodplains as rearing habitat is affected by other variables besides inundation, and consequently, only a fraction of the inundated area provides rearing habitat. This fraction can range from less than 10% to more than 25%. Assuming 17.5% suitability on average, an additional 2,800 acres of inundated floodplain would be needed to provide habitat required by reintroduced salmon.



Source: Appendix H.

Historical and Existing Inundated Floodplain Area and Amount Needed to Conserve Species

Notes: Acreages are for areas inundated for at least 14 days during December–May by a flood with a recurrence interval of 2 years or less. Only a small portion of the active floodplain along the San Joaquin River meets these criteria (shown in black). The dashed outline represents the additional area of floodplain needed to provide rearing habitat for the salmon populations being reintroduced by the SJRRP. This amount is based on floodplains providing rearing habitat of intermediate suitability (17.5%). The error bar denotes the range in needed floodplain area that corresponds to the range from low to high floodplain suitability as rearing habitat (10–25%). The range is large because suitability can have a several-fold effect on the number of fish supported per unit area. These data are results of the analysis presented in SJRRP 2012.

Lower San Joaquin River Conservation Planning Area

Lower San Joaquin River CPA
Box 1. Riparian Habitat

Summary of Conservation Need

8,800 additional acres of riparian habitat on the active floodplain may be needed to recover riparian brush rabbit, riparian woodrat, western yellow-billed cuckoo, and other target species. This amount is in part quantified in conservation plans, and in part is based on the interpretation below. There is a moderate level of uncertainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify riparian habitat needs for anadromous fish, VELB, riparian brush rabbit, riparian woodrat, yellow-billed cuckoo, and least Bell's vireo. Riparian vegetation increases the quality of inundated floodplain and nearshore habitats for fish, see "Riparian-Lined Bank" and "Inundated Floodplain." For the birds and mammals, riparian vegetation provides reproduction and foraging habitat, and for the mammals it also provides movement corridors (as described in Appendix G).

Specific identified actions include (1) restoring 1,900 and 2,500 acres of yellow-billed cuckoo habitat along the Stanislaus and Merced Rivers, respectively; (2) 5-year CVJV objectives for restoring 2,500 and 1,500 acres of riparian habitat in the San Joaquin and Delta Basins, respectively; and (3) restoring corridors of riparian habitat for riparian brush rabbit within its historical range (i.e., lower reaches of Tuolumne and Stanislaus Rivers, and San Joaquin River from the Tuolumne to the Delta).

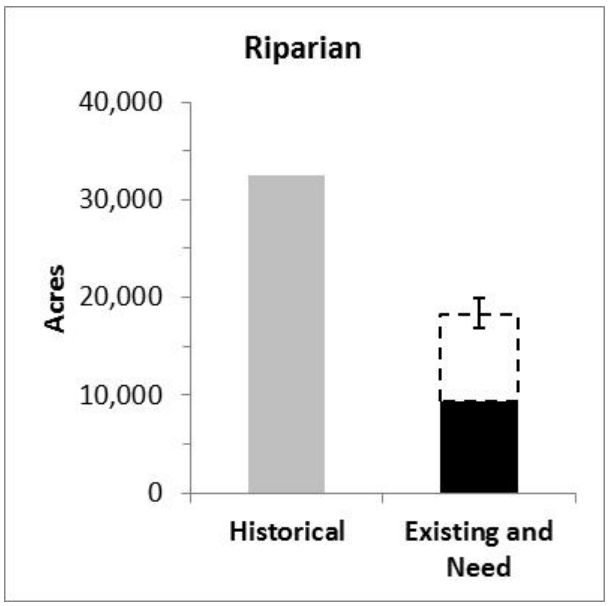
In addition, although not addressed by conservation plans, Swainson's hawk (riparian forest) and slough thistle (riparian scrub) also depend on riparian habitat.

Interpretation of Conservation Plans

The need for riparian habitat on active floodplain has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). However, this need is only moderately predictable, primarily because the size of habitat corridors needed by riparian brush rabbit and riparian woodrat is determined only generally, and this is the greatest need for additional riparian habitat.

5,000–6,600 acres of additional riparian habitat would be required to create 300- to 400-foot-wide corridors throughout the historical range of these mammals. Such corridors would occupy most of the active floodplain and historical meander zone and would contain the different habitat attributes required by each species (see Appendix G).

Habitat needed by western yellow-billed cuckoo along the Merced River (2,500 acres) is outside the historical range of the mammals; and thus, would be in addition to the amount required to provide continuous habitat corridors for the mammals. This need corresponds to 2,500–4,200 additional acres of restored riparian vegetation, assuming 60–100% of restored riparian vegetation would be suitable for yellow-billed cuckoo.



Sources: Appendix F; The Bay Institute 2003

Historical and Existing Riparian Habitat and Amount Needed to Conserve Species

Notes: The need for riparian vegetation consists of existing habitat (shown in black) and additional restoration (shown with a dashed outline) to provide 350-foot-wide corridors of habitat for riparian brush rabbit and riparian woodrat along the San Joaquin River from the junction with the Tuolumne to the Delta and along the lower reach of the Tuolumne and Stanislaus Rivers (based on existing amounts in Appendix F). The need also includes riparian vegetation restored along the Merced River to provide 2,500 acres of habitat for yellow-billed cuckoo (i.e., 80% suitability of restored vegetation assumed). The error bar spans the range from 300-foot-wide corridors and 100% of restored habitat suitable for yellow-billed cuckoo to 400-foot-wide corridors and 60% habitat suitability.

Lower San Joaquin River CPA
Box 2. Marsh and Other Wetland Habitat

Summary of Conservation Need

6,500 additional acres of marsh and other wetlands may be required to recover greater sandhill crane, California black rail, and other target species. This amount is based on a need quantified in a conservation plan. However, there is a low level of certainty regarding its size.

Conservation Plan Content

Conservation plans identify marsh and other wetland needs for anadromous fish, giant garter snake, California black rail, and greater sandhill crane.

Marsh and other wetlands can provide high inundated floodplain habitat for fish, a need that also may be met by other vegetation; fish needs are not discussed further here (for related fish needs, see “Inundated Floodplain”).

For giant garter snake, marsh provides foraging habitat, cover, hibernacula, and corridors for dispersal and other movements. For greater sandhill crane, marsh and other wetlands can provide foraging, loafing, and roosting habitat. For California black rail, marsh provides cover and habitat for foraging and reproduction.

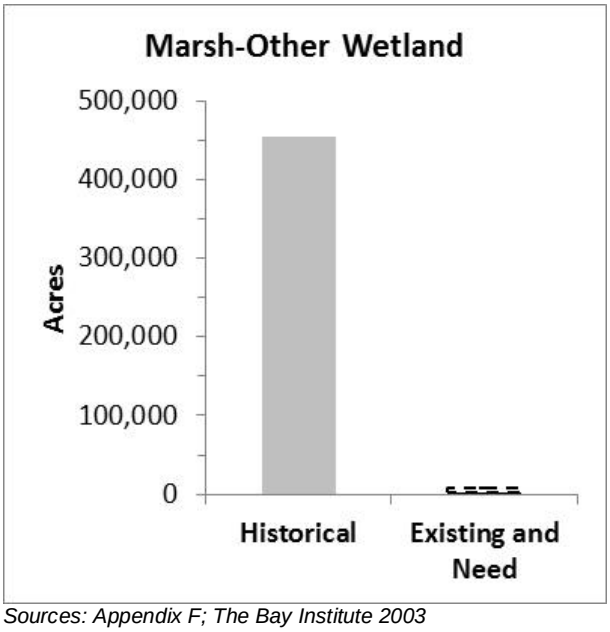
One specific action has been identified: restoring 3,000 and 42,000 acres of semi-permanent and seasonal wetlands, respectively, in the San Joaquin and Delta Basins combined. The revised draft recovery plan for giant garter snake specifies preservation of at least 5,121 acres of existing, enhanced, or preserved perennial wetlands in this CPA, in blocks 539 acres in size.

Although not addressed by conservation plans, Delta button-celery (seasonal wetland) and slough thistle (marsh) also may require restoration of wetland habitat.

Interpretation of Conservation Plans

The need for marsh and other wetland habitat is of high importance for these species. These species’ needs are moderately well understood (see Appendix G), except that slough thistle’s needs have only a low level of understanding because its presence and distribution in this CPA is only known from historical records. But, the overall need has a low level of predictability because of significant data gaps. In this CPA, the size and location of California black rail populations are not known, and the suitable portion of existing marsh is only imprecisely known. Similarly, for greater sandhill crane, the desired population size and locations where it would benefit from additional wetland have not been identified.

CVJV objectives were used as the basis for this need. These objectives are being reassessed in the context of habitat need and the restoration that has been achieved to date (Seavy pers. comm. 2014). Because this estimated need is based on short-term objectives, it may underestimate long-term conservation needs. These proxies for long-term CVJV objectives were scaled to the portion of the CVJV basins accounted for by this CPA.



Sources: Appendix F; The Bay Institute 2003

Historical and Existing Marsh Area and Amount Needed to Conserve Species

Notes: The need for marsh and other wetlands (outlined with a dashed line) consists of existing habitat (shown in black) and additional restoration to meet CVJV objectives. Because the plan area of the CVJV is much larger than the SPA, and wetland restoration opportunities are extensive both in and outside the SPA, the need shown here has been scaled to the portion of the CVJV basins that the SPA accounts for in this CPA. There is no error bar because the CVJV implementation plan specified the amount of restoration required.

Lower San Joaquin River CPA
Box 3. Riparian-Lined Bank
[Major Predictability Limitation]

Summary of Conservation Need

60 additional miles of riparian-lined bank may be required to recover target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding its size.

Conservation Plan Content

Anadromous fish conservation plans identify needs for riparian-lined bank, which is a component of SRA cover.

However, conservation plans have not quantified the need for additional riparian-lined bank.

Specific identified actions include: (1) increasing instream habitat complexity and cover in the Tuolumne and Stanislaus Rivers, including the addition of LWM; and (2) adding instream cover if determined to be lacking (based on available data and new analyses).

Conservation of other target species does not require riparian-lined bank.

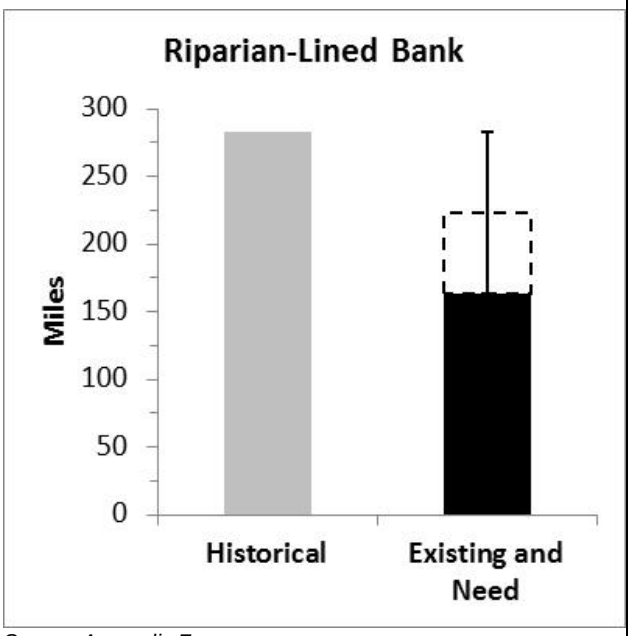
Interpretation of Conservation Plans

Riparian vegetation shades and adds woody material to the nearshore environment, which increases the quality of migration and rearing habitat, and provides refuge from predators. The need for the resulting high-quality nearshore habitat has high importance. It is based on a moderate level of understanding of the species' ecology: habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G). This need has a low level of predictability in part because it is strongly affected by changes to bank revetment and inundated floodplain, and by management of dying and fallen trees and instream woody material.

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in riparian-lined bank. Although this plan does not quantify this need, its size could entail woody vegetation along nearly all bank length.

Fish require suitable depth, velocity, and cover to be available throughout the river system at a fine scale (i.e., every few feet). These are provided only by a narrow zone along each bank, and riparian-lined banks may support the growth and survival of several times more fish than banks lacking woody plants (see SJRRP 2012).

Doubling salmonid populations (per the AFRP) could depend on at least doubling the ability of nearshore habitats to support fish, particularly without large increases in inundated floodplain. However, riparian-lined banks already account for 57% of bank length. Thus, substantial improvements to nearshore habitats would also require other related actions. Related actions include increasing the length of natural banks, increasing the area of the shallow nearshore environment, increasing the frequency and duration of floodplain inundation, and changing management to increase inputs and retention of woody material.



Source: Appendix F.

Historical and Existing Riparian-Lined Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical riparian-lined bank length. It is an overestimate. Existing bank length is shown in black. Additional needed bank (outlined with a dashed line) is the midpoint of existing and maximal values. The error bar spans this range, because the need is uncertain and may in part be met by other changes.

Lower San Joaquin River CPA
Box 4. Natural Bank

Summary of Conservation Need

13 additional miles of natural bank may be required to recover western yellow-billed cuckoo and other target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding its size.

Conservation Plan Content

Conservation plans identify river meander needs for anadromous fish, least Bell's vireo, and western yellow-billed cuckoo. Natural bank provides fish with migration and rearing habitat and refuge from predators. Natural bank also allows for channel migration, which sustains the diversity of riparian habitats and early successional habitats used by target bird species. Conservation of other target species does not depend on natural bank.

Specific identified actions include: (1) restoring side channels to increase river function and habitat diversity along the Merced, Tuolumne, and Stanislaus Rivers; and (2) restoring yellow-billed cuckoo habitat along the Stanislaus and Merced Rivers (1,900 and 2,500 acres, respectively).

Interpretation of Conservation Plans

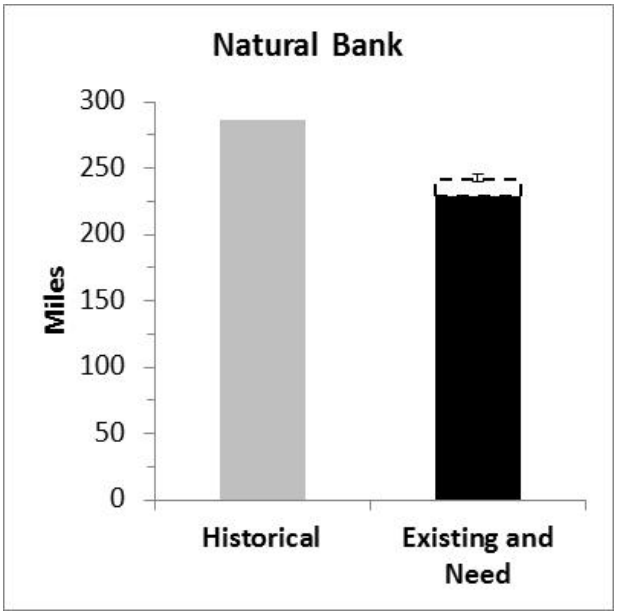
The need for natural banks and high-quality nearshore habitat dependent on natural banks has high importance. It is based on a high level of understanding of the ecology of target birds. For target fish, habitat requirements are well understood, but the relationship to predation and competition with nonnative species in nearshore environments is only moderately understood (see Appendix G).

In general, this need has a moderate level of predictability for target birds, and a low level of predictability for target fish. For the fish, predictability is low in part because it is strongly affected by management of channel bank vegetation and instream woody material (see "Riparian-Lined Bank"), and by inundation of floodplains. In this CPA, however, the inventory of revetment is incomplete, and thus the need for additional natural bank has a low level of predictability.

Because of its greater predictability, the overall need given here is for sustaining additional riparian habitat. (However, anadromous fish needs, though less predictable could be much larger.)

This overall need was calculated by dividing the acres of additional needed riparian habitat by the average acres of floodplain in the river meander zone per mile of bank, and then multiplying that result by the percentage of banks with revetment in this CPA (using information from Appendix F).

However, because the inventory of bank revetment is incomplete in this CPA, this calculated need for additional natural bank is an underestimate.



Source: Appendix F

Historical and Existing Natural Bank and Amount Needed to Conserve Species

Notes: Total bank length is used as a proxy for historical natural bank length. It is an underestimate because of channel simplification over time. Data for existing condition are incomplete; the maximum value is shown. The need for natural bank is the sum of the existing length (shown in black) and additional length (shown with a dashed outline) needed to sustain additional western yellow-billed cuckoo habitat. The need has been calculated by multiplying the area of additional riparian vegetation by the average percentage of floodplain with river meander constrained only by revetment or levees, and then dividing the product by the average acreage of meander potential per mile of bank.
The error bar spans the range of in restored riparian vegetation acreage potentially needed to meet yellow-billed cuckoo objectives. (Yellow-billed cuckoo riparian habitat needs are described under riparian habitat.)

Lower San Joaquin River CPA
Box 5. River Meander Potential

Summary of Conservation Need

4,300 additional acres of river meander potential may be needed to recover target species. This need is not quantified in conservation plans; the amount is based on the interpretation below. There is a low level of certainty regarding the size of this need.

Conservation Plan Content

Conservation plans identify river meander needs for anadromous fish, least Bell's vireo, and western yellow-billed cuckoo. River meander sustains nearshore environments for fish. River meander also sustains early successional riparian habitat for least Bell's vireo, and habitat diversity for western yellow-billed cuckoo. Target species not addressed by conservation plans do not require an increase in river meander.

Specific identified actions include: (1) restoring side channels to increase river function and habitat diversity along the Merced, Tuolumne, and Stanislaus Rivers; and (2) restoring western yellow-billed cuckoo habitat along the Stanislaus and Merced Rivers (1,900 and 2,500 acres, respectively).

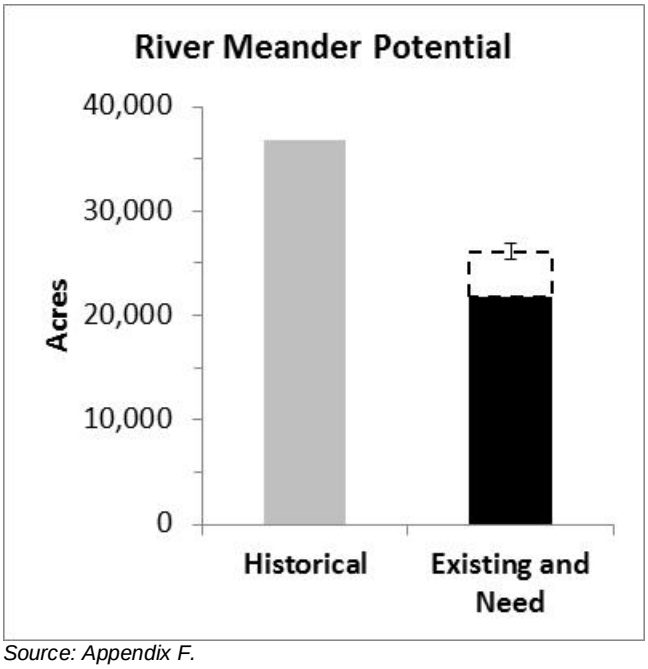
Interpretation of Conservation Plans

Increases in meander potential have high importance for sustaining the quality of nearshore habitat, natural bank, and early successional riparian habitat. The physical process of meander migration and how it sustains habitats is well understood.

The needs for additional riparian habitats and improved nearshore habitats have moderate and low levels of predictability, respectively. Also, inventory data for revetted bank (and thus meander potential) are incomplete in this CPA. Thus, the need for additional meander potential has a low level of predictability.

Because of its greater level of predictability, the overall need given here is for sustaining additional riparian habitat. (However, anadromous fish needs, which are less predictable, could be much larger.) The need has been calculated as the product of the area of additional riparian vegetation and the average percentage of floodplain with river meander constrained only by revetment or levees.

Because the inventory of bank revetment is incomplete in this CPA, this calculated need for additional meander migration is an underestimate.



Source: Appendix F.

Historical and Existing River Meander Potential and Amount Needed to Conserve Species

Notes: Historical meander potential is based on the area in the meander zone not constrained by geology (see Appendix F). Existing meander potential is the area in the meander zone not constrained by geology, revetment, or levees. Data for existing condition are incomplete; the maximum value is shown. The need (outlined with a dashed line) is the sum of the existing area and additional area to sustain additional riparian restored to meet western yellow-billed cuckoos habitat needs. This additional amount is the product of the additional acreage of riparian vegetation to be sustained and the portion of the meander zone constrained by revetment or levees. The additional amount of riparian vegetation is based on the assumption that 80% is suitable for yellow-billed cuckoo. The error bar spans the range from 60–100% of restored riparian vegetation being suitable for yellow-billed cuckoo. Because existing revetted bank data are incomplete, this is an underestimate of the need for additional meander potential.

Lower San Joaquin River CPA
Box 6. Inundated Floodplain

Summary of Conservation Need

Conservation of target species may require 25,700 additional acres of floodplain inundated by flows of a timing, duration, and frequency adequate for fish rearing. This need is not quantified in conservation plans; the amount is based on the interpretation below. The size of this need has a moderate level of certainty.

Conservation Plan Content

Conservation plans identify inundated floodplain needs for anadromous fish, least Bell's vireo, and western yellow-billed cuckoo. Fish needs are for providing migration/rearing habitat. Bird needs are for sustaining riparian habitat.

Specific identified actions include (1) Restoring 17,000–20,000 acres of floodplain in this and the Lower Sacramento River CPAs; (2) restoring floodplains to increase river function and habitat diversity along the Merced, Tuolumne, and Stanislaus Rivers; and (3) restoring western yellow-billed cuckoo habitat along the Stanislaus and Merced Rivers (1,900 and 2,500 acres, respectively).

Floodplain inundation also sustains habitat for Delta-button celery and slough thistle, which conservation plans do not address.

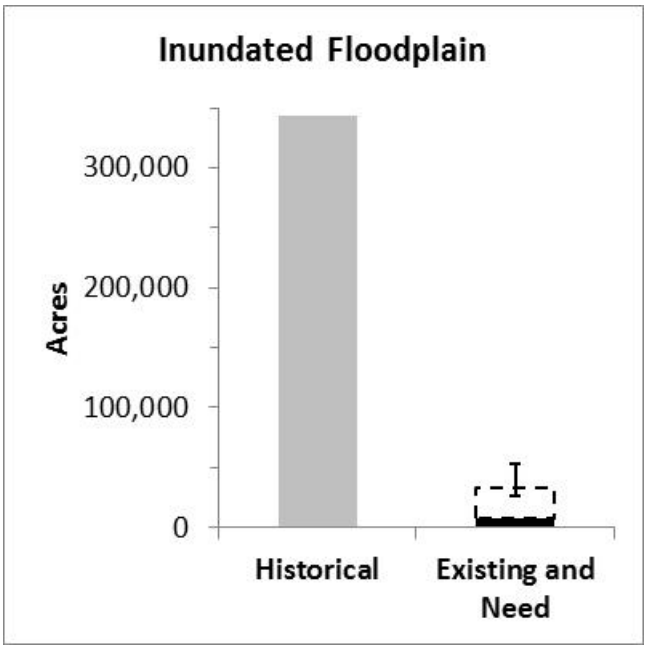
Interpretation of Conservation Plans

Supporting the AFRP doubling goal for salmonid populations would require the greatest increase in inundated floodplain; perhaps an order of magnitude more land than needed to meet the needs identified for target bird species.

The need for rearing habitat on inundated floodplains has high importance, and is based on a high level of understanding of the species' ecology (see Appendix G). This need has a moderate level of predictability; predictability is limited by variability in floodplain suitability as rearing habitat.

The ESHE model was used to estimate the amount of rearing habitat required to support the AFRP doubling goal under existing hydrology (Appendix H). Appendix H also provides an estimate of existing rearing habitat. Amount of inundated floodplain is a product of both floodplain area and water flows.

Suitability of floodplains as rearing habitat is affected by other variables besides inundation, and consequently, only a fraction of the inundated area provides rearing habitat. This fraction can range from less than 10% to more than 25%. Assuming 17.5% suitability on average, an additional 25,700 acres of inundated floodplain would be needed to provide habitat required for doubling salmonid populations under current hydrology.



Source: Appendix F.

Historical and Existing Floodplain Inundation and Amount Needed to Conserve Species

Notes: Acreages are for areas inundated for at least 14 days during December–May by a flood with a recurrence interval of 2 years or less. Only a small portion of the active floodplain along major river reaches meets these criteria. The need is the sum of the existing area (shown in black) and the additional area (shown by a dashed outline) needed to provide rearing habitat for the AFRP goal to double salmonid populations. This amount is based on floodplains providing rearing habitat of intermediate suitability (17.5%). The error bar denotes the range from low to high floodplain suitability as rearing habitat (10–25%). The range is large because suitability can have a several-fold effect on the number of fish supported per unit area. These data are results of the analysis presented in Appendix H, and the model used to generate these estimates is further described in SJRRP 2012.

The amount of habitat required to double salmonid populations is more than twice existing habitat because existing populations are supported by both natural production and fish hatcheries. Consequently, because existing habitat supports only a portion of the existing population, habitat for 100% more fish would require more than a 100% increase in habitat.

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L3. Potential Conservation Opportunities

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Table L3-1. Potential Conservation Opportunities in the Upper Sacramento River CPA

Target: Metric	BWFSs	FROA	Total	Notes
Ecosystem processes				
Floodplain inundation: major river reaches (acres)[1]	0–1,000	4,000–7,500	4,000–8,500	Includes all reconnected land, not all of which has frequent, sustained inundation
Floodplain inundation: bypasses/transient storage areas (acres)	9,600	—	9,600	Potentially inundated in 50% of years or more often.
Riverine geomorphic processes: natural bank (miles)[2]	0–5	17	17–22	Preliminary DWR evaluation has identified an additional 18 miles of potential opportunities.
Riverine geomorphic processes: river meander potential (acres)	0–900	3,600–6,700	3,600–7,600	Assumes all land reconnected to rivers is in meander zone, and that geologic constraints equal CPA mean.
Habitats				
SRA cover: natural bank (miles)[2]	0–5	17	17–22	Preliminary DWR evaluation has identified an additional 18 miles of potential opportunities.
SRA cover: riparian-lined bank (miles)	0–3	6	6–9	Preliminary DWR evaluation has identified an additional 12 miles of potential opportunities.
Riparian habitat (acres)[3]	0–500	2,000–4,200	2,000–4,700	With grassland/upland inclusions
Marsh-other wetland habitat (acres)[3]	2,400	—	2,400	With inclusions of upland vegetation.
Floodplain agriculture (acres)[4]	7,200–7,700	2,200–4,200	9,400–11,900	Includes all land in BWFS/FROA footprints not in or restored to natural vegetation.
Stressors				
Revetment (miles)	0 to -5	-17	-17 to -22	Preliminary DWR evaluation has identified an additional 18 miles of potential opportunities.
Levees (miles)	0 to -1	-4 to -5	-4 to -7[5]	Includes only levees bordering river reaches.

Sources: Appendix I, "Floodplain Restoration Opportunity Analysis"; DWR BWFS and preliminary revetment analysis, and NGO GIS data files.

Key: BWFS = Basin-Wide Feasibility Study; DWR = Department of Water Resources, FROA = Floodplain Restoration Opportunity Analysis, NGO = Non-governmental organization, SRA = shaded riverine aquatic.

Notes:

[1] Metric is for area inundated by 2-year, 14-day or longer flows during December–May; opportunity includes all reconnected land.

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

[3] Assumes 25% and 50% of bypass expansions and setback areas, respectively, are in or will be restored to natural vegetation (primarily marsh-other wetland in bypasses and primarily riparian along rivers).

[4] Area managed for targeted terrestrial wildlife species (i.e., Swainson's hawk, giant garter snake, greater sandhill crane).

[5] Total does not equal sum of BWFSs and FROA columns because of rounding.

Table L3-2. Potential Conservation Opportunities in the Feather River CPA

Target: Metric	BWFSs	FROA	Total	Notes
Ecosystem processes				
Floodplain inundation: major river reaches (acres)[1]	—	3,700	3,700	Includes all reconnected land, not all of which has frequent, sustained inundation
Floodplain inundation: bypasses/transient storage areas (acres)	—	—	—	Not applicable.
Riverine geomorphic processes: natural bank (miles)[2]	—	—	—	Preliminary DWR evaluation has identified 7 miles of potential opportunities.
Riverine geomorphic processes: river meander potential (acres)	—	2,600	2,600	Assumes all land reconnected to rivers is in meander zone, and that geologic constraints equal CPA mean.
Habitats				
SRA cover: natural bank (miles)[2]	—	—	—	Preliminary DWR evaluation has identified 7 miles of potential opportunities.
SRA cover: riparian-lined bank (miles)	—	—	—	Some additional opportunity noted in LFR CMP. Does not include opportunities to integrate woody vegetation into revetment
Riparian habitat (acres)[3]	—	1,800	1,800	With grassland/upland inclusions. LFR CMP identifies 717 acres of additional opportunities outside of FROA footprints
Marsh/other wetland habitat (acres)[3]	—	—	—	With grassland/upland inclusions. LFR CMP identifies 15 acres of opportunities to restore marsh outside of FROA footprints.
Floodplain agriculture (acres)[4]	—	1,800	1,800	Includes all land in BWFS/FROA footprints not in or restored to natural vegetation.
Stressors				
Revetment (miles)	—	0	0	Preliminary DWR evaluation has identified an additional 7 miles of potential opportunities.
Levees (miles)	—	-3	-3	Includes only levees bordering river reaches.

Sources: Appendix I, "Floodplain Restoration Opportunity Analysis"; DWR BWFS and preliminary revetment analysis and NGO GIS data files, DWR 2014.

Key: BWFS = Basin-Wide Feasibility Study, CMP = corridor management plan, CPA = corridor management plan, DWR = Department of Water Resources, FROA = Floodplain Restoration Opportunity Analysis, LFR = Lower Feather River, NGO = non-governmental organization, SRA = shaded riverine aquatic.

Notes:

[1] Metric is for area inundated by 2-year, 14-day or longer flows during December–May; opportunity includes all reconnected land.

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

[3] Assumes 25% and 50% of bypass expansions and setback areas, respectively, are in or will be restored to natural vegetation (primarily marsh-other wetland in bypasses and primarily riparian along rivers).

[4] Area managed for targeted terrestrial wildlife species (i.e., Swainson's hawk, giant garter snake, greater sandhill crane).

Table L3-3. Potential Conservation Opportunities in the Lower Sacramento River CPA

Target: Metric	BWFSs	FROA	Total	Notes
Ecosystem processes				
Floodplain inundation: major river reaches (acres)[1]	0–7,100	4,100	4,100–11,200	Includes all reconnected land, not all of which has frequent, sustained inundation
Floodplain inundation: bypasses/transient storage areas (acres)	1,100–13,900	—	1,100-13,900	Portions of bypass inundated in 50% of years or more often.
Riverine geomorphic processes: natural bank (miles)[2]	0–3	9	9–12	Preliminary DWR evaluation has identified an additional 2 miles of potential opportunities.
Riverine geomorphic processes: river meander potential (acres)	0–6,600	3,800	3,800–10,400	Assumes all land reconnected to rivers is in meander zone, and that geologic constraints equal CPA mean.
Habitats				
SRA cover: natural bank (miles)[2]	0–3	9	9–12	Preliminary DWR evaluation has identified an additional 2 miles of potential opportunities.
SRA cover: riparian-lined bank (miles)	0–1	2	2–3	Preliminary DWR evaluation has identified an additional 1 mile of potential opportunities. Does not include opportunities to integrate woody vegetation into revetment.
Riparian habitat (acres)[3]	0-3,500	2,100	2,100–5,600	With grassland/upland inclusions.
Marsh/other wetland habitat (acres)[3]	300–3,500	—	300–3,500	With grassland/upland inclusions.
Floodplain agriculture (acres)[4]	800–10,400	2,000	2,800–12,400	Includes all land in BWFS/FROA footprints not in or restored to natural vegetation.
Stressors				
Revetment (miles)	0 to -3	- 9	-9 to -12	Preliminary DWR evaluation has identified an additional 2 miles of potential opportunities.
Levees (miles)	0 to -6	-3	-3 to -9	Includes only levees bordering river reaches.

Sources: Appendix I, "Floodplain Restoration Opportunity Analysis"; DWR BWFS and preliminary revetment analysis, and NGO GIS data files.

Key: BWFS = Basin-Wide Feasibility Study; CPA = conservation planning area, DWR = Department of Water Resources, FROA = Floodplain Restoration Opportunity Analysis, NGO = non-governmental organization, SRA = shaded riverine aquatic.

Notes:

[1] Metric is for area inundated by 2-year, 14-day or longer flows during December–May; opportunity includes all reconnected land.

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

[3] Assumes 25% and 50% of bypass expansions and setback areas, respectively, are in or will be restored to natural vegetation (primarily marsh-other wetland in bypasses and primarily riparian along rivers).

[4] Area managed for targeted terrestrial wildlife species (i.e., Swainson's hawk, giant garter snake, greater sandhill crane).

Table L3-4. Potential Conservation Opportunities in the Upper San Joaquin River CPA

Target: Metric	BWFSs	FROA	Total	Notes
Ecosystem processes				
Floodplain inundation: major river reaches (acres)[1]	300–900	4,000	4,300–4,900	Includes all reconnected land, not all of which has frequent, sustained inundation. Additional 788 acres in NGO-identified footprints.
Floodplain inundation: bypasses/transient storage areas (acres)	—	—	—	Not necessarily inundated in 50% of years or more often. Additional 2,136 acres in NGO-identified footprints.
Riverine geomorphic processes: natural bank (miles)[2]	2	6	8	Opportunities outside of BWFS/FROA footprints have not been evaluated by DWR.
Riverine geomorphic processes: river meander potential (acres)	200–800	3,500	3,700–4,300	Assumes all land reconnected to rivers is in meander zone, and that geologic constraints equal CPA mean.
Habitats				
SRA cover: natural bank (miles)[2]	2	6	8	Opportunities outside of BWFS/FROA footprints have not been evaluated by DWR.
SRA cover: riparian-lined bank (miles)	1	1	2	Assumes 20% of existing revetted bank riparian-lined (CPA average). Opportunities outside of BWFS/FROA footprints have not been evaluated by DWR. Does not include opportunities to integrate woody vegetation into revetment
Riparian habitat (acres)[3]	100–400	2,000	2,100– 2,400	With grassland/upland inclusions. Additional potential for 394 acres in NGO-identified footprints.
Marsh/other wetland habitat (acres)[3]	—	—	—	With grassland/upland inclusions. Additional potential for 534 acres in NGO-identified footprints.
Floodplain agriculture[4] (acres)	200–500	2,000	2,200–2,300	Includes all land in BWFS/FROA footprints not in or restored to natural vegetation. Additional potential for 1,996 acres in NGO-identified footprints.
Stressors				
Revetment (miles)	-2	-6	-8	Opportunities outside of BWFS/FROA footprints have not been evaluated by DWR
Levees (miles)	-4 to - 7	-10	-14 to -17	Includes only levees bordering river reaches.

Sources: Appendix I, "Floodplain Restoration Opportunity Analysis"; DWR BWFS and preliminary revetment analysis, and NGO GIS data files.

Key: BWFS = Basin-Wide Feasibility Study; CPA = conservation planning area, DWR = Department of Water Resources, FROA = Floodplain Restoration Opportunity Analysis, NGO = non-governmental organization, SRA = shaded riverine aquatic.

Notes:

[1] Metric is for area inundated by 2-year, 14-day or longer flows during December–May; opportunity includes all reconnected land.

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

[3] Assumes 25% and 50% of bypass expansions and setback areas, respectively, are in or will be restored to natural vegetation (primarily marsh-other wetland in bypasses and primarily riparian along rivers).

[4] Area managed for targeted terrestrial wildlife species (i.e., Swainson's hawk, giant garter snake, greater sandhill crane).

Table L3-5. Potential Conservation Opportunities in the Lower San Joaquin River CPA

Target: Metric	BWFSs	FROA	Total	Notes
Ecosystem processes				
Floodplain inundation: major river reaches (acres)[1]	5,600	6,000	11,600	Includes all reconnected land, not all of which has frequent, sustained inundation
Floodplain inundation: bypasses/transient storage areas (acres)	200	—	200	Not necessarily inundated in 50% of years or more often. Additional 3,811 acres in NGO footprint for expanded Paradise Cut.
Riverine geomorphic processes: natural bank[2] (miles)[2]	2–4	10	12–14	Preliminary DWR evaluation has identified an additional 8 miles of potential opportunities.
Riverine geomorphic processes: river meander potential (acres)	4,900	5,300	10,200	Assumes all land reconnected to rivers is in meander zone, and that geologic constraints equal CPA mean.
Habitats				
SRA cover: natural bank (miles)[2]	2–4	10	12–14	Preliminary DWR evaluation has identified an additional 9 miles of potential opportunities.
SRA cover: riparian-lined bank (miles)	2	4	6	Preliminary DWR evaluation has identified an additional 4 miles of potential opportunities. Does not include opportunities to integrate woody vegetation into revetment
Riparian habitat (acres)[3]	2,800	3,000	5,800	With grassland/upland inclusions
Marsh/other wetland habitat (acres)[3]	100	0	100	Additional potential for 952 acres in NGO footprint for expanded Paradise Cut. Includes grassland/upland inclusions
Floodplain agriculture (acres)[4]	2,900	3,000	5,900	Includes all land in BWFS/FROA footprints not in or restored to natural vegetation. Additional potential for 2,858 acres in NGO footprint for expanded Paradise Cut.
Stressors				
Revetment (miles)	-4	-10	-14	Preliminary DWR evaluation has identified an additional 9 miles of potential opportunities.
Levees (miles)	-15 to -18	-10	-24[5] to - 28	Includes only levees bordering river reaches. Potential for 2.3 miles associated with NGO footprint for expanded Paradise Cut.

Sources: Appendix I, "Floodplain Restoration Opportunity Analysis"; DWR BWFS and preliminary revetment analysis, and NGO GIS data files.

Key: BWFS = Basin-Wide Feasibility Study; DWR = Department of Water Resources, FROA = Floodplain Restoration Opportunity Analysis, NGO = non-governmental organization, SRA = shaded riverine aquatic.

Notes:

[1] Metric is for area inundated by 2-year, 14-day or longer flows during December–May; opportunity includes all reconnected land.

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

[3] Assumes 25% and 50% of bypass expansions and setback areas, respectively, are in or will be restored to natural vegetation (primarily marsh-other wetland in bypasses and primarily riparian along rivers).

[4] Area managed for targeted terrestrial wildlife species (i.e., Swainson's hawk, giant garter snake, greater sandhill crane).

[5] Total does not equal sum of BWFSs and FROA columns because of rounding.

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