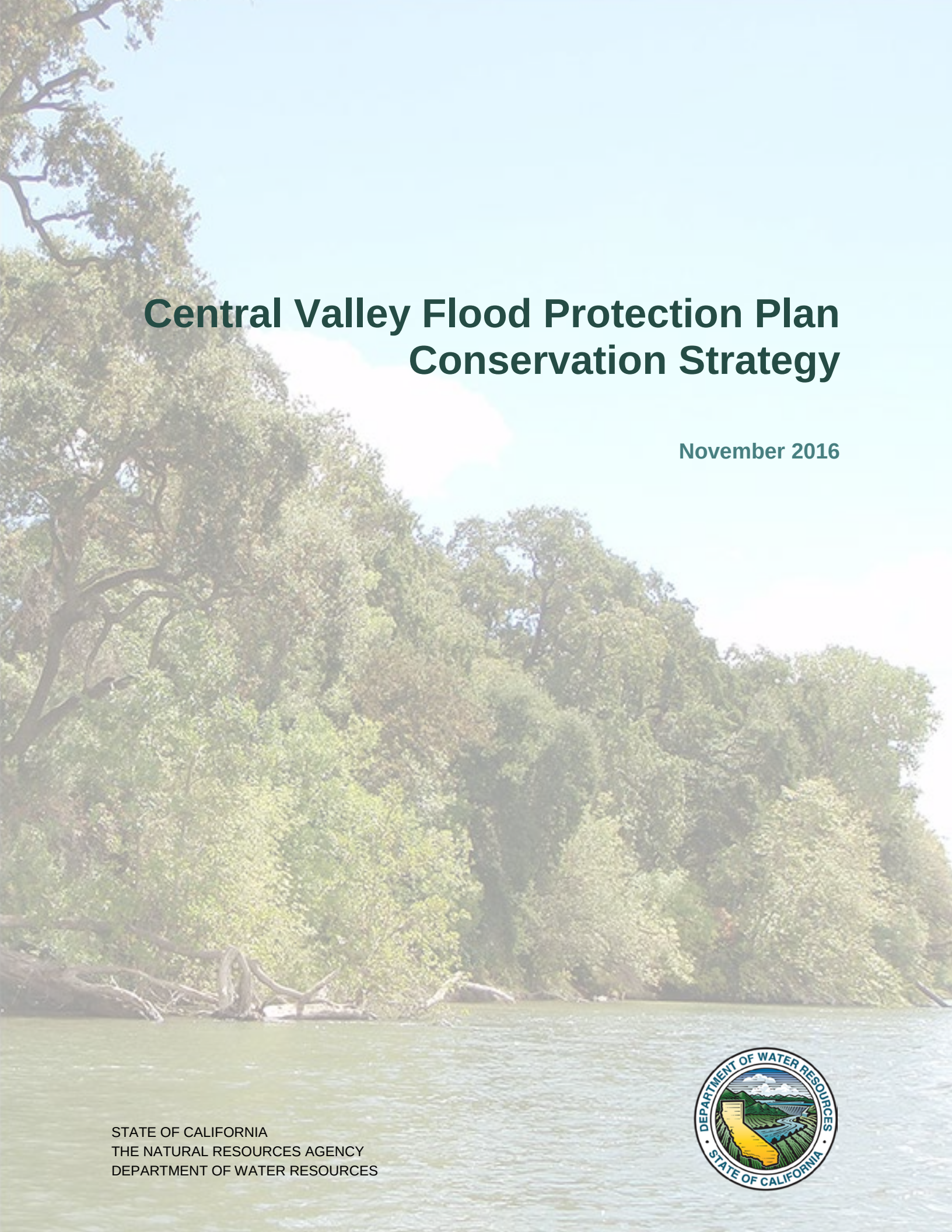


Central Valley Flood Protection Plan Conservation Strategy

November 2016

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

This page left blank intentionally.

Table of Contents

Preface vii

1.0 Introduction 1-1
1.1 Purpose and Scope 1-2
1.2 Geographic Scope 1-4
1.2.1 The Systemwide Planning Area 1-4
1.2.2 Conservation Planning Areas 1-4
1.3 Conservation Strategy Development 1-6
1.4 Document Organization 1-9

2.0 Need for Improved Conservation of Rivers and Floodplains 2-1

3.0 Guiding Principles and Goals 3-1
3.1 Guiding Principles 3-1
3.2 Goals 3-2
3.2.1 CVFPP Primary and Secondary Goals 3-2
3.2.2 Conservation Strategy Goals 3-2
3.2.3 Potential Contributions to the CVFPP's Primary and Supporting Goals 3-3

4.0 Targeted Processes, Habitats, Species, and Stressors 4-1
4.1 Targeted Processes and Habitats 4-2
4.1.1 Targeted Ecosystem Processes 4-2
4.1.2 Targeted Habitats 4-4
4.2 Targeted Species 4-7
4.3 Targeted Stressors 4-10
4.3.1 Revetment and Levees 4-10
4.3.2 Fish Passage Barriers 4-14
4.3.3 Invasive Plants 4-15

5.0 Ecological Objectives 5-1
5.1 Basis of Objectives 5-2
5.1.1 Metrics for Ecological Objectives 5-2
5.1.2 Enhancement Amounts for Ecological Objectives 5-4
5.2 Regional Conditions, Needs, and Objectives 5-6
5.2.1 Upper Sacramento River CPA 5-9
5.2.2 Feather River CPA 5-17

5.2.3 Lower Sacramento River CPA 5-23
5.2.4 Upper San Joaquin River CPA 5-32
5-40
5.2.5 Lower San Joaquin River CPA 5-40

6.0 Integrated Flood Risk Management and Conservation Approaches 6-1
6.1 Integrated Projects and O&M 6-1
6.1.1 Habitat Restoration Actions 6-1
6.1.2 Integrating Restoration with Flood Risk Management Actions 6-3
6.2 Vegetation Management 6-17
6.2.1 Levee Vegetation Management 6-18
6.2.2 Channel Vegetation Management 6-19
6.2.3 Invasive Plant Management 6-19
6.3 Agricultural Land Stewardship 6-20
6.3.1 Safe Harbor Agreements and Voluntary Local Programs 6-23
6.3.2 Wildlife-Friendly Agricultural Practices 6-24

7.0 Regulatory Compliance and Regional Permitting 7-1
7.1 Routine Maintenance Agreements 7-3
7.2 Small Erosion Repair Program 7-3
7.3 System-Wide Improvement Frameworks 7-4
7.4 Advance Mitigation 7-4
7.5 Regional Permitting Programs 7-5
7.5.1 Regional Permitting Program Approach and Implementation 7-8
7.5.2 Near-Term Tracking of Conservation Efforts and Mitigation Credits 7-10
7.5.3 Relationship of This Conservation Strategy to Regional Permitting Programs 7-11
7.6 Primary Laws and Regulations Addressed by Regional Permitting Programs 7-11
7.6.1 Federal and California Endangered Species Acts 7-11
7.6.2 Clean Water Act Section 404 and Rivers and Harbors Act Section 10 7-14
7.6.3 Rivers and Harbors Act Section 14 (Section 408) 7-15
7.6.4 National Historic Preservation Act Section 106 7-16
7.6.5 Clean Water Act Section 401 7-17
7.6.6 California Fish and Game Code Section 1600 7-17

8.0 Implementation 8-1
8.1 Adaptive Management 8-1
8.1.1 Adaptive Management Process 8-2
8.1.2 Monitoring 8-4
8.1.3 Informing Management through Focused Studies 8-7
8.1.4 Implementation Tracking and Data Dissemination 8-9
8.1.5 Evaluation Guidance 8-12
8.1.6 Reporting 8-13
8.2 Funding Approach 8-13
8.3 Coordination and Collaboration to Integrate Conservation into Flood Management 8-15
8.3.1 Partners in Flood Management and Conservation 8-15
8.3.2 Coordination and Collaboration in CVFPP Refinement 8-18
8.3.3 Coordination and Collaboration with Ongoing Programs 8-19
8.3.4 Coordination and Collaboration with Other Regional Conservation Planning Efforts 8-21
8.4 Outreach and Engagement 8-22

9.0 References 9-1

10.0 Acronyms and Other Abbreviations 10-1

11.0 Glossary 11-1

12.0 Species Names 12-1

13.0 Preparers 13-1

Appendices[1]

Appendix A. Regulatory Setting
Appendix B. Advance Mitigation
Appendix C. Description of Construction Activities for Structural Modifications
Appendix D. Vegetation Management Strategy
Appendix E. Invasive Plant Management Plan
Appendix F. Existing Conditions

[1] The Conservation Strategy appendices were published in July and are available on the California Department of Water Resources' website: http://www.water.ca.gov/conservationstrategy/cs_appendices.cfm.

Appendix G. Identification of Target Species and Focused Conservation Plans

Appendix H. Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal

Appendix I. Floodplain Restoration Opportunity Analysis

Appendix J. Existing Conservation Objectives from Other Plans

Appendix K. Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System

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

List of Tables

Table 3-1. Potential Contributions of Conservation Strategy to the Attainment of CVFPP Goals 3-4

Table 4-1. Ecological Goals and Targeted Ecosystem Processes, Habitats, Species, and Stressors 4-1

Table 4-2. Targeted Species 4-8

Table 5-1. Metrics for Ecosystem Process, Habitat, and Stressor Objectives 5-3

Table 5-2. Existing Conditions along Major River Reaches in the Upper Sacramento River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors 5-11

Table 5-3. Conservation Needs, Potential Opportunities, and Objectives in the Upper Sacramento River Conservation Planning Area 5-15

Table 5-4. Summary of Specificity Added to Upper Sacramento River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery 5-16

Table 5-5. Existing Conditions along Major River Reaches in the Feather River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors 5-18

Table 5-6. Conservation Needs, Potential Opportunities, and Objectives in the Feather River Conservation Planning Area 5-21

Table 5-7. Summary of Specificity Added to Feather River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery 5-22

Table 5-8. Existing Conditions along Major River Reaches in the Lower Sacramento River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors 5-26

Table 5-9. Conservation Needs, Potential Opportunities, and Objectives in the Lower Sacramento River Conservation Planning Area 5-30

Table 5-10. Summary of Specificity Added to Lower Sacramento River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery 5-31
Table 5-11. Existing Conditions along Major River Reaches in the Upper San Joaquin River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors..... 5-35
Table 5-12. Conservation Needs, Potential Opportunities, and Objectives in the Upper San Joaquin River Conservation Planning Area 5-38
Table 5-13. Summary of Specificity Added to Upper San Joaquin River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery 5-39
Table 5-14. Existing Conditions along Major River Reaches in the Lower San Joaquin River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors..... 5-43
Table 5-15. Conservation Needs, Potential Opportunities, and Objectives in the Lower San Joaquin River Conservation Planning Area 5-46
Table 5-16. Summary of Specificity Added to Lower San Joaquin River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery 5-47
Table 6-1. Management Actions Contributing to Attainment of Objectives and Benefitting Target Species through Integration of Restoration and Ecosystem Enhancement 6-4
Table 7-1. Laws to Be Addressed and Types of Regulatory Approvals Being Pursued through the Feather River Regional Permitting Program..... 7-6
Table 8-1. Ecological Goals, Targets, Metrics, and Basis of Regional and Systemwide Tracking 8-5
Table 8-2. Data Gaps Related to Existing Conditions for Ecological Objectives and Target Species 8-8

List of Figures

Figure 1-1. Conservation Planning Areas of the Conservation Strategy 1-5
Figure 1-2. Timeline and Major Components of the 2012–2017 Update of the Central Valley Flood Protection Plan 1-7
Figure 2-1. Historical and Existing Distribution of California Central Valley Steelhead in the Sacramento and San Joaquin Valleys 2-2
Figure 2-2. Historical and Existing Chinook Salmon Rearing Habitat..... 2-3
Figure 2-3. Historical and Existing Distribution of Riparian and Wetland Vegetation in the SPA 2-5

Figure 2-4a. Representative Photograph of Remnant Riparian Habitat along the Sacramento River (at River Mile 71) 2-6
Figure 2-4b. Representative Photograph of Riparian Habitat and Remnant Floodplain along the Feather River (at River Mile 21) 2-6
Figure 2-5. General Relationships of Human Influences and the Riverine-Floodplain Ecosystems 2-8
Figure 3-1. CVFPP and Conservation Strategy Goals 3-2
Figure 4-1. Levee Locations in the Systemwide Planning Area 4-11
Figure 4-2. Revetment Associated with the State Plan of Flood Control 4-12
Figure 4-3. Documented Fish Passage Barriers 4-16
Figure 5-1. Landscape Units of the Conservation Planning Areas 5-8
Figure 5-2. Upper Sacramento River and Feather River Conservation Planning Areas 5-10
Figure 5-3. Lower Sacramento River Conservation Planning Area 5-24
Figure 5-4. Upper San Joaquin River Conservation Planning Area 5-33
Figure 5-5. Lower San Joaquin River Conservation Planning Area 5-41
Figure 7-1. Boundaries of the Feather River Regional Permitting Program 7-7
Figure 8-1. Adaptive Management Process 8-2
Figure 8-2. Conceptual Depiction of Data Organization in Tracking System 8-10

Preface

Since the 1850s, approximately 95 percent of historical wetlands and riparian habitats in the Central Valley have been eliminated, and more than 90 percent of historical native anadromous fish-rearing habitat has been lost. Because Central Valley rivers and floodplains provide critical remnant riparian and floodplain habitats and ecosystems for numerous sensitive fish and wildlife species, protecting and improving these habitats and their underlying ecosystem functions are essential parts of the Central Valley Flood Protection Plan (CVFPP).

The CVFPP recognizes that flood risks, water supplies, and the functioning of ecosystems are linked, with actions in one area affecting the other areas. This Conservation Strategy (Strategy) is a primary component of the CVFPP and was prepared in accordance with the requirements of the Central Valley Flood Protection Act of 2008. It contributes to the attainment of all CVFPP goals but focuses on the improvement of ecosystem functions through the integration of ecological restoration with flood risk reduction and management projects. Based on the best available science, this Strategy describes the basis for recommending various conservation actions and setting long-term objectives for the Central Valley flood management system as a whole.

Consistent with the purpose of the CVFPP, this Strategy is a planning document. It will be updated every 5 years based on new information, science, research, and policy to support future CVFPP updates. It does not establish any new performance obligations with regard to attaining ecological restoration objectives or specify any permit conditions or requirements. Like other CVFPP-supporting documents, this draft Strategy will be finalized after completion of the California Environmental Quality Act documents and public process for the 2017 CVFPP update and action by the Central Valley Flood Protection Board.

This Strategy is intended to be implemented over the life of the CVFPP through actions by the California Department of Water Resources and its partners in flood management and conservation in the Sacramento and San Joaquin Valleys. These partners include federal and State agencies, Local Maintaining Agencies, local communities, and nongovernmental organizations.

We would like to thank our partners and the public for providing comments on the Strategy, and we look forward to receiving additional input from you on the 2017 CVFPP update and future updates of the Conservation Strategy and CVFPP.

This page left blank intentionally.

1.0 Introduction

In the Central Valley of California, flood risks, water supplies, and the functioning of ecosystems are linked, with actions in one area affecting the other areas. The majority of flows that pass through the State Plan of Flood Control (SPFC) are regulated by reservoirs operated for flood management, water supply, water quality, power generation, wildlife and fisheries habitat, and recreation. Similarly, the system of river and bypass channels, levees, and water control structures in the Central Valley does more than just contain floodwaters that previously flooded the valley floor for months at a time. It supports agricultural uses in the bypasses, serves as valued recreational areas and open space, helps in the management of surface water supplies and management of groundwater and water quality, and provides critical remnant riparian and floodplain habitats for numerous fish and wildlife species.

The Central Valley Flood Protection Plan (CVFPP) recognizes these interconnections in its approach to flood management. The CVFPP is a long-term planning document that provides a framework for prioritization of investments in the SPFC. It seeks to improve flood risk management (the primary goal), as well as improve operations and maintenance (O&M), promote ecosystem functions, improve institutional support, and promote multi-benefit projects where feasible (supporting goals) (California Department of Water Resources [DWR] 2012a).

This Conservation Strategy (or Strategy) is an integral part of the CVFPP. It supports the attainment of all CVFPP goals, but focuses on the improvement of ecosystem functions through the integration of ecological restoration with flood risk reduction projects where feasible. This Conservation Strategy, including Appendices A–L, describes the basis for recommending various conservation actions and setting long-term objectives for the Central Valley flood management system as a whole. The integration of specific environmental restoration features with DWR's proposed flood management system improvements is summarized in Chapters 2 and 3 of the CVFPP and will also be described further in the 2017 CVFPP update and supporting documents, such as the Sacramento River Basin-Wide Feasibility Study (BWFS) and the San Joaquin River BWFS.

The Conservation Strategy and CVFPP as a whole would contribute to achieving the California Water Action Plan's overarching goals of reliability, restoration, and resilience (California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency 2015, 2016). In particular, this Strategy and the CVFPP as a whole are integral to three of the 10 "key actions" identified in the California Water Action Plan:

- Increase flood protection.
- Protect and restore important ecosystems.
- Increase operational and regulatory efficiency.

This introductory section states the Conservation Strategy's purpose and describes its geographic scope and development. It also describes the content of each section of this document.

1.1 Purpose and Scope

The purpose of this Conservation Strategy is to provide:

- a comprehensive, long-term, nonregulatory approach for improving riverine and floodplain ecosystems through multi-benefit projects that provide ecological benefits while protecting public safety;
- a regional programmatic framework for increasing the predictability and cost-effectiveness of permitting, while resulting in more effective and less costly conservation outcomes; and
- contextual information and tools for use in planning and permitting processes.

More specifically, this Strategy:

- discusses the importance of incorporating environmental improvements into flood risk management activities;
- provides goals and measurable objectives for monitoring and evaluating progress in implementing conservation in conjunction with investments in flood reduction actions;
- describes approaches for integrating ecosystem restoration into multi-benefit flood risk management projects and for fostering agricultural stewardship;
- provides a strategic approach for DWR and other agencies (federal, State, and local) to achieve permitting efficiencies for capital improvements and system maintenance in conjunction with ecosystem improvements and provides foundational scientific, institutional, and regulatory information needed to implement such an approach;
- recommends an implementation approach that could attract greater cost sharing because of the broader range of benefits it yields; and
- proposes an adaptive management approach that relies on ongoing monitoring and evaluation to adapt plans, designs, construction, and O&M to achieve the goals and objectives of the CVFPP.

This Conservation Strategy is intended to be implemented through actions by DWR and its partners in flood management and conservation in the Sacramento and San Joaquin Valleys. These partners include federal and State agencies, Local Maintaining Agencies (LMAs), local communities, and nongovernmental organizations.

This Strategy applies DWR's Environmental Stewardship Policy to the SPFC. Environmental stewardship embodies responsibly managing and protecting natural resources (water, air, land, plants, and animals) and ecosystems in a sustainable manner. DWR's Environmental Stewardship Policy, formally adopted in September 2010, applies to water and flood risk management projects and activities throughout DWR's jurisdiction (DWR 2010a). This policy specifies that DWR will incorporate ecosystem restoration as an objective into water and flood management projects, including partnering with the restoration efforts of others, to achieve net environmental benefit. The intent of the policy is to produce environmental benefits at a scale that can provide long-term sustainability from economic, social, and environmental perspectives.

Consistent with the purpose of the CVFPP as a whole, this Conservation Strategy is a planning document; as such, it does not establish any new performance or regulatory obligations for DWR or other LMAs within the SPFC areas of responsibility with regard to attaining ecological restoration objectives. All proposed actions are subject to feasibility constraints, such as available funding, statutory authority, policy constraints, cost-effectiveness, and acceptability. The proposed framework of measurable objectives is intended to begin the process of developing a scientifically supportable and stable framework for evaluating progress over time rather than setting absolute performance criteria for DWR to meet. Thus, this Conservation Strategy does not impose a new regulatory framework on DWR, nor does DWR have the authority to impose such a framework on LMAs.

It is DWR's intent to integrate environmental restoration actions with flood system O&M and capital improvements in a manner that increases the resilience of the flood management system and supports the State's efforts to adapt to climate change.

Within this context, environmental restoration actions will be an important element of the proposed strategies for improving flood system permitting efficiencies. However, the Conservation Strategy was crafted with an understanding of the evolving regulatory framework, which at times imposes conflicting mandates on DWR and other agencies with responsibility for flood system O&M and capital improvements. Foremost among these conflicting mandates are the federal flood system maintenance criteria codified in 33 Code of Federal Regulations (CFR) 208.10, which require rigorous maintenance of flood system integrity and capacity, and the host of environmental protection laws enacted mostly after the State accepted responsibility for maintenance of federal project features. In some cases, it is not possible to comply with both federal project maintenance and environmental protection imperatives. Consistent with and anticipating the resolution of conflicts among mandates, this Conservation Strategy seeks to encourage restoration consistent with required flood system O&M as a primary objective.

Finally, this Conservation Strategy reaffirms the CVFPP's recognition of the benefits that agriculture provides to ecosystems and flood management. In the Central Valley, agriculture is a dominant land use and represents a vital component of the economy. Agriculture can be compatible with flood system O&M and reduce the need for some types of maintenance. It also provides habitat for some species, including some that are targets of this Strategy. Recognizing these important benefits of agriculture, this Strategy will be implemented in a manner that considers achieving its objectives on working agricultural lands where feasible.

1.2 Geographic Scope

1.2.1 The Systemwide Planning Area

Consistent with the CVFPP, the geographic scope of this Conservation Strategy encompasses the Systemwide Planning Area (SPA), which consists of lands currently receiving protection from the SPFC and additional areas where management actions may be implemented as part of the CVFPP (DWR 2012b). The SPFC is a portion of the Central Valley flood management system for which the State has certain responsibilities, as defined in the California Water Code (Section 9110[f]):

> …the state and federal flood control works, lands, programs, plans, policies, conditions, and mode of maintenance and operations of the Sacramento River Flood Control Project described in Section 8350, and of flood control projects in the Sacramento River and San Joaquin River watersheds authorized pursuant to Article 2 (commencing with Section 12648) of Chapter 2 of Part 6 of Division 6 for which the board or the department has provided the assurances of nonfederal cooperation to the United States, and those facilities identified in Section 8361.

The SPFC was constructed incrementally as a series of projects beginning with the Sacramento River Flood Control Project, which was originally authorized in 1917 and which accounts for the majority of facilities that make up the SPFC. In the Sacramento and San Joaquin Valleys, the SPFC includes approximately 1,600 miles of levees and associated bank protection, drainage facilities, channels, bypasses, sediment basins, weirs and control structures, environmental mitigation areas, a dam, and seven pumping plants. It spans approximately 18,000 parcels on which the Sacramento-San Joaquin Drainage District, acting by and through the Central Valley Flood Protection Board (CVFPB), primarily has fee title, easements, or land use agreements and is maintained by 81 LMAs (DWR 2010b). The SPFC is described in detail in the *State Plan of Flood Control Descriptive Document* (DWR 2010b).

1.2.2 Conservation Planning Areas

For the purposes of this Strategy, the SPA has been divided into five regional areas (Figure 1-1) that differ in regard to flood risk management and conservation needs and opportunities. To be consistent with regional flood management plan (RFMP) efforts (i.e., development of RFMPs consistent with the CVFPP), each of these five areas consists of one or more RFMP regions and the adjoining upstream portions of the SPA (e.g., reservoirs and foothills tributaries):

- The Upper Sacramento River Conservation Planning Area (CPA) includes the Sacramento River and tributaries from Red Bluff to the Fremont Weir (Upper and Mid–Sacramento River CVFPP RFMP regions).

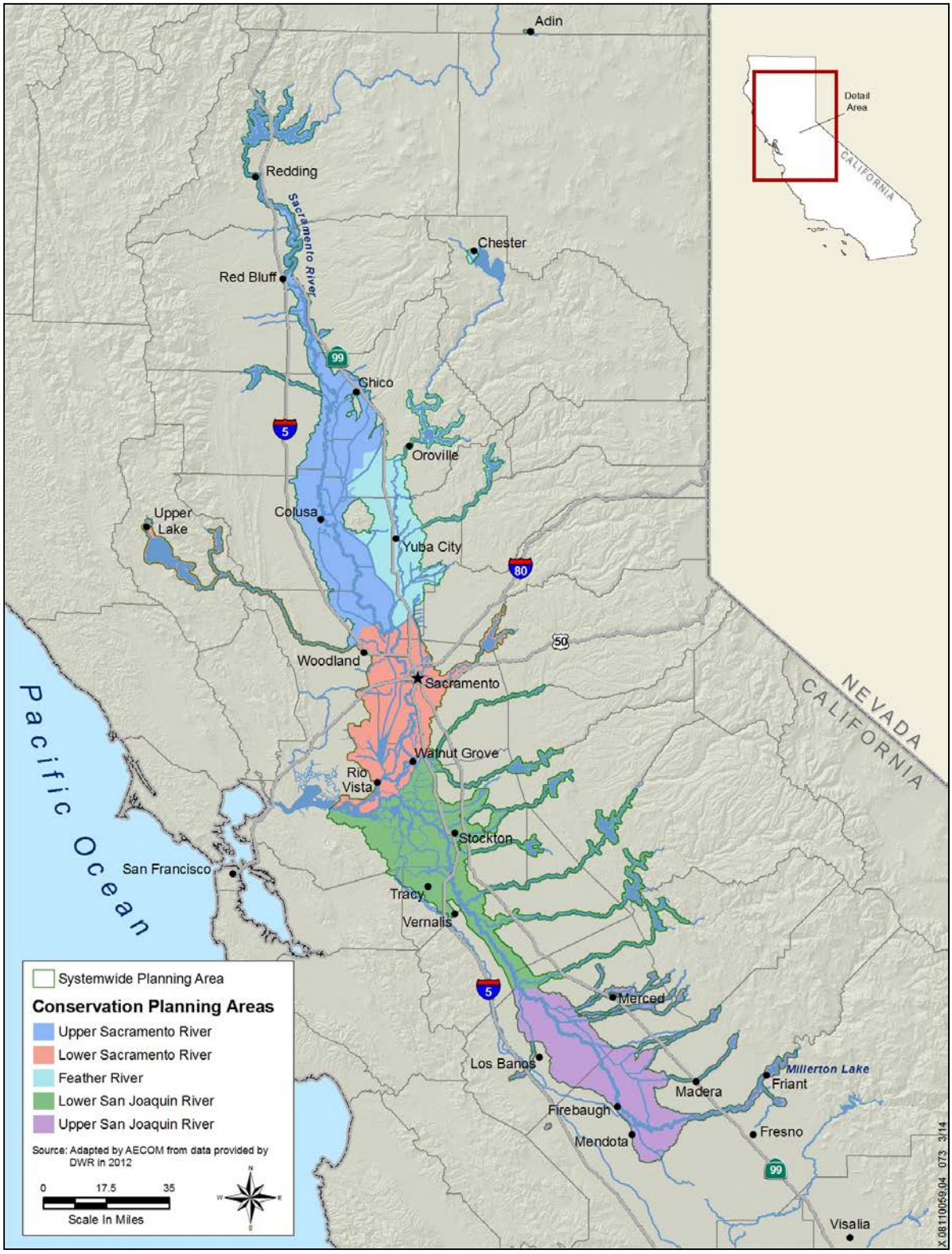


Figure 1-1. Conservation Planning Areas of the Conservation Strategy

- The Feather River CPA includes the Feather River, as well as the Yuba and Bear Rivers and other tributaries (Feather River CVFPP RFMP region).
- The Lower Sacramento River CPA includes the Sacramento River and tributaries from the Fremont Weir to Isleton (Lower Sacramento River and Delta-North CVFPP RFMP regions).
- The Upper San Joaquin River CPA includes the San Joaquin River and tributaries from Friant Dam to the Merced River (Upper San Joaquin River CVFPP RFMP region).
- The Lower San Joaquin River CPA includes the San Joaquin River and tributaries from the Merced River to Stockton (Lower and Mid–San Joaquin River and Delta-South CVFPP RFMP regions).

Dividing the SPA into CPAs allows the Conservation Strategy's objectives to be tailored to regional flood risk management and conservation needs and opportunities.

The Sacramento–San Joaquin River Delta (Delta) represents part of the SPA, but only a portion of the Delta receives flood protection from the SPFC. Delta areas that contain SPFC facilities or receive flood protection from the SPFC are included in the Lower Sacramento River and Lower San Joaquin River CPAs. Areas of the Delta outside the SPA include portions of the Sacramento River and its distributaries, mostly located south and east of Isleton, and portions of the San Joaquin River and its distributaries, mostly located west of Stockton.

Restoring ecosystem functions and aquatic habitats in the Delta has been and continues to be the focus of various State, federal, and local efforts, including California EcoRestore and the Sacramento River General Reevaluation Report. The State and local efforts are informed by the Delta Stewardship Council's Delta Plan (Delta Stewardship Council 2013). Local agencies are responsible for flood risk management in these areas, supported by the State's Delta Levees Program. DWR is working to foster compatibility among these State, federal, and local efforts.

The SPA also includes small flood conveyance channel improvements for outlying communities (e.g., Adin and Chester) that are not in the Central Valley. Although the facilities in these communities are in the SPFC, this Strategy focuses on the river and floodplain ecosystems of the Central Valley, so these communities are not discussed further.

1.3 Conservation Strategy Development

This Conservation Strategy has been developed as part of the implementation of the CVFPP (DWR 2012a). The CVFPP was first developed by DWR and adopted by CVFPB in 2012, and it is to be updated every 5 years.

A Conservation Framework was part of the 2012 CVFPP. This Strategy updates and expands upon that Conservation Framework to inform and support the 2017 update to the CVFPP. Since

2012, the Strategy has been formulated in close coordination with BWFSs for the Sacramento River and San Joaquin River and six RFMPs for subdivisions of those basins (Figure 1-2). Below, the Strategy's development is described in greater detail.

The concept of a conservation strategy for the Central Valley flood system was first called for in 2009, by the California Levees Roundtable in its framework document, the *California Central Valley Flood System Improvement Framework* (2009). The California Levees Roundtable was a partnership of federal, State, and local agencies; its document addressed vegetation issues affecting the State-federal levee system in the Central Valley. The document advocated the creation of a conservation strategy for the Central Valley flood system with an approach comparable to that of this Conservation Strategy.

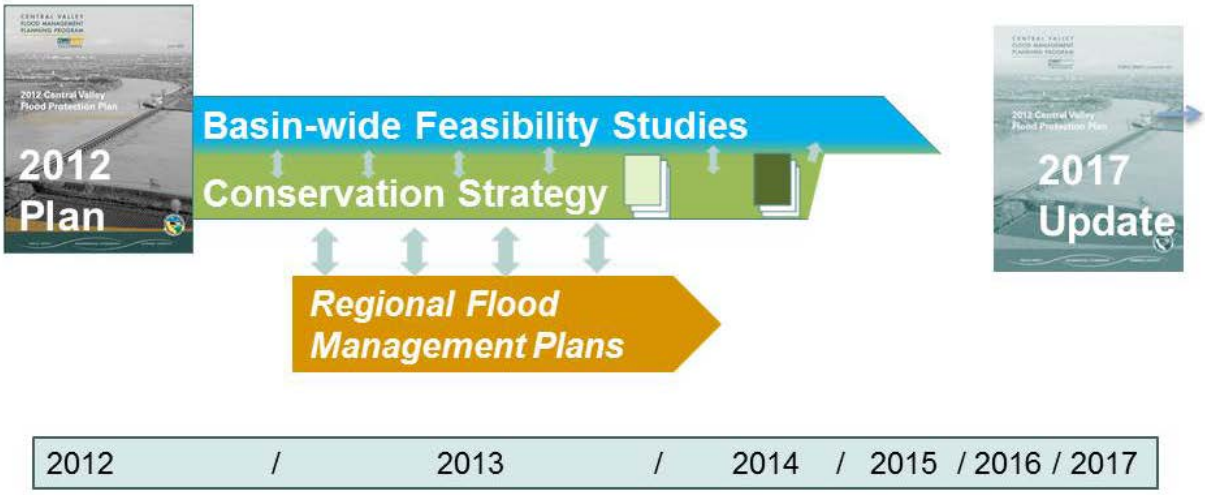


Figure 1-2. Timeline and Major Components of the 2012–2017 Update of the Central Valley Flood Protection Plan

The subsequent development of this Conservation Strategy began with the Conservation Framework of the 2012 CVFPP (DWR 2012c). The Conservation Framework provided direction for conservation planning in the context of flood risk management, and presented a broad outline for this Conservation Strategy.

Input from environmental and agricultural stakeholders provided guidance for much of the Conservation Framework. In particular, the Environmental Stewardship Scope Definition Work Group (ESSDWG) and the Agricultural Stewardship Scope Definition Joint Subcommittee provided helpful input. Both were chartered early in the process of developing the 2012 CVFPP. The ESSDWG prepared a summary of the group's efforts, the *Environmental Stewardship Scope Definition Work Group Summary Report* (DWR 2009). The Agricultural Stewardship Scope Definition Joint Subcommittee developed a framework that was included in the draft report *Important Considerations for the Central Valley Flood Protection Plan Related to Sacramento-San Joaquin Valley Agriculture* (DWR 2010c). DWR subsequently interviewed 12 strategically

selected agricultural stakeholders, representing a broad range of agricultural organizations and interests, to identify concerns and opportunities to work together to reduce impacts of conservation on the agricultural community.

Also, during preparation of the Conservation Framework, to promote a strong working relationship with other resource agencies, DWR established the Interagency Advisory Committee (IAC). Participants included CVFPB, the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Wildlife (CDFW), the National Marine Fisheries Service (NMFS), and the State Water Resources Control Board (SWRCB). The committee supported DWR in accomplishing the following objectives:

- Solicit advice on policy, permitting, and technical conservation topics, including guidance on the content of this Strategy.
- Identify critical issues and discuss options for resolving these issues.
- Identify key opportunities for collaboration with other programs and efforts.
- Expand partnerships for improving conservation in the SPFC.

After release of the public draft of the CVFPP in January 2012, DWR began to develop this Conservation Strategy from the Conservation Framework, consistent with the direction of Resolution 2012-25 of CVFPB, in which it adopted the 2012 CVFPP based in part on the Program Environmental Impact Report (PEIR) for the 2012 CVFPP (DWR 2012b). From the start, this Strategy has aligned with the locally led RFMP efforts and the State-led BWFSs. The RFMP efforts identify projects and strategies to address local and regional flood risk management needs. The BWFSs recommend large-scale improvements that provide cross-regional benefits and improve overall flood system function, flexibility, and resilience. These two planning efforts apply to this Conservation Strategy because they integrate conservation into the planning of flood risk management actions so that the actions provide multiple benefits.

During development of this Strategy, guidance was sought from the IAC; from representatives of agricultural, rural, and conservation groups; and from local governments with a strong interest in the future of the SPFC. The draft Conservation Strategy was made available for public and agency review from July 14, 2015, through September 14, 2015. All the comments received during this period were available for review on the DWR website and were considered during the refinement of the Strategy. In addition, the development of the BWFSs, RFMPs, and this Strategy was coordinated, and data and tools were shared, through public workshops, participation in public and informal meetings with RFMP partners, and close coordination among DWR's programs and offices. This engagement and coordination included receiving input from a technical advisory workgroup on the evaluation of conservation needs and opportunities, which provided the basis of this Strategy's measurable objectives. This workgroup was composed of resource agency and stakeholder representatives. Appendix L, "Measureable Objectives Development: Summary of Conservation Needs and Scale of Restoration

Opportunities," documents this evaluation, the use of data from the BWFSs and other sources, and the composition and role of the workgroup.

This Strategy also builds upon the mitigation measures for aquatic and terrestrial species identified in the PEIR for the CVFPP (DWR 2012b). Specifically, the 2012 PEIR included measures to evaluate, monitor, avoid, and/or compensate for impacts on species and habitats that could be anticipated to result from both near-term and long-term management actions under the CVFPP. Although the approaches in this Strategy overlap with or elaborate on the content of some PEIR mitigation measures, this Strategy describes a broader application of these approaches for improving ecosystem conditions beyond mitigating adverse effects. It is anticipated that the mitigation measures in the California Environmental Quality Act (CEQA) document supporting the 2017 CVFPP update may be modified to incorporate elements of this Strategy.

1.4 Document Organization

The organization of this document is as follows:

- Section 1.0, "Introduction," describes the planning context and purpose of the Conservation Strategy, its geographic scope and development, and the organization of the document.
- Section 2.0, "Need for Improved Conservation of Rivers and Floodplains," describes the need for improved conservation and resolution of related issues affecting flood risk management.
- Section 3.0, "Guiding Principles and Goals," describes the principles applied in developing the Strategy and lists its goals.
- Section 4.0, "Targeted Processes, Habitats, Species, and Stressors," identifies the ecosystem processes, habitats, species, and stressors targeted by this Strategy.
- Section 5.0, "Ecological Objectives," provides for each CPA a summary of existing conditions, major conservation needs, potential opportunities, and objectives for contributions to those needs by flood management actions.
- Section 6.0, "Integrated Flood Risk Management and Conservation Approaches," describes approaches to integrating flood risk management and conservation in project planning and design, and it discusses DWR's approach to agricultural stewardship.
- Section 7.0, "Regulatory Compliance and Regional Permitting," outlines a regional approach to acquiring permits for CVFPP actions.

- Section 8.0, “Implementation,” describes DWR’s approach to funding, monitoring, tracking, and adaptively managing the implementation of this Conservation Strategy, as well as its approach to related coordination, collaboration, outreach, and engagement.
- Section 9.0, “References,” provides information on literature and other sources cited in the text.
- Section 10.0, “Acronyms and Other Abbreviations,” lists the acronyms and other abbreviations used in the text.
- Section 11.0, “Glossary,” provides definitions of terms used in this Conservation Strategy.
- Section 12.0, “Species Names,” lists the common and scientific names of species mentioned in the text.
- Section 13.0, “Preparers,” lists the preparers of this Conservation Strategy.
- Appendix A, “Regulatory Setting,” describes applicable environmental permits and permitting mechanisms.
- Appendix B, “Advance Mitigation,” explains DWR’s process for selecting the first advance mitigation projects that will support the CVFPP, and lists funded projects.
- Appendix C, “Description of Construction Activities for Structural Modifications,” summarizes the general types of construction activities and equipment involved in the construction or modification of levees and related facilities.
- Appendix D, “Vegetation Management Strategy,” details the State’s strategy for managing levee and channel vegetation.
- Appendix E, “Invasive Plant Management Plan,” describes DWR’s approach to managing invasive plant species, identifies invasive plant species to prioritize for treatment, and recommends treatment methods.
- Appendix F, “Existing Conditions,” summarizes the existing conditions in each CPA with regard to each objective of the Conservation Strategy.
- Appendix G, “Identification of Target Species and Focused Conservation Plans,” provides screening tables that summarize how target species were identified from among potentially affected sensitive species, and it contains conservation plans for each of 17 target species.
- Appendix H, “Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal,” contains an analysis of historical

and existing fish-rearing habitat and of the amount of additional habitat needed to attain the Anadromous Fish Restoration Program (AFRP) doubling goal for salmonid populations in the Central Valley.

- Appendix I, "Floodplain Restoration Opportunity Analysis," identifies the extent of potentially feasible locations for setting back levees or lowering floodplain elevations to provide ecosystem benefits.

- Appendix J, "Existing Conservation Objectives from Other Plans," summarizes established and ongoing planning efforts that have geographic areas and conservation objectives that overlap with those of this Strategy and therefore present opportunities for collaboration.

- Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System," summarizes and prioritizes opportunities to remove or minimize impediments to the migration of anadromous native fish in the Central Valley.

- Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities," synthesizes the conservation needs identified by existing conservation plans and potential opportunities for ecosystem improvements identified during preliminary CVFPP planning that are related to this Strategy.

The Conservation Strategy appendices were published in July and are available on DWR's website: http://www.water.ca.gov/conservationstrategy/cs_appendices.cfm.

This page left blank intentionally.

2.0 Need for Improved Conservation of Rivers and Floodplains

The aquatic, marsh, and riparian ecosystems of river channels, floodplains, and flood basins are among the most important natural resources of the Sacramento and San Joaquin Valleys, and they provide habitats of critical importance to numerous native aquatic and terrestrial species. There is a need to improve the conservation of these ecosystems and to resolve related regulatory, funding, and O&M challenges affecting flood risk management.

In the recent historical period (i.e., during the last 160 years), these ecosystems have been adversely affected by a variety of stressors: human settlement, historical and current land use, nonnative species invasions, water diversions, flood management, and other modifications to conditions that once characterized the watersheds of the Sacramento and San Joaquin Valleys.

These stressors have resulted in three river and floodplain ecosystem problems:

- impaired ecosystem processes (particularly hydraulic and geomorphic processes);
- eliminated, fragmented, and degraded habitats; and
- declining native species populations.

Natural river processes, such as floodplain inundation and channel meander migration, maintain the complex mosaic of riverine and floodplain habitats and support native species abundance and diversity (Naiman et al. 1993; Lytle and Poff 2004). These processes have been altered by construction of dams and subsequent changes to natural flows, water diversions, and deposition of mining debris. The historical design and construction of the flood system, which have facilitated the development of agriculture, communities, and infrastructure of regional importance in the Sacramento and San Joaquin Valleys, have also been a factor. Many levees were located close to channels to facilitate scour of hydraulic mining debris, take advantage of natural levee topography, and maximize the area available for agriculture. This has effectively separated rivers from their floodplains and disrupted characteristic river processes. For example, nearly two-thirds of the floodplain that was historically inundated has been isolated from rivers by levees, and dams and diversions have substantially reduced the inundation of floodplain that remains connected to rivers (DWR 2012a, 2012b).

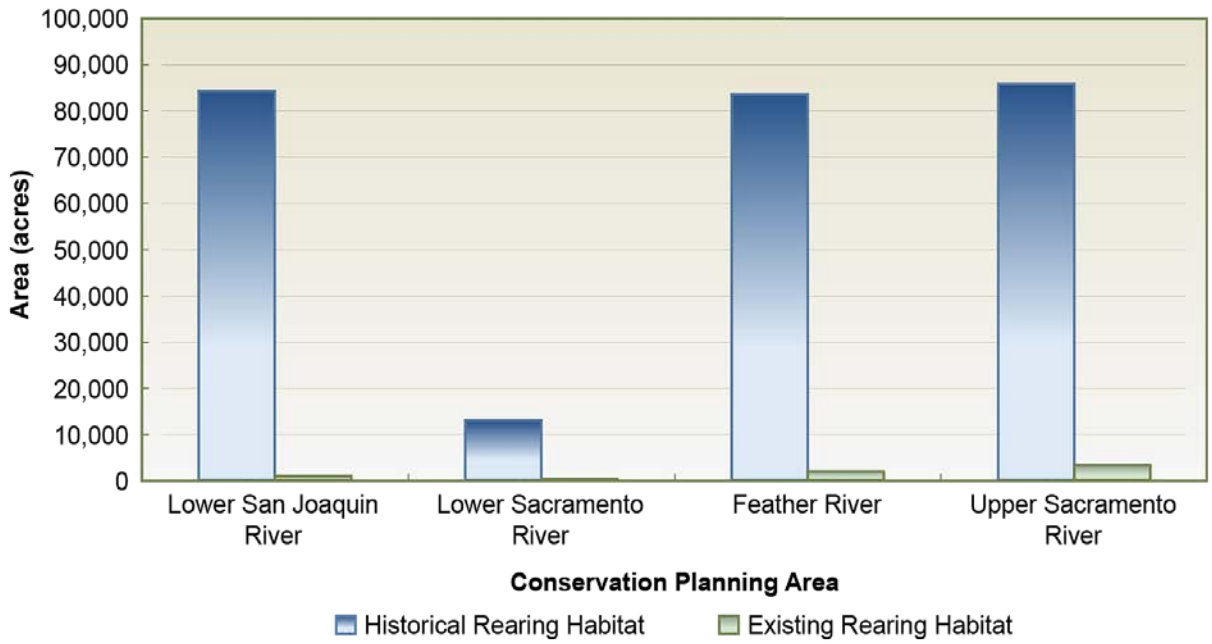
The connectivity, quantity, and quality of aquatic habitats for anadromous and other native fishes have been greatly reduced or degraded by these process changes (for example, see Figure 2-1).

Source: National Oceanic and Atmospheric Administration (NOAA) Fisheries 2005.

Figure 2-1. Historical and Existing Distribution of California Central Valley Steelhead in the Sacramento and San Joaquin Valleys

Dams and other impediments to fish migration in Central Valley waterways have been identified as a stressor to the viability of native anadromous fish species, many of which are protected under the federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA) (NMFS 2014). Fish migration through the Central Valley's migratory corridors remains impeded at structures where passage is inefficient or nonexistent. Fish passage improvements are needed to increase access to suitable habitat, improve fish survival, and increase population size.

In addition, fish-rearing habitat has been substantially reduced. As a result of the alterations in flow caused by dams and diversions, and the isolation of floodplains from rivers by levees, more than 90 percent of historical rearing habitat has been lost in the Sacramento and San Joaquin Valleys (Figure 2-2) (San Joaquin River Restoration Program [SJRRP] 2012; NewFields and Cramer Fish Sciences 2014 [see Appendix H]).



Source: NewFields and Cramer Fish Sciences 2014.

Figure 2-2. Historical and Existing Chinook Salmon Rearing Habitat

Two other important habitat components for salmonids, large woody material (LWM) in river channels and shaded riverine aquatic (SRA) cover along channels, have dramatically diminished in the past century, mainly because of the loss of natural riverbanks and riparian vegetation along the Sacramento and San Joaquin Rivers and their tributaries:

- LWM consists of logs, typically more than 4 inches in diameter and more than 6 feet long, lying in river or stream channels. This material provides valuable cover and resting habitat for fish. With the decreased extent of riparian forest connected to rivers, the supply of LWM in river channels has been substantially reduced. In recognition of its habitat and ecological value, removal of LWM has ceased, but the supply of LWM remains reduced because of the diminished extent of riparian forest.

- SRA cover is found at the interface between a river and adjacent woody riparian areas, where natural banks support overhanging vegetation and provide inputs of woody debris, falling insects, and other foods for aquatic species, and create variable velocities, depths, and flows. Federal, State, and private application of revetment has eliminated much of the high-value SRA cover on the Sacramento River system. Current data show that the amount of high-quality SRA cover along the banks of the Sacramento and San Joaquin Rivers represents a small fraction of what was present historically (DWR 2012a).

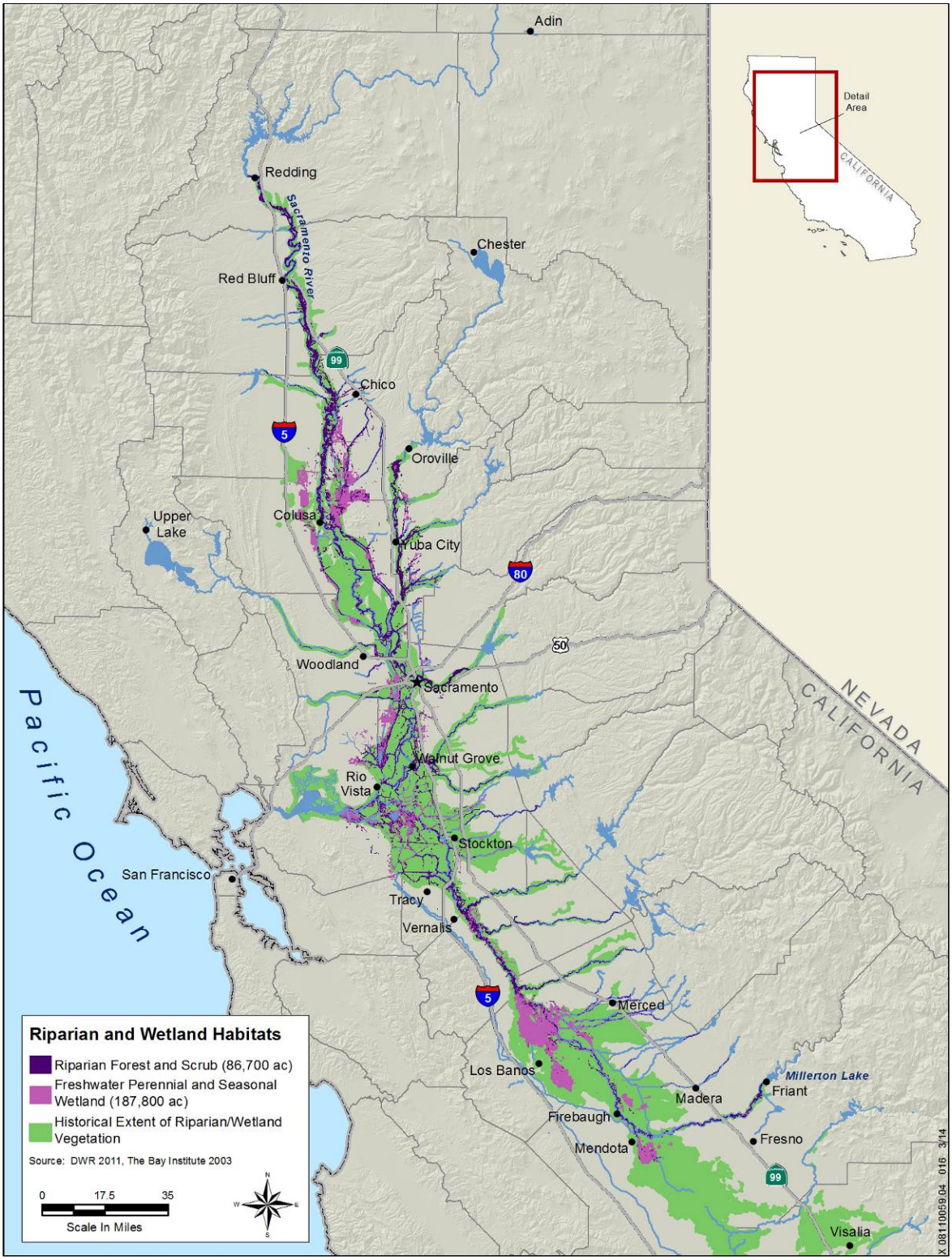
Spawning habitat for salmonids also has been reduced and fragmented. Spawning salmon need clean gravel with small to moderate pebble sizes in which they can build their redds. If not regularly replenished by high river flows acting on available sources of sediment, gravel beds degrade. Large gravel particles remain while small ones wash away. By limiting peak flood flows and preventing the recruitment of new gravel, dams and other instream structures substantially degrade salmon spawning habitat and contribute to the loss of connectivity of this habitat in Central Valley rivers.

Floodplain and flood basin ecosystems have been adversely affected by many of the same stressors and by population growth and changes in land use. These combined factors have eliminated extensive areas of wetland and riparian habitat; reduced the diversity, abundance, and distribution of numerous plant and animal species; and degraded the remaining habitat. These changes have contributed to the extinction or extirpation of several species and the endangerment of others (California Department of Fish and Game [CDFG] 2005).

Approximately 95 percent of historical wetlands and riparian habitats no longer exist in the Sacramento and San Joaquin Valleys (The Bay Institute 1998) (Figure 2-3). Most of the remaining wetlands are managed habitat (e.g., for waterfowl) and are located in federal and State wildlife areas or on land owned by private duck clubs; most of these are not directly connected to rivers. Much of the remaining 56,000 acres of riparian habitat in the Central Valley is highly fragmented or occurs as narrow strips along waterways (Figures 2-4a and 2-4b).

The fragmentation and reduction in the overall acreage of wetlands and riparian forest have reduced the abundance of fish and wildlife species supported by these habitats. Although many of these species still exist, their population sizes and spatial distributions have been reduced relative to historical conditions. More than 16 animal species associated with floodplain and flood basin habitats of the Sacramento and San Joaquin Valleys are currently listed under either CESA or the ESA, and 22 other animal species dependent on floodplain habitats are considered sensitive species (CDFG 2011, and Appendix G, “Identification of Target Species and Focused Conservation Plans”).[2]

[2] Sensitive (i.e., at-risk) species are those assigned a special status in local or regional plans, policies, or regulations or by CDFW, NMFS, or USFWS because they are at risk of extinction or extirpation or because they meet the criteria for such special status.



Sources: DWR 2011; The Bay Institute 2003.

Figure 2-3. Historical and Existing Distribution of Riparian and Wetland Vegetation in the SPA

Source: Google Earth review in 2010.

Figure 2-4a. Representative Photograph of Remnant Riparian Habitat along the Sacramento River (at River Mile 71)

Source: Google Earth review in 2010.

Figure 2-4b. Representative Photograph of Riparian Habitat and Remnant Floodplain along the Feather River (at River Mile 21)

Because natural habitats are largely unavailable, agricultural lands developed in historical floodplains and flood basins, when managed for habitat value, provide important foraging and breeding habitat for diverse fish and wildlife species, including several threatened and endangered species (such as Swainson's hawk and giant garter snake, as described in Appendix G). These agricultural lands are also affected by stressors such as urbanization, competition for limited water supplies, rising operating costs, regulatory constraints, and other factors. Although technological changes, such as the development and use of pesticides and herbicides, increased harvesting efficiency, and other developments, have improved agricultural productivity, they have had unintended impacts on fisheries and wildlife, and in the past several decades, conversion of farmland to nonagricultural uses has reduced the extent and quality of agricultural habitats and the distribution and abundance of associated species. Agricultural acreage in the Central Valley peaked around 1959 and has since gradually declined as urban areas have expanded into the floodplains of the Sacramento and San Joaquin Rivers. From 1990 to 2004, approximately 95,000 acres of agricultural lands were converted to nonagricultural uses in the Sacramento and San Joaquin Valleys (excluding the Tulare Lake Basin) (American Farmland Trust 2007).

Climate change is expected to have additional effects on the aquatic, marsh, riparian, and agricultural ecosystems of the Sacramento and San Joaquin Rivers and their tributaries (DWR 2008). Although climate change has affected natural ecosystems for thousands of years, the rate of climate change is now more rapid than experienced before in the earth's history (Staudinger et al. 2012). Historical data trends and climatic modeling both suggest that for California, the likely effects will include a rising sea level; a diminishing snowpack; earlier snowmelt; reduced flows during the dry season; and more extreme weather, including both floods and droughts. Although fish and wildlife species have had to adapt to changing climate in the past, the combination of rapid climate change and other human-induced changes is likely to place unprecedented stress on the Central Valley's riverine and floodplain ecosystems.

Examples of current stressors that diminish the ability of native species and ecosystems to respond to climate change include fragmentation of contiguous habitat corridors, spread of invasive nonnative species, flow alteration that affects channel geomorphology and floodplain inundation, flow alteration and vegetation loss that result in increased water temperatures, reduced connectivity between channels and floodplains, lack of space for tidal marshes to accommodate sea level rise, continued land subsidence, and loss of upper watershed forest and meadow systems. In sum, climate change exacerbates the major problems affecting river and floodplain ecosystems.

The relationships among riverine and floodplain ecosystems and major human influences that are related stressors are depicted in Figure 2-5. The processes, habitats, and species of natural riverine and floodplain ecosystems are interdependent, and both influence and are influenced by the human impact on the environment.

Flood risk management activities are among the human influences that can adversely affect these processes, habitats, and species. State and federal resource agencies have responded to these problems by strictly regulating construction and O&M practices and requiring more extensive

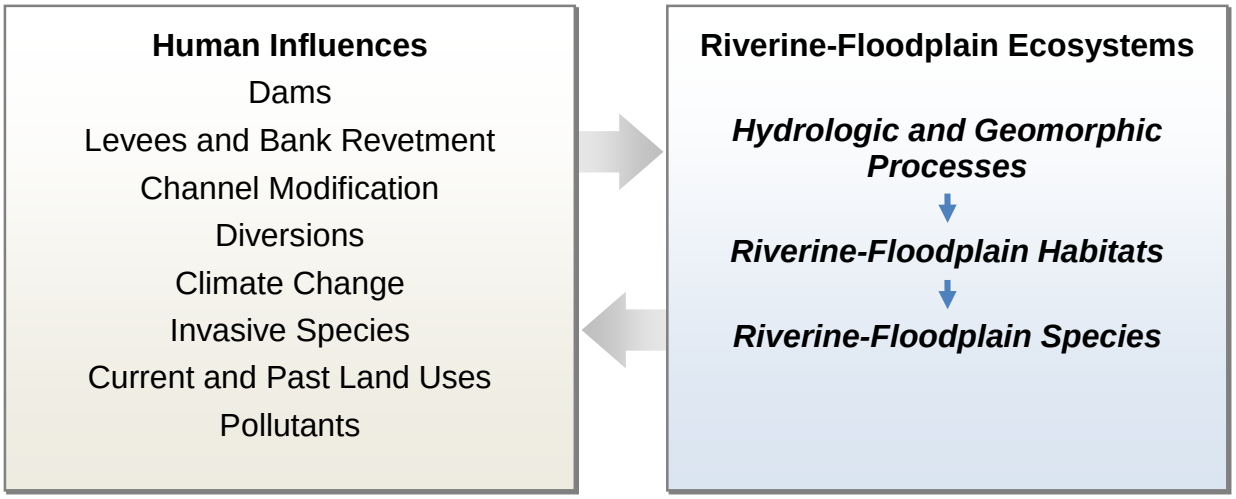


Figure 2-5. General Relationships of Human Influences and the Riverine-Floodplain Ecosystems

mitigation for their impacts. Flood risk management agencies find it increasingly difficult to fulfill their public safety missions under these restrictions.

In particular, more stringent permitting and mitigation requirements exacerbate the funding challenges faced by flood managers and complicate the performance of O&M. Funding of flood risk management improvements and O&M has been inadequate and unreliable, which has hindered the ability of local flood management agencies to achieve flood risk reduction goals and has contributed to maintenance backlogs.

Therefore, this Strategy addresses the need to both improve ecosystems and reduce the effects of regulatory compliance on flood management.

3.0 Guiding Principles and Goals

This section describes the principles that guided the development of this Conservation Strategy. It also describes the Strategy's goals and their relationship to the overarching goals of the CVFPP, and it lists the major types of contributions that implementation of this Strategy would make to all goals of the CVFPP.

3.1 Guiding Principles

DWR used the following principles to develop the Conservation Strategy and will use them to implement it:

- Achieve net systemwide improvements to riverine and floodplain ecosystems.
- Achieve increases in flood system flexibility and ecosystem resiliency.
- Achieve greater permitting efficiencies for capital improvements and system maintenance.
- Reduce maintenance costs and secure funding to maintain restored habitat.
- Plan and implement ecosystem improvements that avoid significant hydraulic and other unintended impacts.
- Prioritize investments in multi-benefit flood risk reduction projects that incorporate ecosystem improvements.
- Prioritize restoration at existing habitat reserves and public lands.
- Coordinate and collaborate with LMAs and existing conservation efforts.
- Implement conservation incrementally in relationship to investments in flood risk reduction.
- Evaluate and adapt implementation in response to monitoring results and changes to funding, scientific understanding, and laws and regulations.

Box 3-1
What Is a Multi-Benefit Project?
In the context of this Strategy, multi-benefit projects are those designed and implemented to achieve the objectives of both flood safety and ecosystem functions, while providing additional benefits as much as possible.

3.2 Goals

This Conservation Strategy is intended to be an integral part of the 2017 CVFPP update. Therefore, this section describes the goals of the CVFPP and those of this Strategy, and the relationship between them.

3.2.1 CVFPP Primary and Secondary Goals

This Conservation Strategy supports the CVFPP's goals. The CVFPP has one primary goal and four supporting goals (Figure 3-1). The primary goal is to improve flood risk management. The supporting goals are to improve O&M, promote ecosystem functions, improve institutional support, and promote multi-benefit projects. Promoting ecosystem functions means to integrate the recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species into flood management system improvements (DWR 2012a). Multi-benefit projects are designed to reduce flood risk and enhance fish and wildlife habitat by allowing rivers and floodplains to function more naturally. These projects create additional public benefits such as protecting farms and ranches, improving water quality, increasing groundwater recharge, and providing public recreation opportunities, or any combination thereof (DWR 2012a).

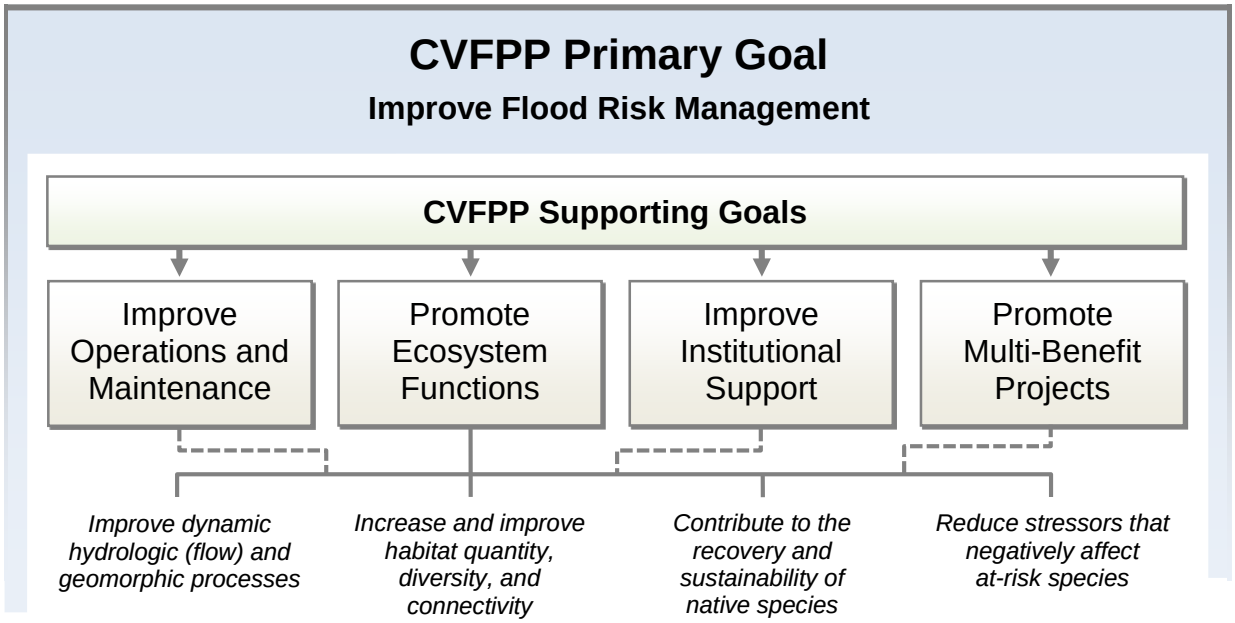


Figure 3-1. CVFPP Primary and Supporting Goals

3.2.2 Conservation Strategy Goals

This Conservation Strategy provides more specific goals to better articulate and guide the promotion of ecosystem functions (Figure 3-1). These goals are based on the environmental objectives of the Central Valley Flood Protection Act (California Water Code, Section 9616[a]), which are as follows.

- Promote natural dynamic hydrologic and geomorphic processes.
- Increase and improve the quantity, diversity, and connectivity of riparian, wetland, floodplain, and SRA habitats, including the agricultural and ecological values of these lands.
- Promote the recovery and stability of native species populations and overall biotic community diversity.

The goals of the Conservation Framework of the 2012 CVFPP (DWR 2012b) were based on this portion of the Central Valley Flood Protection Act and, with only minor revisions, also serve as the goals of this Strategy:

- **Ecosystem Processes: Improve dynamic hydrologic (flow) and geomorphic processes in the SPFC**—These ecosystem processes are critical for maintaining certain habitats and species. A diversity of flows, suitable sources of sediment, and a sufficiently broad river corridor to allow stream meandering are necessary to sustain fisheries and riverine habitats.
- **Habitats: Increase and improve the quantity, diversity, and connectivity of riverine and floodplain habitats**—These habitats include aquatic, riparian, wetland, SRA cover, and other floodplain habitats, as well as agricultural lands that can provide important wildlife values.
- **Species: Contribute to the recovery and sustainability of native species populations and overall biotic community diversity**—Native species addressed by this Strategy include species that are primarily associated with riverine habitats and that are at risk of extirpation or extinction. Although the preceding goals are the foundation for species conservation, this goal emphasizes the need to avoid and minimize adverse effects on sensitive species, develop compensatory habitat (particularly on adversely affected sites), and contribute to species recovery in addition to mitigating impacts.
- **Stressors: Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species**—These stressors include invasive plant species, constraints on sediment sources and channel meander migration, isolation of floodplains from rivers by levees, and fish passage barriers, all of which contribute to loss and degradation of ecosystem functions and habitat.

3.2.3 Potential Contributions to the CVFPP's Primary and Supporting Goals

Progress in attaining this Conservation Strategy's goals for improving the flood system's river and floodplain ecosystems is expected to facilitate attainment of the primary and supporting goals of the CVFPP. These potential contributions of the Strategy to the attainment of CVFPP goals are summarized in Table 3-1.

Table 3-1. Potential Contributions of Conservation Strategy to the Attainment of CVFPP Goals

CVFPP Goal	Potential Contribution of Conservation Strategy
Primary Goal	
Improve flood risk management	• **Increased system flexibility and reliability.** Because of their greater potential for improving floodplain ecosystems, this Strategy promotes structural improvements that increase the size of the floodway, including bypass expansions, new transient storage areas, and setback levees. These structural improvements improve flood risk management by increasing system flexibility and reliability.
Supporting Goals	
Promote ecosystem functions	• **Improved ecosystem functions.** This Strategy has a goal to promote ecosystem functions and provides supporting objectives, approaches, and data for project planning. Therefore, implementing this Strategy would result in improved ecosystem functions.
Improve O&M	• **Reduced conflicts with habitat.** Multi-benefit projects can locate habitat and facilities where conflicts between conservation and O&M are minimized; thus, multi-benefit projects can reduce the amount of vegetation and sediment that needs to be removed from channels. • **Reduced conflicts with geomorphic processes.** The footprint of the current levee system exposes levees to geomorphic forces that result in a chronic need for repairs. Because of the conservation need to restore these geomorphic processes, this Strategy promotes relocating facilities to reduce the physical forces acting on them, which would reduce maintenance needs. Such relocated facilities would often be much shorter in length than those they replace, further reducing maintenance needs. • **More reliable and less costly permitting.** This Strategy proposes a system of regional programmatic permitting agreements, advance mitigation and enhancement measures, long-term maintenance, and incorporation of multi-benefit features into projects that would proactively improve habitat quality and ecosystem resiliency. These programmatic agreements and physical changes could increase the reliability and cost-efficiency of the permitting process for new capital outlay projects and O&M tasks.
Improve institutional support	• **More reliable and less costly permitting process.** As described for “Improve O&M,” this Strategy proposes a system of programmatic agreements and physical changes that could increase the reliability and cost-efficiency of the permitting process for new capital outlay projects and O&M tasks. • **Additional funding.** Projects that advance conservation goals may also attract funding from sources not traditionally available for flood improvement projects. This support could be from government agencies, nongovernmental organizations, special interest groups, and individuals committed to various aspects of conservation, greenhouse gas reduction, or other benefits provided by ecosystem restoration. • **Greater public and resource agency support.** The public has demonstrated interest in improving environmental quality, including the conservation of the fish and wildlife of the Central Valley’s rivers and floodplains. Successful implementation of flood risk reduction projects that concurrently help restore ecological processes and habitats is likely to build public and resource agency support for funding and implementing the flood risk reduction projects.
Promote multi-benefit projects	• **Development of additional multi-benefit projects because of greater integration of conservation into flood projects.** This Strategy promotes multi-benefit projects by relying primarily on the integration of conservation into flood projects, rather than on the implementation of separate conservation actions.

Key: CVFPP = Central Valley Flood Protection Plan; O&M = operations and maintenance.

4.0 Targeted Processes, Habitats, Species, and Stressors

To achieve its goals, this Conservation Strategy focuses on the processes, habitats, and species in need of recovery with the greatest potential to benefit from conservation actions integrated with flood risk management actions. It also focuses on stressors to these processes, habitats, and species that could be addressed by flood risk management. Measurable objectives for these targets, such as measurements of floodplain inundation, riparian habitat, or fish passage barriers, will inform the CVFPP and future State funding guidelines and grant programs (e.g., by providing a framework for measuring the accomplishment of ecosystem improvements).

The following sections describe the basis for targeting these particular ecosystem processes, habitats, species, and stressors, which are listed in Table 4-1. Their status is described in greater detail in Appendix F, "Existing Conditions," and Appendix G, "Identification of Target Species and Focused Conservation Plans." Section 5.0, "Ecological Objectives," provides measurable objectives for these targets.

Table 4-1. Ecological Goals and Targeted Ecosystem Processes, Habitats, Species, and Stressors

Ecological Goal	Targeted Ecosystem Process, Habitat, Species, or Stressor
Ecosystem processes. Improve dynamic hydrologic and geomorphic processes.	Floodplain inundation
	Riverine geomorphic processes
Habitats. Increase and improve quantity, diversity, and connectivity of riverine and floodplain habitats.	SRA cover
	Riparian
	Marshes and other wetlands
Species. Contribute to the recovery and sustainability of native species populations and overall biotic community diversity.	Targeted species
Stressors. Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.	Revetment
	Levees[1]
	Fish passage barriers
	Invasive plants

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.

4.1 Targeted Processes and Habitats

4.1.1 Targeted Ecosystem Processes

The ecosystem processes targeted by this Conservation Strategy are riverine geomorphic processes and floodplain inundation. These are the natural, dynamic hydrologic and geomorphic processes that sustain targeted habitats and species. Their restoration can also promote flood risk management objectives—in particular, improving flood system flexibility and reducing O&M regulatory requirements. These processes are described below.

The frequency, magnitude, duration, timing, and rate of change of river flows are the primary determinants of riverine geomorphic processes and floodplain inundation, influence aquatic habitat conditions, and serve as critical life history cues to riverine species. For these reasons, ecosystems respond strongly to flow alterations (Poff and Zimmerman 2010), and flow alterations have substantially degraded the riverine and floodplain ecosystems of California's Central Valley (CDFW 2015).

Box 4-1
What Are Dynamic Hydrologic and Geomorphic Processes?
In the context of river systems, *dynamic hydrologic processes* describe the flow of water under the ground, over land, and in rivers. *Dynamic geomorphic processes* are the ways in which soil and sediment are eroded, trapped, transported, and accumulated in river channels and on floodplains, changing landforms and thereby sustaining habitats.

This Conservation Strategy does not include objectives for river flows because these flows are managed for other purposes in addition to flood risk management—in particular, water supply and hydroelectric power production. However, DWR is evaluating opportunities to improve the management of river flows. For example, DWR is evaluating forecast-based operations, coordinated among reservoirs, to optimize the use of reservoir storage and downstream channel capacity and thus benefit flood risk reduction and the ecosystem in ways that will not substantially affect water supply reliability, water deliveries, or power production. Forecast-based and coordinated operations are described in Section 6.0, "Integrated Flood Risk Management and Conservation Approaches."

Floodplain Inundation

Ecosystem processes that sustain both riverine and riparian ecosystems occur during floodplain inundation events (Opperman 2012). Floodplain inundation occurs when river flows exceed channel capacity and water overflows onto adjacent land.

During floodplain inundation, a variety of physical processes occur. The magnitude of ecosystem responses to these events depends on flow timing, frequency, magnitude, and duration. Overbank flows help create side channels, sloughs, and oxbow lakes through erosion and deposition of fluvial sediments. Sediment scouring, erosion and deposition, and prolonged inundation disturb existing vegetation, creating opportunities for cottonwoods, willows, and other early successional riparian species to establish from seed.

Box 4-2
The Benefits of Floodplain Inundation

With the right timing and duration, the inundation of floodplains increases the amount and quality of rearing habitat for fish and other native aquatic species. Inundation influences the development of floodplain topography, soils, and vegetation, and thus the formation of habitats. Juvenile salmonids make use of the cover and food provided by inundated floodplains.

Source: Jeffres et al. 2008; reprinted with permission.

The juvenile salmonids shown in the photograph are all of similar age; those on the right grew in habitat on the inundated floodplain of the Cosumnes River; those on the left grew in river habitat below the floodplain (Jeffres et al. 2008).

Besides affecting the successional processes of riparian vegetation through disturbance, vegetation recruitment, and the formation of off-channel habitats, sustained overbank flows generate food for aquatic organisms on the floodplain and downstream. Floodplain inundation for 1–2 weeks or longer allows for the growth of microorganisms and the animals that feed on them (Opperman 2012). These inputs to the aquatic food web increase the amount and quality of rearing habitat for anadromous fish and other native aquatic species.

Riverine Geomorphic Processes

The fundamental geomorphic processes of alluvial floodplain rivers are lateral channel migration, channel cutoff and formation of multiple channels, bed mobility, and fine and coarse sediment transport. These interrelated processes influence channel, bank, and floodplain formation and other floodplain dynamics, which in turn create and sustain the targeted habitats described in the following section.

Channel migration (i.e., meander migration) is particularly important and readily measured using aerial images taken at intervals. It is closely related to the transport of sediment, the creation of specialized habitat for bank swallows on cut banks, and the creation of new floodplain surfaces that serve as seedbeds for riparian plants of early successional habitats. When not constrained by erosion-resistant banks (e.g., banks lined with revetment), the channel of a large, alluvial river tends to move from side to side across the floodplain (Johannesson and Parker 1989). This meander migration is one of the primary processes sustaining floodplain habitats on large, single-channel alluvial rivers (Hughes 1997). The channel migration of meandering rivers erodes banks, forms cutoffs and oxbow lakes, and creates floodplain surfaces of different ages, which in turn provide a variety of habitats (Hupp and Osterkamp 1996; Scott et al. 1996; Ward et al. 2001; Greco et al. 2007). These surfaces are where early successional riparian forest species colonize and begin to develop habitat for riparian-associated wildlife.

While ecologically important, channel migration can damage levees, roads, farms, and other improvements that represent substantial investments. Thus, these investments generally are

protected by revetment that impedes channel migration (see Section, 4.3.1, “Revetment and Levees”).

4.1.2 Targeted Habitats

This Conservation Strategy targets restoration of riverine and floodplain habitats, which can be accomplished by directly creating habitats, increasing floodplain inundation, and improving riverine geomorphic processes, which create and sustain habitats (as described in the preceding section, “Targeted Ecosystem Processes”) and by reducing the effects of stressors on riverine habitats (see “Targeted Stressors,” below). This Conservation Strategy’s targeted habitats are SRA cover, riparian habitats, and marshes and other wetlands. These are described in the following sections. Although not a target of this Strategy, agricultural lands can provide surrogate habitat for fish and wildlife. For this reason, support of agricultural stewardship is one of this Strategy’s approaches to conservation (see Section 6.3, “Agricultural Land Stewardship”).

Shaded Riverine Aquatic Cover

SRA cover is defined as follows (USFWS 1992):

> …the unique near-shore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. Key attributes of this aquatic area include (a) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (b) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, often substantial detritus, and variable velocities, depths, and flows.

Three attributes of SRA cover make it an important component of fish and wildlife species habitat (USFWS 1992), with each attribute providing different habitat elements:

- Overhanging riparian vegetation and (sometimes) riverbanks provide several types of habitat values to fish and wildlife species:
  - Shade moderates water temperatures, which is particularly important to salmonids.
  - Shade and cover also reduce visibility to predators.
  - Input of plant material provides instream cover for fish.
  - The terrestrial and aquatic invertebrates associated with vegetation and plant material provide food to birds and aquatic species.
  - Plant stems and branches serve as perches, and as nesting and resting areas, for birds.
- Natural, eroding banks often have cavities, depressions, and vertical faces that support bank-dwelling species, such as bank swallow, northern rough-winged swallow, belted kingfisher, mink, and river otter, and that provide cover and shelter for fish. Bank-dwelling species may use these banks and their cavities to access the water or for nesting.

Erosion of natural bank substrates provides instream spawning substrate for aquatic species, including salmonids.

- Instream cover, including overhanging or fallen trees or branches, aquatic vegetation, diverse substrate sizes, and irregular banks, provides habitat complexity to fish and wildlife, and supports a high diversity and abundance of invertebrate and fish species.

Many streambanks have some, but not all, of these attributes, and thus provide some, but not all, of these habitat elements. For example, natural banks that lack overhanging riparian vegetation may have an eroding surface with cavities and depressions; conversely, vegetated revetment that lacks eroding banks may have overhanging riparian vegetation that shades the water surface and provides inputs of plant material and insects. Near-shore LWM is part of the instream cover component of SRA cover, but LWM may also occur away from the shore, in the river channel. LWM is critically important to aquatic species, contributing to habitat creation (e.g., by adding complexity and providing refuge) and storage of sediment and organic matter. It is particularly important to salmonid populations in the Sacramento River. LWM can often mobilize in flood events, contributing to habitat not only locally at the point of recruitment, but also downstream, whether within the channel, near the bank, or on the floodplain. Upstream inputs of LWM are the only significant source of LWM in river reaches that lack SRA and riparian forest.

Box 4-3
What Is Large Woody Material (LWM)?
LWM consists of logs, typically more than 4 inches in diameter and more than 6 feet long, lying in river or stream channels. This material provides valuable cover and resting habitat for fish and wildlife, but the amount of LWM has been reduced as a result of impacts on riparian forests.

Riparian Habitats

Riparian areas are the land between riverbanks or streambanks and adjacent uplands, generally corresponding to the frequently inundated floodplain. As used in this Conservation Strategy, *riparian habitats* refers to the forest, woodland, and scrub vegetation characteristic of riparian areas in the Sacramento and San Joaquin Valleys (as described in Sawyer et al. 2009 and Vaghti and Greco 2007).

River flows and associated hydrologic and geomorphic processes are integral to riparian ecosystems. Most aspects of a flow regime—the magnitude, frequency, timing, duration, and sediment load of flows—affect a variety of riparian habitat processes (Mahoney and Rood 1998; Vaghti and Greco 2007; Fremier et al. 2008). Two of the most important processes for riparian vegetation are plant recruitment and disturbance. The interaction of these processes across the landscape is primarily responsible for the pattern and distribution of riparian vegetation and for its species composition, age distribution, and habitat structure. As riverine geomorphic processes create new land surfaces over time (Greco et al. 2007), a succession of riparian vegetation communities develops on these surfaces. This results in a mosaic of riparian habitats for fish and wildlife species.

Riparian habitats that are diverse in both plant species composition and physical structure are likely to accommodate a wider variety of wildlife (Riparian Habitat Joint Venture [RHJV] 2004). Wildlife species vary considerably in their habitat requirements and preferences for different structures in riparian vegetation. For example, nesting requirements for birds range from dense herbaceous vegetation to larger trees, tree cavities, and even eroding bluffs (for bank swallows). Additionally, the number of wildlife species in riparian corridors increases with corridor size, width, and continuity (for example, see Hagar 1999, Hannon et al. 2002, and Heath and Ballard 2003).

Marshes and Other Wetlands

Freshwater emergent wetlands, or marshes, are dominated by large, perennial herbaceous plants, particularly tules and cattails. In marshes, vegetation structure and the number of species are strongly influenced by disturbance, changes in water levels, and the range of elevations present at a site (Atwater and Hedel 1976; Keddy 2000). In addition to marshes, floodplains support extensive areas of other wetlands (and interspersed uplands) dominated by herbaceous plants. These are “seasonal” wetlands that occur in a wide variety of physical settings and support a diversity of plant species.

Marshes and other wetlands are among the most productive fish and wildlife habitats in California (Kramer 1988). Perennial freshwater wetlands provide food, cover, and water for numerous common and sensitive species of fish and wildlife that rely on wetlands for all or part of their life cycles. In the Sacramento and San Joaquin Valleys, wetlands, including marshes, are especially important to migratory birds during fall and winter.

Although there are similarities, the species composition and ecology of marshes in the Delta differ in several important ways from corresponding habitats in the upstream portions of the Sacramento and San Joaquin Valleys. In particular, many marshes in the Delta are influenced by the daily tides, whereas marshes upstream of the Delta in the Sacramento and San Joaquin Valleys are nontidal. Both nontidal and tidal marshes in the Delta have dense emergent vegetation that provides essential cover, resting, and foraging sites for a variety of wildlife species. Tidal marshes and associated mudflats are exposed at low tides and support many types of foraging shorebirds and ducks. Adjacent upland habitats are also required by some species for seasonal hibernation and reproduction, and offer important cover and resting and nesting sites for birds and mammals that move into uplands during high tides and other high-water events.

Box 4-4
The Selection of Targeted Species
One goal of this Strategy is to support the recovery and stability of native species populations and overall biotic community diversity. To address this goal, a broad set of species associated with Central Valley river and floodplain ecosystems was first identified; then, for species that have the greatest need for recovery and that could be most affected by implementation of the CVFPP, focused conservation planning was conducted (see Appendix G). These focal species are referred to by the term *target.*

Canals, side channels, and backflow pools that contain emergent vegetation provide forage and cover. They also represent dispersal corridors that link habitat areas for terrestrial and semiaquatic species, as well as many bird species.

4.2 Targeted Species

Restoring the ecosystem processes and habitats targeted by this Strategy would result in an overall improvement in environmental quality and broad benefits to many species. However, some sensitive species that could benefit from the restoration of ecosystem processes and habitats have specialized habitat needs that may not be met without focused conservation measures that are implemented as part of flood improvement projects. Therefore, this Conservation Strategy has targeted those sensitive species that could be most affected by implementation of the CVFPP, primarily because of their strong dependence on the river and floodplain ecosystems of the Sacramento and San Joaquin Valleys. The habitat requirements of these species have guided the formulation of the Conservation Strategy's objectives and specific advance mitigation projects described in Appendix B. (For a description of how adverse effects of CVFPP actions on these and other sensitive species would be avoided, minimized, and mitigated, see the mitigation strategies and measures listed in the PEIR for the 2012 CVFPP [DWR 2012a].)

Table 4-2 lists the targeted plant and animal species that may benefit from the restoration of ecosystem processes and habitats. To select them, preliminary lists were developed and screening criteria applied. Appendix G, "Identification of Target Species and Focused Conservation Plans," describes the preliminary list of candidate target species and the screening criteria applied to select the target species. In brief, highly sensitive species were selected if the flood system represented a large part of their statewide range and if flood risk management actions could cause significant cumulative impacts on, or potentially make significant contributions to, the species' recovery.

Table 4-2. Targeted Species

Common Name[1] *Scientific Name*	Status FED/CA/CRPR[2]	Conservation Planning Area[3]					Habitats[4]
		USR	FR	LSR	USJR	LSJR	
Plants							
Delta button-celery *Eryngium racemosum*	–/E/1B.1				✓	✓	Riparian scrub, inundated floodplain (in vernally mesic clay depressions)
Slough thistle *Cirsium crassicaule*	–/–/1B.1				✓[5]	✓	Chenopod scrub, riparian scrub, and marsh along sloughs; inundated floodplain
Invertebrates							
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/–/–	✓	✓	✓	✓	✓	Elderberry shrubs in riparian habitat
Fish							
California Central Valley steelhead DPS *Oncorhynchus mykiss*	T/–/–	✓	✓	✓	✓[5]	✓	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain[6]
Chinook salmon—Central Valley fall-/late fall–run ESU *Oncorhynchus tshawytscha*	–/CSC/–	✓	✓	✓	✓[5]	✓	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain[6]
Chinook salmon—Central Valley spring-run ESU *Oncorhynchus tshawytscha*	T/T/–	✓	✓	✓	✓[5]	✓	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain[6]
Chinook salmon—Sacramento River winter-run ESU *Oncorhynchus tshawytscha*	E/E/–	✓		✓			Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain[6]
Green sturgeon—southern DPS *Acipenser medirostris*	T/CSC/–	✓	✓	✓		✓	Riverine, estuarine, and oceanic waters; SRA cover; inundated floodplain[6]
Reptiles							
Giant garter snake *Thamnophis gigas*	T/T/–	✓	✓	✓	✓	✓	Freshwater emergent wetlands, floodplain agricultural land (drainage canals, irrigation ditches, rice fields, and adjacent vegetation)
Birds							
Bank swallow *Riparia riparia*	–/T/–	✓	✓	✓			Natural banks and cliffs near aquatic habitat (nesting); riparian, grasslands, wetlands, open water, and croplands (foraging)

Table 4-2. Targeted Species

Common Name[1] *Scientific Name*	Status FED/CA/CRPR[2]	Conservation Planning Area[3]					Habitats[4]
		USR	FR	LSR	USJR	LSJR	
California black rail *Laterallus jamaicensis coturniculus*	–/T, FP/–			✓		✓	Marsh
Greater sandhill crane *Grus canadensis tabida*	–/T, FP/–	✓	✓	✓	✓	✓	Open grasslands, floodplain agricultural land (grain fields), and open wetlands; does not breed in SPA
Least Bell's vireo *Vireo bellii pusillus*	E/E/–	✓[5]	✓[5]	✓[5]	✓[5]	✓	Riparian, adjacent to open water
Swainson's hawk *Buteo swainsoni*	–/T/–	✓	✓	✓	✓	✓	Riparian forest, larger trees (nesting); grasslands and croplands (foraging)
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	T/E/–	✓	✓	✓[5]	✓[5]	✓[5]	Riparian, inundated floodplain
Mammals							
Riparian brush rabbit *Sylvilagus bachmani riparius*	E/E/–					✓	Riparian
Riparian (= San Joaquin Valley) woodrat *Neotoma fuscipes riparia*	E/CSC/–					✓	Riparian

Sources: California Interagency Wildlife Task Group 2008; California Native Plant Society 2012; CDFG 2012; Shuford and Gardali 2008.

Notes:

1 DPS = Distinct Population Segment; ESU = Evolutionarily Significant Unit.

2 Status FED/CA/CRPR

Federal

E = Listed as endangered under the federal Endangered Species Act (ESA).

T = Listed as threatened under ESA.

California

E = Listed as endangered under the California Endangered Species Act (CESA).

T = Listed as threatened under CESA.

CSC = California Species of Special Concern.

FP = Fully protected under the California Fish and Game Code.

California Rare Plant Rank (CRPR)

1B.1 = Plants rare, threatened, or endangered in California and elsewhere. Seriously endangered in California.

3 Conservation Planning Area

FR = Feather River Conservation Planning Area (CPA).

LSJR = Lower San Joaquin River CPA.

LSR = Lower Sacramento River CPA.

USJR = Upper San Joaquin River CPA.

USR = Upper Sacramento River CPA.

4 SPA = Systemwide Planning Area; SRA = shaded riverine aquatic.

5 Potential distribution in CPA based on historical distribution or poorly known.

6 Inundated floodplain habitats include both natural and agricultural land covers.

CVFPP implementation will contribute to the conservation of targeted species by restoring ecological processes and habitats and by reducing stressors as part of multi-benefit flood risk reduction projects, as described in the following section. (Ecological processes sustain habitats for targeted and other native species.) However, the targeted species may have additional, more specialized or localized habitat requirements or other factors besides habitat availability that restrict their populations. For example, the valley elderberry longhorn beetle needs not only riparian habitat, but also elderberry bushes within riparian areas. Therefore, focused conservation planning was conducted with guidance from species experts to identify methods and actions that could be incorporated into flood risk management projects to contribute to recovery of these species. The resulting methods and actions are provided in Appendix G, "Identification of Target Species and Focused Conservation Plans." Conservation actions identified by these plans have been incorporated into the Conservation Strategy's objectives and measures for integrating restoration and enhancement with flood risk management in multi-benefit projects.

Because the conservation needs of species change, in the future, additional species may become suitable targets for this Strategy. Therefore, during the 5-year updates to the CVFPP and this Strategy, the preliminary list of species in Appendix G will be reevaluated using the same criteria described above. Species meeting these criteria will be added as targets of the Strategy. In this case, focused conservation plans will be developed for these species and included in subsequent updates of this document. During the public comment period, new information regarding the status of delta smelt and its habitat use in the SPA was made available, and although a recovery plan for the species was expected to be released in 2016, it was not; therefore, this species will be considered for inclusion in the 2022 CVFPP and Conservation Strategy. Other species that were considered during the initial screening could be reconsidered, and targeted conservation plans may be developed. These species include the western pond turtle, tricolored blackbird, western red bat, and western burrowing owl.

Targeted Stressors

The targeted stressors in this Conservation Strategy are limited to those most closely related to flood risk management actions: erosion-resistant materials, generally referred to as revetment, that reinforce and protect streambanks and levees and flood system encroachments, such as bridges, roads, docks, and utility lines; narrowly confining levees; weirs and other structures that are barriers to fish passage; and invasive plants. The role of flood risk management actions or facilities in contributing to these stressors on ecosystem processes, habitats, and species is described in the following sections.

4.2.1 Revetment and Levees

Over the past 160 years, communities, farms, homes, bridges, and other facilities located within historical meander zones and floodplains of the Central Valley have been protected by an evolving system of levees and revetment (Figures 4-1 and 4-2). Although these facilities have made it possible to occupy, farm, and develop these lands, they have affected the fluvial processes needed to sustain river and floodplain ecosystems. Revetment directly affects dynamic fluvial processes, whereas levees isolate rivers from their historical floodplains.

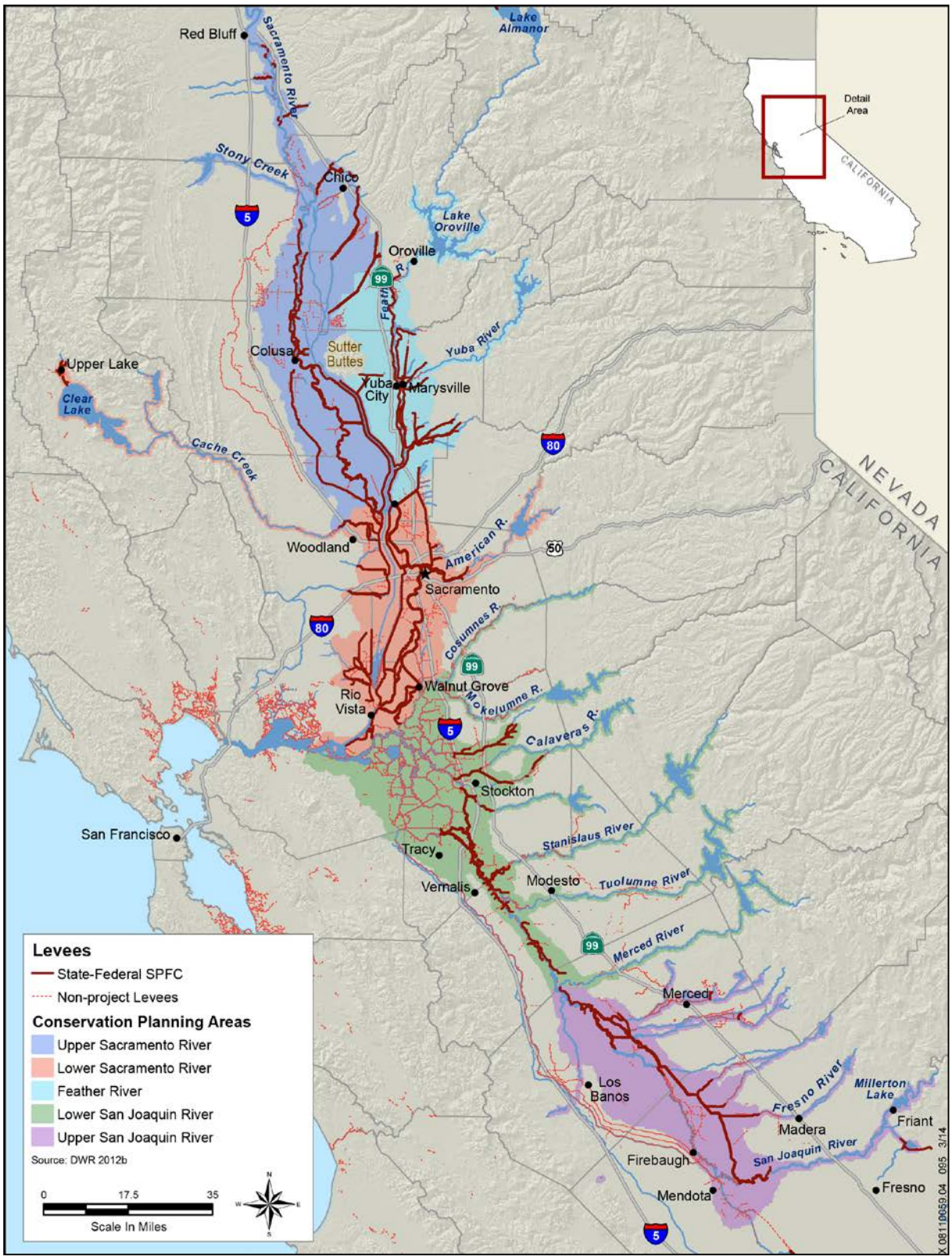


Figure 4-1. Levee Locations in the Systemwide Planning Area

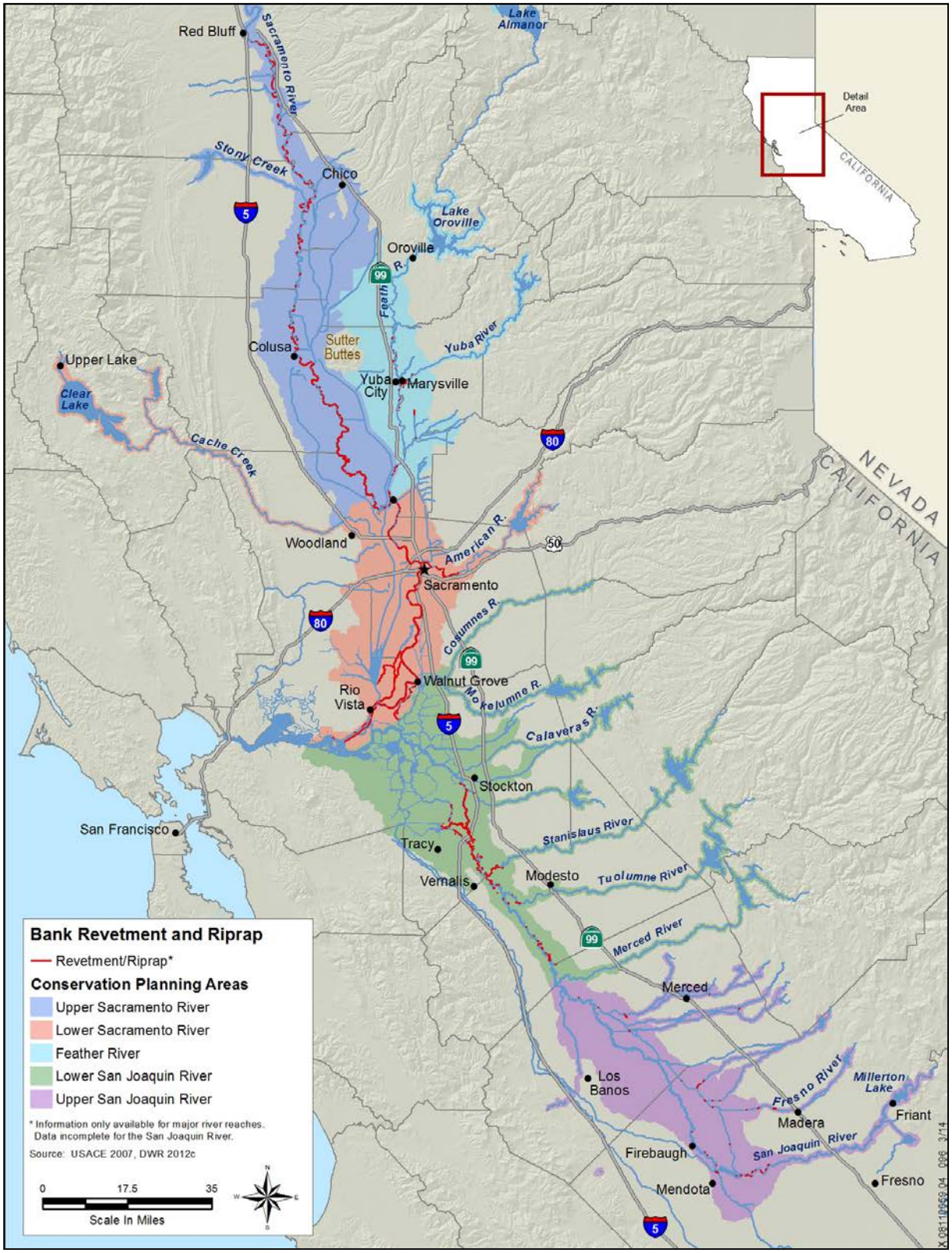


Figure 4-2. Revetment Associated with the State Plan of Flood Control

Box 4-5
What Is Revetment?
Revetment refers to a variety of erosion-resistant materials that reinforce and protect streambanks and levees, but that also can eliminate habitat and preclude the formation of new habitat. The photographs show representative revetment; the right-hand photograph depicts how some vegetation can develop on revetment sites.

Source: DWR.

Source: DWR.

Revetment
River channel migration results in bank retreat in some areas and the deposition of sediment elsewhere. Where located within a river's natural meander zone, revetment on riverbanks or in combination with levees reduces channel meander migration and thus the complexity of aquatic and riparian ecosystems (Naiman et al. 1993; Lytle and Poff 2004). In portions of the SPA, revetment and levees isolate most of this natural meander zone from river channels and thus have virtually halted natural river processes, such as river channel meander migration and meander cutoffs.

Installation of revetment has substantially reduced streamside wetlands, SRA cover, and LWM production and thus disconnected and eliminated habitat for many species of fish and wildlife, including threatened and endangered species, such as the Chinook salmon and the bank swallow (USFWS 2004). Revetment has also precluded the potential formation of new habitat (e.g., cut banks created by channel migration, additional recruited trees). However, riparian trees and shrubs can be successfully planted in revetment, which can shade and add LWM to the nearshore environment.

Levees
Over 1,600 miles of levees, often protected by revetment, have been constructed as part of the SPFC (DWR 2010). These levees have isolated historical floodplains from natural geomorphic processes and inundation.

In particular, the SPFC includes many levees that have been located close to river channels to facilitate the flushing of hydraulic mining debris, to take advantage of the higher ground

provided by natural river levees, and to maximize use of floodplain lands for agriculture and development. Channels that, over time, would naturally migrate laterally as a result of fluvial erosion and sediment deposition (see “Riverine Geomorphic Processes,” above) have been constrained by revetment-protected levees within the meander zone. Such narrowly confining levees substantially impair riverine geomorphic processes.

Such confining levees, because they are subjected to strong erosive currents, are in chronic need of maintenance. Because more than 90 percent of SPFC levees along the Sacramento and San Joaquin Rivers and their major tributaries are within channel meander zones (based on DWR 2012d and Appendix F, “Existing Conditions”), the historical placement of levees close to river channels has created major conservation and maintenance issues.

Where levees are close to the Sacramento and San Joaquin Rivers and their major tributaries, the floodplain that remains connected to the river system (and inundated during flood flows) is often confined to levee slopes and a narrow waterside strip along the levee. Within this narrow band, levee maintenance activities affect habitats, detrimentally simplifying their structure and reducing their diversity. Such activities include removing downed and dying trees, trimming the lower limbs of large trees, and removing shrubs and small trees.

By confining flood flows, levees also alter the width, depth, gradient, and velocity of flows that, without levees, would spread out onto the floodplain. Levees tend to increase the sediment-carrying capacity of the stream, which leads to deepening and widening of the channel. These alterations tend to reduce the habitat values of channels and floodplains (e.g., by reducing the frequency of floodplain inundation).

4.2.2 Fish Passage Barriers

Fish passage barriers are water management structures, such as dams, weirs, control structures, and water diversions, that block, delay, strand, or otherwise adversely influence anadromous fish as they migrate upstream or downstream. These structures can be total, temporal, or partial barriers depending on physical characteristics (e.g., height, hydraulic conditions affecting water depth and velocity, attraction flow, and physical deterioration), operation (e.g., diversion rate and timing and flashboard or gate operations), and relation to species’ biological characteristics (e.g., mode of locomotion, species type, size, physical abilities, and fish condition). Total barriers block all fish migration. Temporal and partial barriers block fish passage for a certain life stage or under certain flow conditions. See Appendix K, “Synthesis of Fish Passage Improvement Opportunities in the Central Valley Flood System” for a full discussion of fish passage barriers.

Passage barriers are a stressor to anadromous species that use the Sacramento and San Joaquin River systems. These fish include the four runs of Chinook salmon in the Central Valley, Central Valley steelhead, the southern Distinct Population Segment (DPS) of green sturgeon, and Pacific lamprey (DWR 2005; Lindley et al. 2006; The Nature Conservancy [TNC] 2007). Fish migration is an inherent part of a fish's life history, from young life stages (e.g., juvenile fish) to mature adult fish. For example, fish migrate in search of food, to avoid predators, to avoid lethal environmental conditions, and to find refuge and suitable habitat for reproduction. Fish migrate upstream, downstream, and laterally into river floodplains.

Box 4-6
What Are Fish Passage Barriers?
These are structures that block, delay, strand, or otherwise negatively affect fish as they migrate upstream or downstream. The photograph shows the Fremont Weir, where fish passage is currently impeded and where improvements are a high priority.

Fish passage barriers have greatly reduced the quality and quantity of available habitat and the amount of time in which available habitat can be accessed. Barriers can also substantially increase stranding or create lethal or sublethal conditions that affect survival and spawning success. Structural barriers identified within the SPA are displayed in Figure 4-3. For more detail regarding barriers, see Appendix K.

4.2.3 Invasive Plants

Nationally, invasive species are the second greatest threat to endangered species, after habitat destruction (California Invasive Plant Council [Cal-IPC] 2011a). As of 2014, at least 68 plant species considered to be invasive by the Cal-IPC potentially occur within upland, riparian, wetland, and open water habitats in the Sacramento and San Joaquin Valleys (Cal-IPC 2014). Many are widespread and abundant in vegetation managed as part of SPFC O&M. These species degrade riverine and floodplain habitats by altering ecosystem processes and displacing native plants. In addition, some of these invasive species, such as tamarisk (or saltcedar), *Arundo* (giant reed), and red sesbania, are stressors that increase the cost and difficulty of operating and maintaining the SPFC.

These species can alter hydrology and sedimentation rates in riparian and aquatic systems (Cal-IPC 2011a) and can degrade flood system effectiveness. Importantly, recent studies have shown that certain invasive plant species have greater impacts on channel conveyance than native

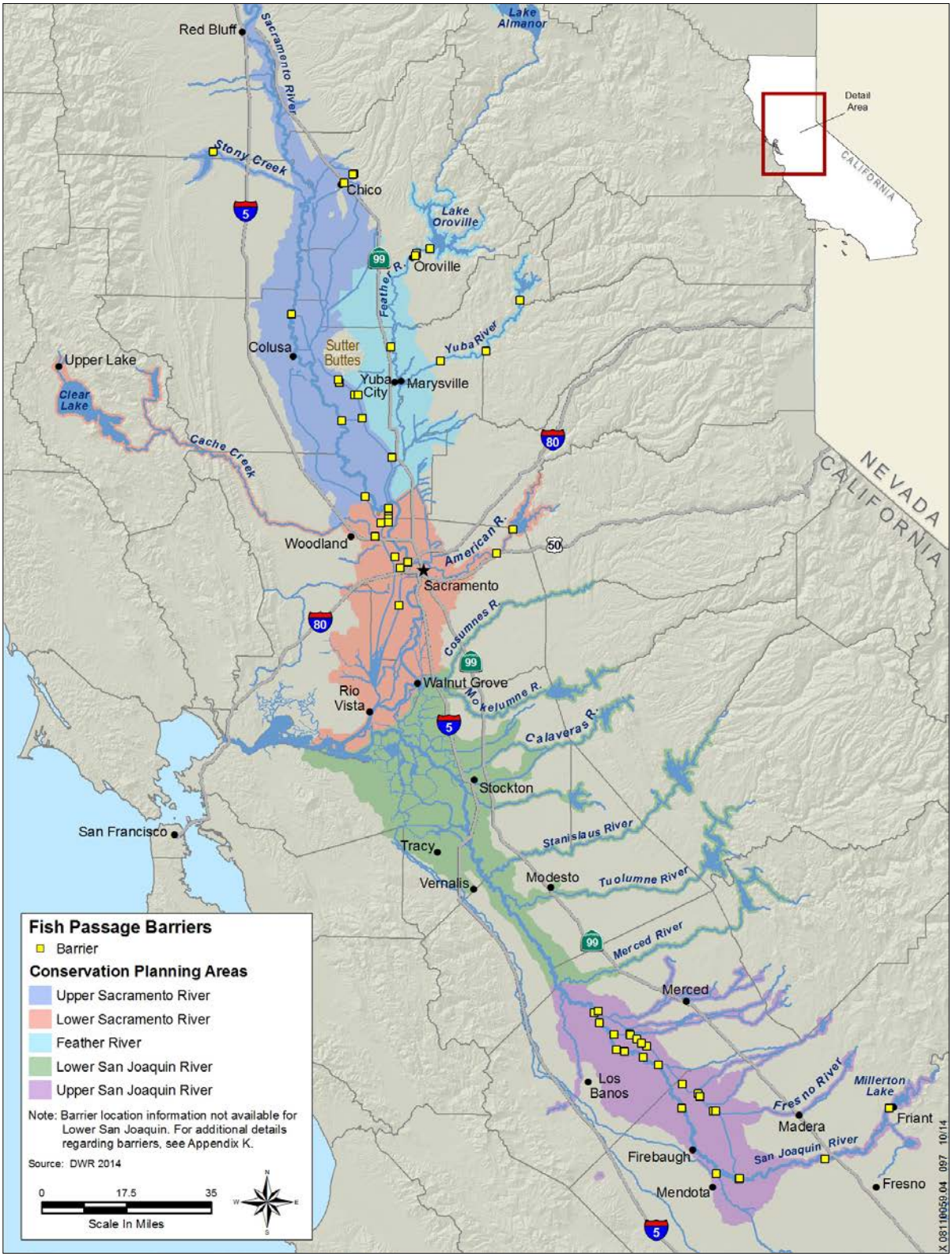


Figure 4-3. Documented Fish Passage Barriers

species adapted to the same areas (Stone et al. 2013). Dense stands of certain invasive species can alter channel morphology by retaining sediments and increasing the hydraulic roughness of the channel, which restricts flows and reduces flood conveyance (Bossard et al. 2000). For example, saltcedar traps and stabilizes alluvial sediments, narrowing stream channels and contributing to more frequent flooding (Bossard et al. 2000). Species with shallow root systems, such as giant reed and red sesbania, promote bank undercutting, collapse, and erosion (Bossard et al. 2000; Cal-IPC 2011b). Invasive terrestrial plants can reduce groundwater availability by transpiring large amounts of water, leaving less water available for native riparian vegetation (Bossard et al. 2000).

Invasive plants can also reduce the integrity of native riparian plant communities by outcompeting native plants, reducing habitat quality and food supply for wildlife, and interfering with wildlife management (Bossard et al. 2000; Cal-IPC 2011a). Aquatic invasive plants can degrade aquatic habitat by reducing areas of open water used by waterfowl for resting, by shading out algae in the water column and thereby diminishing the basis of the aquatic food web, and by displacing native aquatic plants that are used for food or shelter by wildlife (Bossard et al. 2000). In addition, invasive aquatic plants often form dense mats that kill fish by lowering pH, dissolved oxygen levels, and light levels and by increasing carbon dioxide levels (Bossard et al. 2000). Aquatic invasive plants further affect native fish, including salmonids, by providing habitat for nonnative predatory fish, such as largemouth bass. Lastly, large, dense beds of plants such as Brazilian waterweed trap sediment and thereby decrease turbidity, causing additional negative impacts on native fish (Interagency Ecological Program, Management, Analysis, and Synthesis Team 2015).

DWR has developed an approach to managing invasive plant species that is summarized in Section 6.2.3, “Invasive Plant Management,” and more fully described in Appendix E, “Invasive Plant Management Plan.” The plan, which is focused on Channel Maintenance Areas (described in the State Plan of Flood Control Descriptive Document [DWR 2010]), provides the framework for a regional, coordinated approach to managing invasive plants; identifies invasive plant species to prioritize for treatment; and recommends treatment methods.

Box 4-7
What Are Invasive Plants?

In this Strategy, *invasive plants* are plants that could adversely affect the Strategy's goals or public safety by compromising the O&M of the SPFC.

Source: H. T. Harvey & Associates.

In some cases, these species also meet California or federal definitions of *noxious weeds,* and many have been designated by the Cal-IPC's Invasive Plant Inventory (Cal-IPC 2014) as having severe ecological impacts on physical processes, plant or animal communities, and vegetation structure.

The photograph shows giant reed, which develops dense monocultures, displacing native plants, diminishing wildlife habitat, and increasing flooding and siltation (DiTomaso and Healy 2003, 2007).

5.0 Ecological Objectives

Because they are more specific than goals, objectives better describe a plan's desired outcomes. These more specific descriptions support project formulation, support funding and management decisions, and serve as yardsticks for measuring progress in implementation.

As guidance, this Strategy provides objectives that are specific and measurable, are intended to be attainable, are relevant to the SPFC, and include a time frame for achievement. They represent contributions to solving ecosystem problems (in particular, to recovery of native species) that may be achievable through implementation of multi-benefit projects and O&M during the 30-year time frame of the CVFPP. These objectives include contributions to the goals and objectives of other efforts that entail changes to the SPFC, and for this reason they are not necessarily in addition to the objectives of other related conservation plans.

There is considerable uncertainty regarding the number and extent of actions needed to solve ecosystem problems and regarding the potential for flood management activities to contribute to these solutions. Therefore, in conjunction with 5-year updates to the CVFPP, these objectives would be reevaluated and revised as necessary, based on improvements to scientific understanding and further evaluation of opportunities for multi-benefit flood projects (see also Section 8.0, "Implementation").

Box 5-1
What Are the Measurable Objectives?
This Conservation Strategy's objectives are to achieve enhancements of riverine and floodplain ecosystems (i.e., net improvements) through flood system modifications. They are specific and measurable, are intended to be attainable, are relevant to the SPFC, and include a 30-year time frame for achievement as guidance.

Their purpose is to inform implementation of the Conservation Strategy.

Attainment of these objectives, similar to the other objectives of the CVFPP, depends on future funding and on contributing actions by the multiple organizations implementing flood projects and operating and maintaining the SPFC. State policy reflected in the 2007 flood legislation indicates that the long-standing damage to the Central Valley's river and floodplain ecosystems should be addressed in part through the CVFPP, but sufficient funding has not yet been forthcoming. In fact, one of the largest challenges is that the primary source of funding for flood repairs and improvements has been Proposition 1E, which allows spending for mitigation, but not for ecosystem enhancement and restoration.

This section describes the basis for this Strategy's objectives and provides the objectives for each CPA, along with a summary of the regional conditions and conservation needs that these objectives address.

5.1 Basis of Objectives

Each objective addresses a targeted ecosystem process, habitat, or stressor in a CPA. The conservation needs of target species were a basis for these objectives; thus, separate objectives for target species were not developed.

Objectives also were not developed for levees and revetment. Various amounts of levee and revetment modification, removal, or relocation, combined with other actions, could provide benefits to ecosystem processes, habitats, and species. Therefore, needed changes to levees and revetment would be determined during project planning as means to enhance ecosystems, not as objectives in and of themselves. (Similarly, opportunities for wildlife-friendly agricultural practices to benefit target species also would be evaluated during project planning.)

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) is identified. The following sections describe the metrics and the basis for objective magnitudes.

5.1.1 Metrics for Ecological Objectives

Applicable metrics were selected from several sources: the Conservation Framework, supporting reports attached to the Conservation Framework (e.g., Attachment 9B, “Status and Trends of the Riparian and Riverine Ecosystems of the Systemwide Planning Area”), and documents relating to other Central Valley conservation efforts (DWR 2012a). Metrics were selected on the basis of several attributes:

- Relevance: Metrics are related to the Conservation Strategy’s goals and have implications for the management of conservation and flood risk management activities.
- Responsiveness: Metrics are capable of exhibiting changes in response to actions taken in the time frame required for adaptive management (e.g., within 5–10 years).
- Cost-effectiveness: Individually and collectively, measuring the metrics will involve a reasonable expenditure relative to other metrics that could effectively assess progress and inform management decisions.
- Reliability of interpretation: Changes in the metrics will reliably and clearly document the results of Conservation Strategy implementation (as opposed to other causes, such as environmental fluctuations) and will highlight the types of changes that are needed in the Strategy’s ongoing implementation.
- Transparency/ease of communication: As a set, the metrics will tell a clear and concise story to a broad cross section of the interested public about the progress and results of Conservation Strategy implementation.

An additional consideration related to cost-effectiveness is the availability of an existing set of regional or systemwide data, already maintained and updated by DWR or another organization.

The selected metrics are summarized in Table 5-1; the table correlates this Strategy's goals to the applicable targets and to the way in which accomplishments concerning each goal and target would be measured (i.e., the metric). Section 8.1.2, "Monitoring," provides additional information about these metrics, including regional and project-scale data sources and data providers, and the anticipated frequency of updates to regional data sets.

Table 5-1. Metrics for Ecosystem Process, Habitat, and Stressor Objectives

Goal	Targeted Ecosystem Process, Habitat, or Stressor	Metric
Ecosystem Processes. Improve dynamic hydrologic and geomorphic processes.	**Floodplain Inundation**	**Inundated Floodplain—total amount (acres) of 50-percent flows (i.e., a 2-year event) with 14-day or longer duration during December–May:** This is a metric of the amount of inundated floodplain benefiting riverine ecosystems and, in particular, target fish species. These amounts are derived from hydraulic modeling using data developed for planning flood management projects.
	Riverine Geomorphic Processes	**Natural Bank—total length (miles):** Natural bank is a component of SRA cover and bank habitat and is necessary for migration of a river channel. Its length is related to the area of floodplain potentially reworked by channel migration (river meander). The length of natural bank can be readily measured from imagery, topographic data, and DWR-maintained inventories of revetment.
		River Meander Potential—total amount (acres): Movement of a river channel across its floodplain regenerates channel and floodplain habitats. River meander potential is the area of floodplain that has the potential to be reworked by the meandering channel because it is within the river's natural meander zone, not underlain by substrates resistant to erosion and not isolated by revetted banks or levees (project and nonproject). Areas with river meander potential can be cost-effectively mapped using aerial photography, inventories of revetment and levees, and existing geologic/soils data.
Habitats. Increase and improve quantity, diversity, and connectivity of riverine aquatic and floodplain habitats.	**SRA Cover**	**Natural Bank—total length (miles):** See natural bank description under "Riverine Geomorphic Processes," above.
		Riparian-Lined Bank—total length (miles): Riparian-lined banks are natural or revetted banks bordered by trees and shrubs. Riparian-lined banks are an attribute of SRA cover, and because SRA cover exists only along channel margins, length is a direct measure of its quantity. Mapping of riparian-lined banks is related to the mapping of riparian vegetation, natural bank, and revetment, all of which DWR inventories for multiple purposes.
	Riparian	**Habitat Amount—total amount (acres) in floodways:** The area of riparian vegetation (i.e., riparian forests, woodlands, and scrub) is a direct measure of its quantity. DWR has mapped this vegetation in the Sacramento and San Joaquin Valleys.

Table 5-1. Metrics for Ecosystem Process, Habitat, and Stressor Objectives

Goal	Targeted Ecosystem Process, Habitat, or Stressor	Metric
	Marsh (and Other Wetlands)	**Habitat Amount—total area (acres) in floodways:** The area of marsh and other wetlands is a direct measure of their quantity. DWR has mapped this vegetation in the Sacramento and San Joaquin Valleys.
Stressors. Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.	**Fish Passage Barriers**	**Fish Passage Barriers—number of high-priority barriers remediated:** This metric documents the number of high-priority barriers modified to improve passage. DWR has inventoried and prioritized barriers in the Sacramento Valley and inventoried barriers in the San Joaquin Valley (DWR 2014a). (San Joaquin Valley barriers have not yet been prioritized.) This inventory will be updated to support multiple programs. (It is important to recognize that, even among high-priority barriers, there is a range of effects on fish migration.)
	Invasive Plants	**Invasive Plant–Dominated Vegetation in Channel Maintenance Areas—total area reduced (acres):** Land identified as Channel Maintenance Areas in the SPFC Descriptive Document (DWR 2010) includes areas dominated by invasive plants. For species prioritized for treatment, this metric measures reduction in the extent of infested areas that affect both ecosystem targets and O&M of the SPFC. DWR has mapped this vegetation in the Sacramento and San Joaquin Valley.

Source: Data compiled by DWR in 2012.
Key: DWR = California Department of Water Resources; O&M = operations and maintenance; SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.
Note: Target species needs were a basis for process, habitat, and stressor objectives and thus are not represented by separate objectives. Amounts of levee and revetment modification would be determined during project and plan formulation as a means of providing needed improvements to processes, habitats, and other stressors; thus, objectives were not established for these two stressors.

5.1.2 Enhancement Amounts for Ecological Objectives

Enhancement amounts have been based on conservation needs and the opportunities for multi-benefit projects to provide that needed conservation. There is a moderate to high level of uncertainty regarding the size of conservation needs and regarding the scale and feasibility of potential opportunities. Therefore, the objectives provided in the following sections would be reevaluated and revised as necessary during implementation to support effective conservation and wise use of State funds.

With the exception of objectives for invasive plants and fish passage barriers, the size of ecological objectives has been determined as follows:

1) **Synthesize conservation needs identified by recovery planning**. Existing plans for the recovery of target species have identified multiple actions and outcomes needed for species recovery (see plan summaries in Appendix J, “Existing Conservation Objectives from Other Plans”). These identified needs were compiled and synthesized to determine

the enhancements to river and floodplain ecosystems necessary for recovery of this Strategy's target species. Where there was ambiguity in existing plans, or uncertainty about the changes necessary to meet a need, a likely range of values was estimated, and the basis for that range documented. The scientific literature that provides the basis for the needs in recovery plans and their interpretation is synthesized in Appendix G, "Identification of Target Species and Focused Conservation Plans."

2) **Estimate extent of conservation opportunities indicated by flood planning.** Throughout the SPFC, multi-benefit flood projects by flood management agencies could provide ecosystem improvements. The potential extent of these opportunities for providing needed conservation was estimated from an evaluation conducted for the Strategy (see Appendix I, "Floodplain Restoration Opportunity Analysis") and preliminary data from the BWFSs. Because of the preliminary nature of the data used, ranges were estimated for the size of potential opportunities.

This evaluation of conservation needs and opportunities was conducted with input and review from a technical advisory workgroup composed of resource agency and stakeholder representatives. Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities," documents the evaluation.

Where identified needs for improvement of river and floodplain ecosystems are smaller than the potential contributions of multi-benefit flood projects, the size of the objective corresponds to the size of the need for recovery of target species. Where identified needs are greater than the potential contributions of multi-benefit flood projects, the objective corresponds to the potential contribution of multi-benefit flood projects to species recovery needs. In other words, objectives are based on realizing potential contributions to unmet conservation needs.

A significant limitation of this basis for the objectives is the moderate level of uncertainty that exists regarding the size of conservation needs and potential opportunities (see Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities"). This limitation would be addressed by the periodic reevaluation and revision of this Strategy's objectives. As previously stated, these objectives would be subject to revision during 5-year updates to the CVFPP. Section 8.1, "Adaptive Management," describes this evaluation and revision process.

Objectives for invasive plants and fish passage barriers are based, respectively, on Appendix E, "Invasive Plant Management Plan," and Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System." The Invasive Plant Management Plan prioritizes invasive species for management, evaluates opportunities for actions, and provides objectives for reducing the extent of invasive plant infestations. (These objectives are based on infestations of at least 1 acre in size of invasive plants that were detectable by the remote sensing techniques used.) The Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System identifies structures that potentially impede fish passage and prioritizes them for remediation, based in part on the potential benefits for anadromous fish.

For each CPA, the following section includes a summary of the conservation needs and opportunities and of the corresponding objectives.

5.2 Regional Conditions, Needs, and Objectives

For each of the five CPAs, the following sections summarize existing conditions (based primarily on information in Appendix F, "Existing Conditions") and describe major conservation issues in the region and approaches for resolving them. Additional information on existing conditions is provided in Appendix F. Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities," provides information on historical conditions.

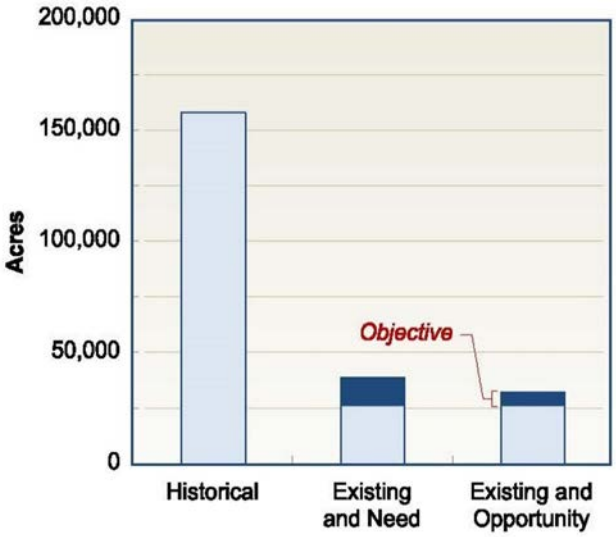
The CPAs were introduced in Section 1.2, "Geographic Scope." These CPAs represent major regions that differ in regard to their natural resources and CVFPP activities. They also correspond to one or more RFMP regions. Within the CPAs, most SPFC facilities and CVFPP actions are concentrated in corridors of land along major rivers, bypasses, and other waterways. These corridors encompass only a portion of the CPAs and differ in their natural resources. Therefore, for describing existing conditions and conservation issues, each CPA is divided into landscape units that distinguish corridors with distinct combinations of habitats and SPFC facilities (Figure 5-1). This classification consists of seven types of landscape units, four of which are located on the floor of the Sacramento and San Joaquin Valleys and three of which are found in the surrounding foothills and Inner Coast Ranges:

- Landscape units of the Sacramento and San Joaquin Valleys:
  - Major River Reach: Approximately 2-mile-wide corridors of land (i.e., corridors extending 1 mile to each side of the river's centerline) along the Feather, Sacramento, and San Joaquin Rivers and the lowermost reaches of major tributaries
  - Basin/Bypass: Land in a flood basin or bypass, plus an adjacent 0.5-mile-wide buffer outside the bordering levees
  - Other Facility/Waterway: One-mile-wide corridors of land (i.e., corridors extending 0.5 mile to each side of the facility's centerline) along SPFC levees (and Urban Levee Evaluation nonproject levees) in the Sacramento and San Joaquin Valleys that are not part of any of the preceding types of landscape units
  - Other Valley SPA: The remainder of the CPA in the Sacramento and San Joaquin Valleys that is not part of a bypass, basin, or otherwise classified corridor
- Landscape units of the foothills and Inner Coast Ranges:
  - Lake/Reservoir: Lakes and reservoirs behind dams in the foothills, representing the uppermost extent of the SPA

- Foothill Tributary: One-mile-wide corridors along tributaries extending from reservoirs in the foothills to major river reaches on the valley floor
- Outlying Community: One-mile-wide corridors along SPFC facilities protecting communities located outside of the Sacramento and San Joaquin Valleys (e.g., at Upper Lake and Chester)

For each of these landscape units, existing conditions for each targeted ecosystem process, habitat, and stressor are described by CPA in Appendix F, "Existing Conditions."

Box 5-2
Setting Objectives Based on Opportunities to Contribute to Conservation Needs



Objectives have been set to realize opportunities to contribute needed conservation.

In the example shown, the historical and existing amounts of riparian vegetation are displayed as light blue bars. The additional amount of riparian vegetation needed and the size of restoration opportunities are displayed as dark blue bars. The additional amount needed to meet species' recovery needs is more than multi-benefit flood projects could likely restore. Therefore, the objective is set to the estimated size of opportunities to restore riparian vegetation. If the potential contributions of flood projects had been greater than the need, the objective would have been set to match the size of the estimated need.

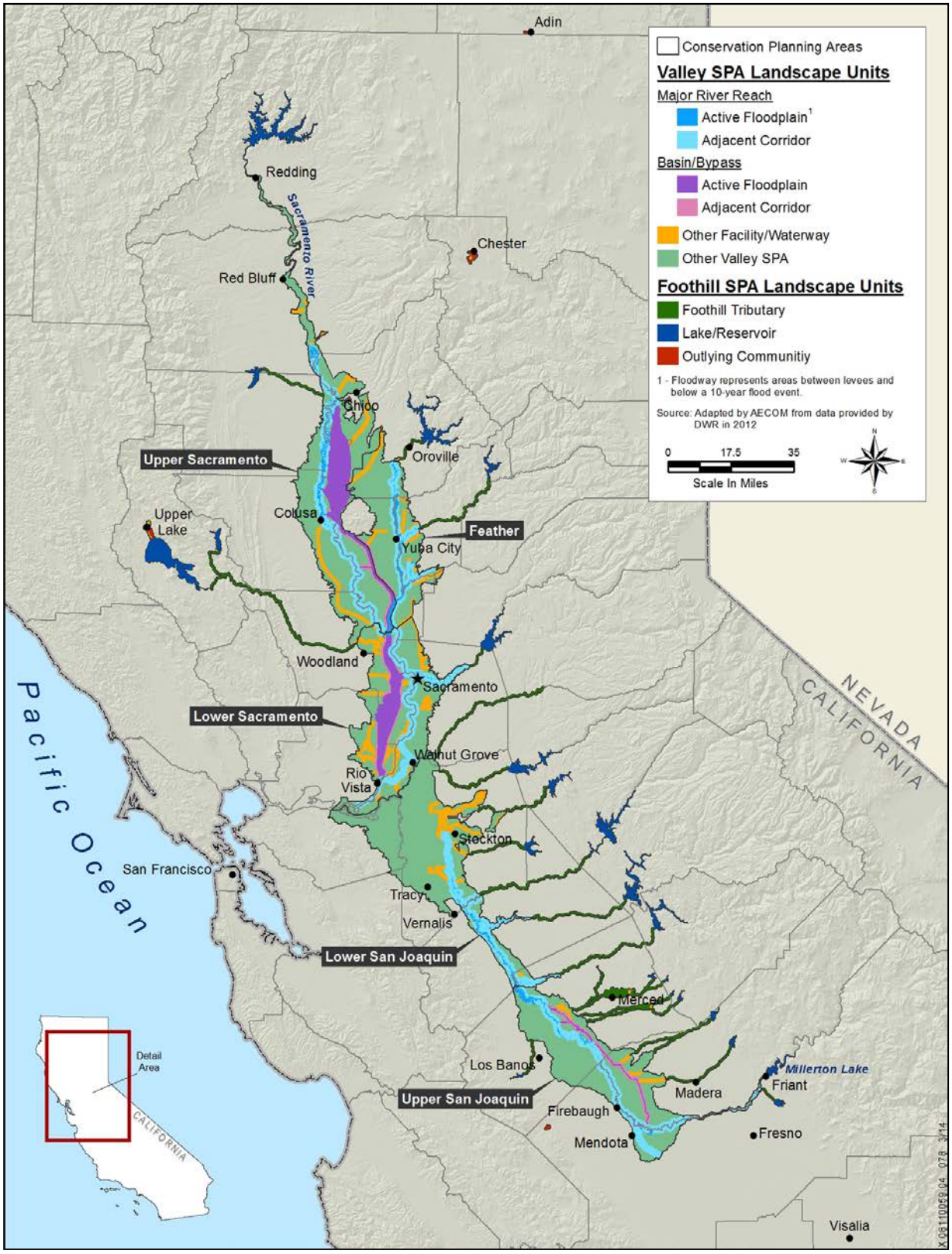


Figure 5-1. Landscape Units of the Conservation Planning Areas

5.2.1 Upper Sacramento River CPA

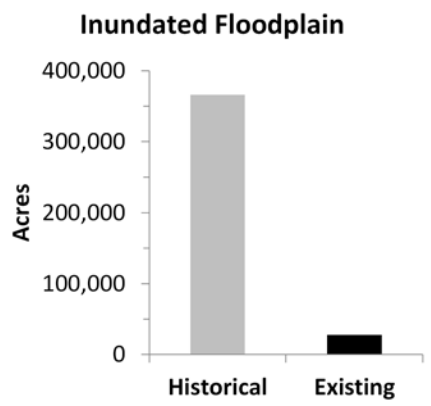
Summary of Existing Conditions

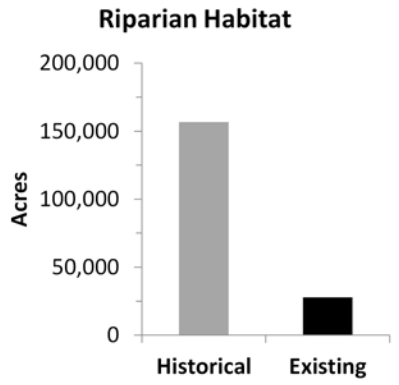
From Red Bluff to Colusa, the Sacramento River is a broadly meandering river with SPFC levees ranging from 0.2 to 1.7 miles apart downstream of Ord Ferry. The landforms bordering the river are natural levees of deposited sediment, beyond which lowland basins cover much of the valley floor. The land surface of the basins in the Sacramento Valley is lower in elevation than the floodplains directly along the river. Historically, the river flowed through openings in the natural levees during overbank events (James and Singer 2008). Currently, the Butte Basin is connected to the Sutter Bypass, which conveys flow from the Sacramento River to the bypass's junction with the Feather River and its subsequent junction with the Sacramento River downstream.

Figure 5-2 shows the Upper Sacramento River CPA. The predominant facilities of the SPFC in the Upper Sacramento River CPA include the Butte Basin Overflow Area, Moulton Weir, Colusa Weir, Tisdale Weir, Butte Slough, Sutter Bypass, and levees along the river and associated revetment. Downstream from Colusa, the levees are often less than a quarter mile apart.

Table 5-2 provides a summary of existing conditions along major river reaches in this CPA with regard to each objective of this Conservation Strategy. Riverine and floodplain ecosystems have been substantially altered in the Upper Sacramento River CPA (although less so than in other CPAs). For example, along the upper Sacramento River, approximately two-thirds of the floodplain potentially inundated by a 50-percent-chance event (i.e., with a 50-percent-chance floodplain inundation potential [FIP]) is disconnected from the river, primarily by levees. Also, the rearing habitat for Chinook salmon provided by inundated floodplains has been reduced by approximately 96 percent (see Appendix H). Similarly, the potential area across which the channel could meander (the meander potential) has been reduced, primarily by revetment, to roughly one-half of what it would be under unconstrained conditions.

Box 5-3
Historical vs. Existing Inundated Floodplain and Riparian Habitat in the Upper Sacramento River CPA





Sources: Appendix H, The Bay Institute 2003, DWR 2011.

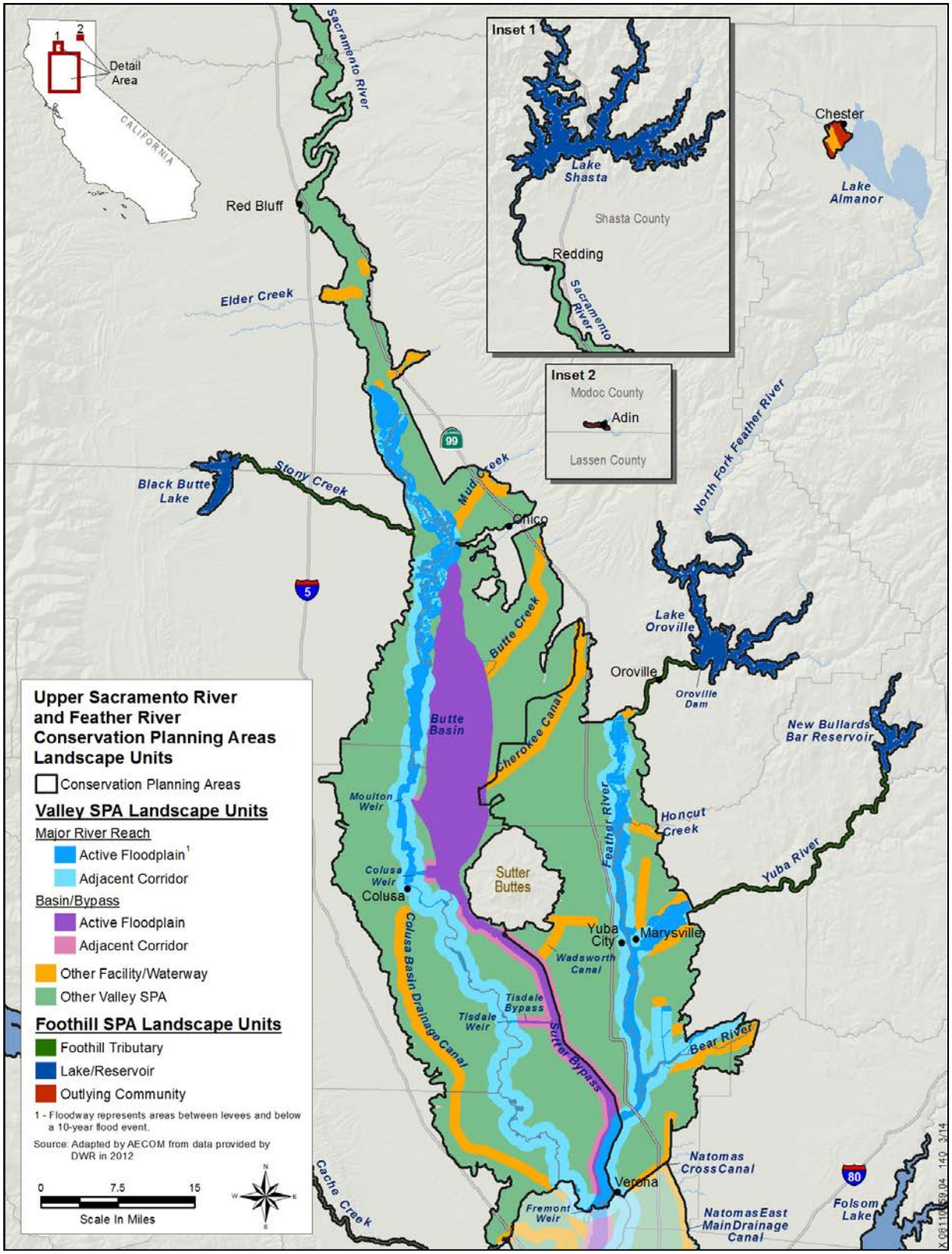


Figure 5-2. Upper Sacramento River and Feather River Conservation Planning Areas

Table 5-2. Existing Conditions along Major River Reaches in the Upper Sacramento River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors

Goal Topic	Target: Metric	Existing Conditions (2012)[1]
Ecosystem processes	Floodplain inundation: inundated floodplain—major river reaches[2]	8,900 acres—8% of historical area
	Floodplain inundation: inundated floodplain—bypasses/transient storage areas[2]	19,000 acres—Note: Additional 98,900 acres inundated, but less frequently than 50 percent of years for 14 days or longer
	Riverine geomorphic processes: natural bank[3]	222 miles—67% of riverbank
	Riverine geomorphic processes: river meander potential	39,700 acres—51% of meander corridor
Habitats	SRA cover: natural bank[3]	222 miles—67% of bank total
	SRA cover: riparian-lined bank	108 (natural) + 54 (revetted) miles—49% of riverbanks
	Riparian[4]	27,000 acres—29% of active river floodplain and 6% of bypasses
	Marsh (and other wetlands): nontidal marsh[4]	2,900 acres—1% of active river floodplain and 2% of bypasses
	Marsh (and other wetlands): tidal marsh	Not applicable
	Marsh (and other wetlands): seasonal wetlands	28,400[4] acres—<1% of active river floodplain and 22% of bypasses
Stressors	Revetment	112 miles—33% of riverbank
	Levees: project	203 miles—88% in meander corridor and 69% condition of higher concern
	Levees: nonproject	45 miles—70% in meander corridor
	Fish passage barriers: Priority 1 and 2 SPFC barriers	5 barriers
	Invasive plants: area infested by prioritized invasive plant species[5]	1,162 acres in SPA (269 acres in Channel Maintenance Areas)

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal", Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and DWR 2011.

Key: SPA = Systemwide Planning Area; SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.

Notes:

1 Values are for major river reaches, except where noted, and have been rounded to the nearest 50 acres and 1 mile, excluding invasive plant infestations, which are provided to the nearest acre.

2 Area inundated by 2-year, 14-day or longer flows, December–May.

3 This condition is provided under both riverine geomorphic processes and SRA cover.

4 Acreage represents amount within 1 mile of the river and within Butte Basin, Butte Slough, and Sutter Bypass. Percentages of "active floodplain" are for the floodplain inundated by a 10-year (10-percent-chance) event.

5 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Upstream and downstream of Colusa, there are considerable differences in the floodplain's connectivity and the channel's potential to meander. Upstream of Colusa, 55 percent of the floodplain with a 50-percent-chance FIP is disconnected from the Sacramento River; downstream of Colusa, nearly 90 percent is disconnected. Similarly, meander potential is 63 percent upstream of Colusa, but only 17 percent downstream.

The extent of riparian and marsh habitats on floodplains has been substantially reduced in the Upper Sacramento River CPA. Riparian vegetation occupies only a small portion of floodplains that historically were dominated by riparian vegetation. Along the upper Sacramento River, riparian vegetation accounts for approximately one-eighth of the land cover within 1 mile of the river and for nearly 30 percent of the active (10-year) floodplain. Natural banks with riparian vegetation still account for almost one-third of the channel bank.

Marsh and other wetlands were the predominant vegetation of flood basins historically. Most wetlands were drained and converted to other land covers, primarily for agricultural use. Marshes and other wetlands now occupy 1 percent of land within 1 mile of the upper Sacramento River and about 24 percent of land in Butte Slough, Butte Basin, and the Sutter Bypass.

Conservation Needs, Opportunities, and Objectives

In the Upper Sacramento River CPA, the alterations of ecosystem processes and habitats described above have contributed to the population declines of 11 targeted species (not including those known only from historical records or whose distribution in this CPA is poorly documented):

- Valley elderberry longhorn beetle
- Steelhead (California Central Valley DPS)
- Chinook salmon, Central Valley fall-/late fall–run Evolutionarily Significant Unit (ESU)
- Chinook salmon, Central Valley spring-run ESU
- Chinook salmon, Sacramento River winter-run ESU
- Green sturgeon (southern DPS)
- Giant garter snake
- Bank swallow
- Greater sandhill crane
- Swainson's hawk
- Western yellow-billed cuckoo

To facilitate the recovery of these and other native species, multiple conservation plans include objectives and actions calling for the restoration of ecosystem processes and habitats in the Upper Sacramento River CPA (see Appendix J, "Existing Conservation Objectives from Other Plans"). These objectives include establishment of more continuous corridors of riparian vegetation and SRA cover along the upper Sacramento River, creation of a river meander zone upstream of Colusa, and improvement of fish passage (CDFG 1992; Sacramento River Advisory Council [SRAC] 2003; Central Valley Joint Venture [CVJV] 2006; NMFS 2014, Bank Swallow Technical Advisory Committee [BANS-TAC] 2013). (Comparable restoration [e.g., creation of a river meander zone] downstream of Colusa also would benefit species but is constrained by the close proximity of levees to the river channel.) Furthermore, to support the AFRP's "doubling goal" for Chinook salmon, more than 20,000 acres of additional rearing habitat on inundated floodplains are required (see Appendix H). Public agencies (including DWR) and nonprofit organizations have been investing in restoration actions to help attain these objectives, particularly north of Colusa. This restoration has made a substantial contribution toward overall conservation needs for aquatic and riparian habitats in this CPA.

Box 5-4
River Meander and the Recovery of Target Species

Recovery of anadromous fish, bank swallow, western yellow-billed cuckoo (shown in photograph), and other species depends in part on increasing the ability of river channels to move across the floodplain (river meander). River meander sustains cut banks that are nesting habitat for bank swallows; provides fish with migration and rearing habitat, refuge from predators, and additional spawning gravels in river beds; and sustains early successional and overall diversity of riparian habitat required by western yellow-billed cuckoos. Table 5-3 identifies a need for additional meander potential based on required habitat for bank swallow recovery. Western yellow-billed cuckoo and salmonid needs may be up to twice as large, but are more uncertain.

Source: H. T. Harvey & Associates.

Portions of the flood management system, and the need for flood protection that they fulfill, constrain further implementation of conservation plans. For example, there are 112 miles of revetment located along waterways downstream of Red Bluff in the Upper Sacramento River CPA, much of it protecting SPFC levees and other levees. This revetment blocks the formation of cut banks, which are an attribute of SRA cover for salmonids and provide nesting habitat for bank swallows. Thus, revetment has degraded habitat for these species and conflicts with habitat restoration. Similarly, the flood management system and the need for flood protection currently constrain the establishment of continuous corridors of riparian vegetation along the upper Sacramento River.

In addition, several SPFC and non-SPFC structures have been impeding fish passage. In addition to dams at multipurpose reservoirs, these structures include:

- Tisdale Weir in the Tisdale Bypass
- Moulton Weir in the Butte Basin Overflow Area
- Weir No. 1 (Parks Weir) on the West Canal of the Sutter Bypass
- One Mile Dam and Sycamore Pool on the lower Big Chico Creek
- Lindo Channel diversion structure at Lindo Channel

These structures have been identified as priorities for remediation (Priority 1 or 2, see Appendix K).

Implementing multi-benefit projects could reduce these constraints and enhance river and floodplain ecosystems. In this CPA, potential major physical and operational elements being evaluated for the CVFPP include expansion of the Sutter Bypass, upgrade and modification of the Colusa Weir and Tisdale Weir, improvements to small weirs in the Butte Basin, fish passage improvements at Deer Creek and the Sutter Bypass, construction of the Feather River Bypass, and levee setbacks at selected locations (Table 3-2 in DWR 2012b). In addition, the CVFPP includes construction or improvement of selected levee segments along mainstem rivers to achieve 200-year protection for urban areas, 100-year protection for small communities, and improved flood protection for rural-agricultural areas (DWR 2012b).

Also, the CVFPP includes investigating whether to modify the function and operation of weirs that spill floodwaters to the Butte Basin and Sutter Bypass. If the crests of overflow weirs are physically lowered or notched and weir operations are modified, bypasses could carry a larger fraction of flood flows, discharge overflow earlier in each flood season and during individual flood events, and continue to discharge for longer durations. The more frequent and longer inundation of the bypasses could provide more productive rearing habitat for juvenile salmonids and other native fish. However, in addition to habitat effects, CVFPP investigations of modifications to weir operations would also consider effects on public safety and current land uses—in particular, the economic viability of agriculture, which is strongly affected by growing-season length, water supply, and drainage.

These elements and O&M activities would enhance this CPA's river and floodplain ecosystems. Table 5-3 provides estimates of these potential contributions and related recovery needs of target species; the corresponding objectives for the Upper Sacramento River CPA are also provided. The bases and development of these objectives are described in Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

The focused conservation plans in Appendix G identified design criteria (additional specificity) to increase the benefits of projects for target species. The criteria applicable to this CPA are listed by objective in Table 5-4. Ecosystem improvements should meet these criteria.

Table 5-3. Conservation Needs, Potential Opportunities, and Objectives in the Upper Sacramento River Conservation Planning Area

Goal Objective: Metric	Additional Need[1]	Potential Opportunity[1]	Objective Amount[1]	Notes
Ecosystem processes				
Floodplain inundation: inundated floodplain—major river reaches Area inundated by 2-year, 14-day or longer flows, December–May (acres)	106,500	4,000–8,500	6,300	Opportunity includes all reconnected land, not just portion with frequent, sustained inundation
Floodplain inundation: inundated floodplain—bypasses/transient storage areas (acres)	Included in rivers above	9,600	9,600	Potentially inundated in 50% of years or more frequently for 14 days or longer
Riverine geomorphic processes: natural bank[2] (miles)	44	17–22	20	—
Riverine geomorphic processes: river meander potential (acres)	9,500	3,600–7,600	5,600	To meet bank swallow needs; western yellow-billed cuckoo and salmonids may require more, but their needs are more uncertain
Habitats				
SRA cover: natural bank[2] (miles)	44	17–22	20	—
SRA cover: riparian-lined bank (miles)	0–170	6–9	8	Need has a high level of uncertainty
Riparian habitat (acres)	11,400	2,000–4,700	3,400	With grassland inclusions
Marsh/other wetland habitat (acres)	12,900	2,400	2,400	With inclusions of upland vegetation
Stressors				
Fish passage barriers: channel-wide structures	8	5	5	Need consists of channel-wide barriers; opportunity includes all Priority 1 and 2 barriers
Invasive plants: prioritized species (infested acres)[3]	1,159	268	268	Opportunity is in Channel Maintenance Areas

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

Key: SRA = shaded riverine aquatic.

Notes:

[1] Values have been rounded to the nearest 100 acres and 1 mile, excluding invasive plant acreages, which are provided to the nearest acre.

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

[3] Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Table 5-4. Summary of Specificity Added to Upper Sacramento River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery

Objective Topic	Specificity Added to Maximize Contribution to Targeted Species Recovery
Floodplain Inundation	• Sustain inundation for 14 days or longer between late November and late April to benefit anadromous fish • Modify floodplain topography to minimize stranding potential • Eliminate or modify ditches potentially trapping fish
Riverine Geomorphic Processes	[No additional specificity identified.][1]
SRA Cover	• Avoid degradation of bank swallow habitat when restoring SRA or near-channel vegetation
Riparian	• Incorporate elderberry shrubs into habitat restored in riparian areas, especially within 12 miles of habitat occupied by valley elderberry longhorn beetle • Establish large trees in close proximity to field and row crops to provide Swainson's hawk nesting habitat • Restore patches of riparian habitat greater than 100 acres in size and 660 feet in width to provide high-quality habitat for western yellow-billed cuckoo, where there is potential for occupancy
Marsh (and Other Wetlands)	• Restore marsh to be inundated throughout the active season for giant garter snake (mid-March–October) and, where feasible, in 539-acre or larger blocks within 5 miles of and connected to comparable or larger areas of marsh by habitat corridors at least 0.5 mile wide • Minimize potential for submerged aquatic vegetation in restored marsh because it reduces habitat value for target species • Include refugia and basking sites for giant garter snake in restored marsh • Restore marsh and seasonal wetland that is shallowly flooded (less than 6 inches in depth) to provide habitat for greater sandhill crane
Fish Passage Barriers	• Remediate the following structures to improve fish passage (see Appendix K): - Tisdale Weir in the Tisdale Bypass - Moulton Weir in the Butte Basin Overflow Area - Weir No. 1 (Parks Weir) in the West Canal of the Sutter Bypass - One Mile Dam and Sycamore Pool in the lower Big Chico Creek - Lindo Channel diversion structure at Lindo Channel
Invasive Plants	[No additional specificity identified.][1]

Sources: Appendix G, "Identification of Target Species and Focused Conservation Plans," and Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System."

Key: SRA = shaded riverine aquatic.

Note:

[1] Focused conservation plans for targeted species do not identify additional specificity as being necessary to maximize contribution of this objective to recovery of species. Lack of additional specificity does not imply lesser importance for species recovery. Objectives making a major contribution to species recovery (e.g., riverine geomorphic processes) simply may not require additional design criteria to be effective.

Collaboration with other conservation efforts will increase the efficiency and effectiveness of restoration actions. In the Upper Sacramento River CPA, major opportunities for collaboration include working with CDFW and USFWS, which manage wildlife areas and refuges along the Sacramento River; with the California Department of Parks and Recreation, which manages recreation areas and parks along the Sacramento River; with LMAs; and with nonprofit organizations, such as TNC, that have invested in restoring riverine and floodplain processes in

the area. DWR may also collaborate with the Sacramento River Forum to develop restoration planning and project designs that address local and regional concerns.

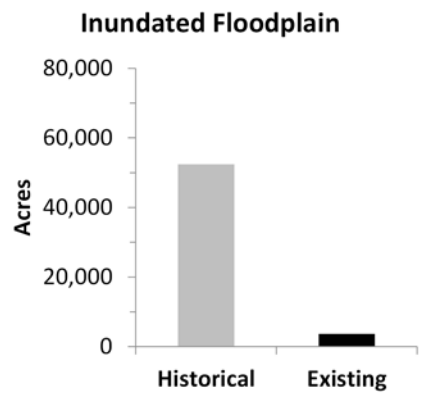
5.2.2 Feather River CPA

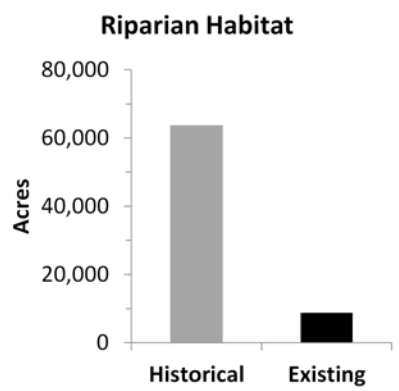
Summary of Existing Conditions

The Feather River CPA, shown in Figure 5-2, encompasses the lower Feather River from Oroville Dam to its confluence with the Sutter Bypass. Its major tributaries are Honcut Creek, the Yuba River, the Bear River, and the Sutter Bypass. The Feather River and lower reaches of the Bear and Yuba Rivers have sinuous channels (although sinuosity was reduced from historical conditions by mining). Floodplain features in this CPA also include remnant channels, some of which have become seasonal or perennial lakes or wetlands. SPFC facilities in the Feather River CPA include the channels and levees along the lower Feather River, along lower Honcut Creek, surrounding Marysville, the downstream reaches of the Yuba River and Bear River, the West Intercepting Canal, the East Intercepting Canal, Wadsworth Canal, and the east levee of the Sutter Bypass.

Table 5-5 provides a summary of existing conditions along major river reaches in this CPA with regard to each objective of this Conservation Strategy. Riverine and floodplain ecosystems have been substantially degraded in the Feather River CPA. Massive sediment deposition from hydraulic mining in the upper watersheds, dredging of cutoff channels, and postmining incision have reduced channel width and sinuosity and created floodplains that are relatively high above the channel compared to the premining era (James et al. 2009). Along the Feather River and lower reaches of the Bear and Yuba Rivers, levees isolate a little more than one-half of the floodplain potentially inundated by a 50-percent-chance event. Moreover, along the lower Feather River, only a very small portion (less than 2 percent) of the floodplain receives sustained winter or spring inundation, and the rearing habitat for Chinook salmon provided by inundated floodplains has been reduced by roughly 98 percent (see Appendix H).

Box 5-5
Historical vs. Existing Inundated Floodplain and Riparian Habitat in the Feather River CPA





Sources: Appendix H, The Bay Institute 2003, DWR 2011.

Channel migration has also been reduced in this CPA, particularly along the Feather River. River flows that erode banks have been reduced, as has the length of natural bank, and levees and revetment isolate about one-quarter of the natural meander zone from the river channel.

Table 5-5. Existing Conditions along Major River Reaches in the Feather River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors

Goal Topic	Target: Metric	Existing Conditions (2012)[1]
Ecosystem processes	Floodplain inundation: inundated floodplain—major river reaches[2]	3,700 acres—7% of historical area
	Floodplain inundation: inundated floodplain—bypasses/transient storage areas[2]	Not applicable
	Riverine geomorphic processes: natural bank[3]	122 miles—89% of riverbank
	Riverine geomorphic processes: river meander potential	20,100 acres—55% of meander corridor
Habitats	SRA cover: natural bank[3]	122 miles—89% of bank total
	SRA cover: riparian-lined bank	73 (natural) + 10 (revetted) miles—61% of riverbanks
	Riparian[4]	8,800 acres—27% of active river floodplain
	Marsh (and other wetlands): nontidal marsh[4]	400 acres—1% of active river floodplain
	Marsh (and other wetlands): tidal marsh	Not applicable
	Marsh (and other wetlands): seasonal wetlands[4]	300 acres—1% of active river floodplain
Stressors	Revetment	14 miles—11% of riverbank
	Levees: project	120 miles—64% in meander corridor and 59% condition of higher concern
	Levees: nonproject	32 miles—57% in meander corridor
	Fish passage barriers: Priority 1 and 2 SPFC barriers	1 barrier
	Invasive plants: area infested by prioritized invasive plant species[5]	451 acres in SPA (256 acres in Channel Maintenance Areas)

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and DWR 2011.

Key: SPA = Systemwide Planning Area; SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.

Notes:

1 Values are for major river reaches, except where noted, and have been rounded to the nearest 50 acres and 1 mile, excluding invasive plant infestations, which are provided to the nearest acre.

2 Area inundated by 2-year, 14-day or longer flows, December–May.

3 This condition is provided under both riverine geomorphic processes and SRA cover.

4 Acreage represents amount within 1 mile of the Feather River and lower reaches of Yuba and Bear Rivers. Percentages of "active floodplain" are for the floodplain inundated by a 10-year (10-percent-chance) event.

5 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

In addition to reductions in floodplain inundation and channel migration, the extent of riparian habitat has been substantially reduced. In the Feather River CPA, riparian vegetation historically covered roughly one-third of the land cover within 1 mile of rivers and waterways (The Bay Institute 1998), but today it covers only 10 percent of this land. However, two-thirds of the channel banks are lined with riparian forest (USACE 2007). Furthermore, in contrast with conditions in other CPAs, most banks in the Feather River CPA that lack riparian vegetation are not protected by revetment; rather, revetment covers only 11 percent of banks (Table 5-5 and Appendix F).

Conservation Needs, Opportunities, and Objectives

The alterations of ecosystem processes and habitats described above have contributed to the population declines of 10 targeted species (not including those known only from historical records or whose distribution in this CPA is poorly documented):

- Valley elderberry longhorn beetle
- Steelhead (California Central Valley DPS)
- Chinook salmon, Central Valley fall-/late fall–run ESU
- Chinook salmon, Central Valley spring-run ESU
- Green sturgeon (southern DPS)
- Giant garter snake
- Bank swallow
- Greater sandhill crane
- Swainson’s hawk
- Western yellow-billed cuckoo

To facilitate the recovery of these and other native species, multiple conservation plans include objectives and actions calling for establishment of more continuous corridors of riparian vegetation and SRA habitat along the Feather River, increases in river meander and floodplain inundation, and improvement of fish passage (e.g., USFWS 2001, CVJV 2006, BANS-TAC 2013, and NMFS 2014). For example, to support the AFRP doubling goal for Chinook salmon, approximately 10,000 acres of additional rearing habitat on inundated floodplains are required (see Appendix H).

The presence of 120 miles of SPFC levees (and 32 miles of other levees) and 14 miles of associated revetment in this CPA constrains the attainment of these objectives because most of these structures contribute to the impairment of ecosystem processes. However, public agencies (including DWR) have been investing in actions that support conservation. In particular, setback

levees have been constructed recently in this CPA (the Three Rivers Levee Improvement Authority's [TRLIA's] Feather River, Star Bend, and Bear River setback levees), creating additional capacity, increasing the area of active floodplain, and providing opportunities for restoration of riparian and floodplain habitat.

These setback levees allow for the removal of revetment and the addition of considerable SRA cover, riparian forest, woodland, scrub, and other floodplain habitats, without significant hydraulic impacts. More than 1,000 acres of habitat could be restored through potential restoration projects identified in regional plans (including the Lower Feather River Corridor Management Plan [DWR 2014b] and Feather River Region Regional Flood Management Plan [Yuba County Water Agency (YCWA), TRLIA, Marysville Levee Commission (MLC), and Sutter Butte Flood Control Agency (SBFCA) 2013]). Even more restoration may be feasible, particularly if the amount of inundated floodplain is further increased. To accomplish this, inundation could be increased on floodplains that are already connected to the river (e.g., by lowering the floodplain), and additional levees could be set back. Through such actions, the CVFPP could substantially contribute to conservation needs in this CPA.

Furthermore, the Sunset Pumps Diversion Dam has been impeding fish passage in the lower Feather River. Although this structure is not part of the SPFC, modifying or removing this weir would improve fish passage (see Appendix K) and also could benefit water supply reliability.

Implementing multi-benefit projects could reduce these constraints and enhance river and floodplain ecosystems. In this CPA, potential major physical and operational elements being evaluated for the CVFPP include fish passage improvements along the Yuba River, low-level reservoir outlets at New Bullards Bar Dam, levee improvements to achieve 200-year flood protection for urban communities, 100-year flood protection for small communities, and improved flood protection for rural-agricultural areas (DWR 2012b). Setback levees have already been constructed in this CPA. Setback levees along the Sutter Bypass were evaluated in the Sacramento River BWFS, consistent with refinement of the 2012 CVFPP (Table 3-2 in DWR 2012b). In addition, implementing the Oroville Wildlife Area Flood Stage Reduction Project would restore ecosystem functions and habitat on floodplain across from the Thermalito Afterbay Outlet; this is currently in the design phase.

These elements and O&M activities would enhance this CPA's river and floodplain ecosystems. Table 5-6 provides estimates of these potential contributions and related recovery needs of target species; the corresponding objectives for the Feather River CPA are also provided. The bases and development of these objectives are described in Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

The focused conservation plans in Appendix G identified design criteria (additional specificity) to increase the benefits of projects for target species. The criteria applicable to this CPA are listed by objective in Table 5-7. Ecosystem improvements should meet these criteria.

Collaboration with other conservation efforts will increase the efficiency and effectiveness of restoration integrated into multi-benefit projects. In the Feather River CPA, major opportunities

for collaboration include working with CDFW (which manages the Oroville and Feather River Wildlife Areas in this planning area) and LMAs. An opportunity also exists to assist with the environmental improvement actions that DWR will carry out pursuant to the Oroville Facilities Relicensing Agreement.

Table 5-6. Conservation Needs, Potential Opportunities, and Objectives in the Feather River Conservation Planning Area

Goal Objective: Metric	Additional Need[1]	Potential Opportunity[1]	Objective Amount[1]	Notes
Ecosystem processes				
Floodplain inundation: inundated floodplain—major river reaches Area inundated by 2-year, 14-day or longer flows, December–May (acres)	53,000	3,700	3,700	Opportunity includes all reconnected land, not just portion with frequent, sustained inundation
Floodplain inundation: inundated floodplain—bypasses/transient storage areas (acres)	—	—	—	Not applicable
Riverine geomorphic processes: natural bank[2] (miles)	2	0	0	—
Riverine geomorphic processes: river meander potential (acres)	400	2,600	400	To support natural bank and riparian habitat objectives
Habitats				
SRA cover: natural bank[2] (miles)	2	0	0	—
SRA cover: riparian-lined bank (miles)	0–66	0	0	Need has a high level of uncertainty
Riparian habitat (acres)	2,400	1,800	1,800	With grassland inclusions
Marsh/other wetland habitat (acres)	6,900	—	—	With inclusions of upland vegetation
Stressors				
Fish passage barriers: channel-wide structures	4	0	0	Need consists of channel-wide barriers
Invasive plants: prioritized species (infested acres)[3]	454	257	257	Opportunity is in Channel Maintenance Areas

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

Key: SRA = shaded riverine aquatic.

Notes:

[1] Values have been rounded to the nearest 100 acres and 1 mile, excluding invasive plant acreages, which are provided to the nearest acre.

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

[3] Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Table 5-7. Summary of Specificity Added to Feather River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery

Objective Topic	Specificity Added to Maximize Contribution to Targeted Species Recovery
Floodplain Inundation	• Sustain inundation for 14 days or longer between late November and late April to benefit anadromous fish • Modify floodplain topography to minimize stranding potential • Eliminate or modify ditches potentially trapping fish
Riverine Geomorphic Processes	[No additional specificity identified.][1]
SRA Cover	• Avoid degradation of bank swallow habitat when restoring SRA or near-channel vegetation
Riparian	• Incorporate elderberry shrubs into habitat restored in riparian areas, especially within 12 miles of habitat occupied by valley elderberry longhorn beetle • Establish large trees in close proximity to field and row crops to provide Swainson's hawk nesting habitat • Restore patches of riparian habitat greater than 100 acres in size and 660 feet in width to provide high-quality habitat for western yellow-billed cuckoo, where there is potential for occupancy
Marsh (and Other Wetlands)	• Restore marsh to be inundated throughout the active season for giant garter snake (mid-March–October) and, where feasible, in 539-acre or larger blocks within 5 miles of and connected to comparable or larger areas of marsh by habitat corridors at least 0.5 mile wide • Minimize potential for submerged aquatic vegetation in restored marsh because it reduces habitat value for target species • Include refugia and basking sites for giant garter snake in restored marsh • Restore marsh and seasonal wetland that is shallowly flooded (less than 6 inches in depth) to provide habitat for greater sandhill crane
Fish Passage Barriers	[No additional specificity identified.][1]
Invasive Plants	[No additional specificity identified.][1]

Sources: Appendix G, "Identification of Target Species and Focused Conservation Plans," and Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System."

Key: SRA = shaded riverine aquatic.

Note:

[1] Focused conservation plans for targeted species do not identify additional specificity as being necessary to maximize contribution of this objective to recovery of species. Lack of additional specificity does not imply lesser importance for species recovery. Objectives making a major contribution to species recovery (e.g., riverine geomorphic processes) simply may not require additional design criteria to be effective.

Box 5-6
Succession and the Diversity of Riparian Habitats

The size and species of plants composing riparian vegetation change over time from the initial establishment and growth of plants on a recently disturbed site to their maturation, death, and replacement by plants that grew in their shade. This sequence of changes is referred to as *succession*. The photographs below illustrate the changes that occur during succession. As a consequence of successional change, wildlife habitat values change. Hence, maintaining diverse riparian vegetation representing all successional stages is important for maintaining wildlife diversity. In riparian ecosystems, floodplain inundation and river channel meander are among the primary determinants of succession and resulting diversity on the landscape.

Source: H. T. Harvey & Associates.

Source: H. T. Harvey & Associates.

5.2.3 Lower Sacramento River CPA

Summary of Existing Conditions

In the Lower Sacramento River CPA, the Sutter Bypass and American River join the Sacramento River, which flows between the Yolo and Natomas Basins and between the cities of West Sacramento and Sacramento (Figure 5-3). Flood flows enter the Yolo Basin from the Fremont Weir, the Knights Landing Ridge Cut, Cache Creek, the Sacramento Weir, and Putah Creek. Downstream, the Sacramento River and the Yolo Bypass enter the tidally influenced Delta, where the river flows through a network of channels separating islands.

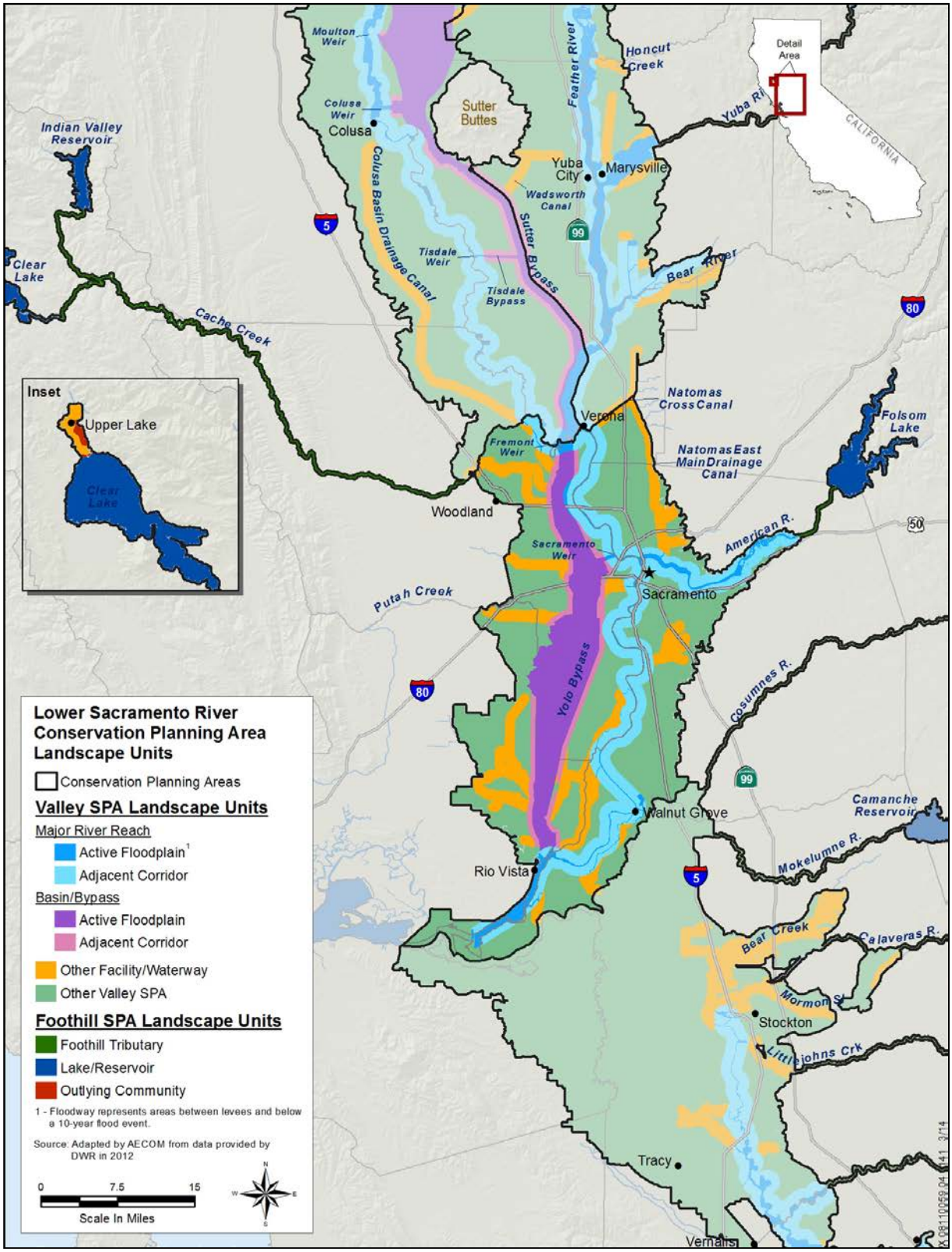
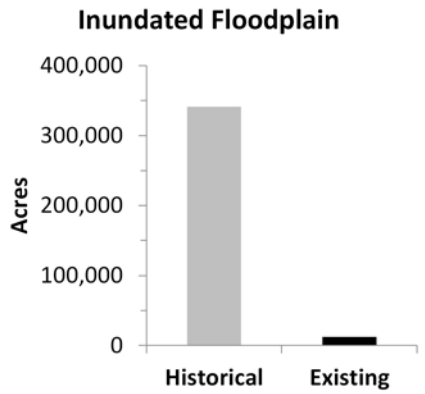
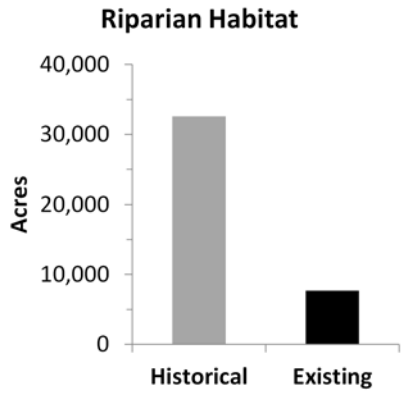


Figure 5-3. Lower Sacramento River Conservation Planning Area

The area's geomorphology transitions from a sinuous Sacramento River with a historically migrating channel to a delta of stable channels between islands bordered by natural levees of deposited sediment. These delta islands occupy the downstream portion of this CPA, and during 1850–1920 they were "reclaimed" by constructing higher levees and draining the island interiors (CBDP 2000). After reclamation, island interiors began to subside, primarily because organic material in the marsh soils began to oxidize more rapidly. Much of the interior Delta now lies below sea level, with subsidence from these causes continuing where peat soils remain. In combination with sea level rise, subsidence is increasing stress on Delta levees. To reduce these deleterious effects, DWR and Delta LMAs have worked cooperatively since 1972 to raise and strengthen Delta levees under the Delta Levees Maintenance Subventions Program. Also, the Delta Levees Special Projects Program, initiated in 1988, has allowed DWR to accelerate levee and habitat improvements, focusing on portions of the levee system that are most important for the protection of State water supplies, water quality, populations and infrastructure, and environmental quality. The result has been substantial improvements in Delta levee integrity, resulting in a reduction in the frequency of levee failures, despite the deleterious effects of subsidence and sea level rise.

Box 5-7
Historical vs. Existing Inundated Floodplain and Riparian Habitat in the Lower Sacramento River CPA





Sources: Appendix H, The Bay Institute 2003, DWR 2011.

In addition to reclamation, other substantial changes to the Delta's physical conditions have occurred. Many new channels have been excavated and lined with levees in the Delta to serve various purposes, most notably the Stockton Deep Water Ship Channel, the Sacramento River Deep Water Ship Channel, Paradise Cut, and Grant Line Canal. Also, State and federal water export facilities, water intakes for Delta communities, and over 1,800 agricultural water diversions have altered the hydrology of the Delta.

Table 5-8 provides a summary of existing conditions in this CPA with regard to each objective of this Conservation Strategy. In summary, in this downstream and relatively developed CPA, riverine and floodplain ecosystems have been substantially degraded by flow alteration by

numerous upstream dams and diversions, bank protection with revetment, disconnection of the floodplain from rivers (by levees), and island subsidence.

Table 5-8. Existing Conditions along Major River Reaches in the Lower Sacramento River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors

Goal Topic	Target: Metric	Existing Conditions (2012)[1]
Ecosystem processes	Floodplain inundation: inundated floodplain—major river reaches[2]	12,300 acres—4% of historical area
	Floodplain inundation: inundated floodplain—bypasses/transient storage areas[2]	0 acres—Note: 70,100 acres inundated, but less frequently than 50 percent of years for 14 days or longer
	Riverine geomorphic processes: natural bank[3]	86 miles—40% of riverbank
	Riverine geomorphic processes: river meander potential	6,900 acres—14% of meander corridor
Habitats	SRA cover: natural bank[3]	86 miles—40% of bank total
	SRA cover: riparian-lined bank	52 (natural) + 47 (revetted) miles—46% of riverbanks
	Riparian[4]	7,300 acres—17% of active river floodplain and 2% of bypasses
	Marsh (and other wetlands): nontidal marsh[4]	8,500 acres—<1% of active river floodplain and 9% of bypasses
	Marsh (and other wetlands): tidal marsh[4]	2,000—1% of active river floodplain and 2% of bypasses
	Marsh (and other wetlands): seasonal wetlands[4]	3,450 acres—1% of active river floodplain and 3% of bypasses
Stressors	Revetment	131 miles—60% of riverbank
	Levees: project	214 miles—76% in meander corridor and 48% condition of higher concern
	Levees: nonproject	53 miles—32% in meander corridor
	Fish passage barriers: Priority 1 and 2 SPFC barriers	4 barriers
	Invasive plants: area of Channel Maintenance Areas infested by prioritized invasive plant species	682 acres in SPA (363 acres in Channel Maintenance Areas)

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and DWR 2011.

Key: SPA = Systemwide Planning Area; SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.

Notes:

1 Values are for major river reaches, except where noted, and have been rounded to the nearest 50 acres and 1 mile, excluding invasive plant infestations, which are provided to the nearest acre.

2 Area inundated by 2-year, 14-day or longer flows, December–May.

3 This condition is provided under both riverine geomorphic processes and SRA cover.

4 Acreage represents amount within 1 mile of the Sacramento River and lower reach of American River and within Yolo Bypass. Percentages of "active floodplain" are for the floodplain inundated by a 10-year (10-percent-chance) event.

5 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Although most of its area is inundated less than 1 out of 2 years (and less frequently during dry periods), the Yolo Bypass accounts for most of the floodplain inundation that occurs in the Lower Sacramento River CPA. Of land within 1 mile of the lower Sacramento River and American River that could potentially be inundated by a 50-percent-chance event (based on its elevation), only 9 percent remains connected to the rivers; the remainder is disconnected from these rivers by levees. As a result, the rearing habitat for Chinook salmon provided by inundated floodplains has been reduced by nearly 96 percent (see Appendix H). Also, because of the presence of these levees and associated revetment, channel meander (although historically limited) has now essentially ceased.

Historically, corridors of riparian vegetation lined the banks of the lower Sacramento River and American River, and extensive marshes were found in the Yolo and Natomas Basins and on Delta islands (The Bay Institute 1998; San Francisco Estuary Institute [SFEI] 2012). The extent of these habitats has been reduced substantially. Riparian vegetation now occupies approximately 17 percent of floodplain that remains connected to the lower Sacramento River and American River. Areas of riparian corridor and associated SRA cover have been reduced to disconnected remnants along river channels that are generally lined by revetment and confined by narrowly spaced levees. Consequently, along the lower Sacramento River and American River, natural banks with riparian vegetation account for less than one-quarter of riverbank length (USACE 2007).

Most marshes and other wetlands in the Lower Sacramento River CPA have been leveed, drained, and converted to agricultural and developed land uses. Marshes and other wetlands account for approximately 1 percent of the active floodplain along the lower Sacramento and American Rivers, and for about 14 percent of the Yolo Bypass and Cache Slough.

Conservation Needs, Opportunities, and Objectives

The alterations of ecosystem processes and habitats described above have contributed to the population declines of 11 targeted species (not including those known only from historical records or whose distribution in this CPA is poorly documented):

- Valley elderberry longhorn beetle
- Steelhead (California Central Valley DPS)
- Chinook salmon, Central Valley fall-/late fall–run ESU)
- Chinook salmon, Central Valley spring-run ESU
- Chinook salmon, Sacramento River winter-run ESU
- Green sturgeon (southern DPS)
- Giant garter snake
- Bank swallow

- California black rail
- Greater sandhill crane
- Swainson's hawk

To facilitate the recovery of these and other native species, multiple conservation plans have been developed that include objectives and actions calling for establishment of continuous corridors of riparian vegetation and SRA cover along the lower Sacramento River, an increase in the frequency of inundation and improvement of fish passage through the Yolo Bypass, and restoration of nontidal and tidal marsh (USFWS 1999; USFWS 2001; CVJV 2006; NMFS 2014). Restoring these processes and habitats would support recovery of multiple aquatic and terrestrial species. For example, to support the AFRP doubling goal for Chinook salmon, from 10,000 to 12,000 acres of additional rearing habitat on inundated floodplains are required (see Appendix H).

In the Lower Sacramento River CPA, there are major opportunities to collaborate with others on habitat restoration, particularly with the development and implementation of Habitat Conservation Plans (HCPs) and HCP/Natural Community Conservation Plans (NCCPs) for this planning area. Such plans already include the Natomas Basin HCP, the Yolo County Natural Heritage Program HCP/NCCP, the South Sacramento HCP, and California EcoRestore.

In this CPA, Conservation Strategy actions would be consistent with California EcoRestore and the Sacramento River General Reevaluation Report and would support attainment of their goals and objectives. In particular, California EcoRestore includes restoration actions in the Yolo Bypass, which is part of the SPFC.

Planning efforts are also underway to implement reasonable and prudent measures to mitigate the long-term effects of operating the federal Central Valley Project and State Water Project on fisheries and other resources, as required under ESA Section 7 by the National Oceanic and Atmospheric Administration (NOAA) Fisheries and USFWS. Improved fisheries habitat in the Yolo Bypass and fish passage facilities for the Fremont Weir and the Sacramento Bypass are among the high-priority actions.

Collaboration of Conservation Strategy actions under the CVFPP with these other conservation efforts will increase the efficiency and effectiveness of restoration actions. However, in this extensively developed CPA, substantial SPFC-related constraints complicate attainment of the mitigation and restoration objectives of these various efforts. Among these constraints is the presence of 214 miles of SPFC levees (and 53 miles of nonproject levees) and 131 miles of revetment along the Sacramento and American Rivers, most of which contribute to the impairment of ecosystem processes. The Fremont and Sacramento Weirs impede fish passage (DWR 2014a). Additional (non-SPFC) constraints, particularly the extensive developed land cover and associated major infrastructure, apply to most of the land protected by levees. Furthermore, where the Sacramento River flows between subsided Delta islands, elevations near

or below sea level preclude near-term restoration of seasonally inundated floodplain, because they would remain inundated year-round.

The establishment of continuous corridors of riparian vegetation and SRA cover along the lower Sacramento River is currently constrained by the flow capacity of the SPFC and its limited ability to accommodate additional roughness without causing increases in flood stage elevations, or altering flows in a way that may adversely affect the opposite bank.

In addition, several SPFC and non-SPFC structures have been impeding fish passage. In addition to dams at multipurpose reservoirs, these structures include:

- Sacramento Weir in the Sacramento Bypass
- Fremont Weir in the Yolo Bypass
- Lisbon Weir in the Yolo Bypass
- Tule Canal crossings (five) in the Yolo Bypass

These structures have been identified as priorities for remediation (Priority 1 or 2, see Appendix K).

Implementing multi-benefit projects could reduce these constraints and enhance river and floodplain ecosystems. In this CPA, the major physical and operational elements being evaluated for the CVFPP include levee improvements to provide 200-year urban flood protection for Sacramento and West Sacramento and 100-year flood protection for small communities; the construction, repair, and improvement of levees in the CPA to improve rural-agricultural flood protection; expansion of the Sacramento and Yolo Bypasses; widening of the Sacramento Weir and automation of the gates; widening of the Fremont Weir; fish passage improvements at the Fremont Weir and at the Yolo Bypass/Willow Slough Weir; and setback levees at selected locations (Table 3-2 in DWR 2012b). Major improvements also include completion of the Joint Federal Project at Folsom Dam to improve flood discharge capacity.

Also, the CVFPP includes investigating whether to modify the function and operation of weirs that spill floodwaters to the Sacramento and Yolo Bypasses (DWR 2012b). If the crests of overflow weirs are physically lowered or notched and weir operations are modified, bypasses could carry a larger fraction of flood flows, discharge overflow earlier in each flood season and during individual flood events, and continue to discharge for longer durations. The more frequent and longer inundation of the bypasses could provide more productive rearing habitat for juvenile salmonids and other native fish. However, in addition to considering habitat effects, CVFPP investigations of modifications to weir operations would also consider effects on public safety and current land uses—in particular, the economic viability of agriculture, which is strongly affected by growing-season length, water supply, and drainage.

These elements and O&M activities would enhance this CPA’s river and floodplain ecosystems. Table 5-9 provides estimates of these potential contributions and related recovery needs of target species; the corresponding objectives for the Lower Sacramento River CPA are also provided.

The bases and development of these objectives are described in Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

Table 5-9. Conservation Needs, Potential Opportunities, and Objectives in the Lower Sacramento River Conservation Planning Area

Goal Objective: Metric	Additional Need[1]	Potential Opportunity[1]	Objective Amount[1]	Notes
Ecosystem processes				
Floodplain inundation: inundated floodplain—major river reaches Area inundated by 2-year, 14-day or longer flows, December–May (acres)	50,500	4,100–11,200	7,650	Opportunity includes all reconnected land, not just portion with frequent, sustained inundation
Floodplain inundation: inundated floodplain—bypasses/transient storage areas (acres)	Included in rivers above	1,100–13,900	7,500	Only portions inundated during 50% of years or more frequently for 14 days or longer
Riverine geomorphic processes: natural bank[2] (miles)	4	9–12	4	Fish needs may be larger but have greater uncertainty
Riverine geomorphic processes: river meander potential (acres)	1,300	3,800–10,400	1,300	Fish needs may be larger but have greater uncertainty
Habitats				
SRA cover: natural bank[2] (miles)	4	9–12	4	Fish needs may be larger but have greater uncertainty
SRA cover: riparian-lined bank (miles)	0–114	2–3	3	Need has a high level of uncertainty
Riparian habitat (acres)	1,500	2,100–5,600	1,900	With grassland inclusions
Marsh/other wetland habitat (acres)	6,600	300–3,500	3,500	With inclusions off upland vegetation
Stressors				
Fish passage barriers: channel-wide structures	6	4	4	Need consists of channel-wide barriers; opportunity includes all Priority 1 and 2 barriers
Invasive plants: prioritized species (infested acres)[3]	682	363	363	Opportunity is in Channel Maintenance Areas

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

Key: SRA = shaded riverine aquatic.

Notes:

1 Values have been rounded to the nearest 100 acres and 1 mile, excluding invasive plant acreages, which are provided to the nearest acre.

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

3 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

The focused conservation plans in Appendix G identified design criteria (additional specificity) to increase the benefits of projects for target species. The criteria applicable to this CPA are listed by objective in Table 5-10. Ecosystem improvements should meet these criteria.

Table 5-10. Summary of Specificity Added to Lower Sacramento River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery

Objective Topic	Specificity Added to Maximize Contribution to Targeted Species Recovery
Floodplain Inundation	• Sustain inundation for 14 days or longer between late November and late April to benefit anadromous fish • Modify floodplain topography to minimize stranding potential • Eliminate or modify ditches potentially trapping fish
Riverine Geomorphic Processes	[No additional specificity identified.][1]
SRA Cover	• Avoid degradation of bank swallow habitat when restoring SRA or near-channel vegetation
Riparian	• Incorporate elderberry shrubs into habitat restored in riparian areas, especially within 12 miles of habitat occupied by valley elderberry longhorn beetle • Establish large trees in close proximity to field and row crops to provide Swainson's hawk nesting habitat
Marsh (and Other Wetlands)	• Restore marsh to be inundated throughout the active season for giant garter snake (mid-March–October) and, where feasible, in 539-acre or larger blocks within 5 miles of and connected to comparable or larger areas of marsh by habitat corridors at least 0.5 mile wide • Restore patches of marsh greater than 20 acres in size to provide habitat for California black rail, where potential for occupancy is high • Minimize potential for submerged aquatic vegetation in restored marsh because it reduces habitat value for target species • Include refugia and basking sites for giant garter snake in restored marsh • Provide refugia from floodwaters for giant garter snake and California black rail • Restore marsh and seasonal wetland that is shallowly flooded (less than 6 inches in depth) to provide habitat for greater sandhill crane
Fish Passage Barriers	• Remediate the following priority structures to improve fish passage: - Sacramento Weir in the Sacramento Bypass - Fremont Weir in the Yolo Bypass - Lisbon Weir in the Yolo Bypass - Tule Canal crossings (five) in the Yolo Bypass
Invasive Plants	[No additional specificity identified.][1]

Sources: Appendix G, "Identification of Target Species and Focused Conservation Plans," and Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System."

Key: SRA = shaded riverine aquatic.

Note:

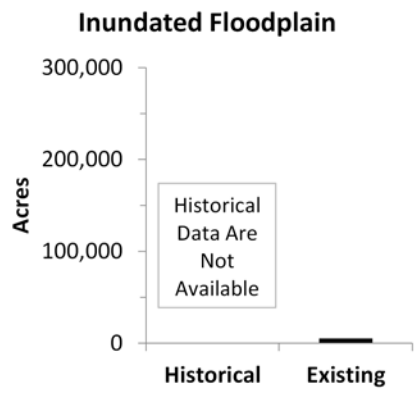
[1] Focused conservation plans for targeted species do not identify additional specificity as being necessary to maximize contribution of this objective to recovery of species. Lack of additional specificity does not imply lesser importance for species recovery. Objectives making a major contribution to species recovery (e.g., riverine geomorphic processes) simply may not require additional design criteria to be effective.

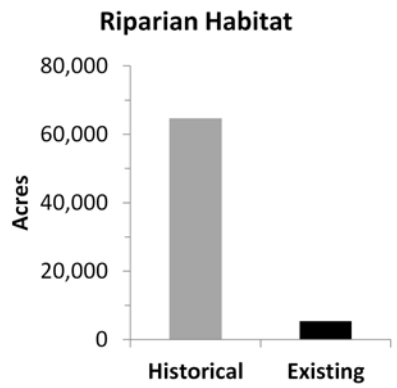
5.2.4 Upper San Joaquin River CPA

Summary of Existing Conditions

The Upper San Joaquin River CPA includes the San Joaquin River from Friant Dam to the confluence with the Merced River, and connected tributaries and bypasses (Figure 5-4). Downstream of Friant Dam, the San Joaquin River is inset between terraces as it descends with a low sinuosity into the San Joaquin Valley and down to Gravelly Ford. At Gravelly Ford, the alluvial fan of the San Joaquin River meets the valley floor. The valley slope decreases here, causing an increase in the river's sinuosity until the river nears Mendota. There, the river reaches Mendota Pool and its confluence with Fresno Slough, which drained the former Tulare Lake. At this confluence, the San Joaquin River moves north with less sinuosity because of the increased valley slope. Downstream 20–25 miles, this single-channel reach enters a basin where the river historically branched into multiple interconnected channels that extended to the confluence with the Merced River.

Box 5-8
Historical vs. Existing Inundated Floodplain and Riparian Habitat in the Upper San Joaquin River CPA





Sources: The Bay Institute 2003, DWR 2011.

Important SPFC facilities in this CPA include a bypass system that diverts floodwaters at the Chowchilla Bifurcation Structure and at the Sand Slough control structure, and returns flows to the San Joaquin River via the Mariposa and Eastside Bypasses. Project levees are present along the bypass system and the lower reaches of streams that it intercepts, including the Fresno River, Berenda Slough, and Bear Creek. There are also project levees along the San Joaquin River, primarily from Gravelly Ford to the Chowchilla Bifurcation Structure and downstream of the confluence of the river with the Mariposa Bypass. Revetment associated with these facilities accounts for only a small percentage of banks along the San Joaquin River.

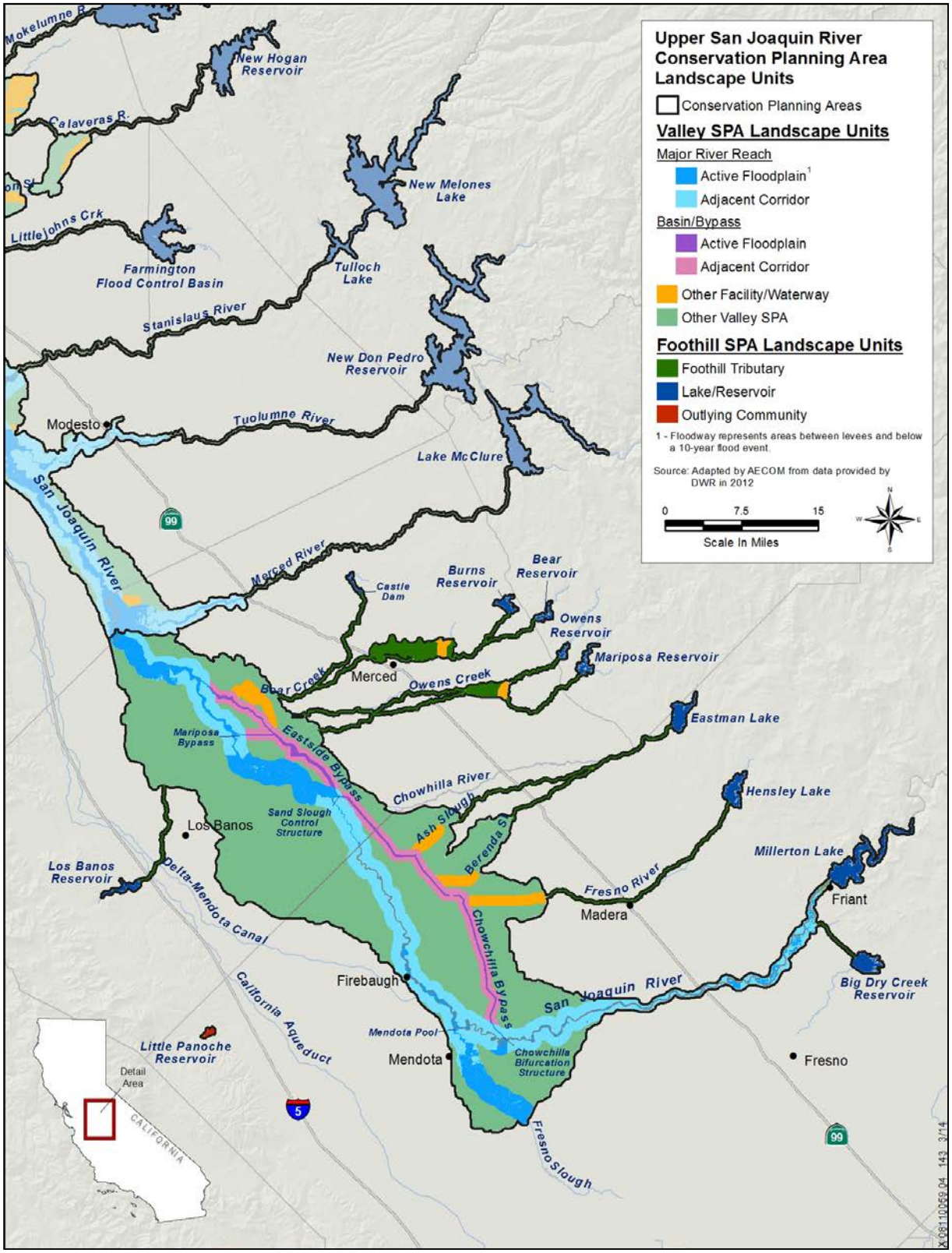


Figure 5-4. Upper San Joaquin River Conservation Planning Area

Table 5-11 provides a summary of existing conditions along the major river reaches in this CPA with regard to each objective of this Conservation Strategy. Riverine and floodplain ecosystems in the Upper San Joaquin River CPA have been substantially altered by flow diversion, gravel mining, levee construction, conversion of natural land covers to agriculture, and incursions of invasive plants. In fact, until recently, portions of the San Joaquin River channel were seasonally dry, because of water diversions for agricultural and municipal uses. Approximately three-quarters of the land along the Upper San Joaquin River is hydraulically disconnected from the river.

The extent of riparian and marsh habitats on floodplains has been reduced in the Upper San Joaquin River CPA. Historically, the amount of riparian vegetation differed among reaches of the San Joaquin River, but was nevertheless extensive along most of the river (The Bay Institute 1998). Riparian vegetation now accounts for only 8 percent of floodplain connected to the Upper San Joaquin River. However, riparian-vegetation lines 65 percent of the river's banks. Historically, marshes and other wetlands were extensive downstream of the river's junction with Fresno Slough, particularly downstream of River Mile 190, where marsh vegetation dominated the floodplain and, in some places, extended 1–3 miles from the river (The Bay Institute 1998). Most of this marsh has been drained and converted to other land cover, primarily for agricultural use. Marshes and seasonal wetlands now account for only about 18 percent of the active floodplain and 9 percent of land in the bypass system.

Conservation Needs, Opportunities, and Objectives

The alterations of ecosystem processes and habitats described above have contributed to the extirpation of Chinook salmon and population declines of five other targeted species (not including those known only from historical records or whose distribution in this CPA is poorly documented):

- Delta button-celery
- Valley elderberry longhorn beetle
- Giant garter snake
- Swainson's hawk
- Greater sandhill crane

Table 5-11. Existing Conditions along Major River Reaches in the Upper San Joaquin River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors

Goal Topic	Target: Metric	Existing Conditions (2012)[1]
Ecosystem processes	Floodplain inundation: inundated floodplain—major river reaches[2]	5,200 acres[3]
	Floodplain inundation: inundated floodplain—bypasses/transient storage areas[2]	0 acres—Note: 5,400 acres inundated, but less frequently than 50 percent of years for 14 days or longer
	Riverine geomorphic processes: natural bank[4]	366 miles—99% of riverbank, maximum value[5]
	Riverine geomorphic processes: river meander potential	19,900 acres—55% of meander corridor
Habitats	SRA cover: natural bank[4]	366 miles—99% of bank total; maximum value[5]
	SRA cover: riparian-lined bank	240 (natural) + <1 (revetted) mile—65% of riverbanks
	Riparian[6]	5,400 acres—8% of active river floodplain and <1% of bypasses
	Marsh (and other wetlands): nontidal marsh[6]	6,700 acres—6% of active river floodplain and 4% of bypasses
	Marsh (and other wetlands): tidal marsh	Not applicable
	Marsh (and other wetlands): seasonal wetlands[6]	9,800 acres—12% of active river floodplain and 5% of bypasses
Stressors	Revetment	3 miles—<1% of riverbank, minimum value[5]
	Levees: project	74 miles—74% in meander corridor and 76% condition of higher concern
	Levees: nonproject	176 miles—54% in meander corridor
	Fish passage barriers	23 barriers
	Invasive plants: area infested by prioritized invasive plant species[7]	677 acres in SPA (143 acres in Channel Maintenance Areas)

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; DWR 2011; and San Joaquin River Restoration Program (SJRRP) 2012.

Key: SPA = Systemwide Planning Area; SRA = shaded riverine aquatic.

Notes:

1 Values are for major river reaches, except where noted, and have been rounded to the nearest 50 acres and 1 mile, excluding invasive plant infestations, which are provided to the nearest acre.

2 Area inundated by 2-year, 14-day or longer flows, December–May.

3 Area that would be inundated by restoration flows of San Joaquin River Restoration Settlement Act (Public Law 111-11).

4 This condition is provided under both riverine geomorphic processes and SRA cover.

5 Data are incomplete or unavailable.

6 Acreage represents amount within 1 mile of the San Joaquin River and within Chowchilla, Mariposa, and Eastside Bypasses. Percentages of "active floodplain" are for the floodplain inundated by a 10-year (10-percent-chance) event.

7 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Furthermore, a number of SPFC and non-SPFC structures have been impeding fish passage. In addition to dams at multipurpose reservoirs, these structures include:

- San Joaquin River control structure on the San Joaquin River
- Chowchilla Bypass control structure at the junction of the San Joaquin River and Chowchilla Bypass
- Mendota Dam on the San Joaquin River
- Sack Dam on the San Joaquin River
- Mariposa Bypass drop structure at the confluence of the San Joaquin River and Mariposa Bypass
- San Joaquin River Headgates at the confluence of the San Joaquin River and Sand Slough Connector
- Farm road crossings (three) on the San Joaquin River
- Lost Lake Rock Weir #1 (lower) on the San Joaquin River
- Merced Refuge Weir #1 (lower) in the Eastside Bypass
- Merced Refuge Weir #2 (upper) in the Eastside Bypass
- Donny Bridge at the San Joaquin River
- Beaver dams on the San Joaquin River
- Mariposa Bypass control structure in the Mariposa Bypass
- Mariposa Bypass drop structure at the confluence of the Mariposa Bypass and the San Joaquin River
- Eastside Bypass control structure in the Eastside Bypass
- Avenue 21 county bridge in the Eastside Bypass
- Eastside Bypass drop 2 (upper) in the Eastside Bypass
- Dan McNamara Road crossing in the Eastside Bypass
- Pipeline crossing in the Eastside Bypass
- Avenue 18½ county bridge in the Eastside Bypass

- Eastside Bypass drop 1 (lower) in the Eastside Bypass
- Eastside Bypass rock weir in the Eastside Bypass

Most of these structures would be rectified by planned SJRRP actions included in the Revised Framework for Implementation (SJRRP 2015).

Implementation of the SJRRP will contribute to the recovery of the species listed above as well as other sensitive species. The SJRRP is removing flow impediments and initiating flows that are more representative of the river's natural hydrograph, and reintroducing spring and fall-/late fall–run Chinook salmon. In addition, the SJRRP is considering setting back levees (that are not part of the SPFC) to accommodate the planned restoration flows, constructing a bypass around Mendota Pool, improving fish passage, filling or isolating gravel pits, and implementing a seepage management program (SJRRP 2011a, 2011b, 2012b, 2015). It also may implement various other restoration actions, which could include modifying floodplain and side-channel habitat and restoring riparian vegetation. Restoration of river flows is anticipated to substantially increase the extent of riparian vegetation along the San Joaquin River in this CPA, particularly along channel banks, unless vegetation is removed to maintain the capacity of the floodway to convey flood flows (SJRRP 2011c).

Systemwide flood risks and restoration actions by the SJRRP are interrelated throughout this CPA. Thus, DWR is working closely with the SJRRP to foster compatibility between SJRRP and the CVFPP, including this Conservation Strategy.

The State's involvement in the SJRRP has been funded primarily through Proposition 84, the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006.

Opportunities to support the SJRRP would be provided by multi-benefit projects that would construct, repair, or improve levees. In this CPA, potential major physical and operational improvements being evaluated for the CVFPP include upgrade of structures in the Chowchilla, Mariposa, and Eastside Bypasses (Table 3-2 in DWR 2012b). Improvements also may include constructing setback levees or transitory storage areas at selected locations, particularly near the junctions of the bypass system with the San Joaquin River.

These elements and O&M activities would enhance this CPA's river and floodplain ecosystems. Table 5-12 provides estimates of these potential contributions and related recovery needs of target species; the corresponding objectives for the Upper San Joaquin River CPA are also provided. The bases and development of these objectives are described in Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

The focused conservation plans in Appendix G identified design criteria (additional specificity) to increase the benefits of projects for target species. The criteria applicable to this CPA are listed by objective in Table 5-13. Ecosystem improvements should meet these criteria.

Table 5-12. Conservation Needs, Potential Opportunities, and Objectives in the Upper San Joaquin River Conservation Planning Area

Goal Objective: Metric	Additional Need[1]	Potential Opportunity[1]	Objective Amount[1]	Notes
Ecosystem processes				
Floodplain inundation: inundated floodplain—major river reaches Area inundated by 2-year, 14-day or longer flows, December–May (acres)	2,800	4,300–4,900	2,800	Opportunity includes all reconnected land, not just portion with frequent, sustained inundation
Floodplain inundation: inundated floodplain—bypasses/transient storage areas (acres)	Included in rivers above	0	0	Not inundated in 50% of years or more frequently for 14 days or longer
Riverine geomorphic processes: natural bank[2] (miles)	0–23	8	8	Need has a high level of uncertainty
Riverine geomorphic processes: river meander potential (acres)	0–2,100	3,700–4,300	2,100	To support natural bank and riparian habitat objectives, and thus has a high level of uncertainty
Habitats				
SRA cover: natural bank[2] (miles)	0–23	8	8	Need has a high level of uncertainty
SRA cover: riparian-lined bank (miles)	0–228	2	2	Need has a high level of uncertainty
Riparian habitat (acres)	2,100	2,100–2,400	2,100	With grassland inclusions
Marsh/other wetland habitat (acres)	5,200	0	0	With inclusions of upland vegetation
Stressors				
Fish passage barriers: channel-wide structures	23	Under evaluation	TBD	—
Invasive plants: prioritized species (infested acres)[3]	677	143	143	Opportunity is in Channel Maintenance Areas

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities"; and SJRRP 2012.

Key: SRA = shaded riverine aquatic; TBD = to be determined.

Notes:

1 Values have been rounded to the nearest 100 acres and 1 mile, excluding invasive plant acreages, which are provided to the nearest acre.

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

3 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Table 5-13. Summary of Specificity Added to Upper San Joaquin River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery

Objective Topic	Specificity Added to Maximize Contribution to Targeted Species Recovery
Floodplain Inundation	• Sustain inundation for 14 days or longer between late November and late April to benefit anadromous fish • Modify floodplain topography to minimize stranding potential • Eliminate or modify ditches potentially trapping fish
Riverine Geomorphic Processes	[No additional specificity identified.][1]
SRA Cover	[No additional specificity identified.][1]
Riparian	• Incorporate elderberry shrubs into habitat restored in riparian areas, especially within 12 miles of habitat occupied by valley elderberry longhorn beetle • Establish large trees in close proximity to field and row crops to provide Swainson's hawk nesting habitat
Marsh (and Other Wetlands)	• Restore seasonal wetland habitat on floodplains of the San Joaquin River between RM 120 and RM 170 and in the Eastside Bypass downstream of the Mariposa Bypass to provide habitat for delta button-celery • Control invasive plants in and near occupied delta button-celery habitat • Restore marsh to be inundated throughout the active season for giant garter snake (mid-March–October) and, where feasible, in 539-acre or larger blocks within 5 miles of and connected to comparable or larger areas of marsh by habitat corridors at least 0.5 mile wide • Include refugia and basking sites for giant garter snake in restored marsh • Restore marsh and seasonal wetland that is shallowly flooded (less than 6 inches in depth) to provide habitat for greater sandhill crane
Fish Passage Barriers	• Remediate the following structures to improve fish passage (see Appendix K): - San Joaquin River control structure - Chowchilla Bypass control structure - Mendota Dam - Sack Dam - Mariposa Bypass drop structure - San Joaquin River Headgates - Lost Lake Rock Weir #1 - Merced Refuge Weir #1 and Weir #2 - Donny Bridge - Mariposa Bypass control structure - Mariposa Bypass drop structure - Eastside Bypass control structure - Eastside Bypass Drop 1 and Drop 2 - Avenue 18½ and Avenue 21 county bridges - Dan McNamara Road crossing - Pipeline crossing in the Eastside Bypass - Eastside Bypass rock weir
Invasive Plants	• Control invasive plants in and near occupied delta button-celery habitat

Source: Appendix G, "Identification of Target Species and Focused Conservation Plans."
Key: RM = River Mile.
Notes:
[1] Focused conservation plans for targeted species do not identify additional specificity as being necessary to maximize contribution of this objective to recovery of species. Lack of additional specificity does not imply lesser importance for species recovery. Objectives making a major contribution to species recovery (e.g., riverine geomorphic processes) simply may not require additional design criteria to be effective.

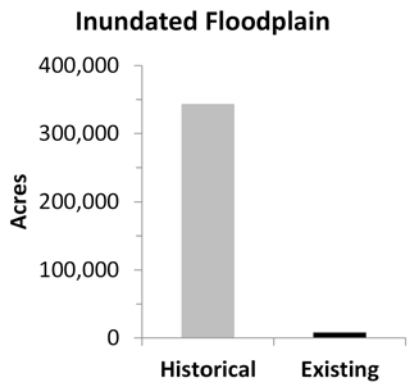
Collaboration with other conservation efforts will increase the efficiency and effectiveness of restoration integrated into multi-benefit projects. In this CPA, major collaboration opportunities include not only supporting the SJRRP, but working with CDFW, which manages the North Grasslands Wildlife Area; the California Department of Parks and Recreation, which manages Great Valley Grasslands State Park; USFWS, which manages the San Luis National Wildlife Refuge Complex; and LMAs. In addition, DWR could collaborate with the San Joaquin River Conservancy on projects involving habitat restoration, invasive species removal, isolation or filling of gravel pits, and other channel and floodplain restoration projects along the upper San Joaquin River above State Route 99. DWR will also collaborate with the San Joaquin River Partnership in support of recreational facilities along the San Joaquin River, in accordance with the San Joaquin River Blueway Vision.

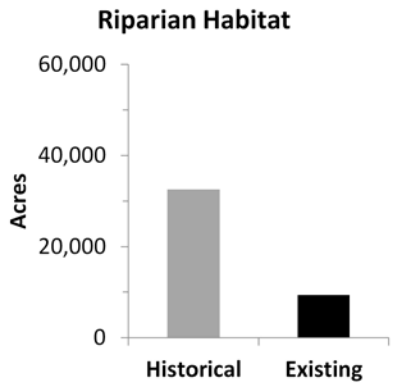
5.2.5 Lower San Joaquin River CPA

Summary of Existing Conditions

The Lower San Joaquin River CPA encompasses the San Joaquin River from its confluence with the Merced River into the Delta (Figure 5-5). It also includes several major tributaries that are of significance for both flood management and conservation: the Merced, Stanislaus, and Tuolumne Rivers. The San Joaquin River actively meanders in portions of the reach between its confluence with the Merced River and its confluence with the Stanislaus River. The river corridor includes floodplain with complex topography, such as oxbows, swales, and other products of channel migration. In their lower reaches, the Merced, Tuolumne, and Stanislaus Rivers also have sinuous channels in alluvial floodplains. Downstream of its confluence with the Stanislaus River, the San Joaquin River flows into a network of channels that spread into the Delta.

Box 5-9
Historical vs. Existing Inundated Floodplain and Riparian Habitat in the Lower San Joaquin River CPA





Sources: Appendix H, The Bay Institute 2003, DWR 2011.

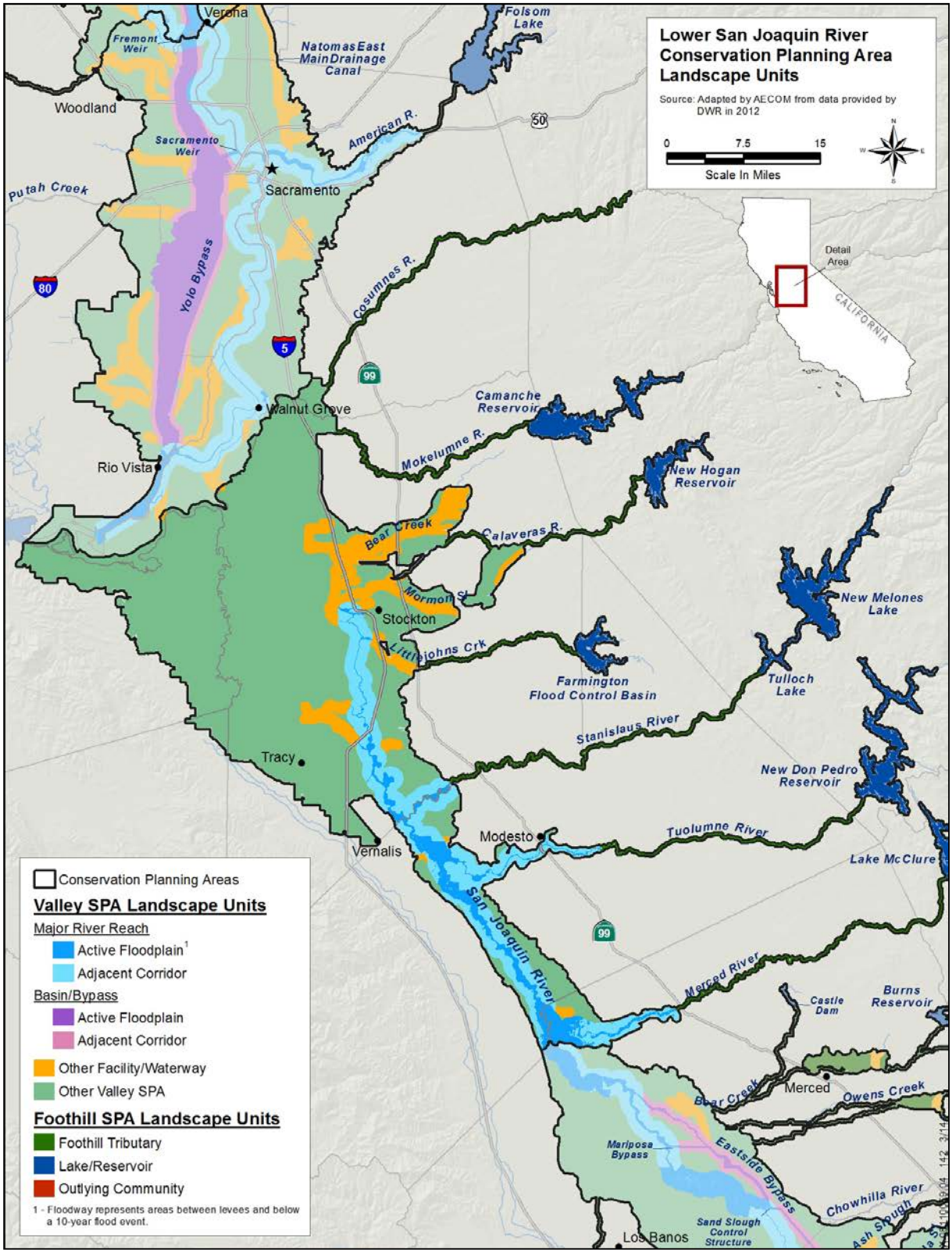


Figure 5-5. Lower San Joaquin River Conservation Planning Area

Along the San Joaquin River from its confluence with the Merced River to its confluence with the Stanislaus River, SPFC and nonproject levees are discontinuous. Upstream of Lathrop, Paradise Cut carries floodwaters directly to Old River and Delta channels. From Mossdale in the Stockton area into the Delta, levees are generally close to channels. Project and nonproject levees are also discontinuous along the lower reaches of the Merced, Tuolumne, and Stanislaus Rivers, except for the lowermost 10 miles of the Stanislaus River, where project levees are nearly continuous. Along the Lower San Joaquin River and lower reaches of the Merced, Tuolumne, and Stanislaus Rivers, revetment associated with SPFC facilities accounts for only about 19 percent of bank length, but privately installed revetment may be extensive and has not been inventoried.

Table 5-14 provides a summary of existing conditions along the major river reaches in this CPA with regard to each objective of this Conservation Strategy. Riverine and floodplain ecosystems have been substantially degraded in the Lower San Joaquin River CPA. The extent of inundated floodplain in this CPA has been reduced considerably by dams, diversions, and the flood control system. Within 1 mile of the major rivers, only about one-third of land with a FIP of 50 percent or more is hydraulically connected to a river. Consequently, rearing habitat for salmonids provided by inundated floodplains has been reduced by more than 98 percent (see Appendix H).

The extent of riparian and marsh vegetation has also substantially diminished. Historically, riparian vegetation formed a corridor 0.5–2 miles wide along the San Joaquin River from its junction with the Merced River to its junction with the Stanislaus River, along the lower reaches of these tributaries, and in a narrower corridor along the lower Tuolumne River (The Bay Institute 1998). Riparian vegetation now accounts for about one-quarter of active floodplains, and about one-third of riverbanks are lined with riparian vegetation.

Historically, marsh was also once a major component of floodplain vegetation along the lower San Joaquin River. Downstream of its confluence with the Stanislaus River, the San Joaquin River flowed through a marsh-dominated landscape as it entered the Delta (The Bay Institute 1998). Almost all of this marsh has been drained and converted to other land cover, primarily for agricultural use. Marshes and other wetlands now account for about 3 percent of floodplain connected to the lower San Joaquin River and the Merced, Tuolumne, and Stanislaus Rivers. Downstream of its confluence with the Stanislaus River, the San Joaquin River flows into a network of channels that spread into the Delta.

Channel migration has also been reduced in the Lower San Joaquin River CPA, particularly along the San Joaquin River, because flows that erode banks and the length of natural bank have been reduced, and levees isolate much of the meander zone from the river channel. Approximately 52 percent of the meander zone is isolated from major rivers by levees or revetment.

Table 5-14. Existing Conditions along Major River Reaches in the Lower San Joaquin River Conservation Planning Area for Targeted Ecosystem Processes, Habitats, and Stressors

Goal Topic	Target: Metric	Existing Conditions (2012)[1]
Ecosystem processes	Floodplain inundation: inundated floodplain—major river reaches[2]	7,900 acres—2% of historical area
	Floodplain inundation: inundated floodplain—bypasses/transient storage areas[2]	Not applicable
	Riverine geomorphic processes: natural bank[3]	229 miles—81% of riverbank, maximum value[4]
	Riverine geomorphic processes: river meander potential	18,300 acres—48% of meander corridor
Habitats	SRA cover: natural bank[3]	229 miles—81% of bank total, maximum value[4]
	SRA cover: riparian-lined bank	146 (natural) + 17 (revetted) miles—57% of riverbanks
	Riparian[5]	9,400 acres—25% of active river floodplain
	Marsh (and other wetlands): nontidal marsh[5]	700 acres—1% of active river floodplain
	Marsh (and other wetlands): tidal marsh[5]	<100 acres—<1% of active river floodplain
	Marsh (and other wetlands): seasonal wetlands[5]	1,000 acres—2% of active river floodplain
Stressors	Revetment	55 miles—19% of riverbank, minimum value[4]
	Levees: project	123 miles—81% in meander corridor and 81% condition of higher concern
	Levees: nonproject	77 miles—64% in meander corridor
	Fish passage barriers[6]	Not available
	Invasive plants: area infested by prioritized invasive plant species[7]	805 acres in SPA (34 acres in Channel Maintenance Areas)

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"; and DWR 2011.

Key: SPA = Systemwide Planning Area; SRA = shaded riverine aquatic.

Notes:

1 Values are for major river reaches, except where noted, and have been rounded to the nearest 50 acres and 1 mile, excluding invasive plant infestations, which are provided to the nearest acre.

2 Area inundated by 2-year, 14-day or longer flows, December–May.

3 This condition is provided under both riverine geomorphic processes and SRA cover.

4 Data are incomplete or unavailable.

5 Acreage represents amount within 1 mile of the San Joaquin River and lower reaches of the Merced, Tuolumne, and Stanislaus Rivers. Percentages of "active floodplain" are for the floodplain inundated by a 10-year (10-percent-chance) event.

6 DWR has not yet identified existing barriers and migration concerns for the Lower San Joaquin River CPA.

7 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

Conservation Needs, Opportunities, and Objectives

The alterations of ecosystem processes and habitats described above have contributed to the population declines of 14 targeted species (not including those known only from historical records or whose distribution in this CPA is poorly documented):

- Delta button-celery
- Slough thistle
- Valley elderberry longhorn beetle
- Steelhead (California Central Valley DPS)
- Chinook salmon, Central Valley fall-/late fall–run ESU
- Chinook salmon, Central Valley spring-run ESU
- Green sturgeon (southern DPS)
- Giant garter snake
- California black rail
- Least Bell's vireo
- Greater sandhill crane
- Swainson's hawk
- Riparian brush rabbit
- Riparian woodrat

To facilitate the recovery of these and other native species, multiple conservation plans include objectives and actions that call for floodplain reconnection and functional riparian corridors along the lower San Joaquin River or for riparian and marsh habitats in general (CVJV 2006; USFWS 1998, 1999, 2001). Restoring these processes and habitats would support recovery of multiple aquatic and terrestrial species. For example, to support the AFRP doubling goal for Chinook salmon, from 4,000 to 5,000 acres of additional rearing habitat on inundated floodplains would be needed (see Appendix H).

Substantial SPFC-related constraints complicate attainment of these objectives. Among these constraints is the presence of 123 miles of SPFC levees (and 77 miles of non-SPFC levees), most of which contribute to the impairment of ecosystem processes. Also, 55 miles of revetment are associated with SPFC levees along waterways in the Lower San Joaquin River CPA. The establishment of continuous corridors of riparian vegetation and SRA cover along the Lower San

Joaquin River is also constrained by the flow capacity of the SPFC and its limited ability to accommodate additional roughness without causing considerable increases in flood stage elevations, or altering flows in a way that would substantially and adversely affect the opposite bank.

Implementing multi-benefit projects could reduce these constraints and enhance river and floodplain ecosystems. In this CPA, potential major physical and operational elements being evaluated for the CVFPP may include construction of the Lower San Joaquin River Bypass (Paradise Cut) and an associated gate structure and/or weir (Table 3-2 in DWR 2012b). Planning and design of this bypass would provide opportunities to integrate marsh, riparian, and inundated floodplain restoration with flood risk reduction. In addition, the CVFPP includes the construction, repair, or improvement of selected levee segments that are located primarily along the San Joaquin River and the bypass system (DWR 2012b). Improvements also may include constructing setback levees and transitory storage areas along the San Joaquin River at selected locations, such as at its junctions with the Tuolumne and Stanislaus Rivers and downstream of its junction with the Stanislaus River. At Dos Rios Ranch, located at the confluence of the San Joaquin and Tuolumne Rivers, DWR recently provided funding for removal of farm levees to reconnect rivers with farmland being restored to natural habitat.

These elements and O&M activities would enhance this CPA's river and floodplain ecosystems. Table 5-15 provides estimates of these potential contributions and related recovery needs of target species; the corresponding objectives for the Lower San Joaquin River CPA are also provided. The bases and development of these objectives are described in Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

Box 5-10
Riparian Woodrat and Riparian Brush Rabbit Needs for Riparian Habitat

Riparian woodrat and riparian brush rabbit (shown in photograph) occur only in the Lower San Joaquin River CPA. Habitat corridors connecting the few remaining populations of these species and extending through their historical range have been identified as important for the recovery of these highly endangered mammals. Their historical range includes riparian areas along the San Joaquin River from the Delta to the junction with the Tuolumne River, and the adjoining reaches of the Stanislaus and Tuolumne Rivers. Corridors throughout these areas are included in the need for additional riparian habitat, listed in Table 5-15.

Source: River Partners; reprinted with permission.

Table 5-15. Conservation Needs, Potential Opportunities, and Objectives in the Lower San Joaquin River Conservation Planning Area

Goal Objective: Metric	Additional Need[1]	Potential Opportunity[1]	Objective Amount[1]	Notes
Ecosystem processes				
Floodplain inundation: inundated floodplain—major river reaches Area inundated by 2-year, 14-day or longer flows, December–May (acres)	25,700	11,600	11,600	Opportunity includes all reconnected land, not just portion with frequent, sustained inundation
Floodplain inundation: inundated floodplain—bypasses/transient storage areas (acres)	Included in rivers above	200	200	May not be inundated in 50% of years or more frequently
Riverine geomorphic processes: natural bank[2] (miles)	13	12–14	13	—
Riverine geomorphic processes: river meander potential (acres)	4,300	10,200	4,300	To support natural bank and riparian habitat objectives
Habitats				
SRA cover: natural bank[2] (miles)	13	12–14	13	—
SRA cover: riparian-lined bank (miles)	0–120	6	6	Need has a high level of uncertainty
Riparian habitat (acres)	8,800	5,800	5,800	With grassland inclusions
Marsh/other wetland habitat (acres)	6,500	100	100	With inclusions of upland vegetation
Stressors				
Fish passage barriers: channel-wide structures	Potential barriers not evaluated	Potential barriers not evaluated	TBD	—
Invasive plants: prioritized species (infested acres)[3]	805	34	34	Opportunity is in Channel Maintenance Areas

Sources: Appendix E, "Invasive Plant Management Plan"; Appendix F, "Existing Conditions"; Appendix H, "Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program Doubling Goal"; and Appendix L, "Measurable Objectives Development: Summary of Conservation Needs and Scale of Restoration Opportunities."

Key: SRA = shaded riverine aquatic; TBD = to be determined.

Notes:

1 Values have been rounded to the nearest 100 acres and 1 mile, excluding invasive plant acreages, which are provided to the nearest acre.

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

3 Acreages are underestimates because of data limitations described in Appendix E, "Invasive Plant Management Plan."

The focused conservation plans in Appendix G identified design criteria (additional specificity) to increase the benefits of projects for target species. The criteria applicable to this CPA are listed by objective in Table 5-16. Ecosystem improvements should meet these criteria.

Table 5-16. Summary of Specificity Added to Lower San Joaquin River Conservation Planning Area Objectives to Maximize Contribution to Targeted Species Recovery

Objective Topic	Specificity Added to Maximize Contribution to Targeted Species Recovery
Floodplain Inundation	• Restore seasonal wetland habitat on San Joaquin River floodplains, RMs 80–120, to benefit multiple target species • Sustain inundation for 14 days or longer between late November and late April to benefit anadromous fish • Modify floodplain topography to minimize stranding potential • Eliminate or modify ditches potentially trapping fish
Riverine Geomorphic Processes	[No additional specificity identified.][1]
SRA Cover	[No additional specificity identified.][1]
Riparian	• Restore patches of riparian habitat greater than 10 acres in size to provide habitat for least Bell's vireo, where potential for occupancy is high • Incorporate elderberry shrubs into habitat restored in riparian areas within 12 miles of habitat occupied by valley elderberry longhorn beetle • Establish large trees in close proximity to field and row crops to provide nesting habitat for Swainson's hawk • Provide high-quality refugia from floodwaters for riparian brush rabbit and riparian woodrat, including in all setbacks and bypasses • Restore habitat to connect riparian areas of Caswell SP, San Joaquin River NWR, and the South Delta
Marsh (Other Wetlands)	• Restore seasonal wetland habitat on San Joaquin River floodplains, RMs 80–120, to benefit delta button-celery • Restore marsh to be inundated throughout the active season for giant garter snake (mid-March–October) and, where feasible, in 539-acre or larger blocks within 5 miles of and connected to comparable or larger areas of marsh by habitat corridors at least 0.5 mile wide • Restore patches of marsh greater than 20 acres in size to provide habitat for California black rail, where potential for occupancy is high • Minimize potential for submerged aquatic vegetation in restored marsh because it reduces habitat value for target species • Include refugia and basking sites for giant garter snake in restored marsh • Provide refugia from floodwaters for giant garter snake and California black rail • Restore marsh and seasonal wetland that is shallowly flooded (less than 6 inches in depth) to provide habitat for greater sandhill crane
Fish Passage Barriers	–[2]
Invasive Plants	• Control invasive plants in and near occupied delta button-celery habitat • Control invasive plants in and near occupied slough thistle habitat

Source: Appendix G, "Identification of Target Species and Focused Conservation Plans."
Key: NWR = National Wildlife Refuge; RM = River Mile; SP = State Park; SRA = shaded riverine aquatic.
Notes:
[1] Focused conservation plans for targeted species do not identify additional specificity as being necessary to maximize contribution of this objective to recovery of species. Lack of additional specificity does not imply lesser importance for species recovery. Objectives making a major contribution to species recovery (e.g., riverine geomorphic processes) simply may not require additional design criteria to be effective.
[2] Fish passage barriers have not yet been identified or prioritized. Information is forthcoming.

Collaboration with other conservation efforts will increase the efficiency and effectiveness of restoration integrated into multi-benefit projects. In the Lower San Joaquin River CPA, major opportunities for collaboration include working with USFWS (which manages the San Joaquin River National Wildlife Refuge in this area), the California Department of Parks and Recreation, and LMAs. Also, the downstream portion of this CPA is in the Sacramento–San Joaquin River Delta. In this area, Conservation Strategy actions would be compatible with restoration actions implemented by California EcoRestore and would support attainment of California EcoRestore's goals.

6.0 Integrated Flood Risk Management and Conservation Approaches

Greater integration of conservation with flood projects and O&M is the means by which this Strategy would improve river and floodplain ecosystems. This section describes approaches to this integration. First, it describes how ecosystem improvements can be integrated with projects and with O&M activities. Next, it describes DWR's approach to vegetation management in the flood system and DWR's support of agricultural stewardship, both of which are essential to the successful integration of conservation actions with flood risk management activities.

6.1 Integrated Projects and O&M

This section provides approaches to the integration of conservation with flood projects and O&M. Section 6.1.1, "Habitat Restoration Actions," describes changes to topography and land cover that can restore targeted ecosystem processes and habitats. Section 6.1.2, "Integrating Restoration with Flood Risk Management Actions," describes how those and other restoration and enhancement actions can be incorporated into structural modifications and O&M.

6.1.1 Habitat Restoration Actions

As discussed below, changes to topography and land cover can restore targeted ecosystem processes and habitats. Restoration actions can also be integrated into multi-benefit projects that expand the floodway, remove facilities, modify levees and control structures, or change flood system O&M practices; these types of actions are described in subsequent sections. As with flood management actions, restoration actions would incorporate measures to avoid and minimize adverse environmental effects, consistent with the 2012 CVFPP PEIR and DWR guidance, during their planning, design, construction, and maintenance (e.g., by incorporating best management practices [BMPs] to minimize mercury methylation).

Modification of Floodplain Topography and Inundation

Floodplain topography can be modified at select locations to increase floodway capacity, inundation frequency and duration, and habitat amounts and diversity; create high-water refugia for wildlife; and reduce or eliminate areas that strand fish.

Currently, where main river channels are incised below the floodway or flows have been reduced, floodplain inundation has decreased in duration, frequency, and magnitude, and associated habitat values have consequently diminished. In these areas, lowering floodplain surfaces (e.g., by creating excavated benches), reconnecting historical channels, modifying flow obstructions, creating floodplain swales, and making other modifications of floodplain topography could allow more frequent and sustained inundation, increasing habitat values. This action could also help increase local floodway capacity.

Floodplains can also be modified in locations where higher ground impedes flow connectivity or capacity. Removing such impediments to increase the hydrologic connectivity and capacity of the active floodplain (the "channels" of the SPFC) could improve fish migration, reduce stranding potential, and allow additional riparian vegetation to establish without causing significant hydraulic impacts. Removed sediment, if suitable, may be used in nearby levee construction or repair projects.

In addition, floodplains can also be modified to provide greater topographic and hydrologic diversity, and to eliminate depressional features (such as isolated gravel pits or deep borrow pits) that strand fish when water recedes. Creating higher ground that can serve as refugia from floodwaters could be important for several targeted species, including the giant garter snake, California black rail, riparian brush rabbit, and riparian woodrat (see Appendix G, "Identification of Target Species and Focused Conservation Plans"). This action may include creating, or opening up, secondary channels and overflow swales that would add riverine and floodplain habitat values (e.g., resting or rearing areas for fish migrating downstream) and provide escape routes for fish during receding flows.

Restoration of Riparian Habitats, SRA Cover, and Marshes and Other Wetlands

Riparian habitat (including SRA cover), marshes, and other wetland habitats can be restored at selected locations in and adjacent to the floodway to benefit a wide variety of native species, including this Strategy's targeted species. These habitats could be restored in conjunction with associated uplands to provide a diverse assemblage of habitat elements for wildlife.

Riparian restoration actions can be either intensive (such as actions that involve grading) or less intensive. Less intensive efforts, which may still require considerable resources, involve facilitating the dispersal and establishment of native plants through maintenance practices, such as removing competing invasive plants.

Riparian restoration is possible in numerous locations where nonriparian vegetation occurs in the floodway. However, at some sites, additional riparian vegetation may have a measureable effect on channel capacity or could conflict with maintenance of SPFC facilities or other infrastructure. Thus, feasible riparian restoration opportunities will often be linked to other flood risk management actions to ensure adequate channel capacity. For example, the Feather River Floodway Corridor Restoration Project (a funded advance mitigation project described in Appendix B, "Advance Mitigation") proposes to restore riparian habitat in an area where levees were previously set back a considerable distance. An endowment has been set aside to contribute to the cost of long-term land management.

Marsh restoration will generally consist of intensive actions involving grading (e.g., creating depressions, berms, and drainage features) to create topography that supports marsh plants, provides habitat elements for target species, and allows fish to exit as floodwaters recede. Marsh restoration also involves planting vegetation and constructing water management facilities. Seasonal wetlands can be restored by both less intensive methods (comparable to those described for riparian vegetation) and by more intensive methods. Generally, marsh and other wetland

restoration will occur in the bypass system and will be implemented in conjunction with bypass expansion and construction. (See Section 6.1.2, under "Floodway Expansion.")

A number of site and habitat attributes determine the benefits provided by restored habitats. In general, however, the benefits of restoring riparian habitats, SRA cover, and marshes and other wetlands are greater in areas where restoration expands or connects existing habitat patches, at locations identified by focused conservation planning for threatened and endangered targeted species, and in conserved areas. For example, restoration of riparian habitat that connects the riparian areas of Caswell State Park, San Joaquin River National Wildlife Refuge, and the South Delta could be particularly beneficial because of its potential value as habitat for riparian brush rabbit and riparian woodrat.

For several targeted species, the patch size of restored habitat is important. In particular, habitat values for least Bell's vireo and western yellow-billed cuckoo are greater in patches of riparian habitat greater than 10 and 100 acres in size, respectively, and habitat values for California black rail are greater in patches greater than 20 acres in size (see Appendix G, "Identification of Target Species and Focused Conservation Plans").

Also, populations of invasive species reduce restoration benefits. So in planning, designing, constructing, and maintaining restored habitat, it is important to avoid or minimize the spread of invasive species and to not create favorable conditions for them. (See also Section 6.2.3, "Invasive Plant Management.")

6.1.2 Integrating Restoration with Flood Risk Management Actions

The incorporation of restoration and enhancement actions into both projects and O&M activities contributes to all of this Strategy's objectives, as shown in Table 6-1. This section describes how such actions will be integrated with diverse efforts to reduce flood risks, regulatory compliance costs, and flood system O&M costs. Projects that modify structures are discussed separately from O&M activities, and the general process for developing project-specific restoration concepts is also discussed.

Integration with Structural Modifications

Structural modifications include:

- floodway expansion—expanding floodways along rivers by relocating levees, and expanding or creating bypasses and transient storage areas;
- facility removal; and
- facility repair and improvement—repairing structures to their originally designed level of function (repair) or improving them to provide a higher level of protection (improvement).

Table 6-1. Management Actions Contributing to Attainment of Objectives and Benefitting Target Species through Integration of Restoration and Ecosystem Enhancement

Management Action	Objective Topic							Target Species
	Ecosystem Processes		Habitats			Stressors		
	Floodplain Inundation	Riverine Geomorphic Processes	SRA Cover	Riparian Habitat	Marshes and Other Wetlands	Fish Passage Barriers	Invasive Plants	
Habitat Restoration Actions								
Modification of floodplain topography and inundation	✓	✓		✓	✓			✓
Restoration of riparian habitat, SRA cover, and marshes and other wetlands			✓	✓	✓		✓	✓
Wildlife-friendly agricultural practices					✓			✓
Integration with Structural Modifications								
Floodway expansion—river levee relocation	✓	✓	✓	✓	✓			✓
Floodway expansion—bypasses and transient storage areas	✓				✓			✓
Facility removal	✓	✓	✓	✓	✓	✓		✓
Facility repair, improvement, and construction—levees[1]				✓				✓
Facility repair, improvement, and construction—revetment[1]			✓					✓
Facility repair, improvement, and construction—weirs and other control structures	✓					✓		✓
Integration with Operations and Maintenance								
Floodwater storage and forecasting, operations, and coordination	✓	✓						✓
Maintenance—vegetation management			✓	✓	✓		✓	✓
Maintenance—invasive plant management			✓	✓	✓		✓	✓

Key: SRA = shaded riverine aquatic.
Notes: Check marks indicate that the management action contributes to measurable objectives for the topics in the corresponding column; the proportions of potential benefits vary.
[1] Benefits provided by only selected types of repair, improvement, and construction, as described in text.

This section describes these actions and how habitat restoration actions can be integrated with them in multi-benefit projects. Because many structural modifications are major construction projects, a general description of construction activities is provided in Appendix C (based on the PEIR for the 2012 CVFPP [DWR 2012a]).

Floodway Expansion

River Levee Relocation
Floodways along rivers can be expanded by relocating or removing confining levees. (Levee removal is described below under "Facility Removal.") To relocate levees, flood easements may be purchased, setback levees constructed, and existing levees removed, degraded, or allowed to degrade over time. (Degraded levees can provide refugia from floodwaters for terrestrial wildlife.)

Setback levees can generate opportunities to improve ecosystem functions and increase the extent, quality, and connectivity of waterside habitat. Expanded floodways would create additional space for river meander, sediment erosion and deposition, natural ecosystem disturbance processes, and diverse riverine and floodplain habitats. In particular, floodway expansion may often be necessary for restoration of natural banks and SRA cover. Increasing the distance of levees from the main river channel would also increase the capacity of the local floodway, which could reduce the velocity of floodwaters, create transitory floodplain storage, and reduce flood stage. In reaches where levees closely follow sinuous river channels, setback levees may reduce overall maintenance costs by substantially reducing overall levee length, reducing erosion of levees by floodwaters or channel migration, eliminating the need for vegetation removal in constricted floodway areas, and reducing the amount of associated mitigation.

Various factors must be considered to determine the suitability of a setback levee, including physical condition of the existing levee, floodway capacity, the presence of existing flood easements and encroachments, the site's geology and topography, existing populations and infrastructure protected by the existing levee, local and regional land use plans and objectives, local and regional hydraulic benefits and impacts, the potential for erosion reduction, costs, and opportunities for agricultural, habitat, and recreational benefits. Appendix I, "Floodplain Restoration Opportunity Analysis," provides an initial evaluation of the extent of potential locations for setback levees. This evaluation did not include flood risk management planning (e.g., potential flood risk reduction facilities that might provide the foundation for ecosystem restoration actions in these areas were not evaluated), but it provides a basis for more detailed and comprehensive opportunity analyses.

Several factors affect the ecosystem benefits that would result from relocating a levee:

- increased acreage and habitat connectivity that would be added to the active floodplain;
- improved frequency, timing, and duration of inundation of the expanded floodplain;

- revetment that could be removed or allowed to degrade, which would restore SRA cover and natural banks; and
- associated opportunities to restore meander migration and other physical processes.

To maximize ecosystem benefits, setback levees could be designed to accommodate riparian vegetation within the expanded floodway, while still meeting conveyance and levee safety needs. Where a river channel is incised or flows have been substantially altered, or both, setback levees alone may be insufficient to considerably improve ecosystem processes and habitats. Thus, in some cases, lowering the floodplain elevation (e.g., by constructing swales or side channels, or removing obstructions to provide river access to remnant channels or oxbows) may also be important to allow the frequent, sustained inundation needed for aquatic productivity and other ecosystem functions. To provide rearing habitat of greater value to steelhead and Chinook salmon, floodplains should be inundated annually or every 2 years for 14 days or longer (see Appendix G, "Identification of Target Species and Focused Conservation Plans") on average.

At selected locations, levees could be relocated and floodways expanded with the following features, as appropriate:

- easements, rights-of-way, and roads that allow for flood emergency response and flood-fighting, maintenance of visibility, and future repairs;
- elevations within the floodway that provide for frequent inundation and support riparian and wetland habitats and species;
- floodway contours and design features that minimize the potential for fish stranding;
- design features that minimize effects on highly productive agricultural land and provide the infrastructure (e.g., access roads, drainage ditches, and water supply canals) necessary for continued agricultural use; and
- removal, relocation, or floodproofing of permanent structures in the setback area, to ensure visibility and access and to reduce impacts on geomorphic processes (i.e., impacts caused when channel migration is inhibited to protect structures).

Bypasses and Transient Storage Areas

To improve system capacity, resiliency, and flexibility, the CVFPP includes as major features the expansion of existing bypasses as well as the consideration of new bypasses. These improvements would be designed to accommodate viable agriculture and restore marsh, seasonal wetland, and riparian habitats (DWR 2012b). These habitats could be restored where bypasses connect to rivers, on land between rivers and transient storage areas and bypasses, along the Feather River where it flows through the Sutter Bypass, on historical floodplain landforms in transient storage areas, and adjacent to canals, drains, and existing managed habitat. As described in the 2012 CVFPP (DWR 2012b), floodplain agriculture, including wildlife-friendly

agriculture, will be encouraged by DWR where habitat is not restored (see Section 6.3, "Agricultural Land Stewardship," for additional information).

The potential ecosystem benefits provided by bypasses and transient storage areas are strongly related to conditions that allow fish to safely move into and out of these areas and to the frequency and duration of inundation. These issues are discussed in the context of modifying weirs that spill floodwaters into the bypasses (see "Facility Repair, Improvement, and Construction," below).

Facility Removal

Where levees or revetment no longer provide significant flood management benefits, these structures could be removed or, in the case of levees, allowed to degrade in place. These facilities may be part of the SPFC (i.e., project levees and revetment) or not. Physical removal of facilities would be subject to case-by-case evaluation.

Removing or degrading these structures would improve riverine geomorphic processes and floodplain inundation, which are important to sustaining riverine and floodplain habitats, and would also reduce O&M costs (as discussed in DWR 2012c, DWR 2012d, and Appendix F). The ecological benefits of removal are greater where removal occurs along salmonid-bearing waterways, at locations providing potential habitat for bank swallow colonies, and where removal contributes to a larger zone of active river meander migration.

There are potential opportunities for removing revetment while still meeting flood risk management needs, but removal is not feasible where sufficient alternate protection cannot be provided and banks would actively erode toward nearby infrastructure. Unprotected banks recede at varied rates, depending on their position along the channel, substrate erodibility, vegetation and bank heights, human activities, and flow regime. Along the upper Sacramento River, some unprotected banks may recede several feet per year, or more in years with greater flows (DWR 1999). At such actively eroding sites, even infrastructure 50–100 feet or more from the channel could soon be damaged, so bank protection is needed to limit or arrest bank retreat. For example, the right bank of the Sacramento River just upstream of Hamilton City migrated over 200 feet westward between 1998 and 2003 (Google 2014).

Biotechnical bank protection is the combined use of plants and other materials to stabilize streambanks and levees; it can effectively limit erosion rates in some settings (Hart and Hunter 2004), but it is generally ineffective where high, steep banks erode below the rooting zone (unless used in conjunction with revetment or other structures along the toe of the bank) (Shields et al. 1995; DWR 1999). Because high, steep banks are widespread along major rivers in the Sacramento and San Joaquin Valleys, revetment is often the most effective form of bank protection at actively eroding sites.

If the erosion site is not located at the levee toe, however, woody vegetation may be incorporated into revetment, or approaches combining biotechnical bank protection, revetment, and structures may be used to arrest bank retreat. Such biotechnical structures have been installed along the lower American River. For example, a collaborative bank stabilization project executed by

USACE and the Sacramento Area Flood Control Agency (SAFCA) in late 2005 at Sand Cove in Sacramento involved placement of a riprap berm foundation, large woody debris, soil, coir fabric, and native plants (SAFCA 2008). The rapidly eroding site was stabilized and, over the course of 4 months of high flows, gained large volumes of silt deposits, with subsequent profuse growth of native vegetation.

Facility Repair, Improvement, and Construction

Levees
Construction of new levees and reconstruction to improve existing levees will be needed to achieve various flood risk management objectives. Remedial actions could address adverse conditions that preclude reliable passage of SPFC design flows, such as geometric conditions (related to the levee's height, width, slope, or cross section) or other known performance problems, such as instability, excessive seepage or underseepage, penetrations, and other encroachments.

Potential levee repair, improvement, and construction activities include the following:

- Raising levees by adding earthen material or constructing floodwalls to the levee crown.
- Strengthening levees to enhance their structural integrity by improving the properties and geometry of embankment soils to resist slope and seepage failures. To improve resistance to slope failure, levees are enlarged by adding material to widen the levee top, flatten steep slopes, or both. Material can be added to the land side of a levee to increase stability by widening the crown and/or decreasing the side slopes. Material can be added on the water side in some situations to protect against erosion. Methods to address seepage include constructing seepage berms, stability berms, impermeable barrier curtains (slurry cutoff walls) in the levee or its foundation, and pressure relief wells and toe drains.
- Armoring levees on the water side or land side to improve resistance to erosion during bank-full and levee-overtopping events.

The construction of levee embankments, seepage berms, cutoff walls, and pressure relief wells is described further in Appendix C, "Description of Construction Activities for Structural Modifications."

Consistent with the 2012 CVFPP, new levees may be constructed or existing levees remediated or improved to provide some or all of the following benefits:

- Increased floodway capacity
- Improved levee integrity
- Reduced long-term maintenance and repair costs

- Increased recreational or open space opportunities
- Opportunities for improving the amount and continuity of SRA cover
- Flexibility to accommodate hydrologic variations resulting from climate change

New levees could be designed to be compatible with existing and potential floodway habitats, including accommodating continuous corridors of riparian vegetation wherever feasible. In some instances, because of the condition of the existing levee and constraints on building a new levee set back at a considerable distance, SPFC facilities could be improved by building entirely new levees next to existing levees. Although costly, this approach would provide ecosystem benefits by allowing existing habitat to persist and additional habitat to develop on the old levee, which, because of its height, would add to the diversity of habitats in the floodway.

In many locations, however, remediating or improving the existing levee will be the most cost-effective way to address long-term flood risk management needs. In these locations, where technically feasible, and in conformance with USACE engineering requirements, designs for levee reconstruction can incorporate measures such as the following to provide ecosystem benefits without compromising public safety:

- **Incorporate biotechnical bank protection along levees or adjacent eroding banks:** Biotechnical bank protection improves bank resistance to erosion, with vegetation (e.g., tules) attenuating wave energy and further reducing erosive forces. Thus, incorporating biotechnical bank protection can complement, or reduce the need for, revetment. This method entails planting cuttings and container plants in shallow water next to banks, in exposed soil along banks, or in revetment. If cuttings and container plants are incorporated into revetment, some localized modification of revetment (such as incorporating uncompacted soil) may be necessary.

- **Incorporate the vegetation component of SRA cover:** Waterside woody riparian vegetation that shades the adjacent water surface is a core component of SRA cover, and a source of LWM that contributes to the aquatic component of SRA cover. Implementation of this measure along salmonid-bearing waterways is particularly desirable, because of the importance of SRA cover to targeted fish species. Native trees and other woody vegetation could be planted on a lower waterside levee slope or riverbank, or on a berm specifically designed for waterside plantings, where building such a berm is feasible. The planting berm, or the entire levee if necessary, would have an overbuilt section with respect to minimum geometries, and so would be of sufficient size and configuration to ensure levee safety. As with the biotechnical bank protection method, plantings would consist of cuttings or container plants, installed into exposed soil or revetment (with uncompacted soil).

- **Use excess channel sediment for levee material, if suitable:** Excavating surplus sediment for use in facility construction can concurrently expand channel capacity and

improve riverine habitats, particularly if the sediment is strategically excavated to increase the connectivity of partially isolated secondary channels.

- **Apply levee design criteria that create compatibility with existing and potential floodway habitats:** Designing levees so that floodwaters can be safely conveyed along floodways that support continuous corridors of riparian vegetation (and associated roughness) would allow for future changes in floodway land use and management, because of the greater height of these levees, and thus increase the flexibility of the system and its ability to yield environmental benefits.

Revetment

Facility remediation, improvement, and construction projects may involve installing rock riprap revetment (a facing, made of rock or pieces of concrete), generally on the water side of a levee or along an eroding bank. Rock revetment provides structural integrity, and erosion protection to the levee prism, roads, bridges, docks, infrastructure, and other encroachments.

The two main measures for incorporating ecosystem restoration into the installation of revetment are (1) using biotechnical bank protection in conjunction with revetment to reduce the extent of revetted bank and (2) planting trees and other woody vegetation into revetment to provide the vegetation component of SRA cover. Both measures are described in the preceding section. The Small Erosion Repair Program (SERP) uses seven templates for incorporating vegetation into revetment that represent a few types of biotechnical treatments (DWR 2012e).

Weirs and Other Control Structures

New flood control structures, such as weirs, gates, and channel diversions, may be constructed in conjunction with new bypasses and transient floodplain storage areas. Also, some existing flood control structures (e.g., the Sacramento Weir and Tisdale Weir) could be modified to more effectively manage floodwaters while reducing their impacts on biological resources. Weirs in particular can be modified in several ways, depending on their configuration, operation, and desired effect: by raising, lowering, lengthening, or notching the weir sills. For example, a weir crest can be raised to prevent flows from entering a storage area too early in a flood event, thereby reserving storage space for the peak of the storm. As an alternative, weirs can be lengthened to pass more flows into a bypass at the same stage, or lowered to divert flows at lower stages. Other modifications include removing sediment or debris to improve the intended performance of a weir. The Sacramento Weir is the only bypass overflow weir in the system that relies on moveable gates to control releases. The existing gates can be rapidly opened, but are expensive and difficult to close. A potential CVFPP action would involve rebuilding the weir with modern gates that could be easily opened and closed.

Improving or constructing flood control structures could change flow and the magnitude, timing, duration, and frequency of inundation of bypasses and transient storage areas. More frequently inundating the floodplain in bypasses and transient storage areas would help restore floodplain ecosystems, supporting more sustainable and higher-quality habitat for some targeted species. In particular, more frequent and sustained inundation may contribute to food web productivity and fish-rearing habitat. However, in addition to habitat effects, proposals to change bypass flow

regimes must include consideration of potential impacts on current land uses—in particular, the economic viability of irrigated agriculture in bypasses, which is strongly affected by growing-season length, water supply, and drainage.

Modifications at identified structural barriers could improve fish passage effectiveness or efficiency and eliminate stressful conditions associated with stranding in structure features, reduce poaching opportunities, reduce the energy expended by migrating fish, improve survival, and increase potential for reproductive success (Appendix K, "Synthesis of Fish Migration Improvement Opportunities in the Central Valley Flood System"). Types of fish passage improvements that could be made at existing structures include structure removal, notching of weir sills, seminatural and technical fishway construction, improvements to the efficiency of existing fishways, and operational adjustments. In some cases, it may be necessary to install physical or behavioral barriers at structures to keep fish from straying into undesirable or detrimental areas.

Several factors affect the ecosystem benefits that would result from passage improvements:

- The degree to which the potential for fish to be stranded or trapped in structures has been reduced.
- Improvement of lateral habitat connectivity. Lateral habitat connectivity restoration and improvements may be combined with longitudinal passage improvements at structures to gain the greatest benefits for fish species (see Appendix K). Examples of improvements to lateral habitat connectivity include setting back levees, restoring floodplains, eliminating isolated depressions where fish could be stranded, and increasing the connectivity of canals, toe drains, and low-flow channels. Reducing backwater areas and creating resting areas may also increase overall benefits.
- The number of species that would gain passage. The design criteria for fishways should be targeted to the needs and requirements of the most limited species.
- The type of approach to improving migration: natural, seminatural, or technical migration improvements. Natural approaches provide the greatest benefits and technical improvements the least (see DWR 2014, Table 2.4.4).
- The extent of reductions in management responses (e.g., fish rescues) and structural maintenance.
- The amount of additional habitat made accessible, if any.

Passage efficiency goals should be set in the context of the site's location in the river network, its spatial relationship to other structural impediments and adjacent habitat types, bioenergetic migration costs, and the multidirectional (upstream and downstream) migration needs of multiple species. The feasibility of passage improvements should be assessed in the context of planned

infrastructure improvements at the site, the purpose of the structure in question, its existing use, and flood system constraints.

DWR will work with other agencies and organizations to improve fish passage at known or potential impediments, including flood diversions, flashboard dams, flood management structures, and pumping stations.

Fish passage is also blocked at major dams in the SPA; improving passage around these dams is complex and challenging (Beckwith et al. 2013). Formal direction from NMFS, in the form of a biological opinion (BO) for the Operations Criteria and Plan (NMFS 2009), directs the U.S. Bureau of Reclamation (USBR) to develop a step-wise process to facilitate fish passage around several major dams (Shasta, Folsom, and New Melones).

Development of Multi-Benefit Flood Projects

Multi-benefit projects that combine structural modifications with ecological restoration would be the primary means by which this Strategy's objectives would be attained. The preceding sections describe the general techniques for incorporating ecosystem restoration into structural modifications. This section describes the application of those techniques to specific projects. It outlines a planning process for developing restoration concepts for a project.

A sequence of steps for developing and integrating ecosystem improvements during the development of projects is detailed below. This sequence is based on the process used to develop restoration concepts for the BWFSs.

- **Assess Initial Footprint.** The integration of ecosystem restoration would begin with an assessment of the preliminary footprint of a potential flood project. Areas in and adjacent to the preliminary footprint would be examined to identify potential restoration opportunities. Based on this initial assessment, the preliminary footprint may be revised to better encompass restoration opportunities.
- **Evaluate Existing Conditions.** Existing conditions would be evaluated to identify opportunities and constraints and otherwise guide project design. This evaluation would entail reviewing and analyzing geographic information system (GIS) data layers or other data sources, focusing on the following site attributes:
  - **Topography.** Elevations and topography affect the feasibility of implementing ecosystem improvements (e.g., the practicality of grading and general construction).
  - **Land use.** Land uses are indicative of agricultural suitability, and provide clues about historical land use, improvement potential, and possible conflicts.
  - **Infrastructure.** Infrastructure such as roads, railroads, buildings, and utilities are potential constraints on ecosystem improvements.
  - **Flood management structures.** Structures such as levees, pumping stations, and weirs present potential constraints as well as improvement opportunities.

- **Revetment.** Revetment precludes channel migration, and thus can be a major impediment to restoring sustainable floodplain habitats. Identifying revetment that is no longer needed represents an opportunity for restoring ecosystem processes.
- **Floodplain inundation potential.** FIP is a measurement of the frequency with which a site might be inundated, and indicates suitability for providing desired ecological benefits, particularly for anadromous fish.
- **Soils.** Soils determine the types of vegetation that can be successfully restored, and have other effects on the design and outcome of ecosystem improvements. Important properties include texture and typical depth to groundwater, and presence of potentially hazardous constituents (e.g., mercury).
- **Vegetation.** Areas of natural vegetation at the project site might be enhanced or expanded to create larger patches of higher-quality habitat.
- **Special-status species.** Special-status species may occupy habitat at or near the project site, in which case the restoration actions could adversely affect or benefit the species.
- **Fish passage barriers.** Fish passage barriers in or near the preliminary footprint could be rectified to benefit target fish species.
- **Invasive plants.** Invasive plant infestations in and near the preliminary footprint may diminish ecological benefits of the project unless they are eradicated.
- **Parcel boundaries and ownership.** The management of adjacent lands can influence restoration success, and neighboring landowners and land managers represent stakeholders and potential teaming partners.
- **Historical conditions.** Knowledge of historical conditions in the project area would inform the development of restoration concepts.

- **Identify Design Considerations for Target Species.** Project-specific design considerations would be identified to benefit target species and habitats.
- **Develop Preliminary Restoration Concepts.** Preliminary restoration concepts would be developed based on the review of existing and historical conditions, and by applying the design considerations for target species and habitats.
- **Review and Refine Ecosystem Improvement Concepts.** The project team would review and refine preliminary concepts, identifying additional opportunities, constraints, and design considerations. Review and refinement of the concepts would be informed by hydraulic modeling and preliminary estimates of anticipated costs and benefits.
- **Engage with Stakeholders.** Stakeholder input on the refined restoration concepts would be sought. In particular, there would be close coordination with related federal, State, and regional agencies and conservation planning efforts.
- **Develop Final Restoration Concept.** Based on stakeholder input, estimated costs, and anticipated benefits, the final ecosystem improvement concept would be developed and incorporated into subsequent planning, design, and funding of the multi-benefit project.

Integration with Operations and Maintenance

Floodwater Storage and Forecasting, Operations, and Coordination
Storage of floodwater—whether in foothill reservoirs or on floodplains and historical overflow basins—and coordination of reservoir releases are valuable tools for managing flood risk. They also generate opportunities to integrate water supply, water quality, ecosystem, agricultural, and recreational benefits.

Since 1850, nearly 150 reservoirs have been constructed on streams draining to the Sacramento and San Joaquin Valleys. These reservoirs were built by a variety of public agencies, including utilities, water districts, DWR, USACE, and USBR (DWR 2012b). Ten major multipurpose reservoirs play a critically important role in moderating Central Valley flood inflows:

- Shasta Lake on the Sacramento River
- Lake Oroville on the Feather River
- New Bullards Bar Reservoir on the Yuba River
- Folsom Lake on the American River
- Camanche Reservoir on the Mokelumne River
- New Hogan Reservoir on the Calaveras River
- New Melones Reservoir on the Stanislaus River
- New Don Pedro Reservoir on the Tuolumne River
- Lake McClure on the Merced River
- Millerton Lake on the San Joaquin River

These reservoirs are operated in accordance with flood control rules established by USACE. In general, the rules require that, during the flood season, a portion of the storage space in the lake be reserved for capturing peak flows and releasing them gradually, so that downstream channel capacity is not overwhelmed. In some reservoirs, the required flood control space is adjusted in proportion to the seasonal precipitation, soil moisture, and snowpack. This space is drained as quickly as feasible after each flood peak to be ready for the next peak. The rules are tuned to the particular runoff characteristics of each river basin.

For Central Valley reservoirs, DWR has been working with other reservoir operators to develop and implement forecast-coordinated operations. Forecast-coordinated operations seek to coordinate flood releases from the reservoirs located in various tributaries of a major river, to optimize the use of downstream channel capacity and the use of total available storage space in the system, and eventually to reduce overall peak flood flows downstream of the reservoirs. The

management process and partnerships, formed through development of forecast-coordinated operations, contribute significantly to enhanced coordination of reservoir operations during flood events.

Implementing forecast-based operation of Central Valley reservoirs is the next logical step in advancing forecast-coordinated operations. Forecast-based operation would involve using improved long-term runoff forecasting and operating within the limits of the existing flood control diagram. (A flood control diagram defines, by date, the volume of reservoir capacity allocated for floodwater storage.) Changing flood control diagrams to be more flexible and allow for more proactive reservoir management would require extensive studies of the most feasible diagrams, environmental documentation for changing reservoir operations, and congressional approval for new dynamic flood control diagrams.

The CVFPP includes implementation of coordinated and forecast-based operations for all reservoirs in the Central Valley. Such operations could provide flow releases that improve aquatic habitat conditions, sustain riverine habitats, reduce fish stranding and passage barriers, and generate other environmental benefits. Consequently, DWR's evaluation of reservoir forecasting, dam operations (e.g., ramping rates), coordinated operation of multiple reservoirs, and management of groundwater may identify opportunities to:

- reduce fish stranding and other adverse effects on targeted species, such as nesting bank swallows;
- improve conditions for passage of targeted fish species;
- enhance the ecological benefits of bank-full and overbank flows;
- enhance meander migration rates;
- improve spawning gravel dynamics (recruitment, flushing, and mobilization); and
- facilitate establishment of cottonwoods and early successional riparian vegetation at intervals (e.g., 5–15 years) sufficient to sustain these vegetation types along major river reaches.

Feasible opportunities identified during these evaluations could be developed into actions to provide conservation, flood risk management, and other benefits. Feasible modifications to operational procedures are those that do not conflict with applicable laws, agreements, and regulations or increase flood risk.

Maintenance

The existing mosaic of floodway habitats is in part the result of maintenance activities. Levee maintenance activities consist of mowing, dragging, grubbing, grazing, and burning vegetation; removing trees; applying rodenticide and herbicide; filling or grouting rodent burrows and other penetration gaps; and placing fill or rock. Activities that occur between levees and river channels

are similar to levee maintenance activities, but also include removing sediment, debris, and other flow obstructions.

These activities are conducted to maintain floodwater conveyance and levee reliability, visibility, and accessibility, in compliance with federal regulations and in accordance with the applicable USACE O&M manual, while minimizing environmental impacts. At a few locations, there are also O&M responsibilities for maintaining natural vegetation at sites designated as mitigation for a flood project. For these areas, land management may require different practices to comply with regulatory requirements.

Structural modifications create local opportunities to change maintenance practices. Thus, maintenance activities would be fully considered when structural modifications are planned and designed. The intention would be to reduce maintenance costs and conflicts with conservation needs, and to increase resulting ecosystem benefits. For example, locating facilities where they would be less exposed to the erosive force of river flows would reduce the extent and frequency of erosion repairs, and would reduce the need to install and maintain additional revetment. Similarly, locating facilities where their structural integrity would be less vulnerable to water seeping through underlying sediments would reduce the need for future costly structural repairs, such as seepage berms. Considering these and other consequences for maintenance could result in modifications that locate levees farther from rivers, or expand the floodway by expanding bypasses or creating transient storage areas. Such modifications create opportunities to locate habitat where conflicts with maintenance activities are reduced (such as farther from levees), and the expanded floodway may require less removal of sediment or vegetation to maintain conveyance. Also, floodway expansions replace older facilities that have chronic maintenance needs with newer facilities, and can reduce the length of facilities, both of which reduce maintenance costs and conflicts with conservation.

In addition, DWR and LMAs have been working to more broadly improve the environmental benefits of maintenance, such as by:

- integrating environmental scientists in project design and development teams,
- increasing environmental training of maintenance staff,
- purchasing specialized equipment to minimize environmental disturbance during maintenance activities,
- using herbicides and rodenticides that are carefully selected to minimize impacts on any species that are not targeted by herbicide and rodenticide application,
- expanding use of hand crews in areas containing sensitive environmental resources,
- scheduling maintenance activities to avoid sensitive time periods for species,
- implementing selective vegetation management to support habitat enhancement,

- changing floodplain vegetation management from dozing and disking to mowing and an expanded grazing program,
- increasing plantings of native species during maintenance activities,
- managing vegetation research to improve understanding of the public safety implications of vegetation on levees,
- developing and implementing a levee vegetation management strategy as an alternative to the approach outlined in USACE's Engineering Technical Letter (ETL) 1110-2-583,[3] and
- implementing enhanced invasive species removal and control.

In particular, DWR is evaluating potential improvements to management of levee and channel vegetation and invasive plants. These are described in more detail in the following sections, in Appendix D, "Vegetation Management Strategy"; and in Appendix E, "Invasive Plant Management Plan."

Box 6-1
What is the Vegetation Management Zone (VMZ)?

The VMZ is the area on and near a levee in which vegetation is managed for visibility, accessibility, and long-term habitat value.

The VMZ includes the entire landside levee slope plus 15 feet beyond the landside toe (or less if the existing easement is less than 15 feet), the levee crown, and the top 20 feet (slope length) of the waterside levee slope.

For levees that have a waterside slope of less than 20 feet, the VMZ includes the entire waterside slope plus the extent of berm within 20 feet of the crown, as measured along the ground surface.

For levees that have a short waterside slope above the water surface elevation that submerges the lower waterside slope frequently enough to prevent long-term tree establishment, the lower 5 feet (slope distance) of the waterside slope immediately above that water surface elevation is not included in the VMZ and should remain unmanaged.

For levees with a landside berm, the VMZ is determined by using the projected landside levee slope instead of the actual landside levee slope.

The VMZ is illustrated in Figures 1-1 and 1-2 in Appendix D.

6.2 Vegetation Management

Upon adoption of the 2012 CVFPP and Conservation Framework, CVFPB considered the plan's levee vegetation management strategy as interim and directed DWR to continue development of this interim strategy into a more comprehensive approach that would be adaptive and responsive to the results of ongoing and future research, including research regarding vegetation on levees; knowledge gained from levee performance during high-water events; and the need to conserve critical riparian habitat. At this time, DWR is aware that the recent enactment of Public Law 113-121, the Water Resources Reform and Development Act of 2014,

[3] ETL 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams and Appurtenant Structures (USACE 2014).

directs USACE to provide revised guidelines for management of vegetation on levees and to provide the public no fewer than 30 days to review and comment on the draft guidance before issuing final guidelines. It is hoped that the review will also lead to substantial changes in the program guidance letter published in the *Federal Register* on 17 February 2012, describing the process for requesting a variance from vegetation standards for levees and floodwalls.

Vegetation management by DWR consists of efforts to manage levee vegetation, channel vegetation, and invasive plants. Levee vegetation management is particularly important because levee vegetation can impede visibility and accessibility for inspections and flood fighting. In areas with levees set back from the banks of rivers, the channel in between the levees provides opportunities for important riparian and wetland habitat as well as agricultural operations; however, riparian, wetland, and agricultural vegetation must be managed to maintain the channel's ability to convey high flows during flood events. Finally, invasive plants can adversely affect O&M and are a documented stressor on the species, habitats, and ecosystem processes targeted by this Conservation Strategy; management of these plants, and eradication where feasible, reduces O&M needs and provides important ecosystem benefits.

6.2.1 Levee Vegetation Management

Overview of Approach to Levee Vegetation Management

The State's strategy for levee vegetation management is adaptive and responsive to (1) the results of ongoing and future research and (2) knowledge gained from levee performance during high-water events. The strategy described in the 2012 CVFPP and Conservation Framework (DWR 2012b, 2012c) is built on concepts embodied in *California's Central Valley Flood System Improvement Framework* (California Levees Roundtable 2009), signed in 2009 by participants in the California Levees Roundtable, and includes a systemwide and risk-informed process to address the requirements of USACE national vegetation policy within the context of multiple levee risk factors.

Long-term management of vegetation will be accomplished through adaptive management of vegetation on the levee—both within the Vegetation Management Zone (VMZ) and on the lower waterside slope (outside the VMZ). This approach:

- allows existing "legacy" trees and other woody vegetation to live out their normal life cycles unless they pose an unacceptable threat,
- precludes growth of new woody vegetation on newly constructed levees,
- allows visibility for inspections and access for maintenance and flood fight to be maintained,
- allows retention of lower waterside vegetation (below the VMZ),

- emphasizes establishment of riparian corridors as a preferred approach for providing compensatory habitat in the short term for loss of habitat on the levee profile in the longer term, and

- allows for limited managed recruitment of woody vegetation within areas of the lower waterside levee slope not currently occupied by riparian habitat.

Further information on DWR's vegetation management strategy is outlined in Appendix D.

6.2.2 Channel Vegetation Management

DWR and LMA management of channels includes mechanical and chemical control of terrestrial and aquatic vegetation, in conformance with the applicable USACE O&M manual. These activities consist of mowing, dragging and grading, burning, grazing livestock, removing trees, and applying herbicide.

In order to implement these activities in a cost-effective manner that minimizes environmental impacts, BMPs are being developed. These BMPs seek to balance maintaining channel conveyance capacity with conservation goals while reducing O&M costs. These BMPs will include planning practices that are being improved by the results of recent and ongoing DWR-funded studies. Of these planning practices, a particularly important one is to account for channel capacity early in the design of multi-benefit projects. Recent and ongoing studies are developing field-based parameters that more accurately represent channel vegetation within hydraulic models and other planning tools. More accurate representation reduces uncertainty and facilitates project designs that optimize both channel conveyance and habitat value. More accurate representation also reduces the need for long-term O&M because the effects of vegetation can be properly accounted for in designs. BMPs also will include controlling invasive weeds and establishing specific native plant communities to improve conveyance, protect floodway infrastructure, and benefit wildlife.

6.2.3 Invasive Plant Management

Invasive plants are a major stressor of ecosystem processes and habitats, and also negatively affect O&M. DWR has developed an Invasive Plant Management Plan to reduce these impacts (Appendix E). The plan has a threefold approach to reducing invasive plant impacts:

- Increase institutional support for an SPA-wide invasive plant treatment program for DWR-maintained areas.

- Develop and implement a coordinated, systemwide invasive plant treatment approach within Channel Maintenance Areas, and effectively track results.

- Further develop partnerships through which the use of DWR resources can be optimized, and provide resources that facilitate consistency with DWR's approaches beyond its maintenance areas.

DWR has already begun to implement this approach:

- DWR is developing BMPs specific to areas for which it has maintenance responsibilities.
- DWR has selected four Initial Priority Species for control: giant reed, red sesbania, Himalayan blackberry, and saltcedar. These species were selected because they are widespread within the SPA; have documented, adverse effects on native species and riparian ecosystems; and have been mapped at a sufficient level of spatial detail to facilitate systemwide planning and prioritization. New fine-scale mapping was combined with other data to develop a baseline inventory of plant communities dominated by these species. This new baseline indicates that these species dominate approximately 3,800 acres in the SPA, of which approximately 1,100 acres are within Channel Maintenance Areas comanaged by DWR and LMAs.
- DWR is adapting an existing computational model (developed by DWR staff) based on GIS data, the Weed Heuristics Invasive Population Prioritization for Eradication Tool, to support DWR's treatment of invasive plant populations. This model prioritizes treatment areas in settings with infestations of multiple species.
- DWR has described available resources (Appendix E) to facilitate actions by other land managers. These resources include broadly applicable BMPs, species life history information, best available treatment methods, common permitting requirements, a catalog of existing efforts to control invasive plants, and descriptions of legislative directives.

Invasive plants are broadly distributed throughout the SPA, so their control will require the collaboration of land managers systemwide. Consequently, the Invasive Plant Management Plan describes DWR's contribution to reducing this stressor and assists other entities in contributing to solutions for this systemwide problem. Implementation of the plan is expected to reduce the effects of invasive plants on ecosystem processes and habitats, and on SPFC O&M. DWR will also evaluate the numerous current efforts by other entities to control invasive plants, to identify where DWR's participation would be most effective in advancing these programs. Also, continued collaboration with current partners will facilitate development of shared goals, improve information exchange and standardized tracking, and reduce duplication of effort.

6.3 Agricultural Land Stewardship

DWR considers agricultural land stewardship to be an important element in its efforts to achieve the economic stability, public safety, and ecological sustainability goals of the CVFPP and this Conservation Strategy. SPFC facilities include productive agricultural lands that are important to local tax revenues and regional economies. *Stewardship* of these lands refers to conserving natural resources and providing public environmental benefits as part of agricultural practices (DWR 2005). These benefits include support of flood protection because landowners maintain their land to be compatible with the safe conveyance of flood flows. Agricultural land

stewardship also protects open spaces and the traditional characteristics of rural communities, and provides habitat for numerous species. Furthermore, support for the public benefits derived from stewardship activities helps landowners maintain their farms and ranches and avoid being forced to sell their land because of pressure from urban development.

Land stewardship has been practiced by farmers and ranchers, and encouraged by State and federal entities, for years. Farmers and ranchers value habitat as part of rural living, and have been active in providing, as part of agricultural activities, beneficial habitats such as hedgerows, vegetation along waterways, and flooded rice fields. These and other stewardship activities not only protect physical resources (e.g., soil and water) and common wildlife (e.g., waterfowl), they also contribute to the sustenance of threatened and endangered species, such as the giant garter snake and the Swainson's hawk (see Section 6.3.2, "Wildlife-Friendly Agricultural Practices").

Recent examples of agricultural land stewardship in the Central Valley include the following:

- In the middle section of the Cache Creek watershed, farmers and local agencies work in partnership to manage invasive species infestations that compromise wildlife values and the stability of creek banks and threaten the success of lower Cache Creek vegetation management efforts (Yolo County Resource Conservation District [Yolo County RCD] 2014a).

- In Shasta County, State and federal agencies worked with the Western Shasta RCD to restore the natural form and function on a portion of Clear Creek, a tributary to the Sacramento River, and its floodplain; increase the quantity and quality of anadromous fish habitat and riparian areas; and establish a corridor for public access and recreation (Western Shasta RCD 2014).

- Under the Working Waterways & Landowner Stewardship Program, farmers revegetate sloughs, canals, and creeks to reduce soil loss, improve weed control, provide habitat for riparian songbirds and pollinators, and reduce pests that would adversely affect agricultural crops (Yolo County RCD 2014b).

DWR recognizes that conservation can create legitimate issues or constraints for agriculture—for instance, by converting productive agricultural land to restored habitat or exacerbating weed control issues. Thus, DWR is committed to developing multi-benefit flood projects in collaboration with agricultural stakeholders. The goal of this collaboration is to benefit agriculture while enhancing flood protection and furthering conservation goals.

To achieve these benefits, DWR has initiated an effort to improve agricultural stewardship policies associated with flood risk management activities. Several Central Valley DWR programs have recognized the concerns of agricultural interests and are engaging agencies, agricultural stakeholders, and other nongovernmental partners in crafting a comprehensive toolbox of agricultural land stewardship strategies. Using these strategies, farmers and other project proponents can voluntarily pursue solutions that:

- keep farmers on the land,
- maintain agricultural and economic viability in the project area,
- provide environmental and habitat benefits,
- are consistent with State and regional polices, and
- support the stability of local governments and special districts.

Specifically, concerns may be addressed effectively by DWR and other project proponents and land managers using the following key stewardship strategies and tools:

- Help maintain farming, such as by:
  - focusing conservation efforts on public lands or low-productivity lands offered by willing landowners;
  - working with farmers and regulatory agencies to identify and resolve impediments to farm productivity;
  - encouraging voluntary engagement in Safe Harbor Agreements (SHAs) and in CDFW's Voluntary Local Program;
  - involving and assisting farmers in planning projects, to avoid loss of productive agricultural land, increase compatibility with flood management (e.g., floodproofing or relocating agricultural facilities), and identify mutual benefits and incentives wherever feasible;
  - providing for agricultural conservation easements;
  - identifying mitigation or assistance that is appropriate for the environmental and social/economic impacts of a project consistent with the mitigation measures of the PEIR for the 2012 CVFPP; and
  - controlling weeds, such as by prioritizing invasive weeds for regional control (see Section 6.2.3).
- Provide financial incentives for taking conservation actions on farmland, such as by:
  - compensating farmers to manage agricultural land as habitat for wildlife and
  - providing incentives for farmers to take part in conservation programs, such as the Central Valley Habitat Exchange.
- Manage land for purposes other than conventional crop production, such as by:

  - assisting landowners in producing and selling greenhouse gas offset credits and
  - compensating farmers to manage habitat lands.

- Focus on economic development and other benefits, such as by:
  - assisting farmers who want to manage their land to incorporate recreation and tourism and
  - studying historical and current land uses and their economic effects on agriculture.

Throughout implementation of this Strategy, DWR will monitor the effects of conservation actions on agriculture. Using an adaptive management approach (see Section 8.0, "Implementation"), DWR will assess changes in hydrological, environmental, economic, institutional, and social conditions to identify needed improvements. Already, to support better understanding of the potential financial impacts of large-scale restoration activities on local economies, DWR has commissioned a study in the Sacramento Valley to quantify how many acres have been converted from agriculture to habitat during the last 20 years and the economic impacts on local communities of that conversion.

6.3.1 Safe Harbor Agreements and Voluntary Local Programs

Habitat restoration may result in the expansion (colonization or increased numbers) of threatened or endangered animal populations onto private lands located in the vicinity of restored habitat. Such expansion could restrict the activities of private landowners.

In some cases, SHAs may be an appropriate mechanism for providing landowners with coverage for take of covered species. An SHA is a voluntary agreement between private or nonfederal landowners and USFWS. These agreements authorize incidental take of federally listed species by landowners whose property has been enhanced in terms of habitat value for listed species. DWR has supported landowner development of SHAs (see below), and would continue to do so.[4]

CDFW operates a program that complements the federal SHA program. Senate Bill 448 (the California State Safe Harbor Agreement Program Act) encourages landowners to manage their lands voluntarily, by means of State SHAs, to benefit CESA candidate, threatened, or endangered species, without being subject to additional regulatory restrictions.

A programmatic SHA recently developed with funding and staff support from CDFW, USFWS, and DWR was signed on 16 September 2013 by USFWS and the Sacramento River Forum. This agreement provides a net conservation benefit to the federally listed as threatened valley elderberry longhorn beetle and giant garter snake (the covered species), assuring nonfederal

[4] The federal and State definitions of *take* differ, but both include actions that would adversely affect individual plants or animals. The federal definition of *take* also includes habitat modification or degradation that harms individuals by modifying behavioral patterns, and the destruction or adverse modification of designated critical habitat. (*Designated critical habitat* encompasses areas that are essential to the conservation of threatened and endangered species.)

participating landowners (cooperators) that no additional regulatory burdens, fines, or penalties will result from management activities designed to benefit federally listed species on privately owned properties in Butte, Glenn, Colusa, Shasta, Yolo, Sutter, and Tehama Counties. The federal permit authorizes the incidental take of the covered species during habitat restoration and during routine and ongoing agricultural activities. Additionally, the permit authorizes incidental take of covered species if a cooperator chooses to return property to baseline conditions. However, the State equivalent, a Voluntary Local Program, has yet to be completed for this area, so coverage under CESA is pending completion of this program.

6.3.2 Wildlife-Friendly Agricultural Practices

Substantial portions of native habitats in the Sacramento and San Joaquin Valleys have been converted to agricultural or urban uses, or have been otherwise disturbed. Compared to other new land uses, agricultural lands are better suited to providing surrogate habitat for fish and wildlife species, and on periodically inundated floodplains, they can be managed to provide habitat for some of this Strategy's target species.

Agricultural lands consist primarily of irrigated row and field crops (e.g., rice, beans, melons, and alfalfa) and orchards and vineyards (e.g., peaches, apricots, walnuts, almonds, and grapes). Agricultural lands go through frequent, often seasonal, cycles of tillage, seedbed preparation, seeding, crop growth, and harvesting, with applications of irrigation water, fertilizers, pesticides, and herbicides.

The value of agricultural lands for sensitive and common fish and wildlife species varies greatly among crop types and agricultural practices. Rice fields can provide relatively high-quality wildlife habitat (Brouder and Hill 1995). Seasonal flooding of rice fields creates surrogate wetlands that can be exploited by giant garter snakes and a variety of resident and migratory birds. Dry and fallow rice fields can attract rodents and their predators (e.g., raptors). Flooding of agricultural land along rivers and within bypass channels can provide rearing habitat for juvenile salmonids (Sommer et al. 2001).

Other field crops and row crops provide forage for raptors, waterfowl, and small rodents at various times of year. For example, pasture and irrigated hayfields provide valuable foraging habitat for raptors, particularly after disking or plowing, when rodents may be especially available for these species.

Box 6-2
What Is Wildlife-Friendly Agriculture?

In the context of this Conservation Strategy, *wildlife-friendly agriculture* consists of practices that benefit this Strategy's targeted wildlife species. For example, Swainson's hawk, greater sandhill crane, and giant garter snake (shown in photograph) rely on some agricultural crops as surrogates for natural habitats that have been lost. Consequently, their recovery depends in part on agricultural practices that enhance habitat values.

Source: Eric Hansen; reprinted with permission.

Orchards and vineyards, however, have relatively low value for most wildlife, in part because understory vegetation that would provide food and cover typically is removed or maintained at a low height. Furthermore, orchards and vineyards provide food for ground squirrels, with the unintended consequence for adjacent levees of increased density of burrows (Van Vuren et al. 2013), which may threaten levee integrity.

On floodplains, agricultural lands in close proximity to natural land cover can provide functions that complement and increase the habitat value of the natural land cover. For example, several raptors (such as Swainson's hawks) nest in riparian forests and woodlands but forage in grasslands and croplands (see the Swainson's hawk plan in Appendix G, "Identification of Target Species and Focused Conservation Plans"). Also, on ecologically functional floodplains along river channels and in the bypass system, this land provides aquatic habitat value when the floodplain is inundated for an adequate duration during the appropriate time of year.

In sum, because agricultural practices strongly affect habitat values and can affect the habitat values of adjacent natural vegetation, implementing wildlife-friendly agricultural practices can contribute to the conservation of target species. These practices also can benefit farmers when they resolve on-the-ground practical farming issues, add to public support for agricultural land uses, or are supported with financial incentives.

Consequently, DWR will work with other State and federal agencies, and with regional and local governments, to support agriculture that is friendly to fish and wildlife and compatible with flood risk management, using tools such as landowner incentive programs, easements, and management of conserved areas, and based on identified and available funding to the extent feasible. This support would be focused on conserved areas and within the footprints of multi-benefit flood projects.

In the context of this Conservation Strategy, *wildlife-friendly agriculture* refers to practices that (1) increase the habitat value of existing agricultural land for targeted wildlife species or (2) reduce the potential for mortality of targeted species and adverse effects on their habitats in adjacent natural areas. Some examples of such practices are as follows:

- Increasing the quality of existing cropland as habitat for Swainson's hawk foraging by increasing the extent of alfalfa, irrigated pasture, and low-height row crops, particularly as alternatives to orchards and vineyards

- Cultivating grain crops near greater sandhill crane roosting sites and deferring tillage of crops to increase foraging opportunities for cranes

- Flooding harvested fields during fall and winter to provide habitat for wading birds (including greater sandhill crane)

- Managing grazing of floodways in a manner that sustains habitat for targeted species (e.g., delta button-celery and Swainson's hawk)

- Maintaining buffers and hedgerows along waterways and adjacent to natural vegetation to diminish the adverse effects of agricultural practices on those habitats and to provide complementary habitat features (e.g., upland refugia and hibernacula for giant garter snake)
- Retaining selected trees and snags and planting trees to provide habitat features for raptors (including Swainson's hawk)
- Maintaining water in canals and ditches during the active periods of sensitive species (e.g., the giant garter snake)
- Managing canal and ditch vegetation to facilitate the dispersal and other movement of giant garter snakes
- Managing pesticide and herbicide use to reduce or avoid adverse effects on native plants and wildlife (e.g., lethal toxicity and reproductive failures)

These and similar practices can also benefit wildlife species that are not targets of this Strategy; for example, flooding harvested fields can provide habitat for waterfowl, and timing silage harvest and water management can minimize impacts on nesting tricolored blackbirds.

7.0 Regulatory Compliance and Regional Permitting

Implementation of the CVFPP, including this Conservation Strategy, will involve numerous flood risk management and conservation actions over a long time frame. These substantial financial investments and commitments to improve public safety, ecosystems, and economic stability are linked to the ability to efficiently obtain permits and a number of regulatory approvals. Therefore, DWR has been collaborating with regulatory agencies to achieve permitting efficiencies and obtain agency cooperation in the form of regional permitting and use of advance mitigation that could facilitate program success for DWR and LMAs.

Actions implementing the CVFPP will need to comply with a variety of federal and State environmental laws, such as the National Environmental Policy Act (NEPA), the Rivers and Harbors Act of 1899, CEQA, CESA, the ESA, and the federal Clean Water Act (CWA). Appendix A, "Regulatory Setting," describes the full suite of environmental laws that need to be complied with while this section focuses on a regional permitting strategy.

In some situations, project proponents will achieve compliance with these laws by implementing activities in a manner that avoids or minimizes environmental effects. In other circumstances, permits and other types of regulatory approvals will be required, including those associated with the public safety requirements of CVFPB and USACE.

Typically, flood risk management and conservation actions have complied with environmental laws on a project-by-project basis. As a result, each project typically has a separate regulatory process, which includes agency consultation, an environmental effects assessment, and identification of mitigation measures. This approach, collectively across multiple projects, results in delays in project approvals and inefficiencies associated with preparing individual regulatory compliance documents for each project. Permit applicants, as well as regulatory agencies charged with issuing permits, are affected by these inefficiencies, which are particularly problematic for O&M activities. Project-by-project permitting also often results in poor conservation outcomes, producing fragmented mitigation sites that are not well integrated with regional conservation priorities and a temporary loss of habitat between when projects are constructed and when the replacement habitat is established. Additionally, the numerous small mitigation sites created through project-by-project permitting necessitate more maintenance than required for the fewer, larger mitigation sites that are the outcome of regional permitting programs. DWR and the resource agencies can work together to surpass what is typically achieved, by implementing a more efficient regional approach to achieve regulatory compliance.

An important role of this Strategy is to inform and support implementation of the CVFPP. This is expected to be accomplished through the following:

1. Help formulate and implement multi-benefit projects that are likely to gain public support and permitting agencies' participation, leading to more predictable and cost-effective permitting. This is expected to result in overall cost savings for project execution. That is, the additional costs associated with implementing the features of multi-benefit projects are offset by savings of the time and effort required to obtain permits for numerous projects with a more singular focus (i.e., projects that do not have multi-benefits).

2. Implement the conservation actions proposed in this Strategy incrementally, in relationship to the investments in flood reduction actions, essentially as part of multi-benefit projects, which will thus help to attain Item 1 and to meet the goal of contributing to the recovery of listed species.

3. Implement advance mitigation projects, which could help ensure that appropriate mitigation will be available when needed, reduce O&M costs, and reduce long-term mitigation costs.

4. Implement regional permitting processes, coupled with long-term monitoring and adaptive management. Regional permitting will be the primary institutional approach to improving long-term permitting efficiency. The specific approaches to doing so are based on existing laws, which are the basis of comparable programs, such as regional HCPs and NCCPs. Agreements forged within these regional planning frameworks are expected to ultimately yield cost savings for more rapid project execution and more efficient O&M. It also would result in more effective conservation outcomes. Permitting on a regional basis would make the permitting process manageable in terms of participants, area of coverage, range of issues, and management complexity. It would cover capital improvements and O&M.

DWR has developed, and is in various stages of pursuing, several opportunities to improve environmental compliance:

- Routine maintenance agreements (RMAs)
- The Small Erosion Repair Program (SERP)
- System-Wide Improvement Frameworks (SWIFs)
- Advance mitigation

These opportunities are discussed below in Sections 7.1 through 7.4.

Additionally, DWR is developing regional permitting programs, a comprehensive effort to combine the flood risk management permitting needs of both DWR and local flood management entities into regional permits, which should allow for compliance with environmental laws, at a

regional level over the long term. This regional approach represents a more predictable, cost-effective, and efficient process than project-by-project permitting, and one that supports coordinated mitigation efforts focused on improving ecosystem functions, resulting in better conservation outcomes and reduced costs for the O&M and improvement of the SPFC.

Also, given the number and complexity of existing regulatory permits and approvals, along with the unique flood and environmental opportunities presented by the CVFPP, DWR intends to work with public safety and environmental regulatory agencies to formulate recommended changes to State and/or federal legislation, policies, and/or procedures to improve the efficiency and effectiveness of the approval process for this program in the long term. DWR's programs for improving environmental compliance are further described below in Section 7.5, "Regional Permitting Programs." Section 7.6 identifies various laws and regulations that apply to implementing this Conservation Strategy.

7.1 Routine Maintenance Agreements

Lake and Streambed Alteration Agreements (LSAAs) for routine maintenance (i.e., RMAs) have been, and will continue to be, developed to provide permitting efficiency and reduced cost for permittees over obtaining individual agreements for maintenance activities. In 2011, CDFW issued DWR's Sacramento and Sutter Maintenance Yards the first of a series of RMAs that provide an efficient process in which DWR submits detailed information after routine maintenance activities are proposed, and CDFW reviews the information to ensure that the proposed maintenance is covered under the RMA. Some of these activities do require a permit from USACE before work is initiated.

7.2 Small Erosion Repair Program

DWR has developed a regulatory review and authorization process for annual repairs of small erosion sites on levees in the Sacramento River Flood Control Project to improve levee reliability, facilitate more efficient project delivery, and often provide environmental benefits. The SERP, developed by a work group of the Interagency Flood Management Collaborative, covers approximately 300 miles of levees maintained by the State in the Sacramento River Flood Control Project. Regulatory approval has been secured, with a goal of making the permitting process more efficient, cost effective, and consistent throughout the system. In addition, more timely repairs of small sites will prevent more extensive erosion (to reduce the risk to public safety, prevent greater environmental damage, and reduce maintenance costs). Following the 5-year SERP pilot effort, which began in 2014, DWR and agency partners will evaluate whether the program can be replicated by other maintaining agencies throughout the SPA.

7.3 System-Wide Improvement Frameworks

DWR has been working with USACE in the development of a programmatic ESA compliance mechanism for SWIFs for SPFC facilities. A SWIF is a plan developed to address systemwide levee issues, including those found during inspections. In this plan, improvements are prioritized to optimize flood risk reduction. For SWIFs for SPFC facilities, a programmatic biological assessment is being developed that will assist USFWS in developing a Section 7 BO for the actions in the SWIF that may adversely affect federally listed species (in this case, the giant garter snake, western yellow-billed cuckoo, and valley elderberry longhorn beetle). USACE plans to append the SWIF activities to the applicable O&M manual for the duration of the proposed activities, along with any required terms and conditions of the BO.

7.4 Advance Mitigation

DWR is planning and funding the development of projects to be used as advance mitigation for habitats and species most commonly affected by flood risk management (i.e., the targets of this Strategy), as further described in Appendix B, “Advance Mitigation.” Advance mitigation establishes habitat before flood projects or actions that need mitigation are permitted. Thus, the created mitigation credits (in the form of habitat) are ready to use at the time of project permitting (where impacts are treated as debits), potentially increasing the efficiency of the permit process and reducing project approval delays and the temporary loss of habitat. Generally, the success of a mitigation effort and preservation of the underlying land (through an easement or other mechanism) needs to be documented and supported by agreements with regulatory agencies before it can count as mitigation. Because the mitigation is purchased and habitat is restored and protected before the immediate need occurs, overall costs can be reduced. Advance mitigation sites provide a preapproved type and amount of habitat credits for a set service area, provided the mitigation projects go through the statewide banking program and all applicable fees are paid to CDFW.

This coordinated mitigation effort can provide a variety of benefits, in terms of both completing flood projects and improving conservation. The credits may be used by DWR and local flood managers to offset the impacts of improvements to SPFC facilities. From a conservation perspective, the mitigation sites are expected to provide better conservation outcomes than those achieved by distinct, project-by-project mitigation efforts. Mitigation sites can be connected or adjacent to existing conservation areas, contribute to improving ecosystem functions, be easier to maintain than individual mitigation sites, and be more viable over the long term. DWR intends to integrate advance mitigation with the development of the regional permitting programs discussed below. Advance mitigation will be implemented incrementally, and efficiency, effectiveness, acceptability, and costs relative to other approaches will be evaluated in an adaptive process that will help determine how extensively this approach will be used by DWR over time.

Assembly Bill (AB) 2087 allows creation of advanced mitigation credits based on voluntary regional conservation investment strategies (RCISs) approved by CDFW. The RCISs can be used to:

- guide investments in resource conservation;
- guide infrastructure design and siting;
- identify conservation priorities, including those needed to address climate change; and
- identify potential mitigation for impacts on wildlife and habitat.

AB 2087 provides an opportunity for broader-based conservation planning. It may be combined with other regional efforts, such HCPs and NCCPs. Under AB 2087, a public agency develops an analysis of conservation needs in a region to guide future actions. It allows infrastructure agencies to implement their projects to avoid impacts on wildlife and maximize the conservation value of their design and siting. Mitigation credit agreements provide a method to establish ongoing funding streams, derived from project mitigation, for actions to protect conservation areas in an RCIS.

The California Legislature will review the progress of this program and limit the number of regional plans that may be approved to eight until the bill expires in 2020. Four regional pilot programs are under development, in the San Francisco Bay Area (two programs), Yolo County, and Antelope Valley (Los Angeles County). Guidelines from CDFW will be available in 2017. DWR is evaluating whether this program would be effective method to provide multi-benefit projects as part of the CVFPP.

7.5 Regional Permitting Programs

In addition to the RMAs, SERP, and advance mitigation opportunities described above, DWR is seeking to establish regional permitting programs. The goal of these programs is to permit multiple flood risk management and conservation activities within defined regions, with an ultimate goal of developing permits that cumulatively cover the entire SPA. Regional permits will be developed to satisfy a broad suite of regulatory requirements. The permits may be used by DWR and local flood management entities that choose to participate.

Developing a permitting program within regions, rather than for the entire flood system at once, is desirable because the permitting process requires (1) considerable funding; (2) extensive data collection, compilation, and analysis; (3) significant public, stakeholder, and agency coordination; and (4) region-specific decisions regarding appropriate permit conditions. Hence, the SPA is too large for a single permitting effort to be feasible.

The regional permitting approach is designed to:

- Meet the multiple permit needs of multiple projects in regional groupings, rather than individually (project by project)

- Meet DWR permitting needs while providing opportunities for local flood management entities to participate and receive permit coverage
- Provide permits of durations greater than 10 years, and up to 30 years where possible, although some permits will likely have shorter durations
- Leverage and coordinate with other regional permitting efforts (e.g., HCP/NCCPs being developed by local jurisdictions) as much as possible

This approach builds on lessons learned by regulatory agencies over the past 30 years in California. Similar approaches have been developed for activities such as land development, timber harvest, and utility and energy projects. For example, local governments have worked with CDFW and USFWS to develop regional conservation plans (HCPs/NCCPs) throughout the state, 10 of which overlap the SPA (mostly in the Delta and the Sacramento Valley). These plans have allowed for economic growth while providing a mechanism for compliance with environmental laws. DWR is examining these plans to identify opportunities for coordination with its own regional permitting efforts. Some of the plans are still in development and may present opportunities over time; others have been approved already, and making amendments to meet DWR's needs may be impractical.

DWR has initiated this regional permitting process in the Feather River area, with an ongoing effort to develop an HCP for the Feather River Regional Permitting Program, funded in part by a grant from USFWS. Lessons learned from the development and implementation of this initial effort will inform the development of regional permitting programs elsewhere in the flood system. The regulatory approvals being pursued through the Feather River Regional Permitting Program are depicted in Table 7-1, and the program's area is shown in Figure 7-1.

Table 7-1. Laws to Be Addressed and Types of Regulatory Approvals Being Pursued through the Feather River Regional Permitting Program

Law to Be Addressed	Type of Regional Permit or Regulatory Approval
Endangered Species Act	Endangered Species Act Section 10 Habitat Conservation Plans
California Endangered Species Act	Incidental Take Permit through California Fish and Game Code Section 2081
Clean Water Act (Section 404) and Rivers and Harbors Act (Section 10)	U.S. Army Corps of Engineers Regional General Permit
Clean Water Act Section 401	Central Valley Regional Water Quality Control Board Clean Water Act Section 401 Certification
California Fish and Game Code Section 1600	California Department of Fish and Wildlife Lake and Streambed Alteration Agreement, Routine Maintenance Agreements
National Historic Preservation Act Section 106	Programmatic Agreement
California Environmental Quality Act and National Environmental Policy Act	Joint Environmental Impact Report/Environmental Impact Statement

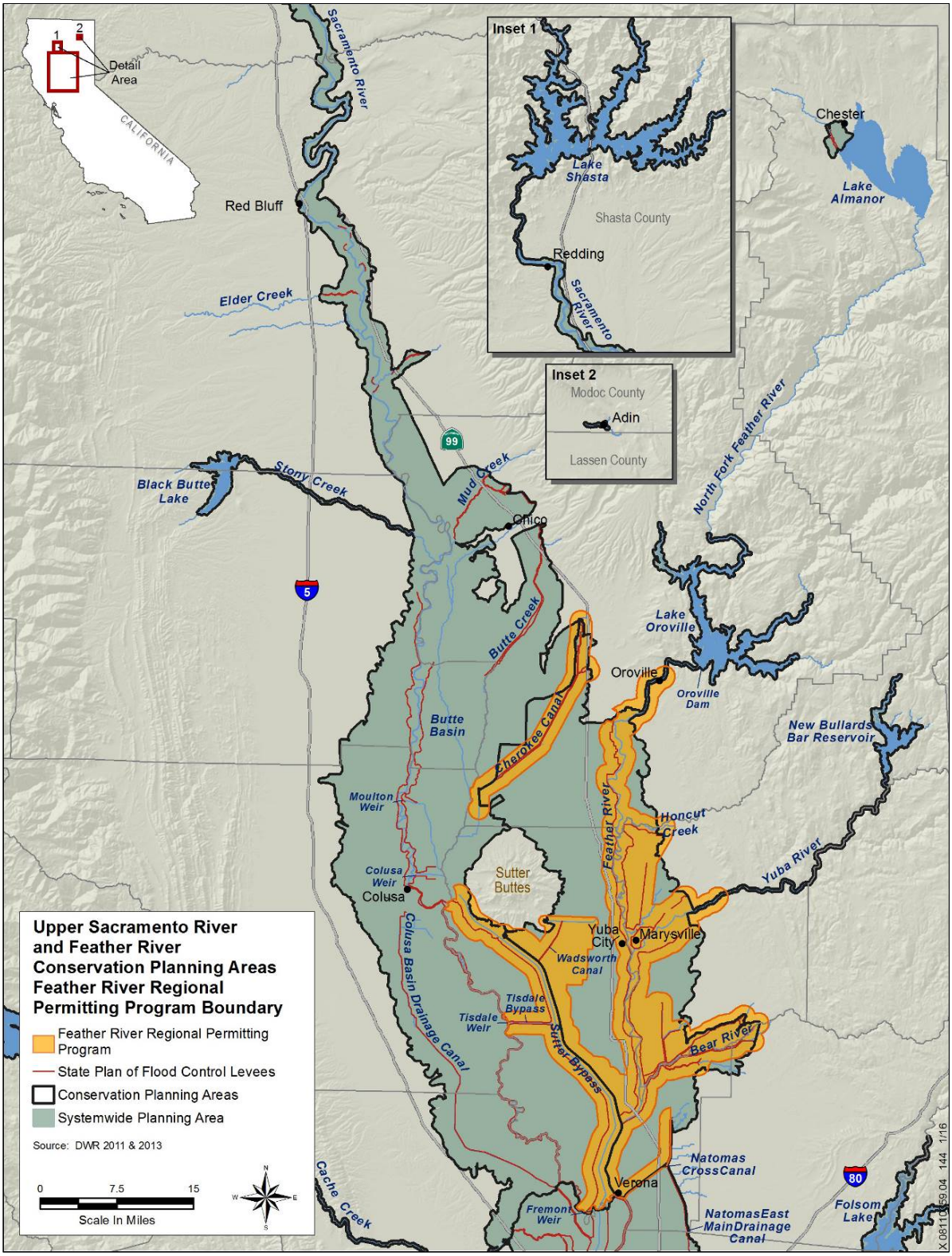


Figure 7-1. Boundaries of the Feather River Regional Permitting Program

Projects are permitted under different sections of the ESA depending on whether they have a federal nexus (i.e., require an approval or permit from a federal agency). Appendix A, "Regulatory Setting," provides details on the differences between Sections 7 and 10 of the ESA. As noted in Table 7-1, regional permitting programs will involve development of ESA Section 10 HCPs to achieve compliance with the ESA unless projects have a federal nexus. Then they may be subject to ESA Section 7 rather than ESA Section 10. Systemwide construction projects that have a federal nexus, such as some bypass construction projects, will use an ESA Section 7 consultation process to authorize take of ESA-listed species. However, as appropriate, project conditions determined during these ESA Section 7 consultations will rely on information generated by regional permitting programs (e.g., the Feather River HCP).

Below is a description of the approach that will be taken in regional permitting programs, followed by brief descriptions of the major laws and regulations that will be addressed by these programs. Until regional permits are developed for a specific area, DWR will continue to use traditional project-by-project permitting processes, as well as the RMA, SERP, SWIF, and advance mitigation programs described above.

7.5.1 Regional Permitting Program Approach and Implementation

Regional permitting programs will consider covering activities including O&M, structural repairs, rehabilitation, improvements to levees or new levee construction, and multi-benefit flood management projects, such as setback levees and ecosystem restoration and enhancement, including the removal of fish passage barriers. The boundaries of each regional permitting program will be determined based on a number of factors, including the distribution of habitats, watershed boundaries, the management areas of local flood risk management entities, and the local jurisdictions of other interested stakeholders.

The following reports, permits, and documented compliance actions will be considered for inclusion in each regional permitting program:

- Compliance with 33 CFR Section 208.10, which sets forth federal project O&M requirements, regulated by CVFPB with oversight by USACE to ensure that federal project facilities achieve their authorized purposes

- ESA Section 7 take authorization or ESA Section 10 take authorization pursuant to an HCP

- Compliance with CESA through procurement of a California Fish and Game Code Section 2081 Incidental Take Permit, development of an NCCP, or procurement of CDFW's consistency determination (under Section 2080.1) with an ESA Section 7 or Section 10 Incidental Take Permit

- Compliance with NEPA and CEQA, typically through developing an Environmental Impact Statement/Environmental Impact Report that analyzes the potential effects of issuing the Incidental Take Permit(s) and implementing the HCP and that identifies measures to avoid, minimize, and mitigate those effects

- A multi-year Regional General Permit (RGP), issued by USACE, authorizing CVFPP activities that involve discharges of dredged or fill material into waters of the United States (Section 404 of the CWA) or that result in work in navigable waters (Section 10 of the Rivers and Harbors Act)

- A Programmatic Agreement (PA) with USACE to expedite permitting for National Historic Preservation Act Section 106 compliance, obtained through the process defined in 36 CFR 800.14 (can be used only if a USACE permit is issued)

- A programmatic ESA Section 7 consultation with USFWS and NMFS to expedite permitting

- Consultations with tribes by USACE, USFWS, and NMFS to expedite permitting

- A standardized approach for compliance with Section 14 of the Rivers and Harbors Act (33 United States Code [USC] 408) (Section 408), including programmatic NEPA compliance for some alterations

- A CWA Section 401 water quality certification, issued by the Regional Water Quality Control Board (RWQCB), authorizing, concurrently with USACE's RGP and potentially other USACE permits, activities subject to Section 401

- A programmatic Storm Water Pollution Prevention Plan to comply with CWA Section 402

- Standard or long-term LSAAs or RMAs, issued by CDFW, authorizing activities that substantially obstruct or divert the natural flow of any river, stream, or lake; substantially change or use any material from the bed, channel, or bank of any river, stream, or lake; or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake (Section 1600 of the California Fish and Game Code)

Regional permitting program participants may benefit from comprehensive regulatory compliance, increased project efficiency, more timely project implementation, already established advance mitigation, and ultimately improved public safety. Also, through these programs, DWR would seek to consolidate the mitigation requirements of O&M activities that regularly reoccur at sites (as sediment reaccumulates and vegetation redevelops, and as erosion reoccurs). Participants will implement applicable avoidance and minimization measures, provide required mitigation, and document project compliance with the programs. Covered activities would incorporate broadly applicable avoidance and minimization measures described in the regional permits. In some defined, highly sensitive areas, more restrictive avoidance and minimization measures would be applied (if these areas could not be altogether avoided). Project impacts and conservation actions would be tracked as described in Section 8.0, "Implementation."

DWR and/or an entity created by plan participants (i.e., the implementing entity) would oversee and administer implementation of the regional permitting program(s). Administration and oversight responsibilities would include:

- Developing and maintaining a compliance tracking database and a database that documents project impacts and benefits
- Developing and maintaining a data repository kept current with project reports and information and species occurrence data (provided by CDFW, NMFS, and USFWS)
- Preparing and submitting an annual report to USACE, CVFPB, CDFW, NMFS, and USFWS summarizing permit implementation
- Facilitating coordination among DWR, USACE, CVFPB, LMAs, CDFW, NMFS, USFWS, RWQCBs, and third-party participants as necessary for permit implementation, including organizing and facilitating a technical review committee

For the compliance tracking database and data repository, the implementing entity would use the databases and data repository established for implementation of this Conservation Strategy (see Section 8.0, “Implementation”).

Representatives from various State and federal agencies (e.g., CDFW, NMFS, and USFWS) would assist with regional conservation program governance and administration by providing technical assistance and guidance, primarily through participation in a technical review committee. The technical review committee would comprise representatives of CVFPB, DWR, and other plan participants, including CDFW, NMFS, and USFWS (i.e., representatives of permittees and permit-issuing agencies). It would meet regularly to review the documents required for incidental take coverage under the programs, including annual reports and other compliance documentation, baseline inventories, effects determinations, mitigation crediting, conservation actions, restoration plans, reserve management plans, and adaptive management decisions (through which monitoring results would be applied to implementation). This process is further described in Section 8.0.

7.5.2 Near-Term Tracking of Conservation Efforts and Mitigation Credits

In the near term, before the regional permits described above can be acquired, some construction and O&M activities are already producing conservation benefits (such as advance mitigation projects funded to restore and preserve habitats). Conservation, mitigation actions, and impacts resulting from covered activities therefore have been tracked since 2012, when the PEIR for the 2012 CVFPP (DWR 2012) was adopted. As appropriate, improvements to ecosystem and habitat conditions will be applied toward the attainment of conservation targets under the regional permitting programs, and impacts on covered species and habitats will be tracked. The system used for tracking these changes is described in Section 8.0, “Implementation.”

7.5.3 Relationship of This Conservation Strategy to Regional Permitting Programs

This Strategy provides an overall framework for developing conservation programs within each region where permits are being developed, and helps ensure consistency in conservation goals and actions across regions. The key contributions of this Strategy toward regional permitting consist of detailed guidance on the following topics:

- Planning context, data, and tools
- Improvements to riverine and floodplain ecosystems and associated habitats (riparian, marsh, and agricultural) and species—such improvements would contribute to species recovery and to fulfilling the conservation requirements of permits
- Planning and design of flood risk management projects to reduce constraints on ecosystem processes and conservation efforts
- Systemwide monitoring and adaptive management of ecosystem processes and habitats
- Tracking databases and a data repository that can be used for permit administration
- Focused studies addressing high-priority data gaps that influence the effectiveness of the conservation actions associated with regional permits

Also, by contributing to the recovery of threatened and endangered species of riverine and floodplain ecosystems, implementation of this Strategy is expected to reduce the complexity and cost of regulatory compliance (e.g., for the ESA, CESA, and the CWA) in the future.

7.6 Primary Laws and Regulations Addressed by Regional Permitting Programs

Appendix A describes the regulatory setting within which this Conservation Strategy will be implemented. Below is a brief description of the laws that are the primary targets for inclusion in the regional permitting programs and how they will be addressed. The federal and State regulatory approvals described below will require documentation showing compliance with CEQA and NEPA.

7.6.1 Federal and California Endangered Species Acts

Both the ESA and CESA prohibit unauthorized “take” of species listed as threatened or endangered; the ESA also prohibits unauthorized take of species proposed for listing, and CESA prohibits take of species that are candidates for listing. The federal and State definitions of “take” differ, but both include actions that adversely affect individual plants or animals. For CESA, “take” is defined in Section 86 of the California Fish and Game Code as “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” For the ESA, “take” is defined

in Section 3 as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” “Harass” and “harm” are defined in terms of take in 50 CFR 17.3 to include disrupting behavioral patterns and modifying or degrading habitat. Section 7 of the ESA also requires federal agencies to ensure that federal actions do not result in the destruction or adverse modification of designated critical habitat. (“Designated critical habitat” encompasses areas that are essential to the conservation of threatened and endangered species.)

Both the ESA and CESA allow for take that is incidental to otherwise lawful activities. Regional permitting programs will obtain federal authorization for incidental take under ESA Section 7 or through development of ESA Section 10 HCPs, and will obtain State permits for incidental take under California Fish and Game Code Section 2081 or through development of NCCPs.

Some flood risk management and conservation actions have a federal nexus; therefore, incidental take is permitted through ESA Section 7 rather than ESA Section 10. Other actions lack a federal nexus. In those cases, incidental take is permitted through development of ESA Section 10 HCPs. During the development phase, regional HCPs will seek to cover most activities, including well-defined systemwide improvements, regardless of whether they have a federal nexus. The activities that ultimately go through Section 7 will apply content from the agreements made during development of the regional HCPs, thus allowing for more efficient Section 7 processes and also increasing certainty regarding the project conditions that will be required. Addressing this broad suite of activities with regional HCPs will improve overall flood risk management efficiency, public safety, and conservation planning and implementation.

Habitat Conservation Plan Process, Scope, and Permit Holders

The general process for developing regional HCPs will be iterative; it will involve many rounds of public, stakeholder, and agency review, and the following six steps:

1. Identify the area, species, and activities to be covered.
2. Determine who will participate in the process and engage participants, including permittees, stakeholders, technical advisors, and regulatory agencies.
3. Establish baseline conditions.
4. Assess potential impacts (take).
5. Develop biological goals, objectives, and conservation measures.
6. Develop an adaptive management plan and funding approach.

The HCPs and associated Incidental Take Permits will authorize most CVFPP-related activities (“covered activities”) to incidentally take threatened and endangered species or species that are proposed or candidates for listing (“covered species”) under the ESA and CESA. The covered CVFPP-related activities would include O&M actions and flood system O&M, repair, rehabilitation, and replacement, as well as restoration projects. These activities are described in

Section 6.0 of this Conservation Strategy, "Integrated Flood Risk Management and Conservation Approaches," and described further in the PEIR for the 2012 CVFPP (DWR 2012). Again, some activities may be permitted individually, particularly if the effects of those projects are not adequately considered by a regional HCP.

HCP-covered species would include most targeted species of this Conservation Strategy, appropriate to the region, as well as (to fully address ESA/CESA compliance needs, regionally) other threatened and endangered species or species that are proposed or candidates for listing that are likely to be affected by covered activities. Species that are likely to become threatened or endangered and that could be affected by covered activities also will be considered for inclusion under the regional HCPs and other permits.

Section 10(a)(2)(B) of the ESA requires that the following criteria be met before USFWS or NMFS may issue an Incidental Take Permit:

- The authorized take is incidental to an otherwise lawful activity.
- The impacts of the authorized take are minimized and mitigated to the maximum extent possible.
- Adequate funding is provided for the HCP, and procedures to deal with unforeseen circumstances are provided.
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild.
- Other measures that USFWS and NMFS may require as being necessary or appropriate are provided.
- USFWS and NMFS have received such other assurances as may be required that the HCP will be implemented.

Incidental Take Permits would be held by the most appropriate entity, given the specific HCP. This entity could be DWR, CVFPB, LMAs, or an entity created to oversee and administer implementation of the HCP. Local flood management entities and other proponents of CVFPP projects would be eligible, and are encouraged, to participate in the HCPs and to obtain incidental take coverage.

Take under California Fish and Game Code Section 2081

Section 2081(b) and (c) of the California Fish and Game Code allows CDFW to issue an Incidental Take Permit for species listed under CESA as threatened or endangered, or species that are candidates for listing, if the following criteria are met:

- The authorized take is incidental to an otherwise lawful activity.
- The impacts of the authorized take are minimized and fully mitigated.

- The measures required to minimize and fully mitigate the impacts of the authorized take:
  - are roughly proportional in extent to the impact of the taking on the species,
  - maintain the applicant's objectives to the greatest extent possible, and
  - are capable of successful implementation.
- Adequate funding is provided to implement the required minimization and mitigation measures and to monitor compliance with and the effectiveness of the measures.
- Issuance of the permit will not jeopardize the continued existence of a CESA-listed species.

Take under California Fish and Game Code Section 2821

Concurrent with approval of an NCCP, CDFW may authorize take of species listed as threatened or endangered, or candidates for listing, under CESA, as described under California Fish and Game Code Section 2821. For the take to be authorized, one or more of the following criteria must be met (from California Fish and Game Code Section 2821):

- Coverage is warranted based on regional or landscape-level consideration, such as healthy population levels, widespread distribution throughout the plan area, and life history characteristics that respond to habitat-scale conservation and management actions.
- Coverage is warranted based on regional or landscape-level considerations with site-specific conservation and management requirements that are clearly identified in the plan for species that are generally well distributed but that have core habitats that must be conserved.
- Coverage is warranted based on site-specific considerations and the identification of specific conservation and management conditions for species within a narrowly defined habitat or limited geographic area within the plan area.

Other requirements for authorization of incidental take are described in the Natural Community Conservation Planning Act (1991).

7.6.2 Clean Water Act Section 404 and Rivers and Harbors Act Section 10

Regional permitting programs will typically include acquisition of an RGP to satisfy CWA Section 404 and Rivers and Harbors Act Section 10. Section 404 (33 USC 1344) authorizes USACE to issue permits (after notice and opportunity for public hearing) for the discharge of dredged or fill material into waters of the United States at specified disposal sites. Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) requires prior authorization for any work within waters of the United States. The construction of any structure in, under, or over any navigable waters of the United States, the excavating from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or

capacity of such waters is unlawful unless a permit is issued by USACE. In compliance with these statutes, USACE would follow its procedures (33 CFR 325) to determine whether it should issue an RGP for the planning areas of the regional permitting programs. The RGP would be evaluated in accordance with provisions of "Regulatory Programs of the Corps of Engineers" (33 CFR 323.2[h]) for activities that are substantially similar in nature and that cause only minimal individual and cumulative environmental impacts. If issued by USACE, the RGP would be part of the overall strategy to balance the protection of important natural resources with flood risk management in the program area. The use of an RGP may also be appropriate when USACE is reviewing applications for alterations under Section 408 (see Section 7.6.3, below), some of which will integrate ecosystem restoration features.

If issued, the RGP would authorize specific categories of activities that would have minimal individual and cumulative impacts on the aquatic environment and that meet the terms and conditions of the RGP. For the purposes of assigning activity-specific conditions in the permit, these activities would be divided into categories such as those listed in Section 7.5.1 (e.g., flood risk management, maintenance, ecosystem improvements). If USACE determines that it is appropriate to proceed with the evaluation of an RGP, it will follow its processing requirements at 33 CFR 325, issuing a public notice and providing an opportunity for a public hearing. No RGP would be issued if USACE determines that the RGP would result in more than minimal individual and cumulative adverse environmental impacts, if the RGP would be contrary to the public interest, or if the RGP would not comply with the U.S. Environmental Protection Agency's Section 404(b)(1) Guidelines.

If issued, an RGP would be valid for multiple years from the date of issuance, and would remain in effect until it automatically expires or is modified, suspended, or revoked by USACE. If not modified, suspended, or revoked, following the expiration of the RGP, USACE may follow procedures at 33 CFR 325 and evaluate the RGP for reissuance.

7.6.3 Rivers and Harbors Act Section 14 (Section 408)

Activities that alter SPFC facilities always require USACE approval under Section 14 of the Rivers and Harbors Act of 1899 (33 USC 408, or Section 408) because the SPFC includes federal projects that the State has given assurances it will maintain (33 CFR 208.10). At this time, all projects, when located within the federal system, may be permitted as encroachments, unless ecosystem enhancements are integrated with a repair or improvement project that involves Section 408 approval of a modification of federal flood risk management features.

If proposed changes are minor, low-impact alterations as defined in Engineering Circular (EC) 1165-2-216,[5] then the USACE District Commanders have the delegated authority to approve of the change.

For USACE to grant permission for an alteration, USACE must determine that the alteration will not be injurious to the public interest and will not impair the usefulness of the federal project. If

[5] EC 1165-2-216, Policy and Procedural Guidance for Processing Requests to Alter U.S. Army Corps of Engineers Civil Works Projects Pursuant to 33 USC 408 (2014).

USACE grants permission for an alteration, the permission letter will present the conditions under which the alteration can be performed and will require maintenance of the alterations per USACE requirements. Although there is currently no mechanism to achieve programmatic Section 408 compliance, DWR is engaging with USACE to explore development of a programmatic mechanism. Approvals from either the District Commanders or Headquarters' Chief of Engineers must be sought on an individual project basis. The following process will be followed:

- Engage with USACE early, and discuss the anticipated Section 408 decision level for the project as described to USACE at that time.
- Adhere to submittal standards. All submittals will follow a set of standards that balance support of technical and environmental review (including assessments of residual risk) with costs and potential delays to projects.
- Integrate environmental review. Through the NEPA process (as determined during early engagement), CVFPP project proponents will maximize the integration of analyses of effects and the avoidance, minimization, and mitigation measures prescribed under project permits.

7.6.4 National Historic Preservation Act Section 106

This section summarizes the regulatory mechanisms that would provide a regional, streamlined process for CVFPP-related projects to comply with Section 106 of the National Historic Preservation Act, as part of regional permitting programs.

For the actions included as covered activities in the permitting programs, USACE and the State Historic Preservation Officer would execute a PA if determined necessary to satisfy compliance with Section 106. The process defined in 36 CFR 800.14 would be used. This process allows deferred identification and management of cultural resources under an agreement document (36 CFR 800.4[b][2]). The PA can programmatically identify types of activities that will and will not be subject to further Section 106 review. This screening mechanism can release numerous minimal activities from the requirements of Section 106 and allow certain types of activities to proceed sooner; also, the PA can stipulate abbreviated consultation periods, reduced reporting requirements, and other necessary processes that are both faster and more efficient than what is possible under the standard Section 106 process. The requirements of the PA may also be integrated into CEQA mitigation to streamline and coordinate CEQA and NEPA compliance.

On execution (signing and approval) of the PA by the consulting parties, Section 106 compliance will be deemed complete for the purpose of permits and authorizations dependent on the Section 106 process (36 CFR 800.14[b][2][iii]). Therefore, execution of the PA would satisfy Section 106 sufficiently to allow USACE to determine whether or not to issue a CWA Section 404 and/or Rivers and Harbors Act Section 10 permit for a project, and to allow DWR and USACE to defer identification and management of historic properties until specific sites require maintenance or habitat restoration. The PA would provide a process for performing an inventory of cultural resources at maintenance and restoration sites as they are identified, for evaluating

those resources, and for resolving adverse effects on significant resources (prehistoric and historic properties).

The Native American Heritage Commission, local Native American tribes, and the interested public (such as local historic preservation organizations) would be consulted to assist with cultural resources inventories and development of the PA. Coordination with other federal agencies providing permits and authorizations for the project would be performed so that the PA could provide a unified Section 106 compliance framework for the project. The PA would be valid for 5 years and could be renewed at the discretion of USACE and the State Historic Preservation Officer, concurrent with renewal of the CWA Section 404 and/or Rivers and Harbors Act Section 10 permit.

7.6.5 Clean Water Act Section 401

Applicants seeking a federal permit under Section 404 of the CWA must also obtain a water quality certification in accordance with Section 401 of the act. In California, the U.S. Environmental Protection Agency has delegated authority to SWRCB, which further delegated authority to the RWQCBs to issue Section 401 water quality certifications.

It has not yet been determined how CWA Section 401 water quality certification will be issued for CVFPP projects. For example, the certifications may be issued on a project-by-project basis or for multiple projects, as envisioned for a regional permitting program. However, for activities considered in the regional permits, the RWQCB may develop a programmatic Section 401 water quality certification, concurrent with the USACE's RGP process to authorize these activities under Section 401. Certification of the USACE's RGP would provide another level of streamlining for flood risk management activities. Issuance of the RWQCB's water quality certification requires completion of a CEQA compliance document. The RWQCB would be a responsible agency under CEQA and would rely on the CEQA compliance document to prepare and issue its own findings regarding the activities covered by the conservation plan, and to decide whether or not to issue a water quality certification. A draft programmatic certification would be circulated for 30–60 days for public review and comment. An additional 60 days may be required to schedule an RWQCB meeting if necessary. The programmatic certification would be effective for 5 years and could be renewed at the RWQCB's discretion, concurrent with renewal of the RGP.

7.6.6 California Fish and Game Code Section 1600

California Fish and Game Code Section 1600 requires that CDFW be notified before a project would substantially obstruct or divert the natural flow of any river, stream, or lake; substantially change or use any material from the bed, channel, or bank of any river, stream, or lake; or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.

In regional permitting programs, CDFW would authorize CVFPP projects under a long-term RMA or LSAA between CDFW, DWR, and CVFPB. This LSAA or RMA would cover routine maintenance projects (e.g., levee or channel management or maintenance) and new projects (e.g.,

levee relocation or levee construction). Conditions identified in the LSAA or RMA would require that subnotifications be filed for each project or type of project (e.g., floodway management, routine maintenance, levee relocation, or levee construction). Ideally, all third parties implementing CVFPP projects would be covered under a long-term RMA or LSAA, each with the same applicable conditions.

The long-term RMA or LSAA would be issued for a 10-year period or longer. Issuance of the LSAA or RMA would require certification of CEQA compliance. CDFW would be a responsible agency under CEQA; in acting on issuance of the LSAA or RMA, CDFW would rely on the CEQA compliance document for the associated conservation plan to prepare and issue its own findings and to decide whether or not to issue the Section 1600 authorization.

Under the LSAA or RMA, CDFW would maintain authority over the LSAA process and be notified of new proposed projects covered by the agreement. The LSAA subnotification process would allow CDFW to determine whether each proposed project could be authorized under the LSAA or RMA and the LSAA CEQA document. Avoidance and minimization measures from the LSAA and/or CEQA document applicable to each project, and based on the species and sensitive resources that may be present, would be incorporated into the authorization. These avoidance and minimization measures would be consistent with those identified in the conservation plan.

The long-term RMA or LSAA would cover both recurring maintenance activities and new projects that are included as part of the original notification package. Although the LSAA or RMA may not cover all activities, it could be used to increase the efficiency of the process for achieving CVFPP compliance with Section 1600 of the California Fish and Game Code. Some activities not authorized under a long-term LSAA may be authorized through RMAs.

8.0 Implementation

DWR and other State and federal agencies, LMAs, local communities, and nongovernmental organizations will need to work together to apply the approaches described in this document and achieve the Strategy's objectives and thereby attain the CVFPP goal of promoting ecosystem functions.

This section describes four key components of this Strategy's implementation that will support these partnerships:

- Adaptive management
- Funding
- Coordination and collaboration
- Outreach and engagement

As noted in Section 1.0, all the implementation proposals described in this section are subject to feasibility constraints, such as available funding, statutory authority, policy constraints, cost-effectiveness, and acceptability.

8.1 Adaptive Management

Adaptive management uses the results of new information, gathered from monitoring and from other sources, to adjust strategies and practices. In collaboration with its partners in flood management and conservation, DWR will, in a manner consistent with available funding, use adaptive management to implement this Strategy and evaluate its success.

Adaptive management allows managers to make decisions and take actions under uncertain conditions, rather than repeatedly delaying actions until more information is available. This Strategy requires such a flexible management approach because of scientific and institutional uncertainties. Although the ecology of the Sacramento and San Joaquin Valleys' riverine and floodplain ecosystems is generally well understood, and the conservation needs of these ecosystems have been repeatedly assessed, many conservation needs have not been precisely determined. There also are uncertainties regarding implementation of the CVFPP. In particular, there is considerable uncertainty regarding the amount and timing of funding for the CVFPP, which will be updated at 5-year intervals.

This section describes how DWR currently intends to adaptively manage implementation of this Conservation Strategy. However, the adaptive management process required by regional permits (see Section 7.0, "Regulatory Compliance and Regional Permitting") has not yet been

determined. Thus, the process described here would be revised as necessary to efficiently meet the needs of regional permitting programs.

8.1.1 Adaptive Management Process

The general process of adaptive management is shown in Figure 8-1. It consists of three key elements:

- Monitoring outcomes
- Evaluating and communicating monitoring results and other information
- Applying the knowledge gained through monitoring and evaluation

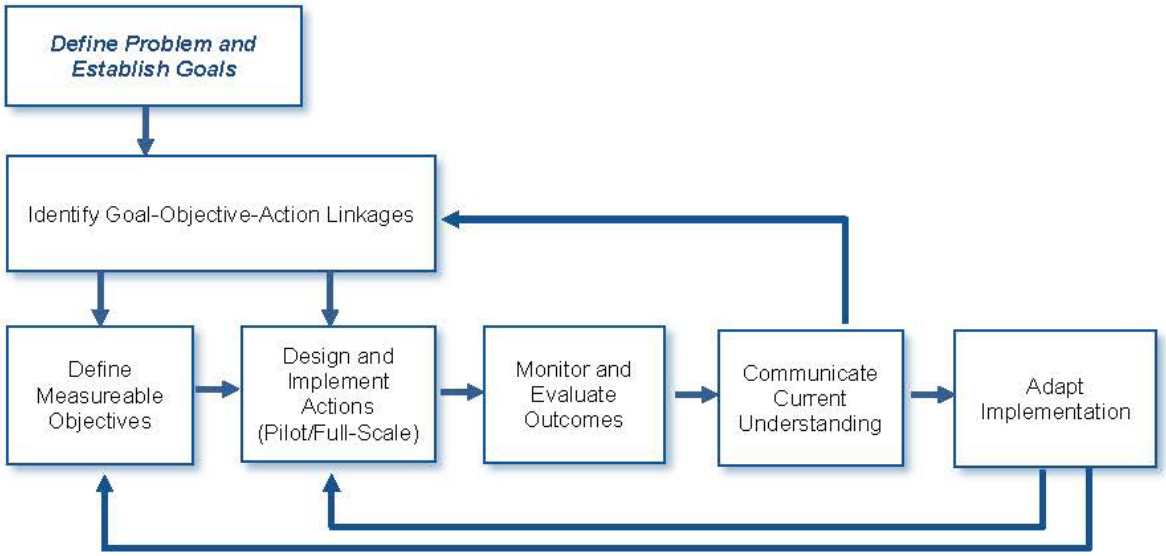


Figure 8-1. Adaptive Management Process

In general, adaptive management uses new information (primarily from monitoring) to identify when changes to actions or objectives may be necessary to attain goals. If monitoring indicates that outcomes are insufficient to meet an objective, or progress toward an objective is not effective in fulfilling goals, there are three possible responses:

- Determine that more data are required and continue (or modify) monitoring.
- Modify CVFPP actions, which may include identifying and implementing remedial actions.
- Modify the objectives of this Conservation Strategy. The objectives would be reviewed and revised as necessary based on further evaluation of opportunities for multi-benefit

projects and improved scientific understanding, including monitoring that indicates that attaining the objective would not be effective in fulfilling this Strategy's goals.

Evaluations of this Strategy's implementation would involve:

- Evaluating the adequacy of progress toward objectives and goals
- Assessing the effectiveness of measures for integrating flood risk management and conservation and revising these measures if opportunities are identified to improve effectiveness
- Assessing the effectiveness of measures to avoid, minimize, and mitigate effects and, in coordination with regulatory agencies, revising measures as necessary and consistent with applicable permits
- Assessing the effectiveness of oversight monitoring and reporting, and revising monitoring programs and reporting practices if opportunities are identified to improve effectiveness
- Assessing the effectiveness of specific actions in providing conservation
- Prioritizing projects for implementation
- Prioritizing research, planning, and outreach and engagement needs
- Assessing cost and feasibility

Evaluations would be based on the results of monitoring and focused studies and on information gained through agency coordination and consultation with science advisors (as described in the following sections).

Although multiple agencies would participate in evaluations, DWR would lead the adaptive management process, and decisions relevant to revising and updating this Strategy would be made by DWR.

Revisions to this Strategy would be applied to implementation and subsequently incorporated into the Conservation Strategy document. The Conservation Strategy document would be revised at 5-year intervals in conjunction with updates to the CVFPP. Revisions would be based on:

- Adaptive management of implementation
- Changes in funding availability and partnerships
- Requirements of regional permits developed for CVFPP activities (see Section 7.0, "Regulatory Compliance and Regional Permitting")

- Collaboration with partners in conservation and flood management (e.g., related regional conservation efforts, such as California EcoRestore)
- Improvements in scientific understanding and further evaluation of opportunities for multi-benefit projects

The adaptive management process is described further in the following sections.

8.1.2 Monitoring

Monitoring Approach

To inform adaptive management of the Conservation Strategy's implementation, and to be consistent with the PEIR for the 2012 CVFPP, DWR, and in some instances, other project proponents or LMAs, would conduct three types of monitoring:

- Documenting the actions implemented and their outcomes (i.e., compliance monitoring)
- Measuring changes in metrics that indicate progress toward objectives (i.e., performance monitoring)
- Measuring local, regional, or system-level changes in response to actions to confirm conservation benefits (i.e., effectiveness monitoring)

Information recorded for compliance monitoring would include the locations, costs, and outcomes of conservation and related flood risk management activities. This monitoring would occur at a project scale and generally would be conducted by project proponents. Such monitoring may be necessary to fulfill the requirements of applicable programmatic and project permits, mitigation measures prescribed by the PEIR for the 2012 CVFPP, and project documents prepared in compliance with CEQA and NEPA. Collected and standardized monitoring could support the tracking of mitigation credits awarded, by resource agencies, for CVFPP activities. In other words, actively restored habitat that is permitted by resource agencies as advance mitigation is documented in a ledger as a credit to the creator. Thus, this project-scale monitoring could encompass both compliance monitoring and the collection of data that could be used to demonstrate progress toward Conservation Strategy objectives (i.e., performance monitoring). Project proponents could contribute such data to a tracking system maintained by DWR (see Section 8.1.4, "Implementation Tracking and Data Dissemination").

Progress toward ecological objectives (i.e., performance monitoring) would also be documented using regional and systemwide inventories of changes in riverine and floodplain ecosystems. Regional inventories are anticipated to take place at 5-year or 10-year intervals, corresponding to the intervals between CVFPP updates, and they would generally be conducted by DWR. These inventories would be closely coordinated with any related large-scale monitoring efforts in the region. The inventories would support adaptive management by identifying changes in ecosystem conditions to which DWR contributes by implementing the CVFPP. Table 8-1 lists

Table 8-1. Ecological Goals, Targets, Metrics, and Basis of Regional and Systemwide Tracking

Ecological Goal	Targeted Process, Habitat, Species, or Stressor	Metric	Status of Data for Existing Conditions	Update Frequency (years)	Data Maintainer
Ecosystem processes. Improve and enhance dynamic hydrologic (flow) and geomorphic processes in the SPFC.	Floodplain inundation	Inundated Floodplain—total amount at selected frequency, timing, and duration of flows, including sustained flows (acres, EAH)	Exists in part—FROA maps (DWR 2012a); modeling of salmonid EAH (Appendix H of this Strategy; SJRRP 2012)	± 10	DWR
	Riverine geomorphic processes	Natural Bank—total length (miles)	Exists in part—Sacramento, Feather, Lower American, and Lower San Joaquin Rivers	± 5	DWR (Northern Region Office and Oroville Field Division)
		River Meander Potential—total amount (acres)	Exists in part—Sacramento River	± 10	DWR-UCD
Habitats. Increase and improve quantity, diversity, and connectivity of riverine and floodplain habitats.	SRA cover	Riparian-Lined Bank—total length (miles)	Exists in part—Sacramento and Feather Rivers (DWR Northern Region Office and Oroville Field Division)	± 5	Collaborative group (includes DWR)
		Natural Bank—total length (miles)	To be developed—Conservation Strategy project tracking	± 1	DWR
	Riparian	Habitat Amount—total amount on active floodplain (acres)	Exists—fine-scale vegetation maps	± 5	Collaborative group (includes DWR)
	Marsh (and other wetland)	Habitat Amount—total amount on active floodplain (acres)	Exists—fine-scale vegetation maps	± 5	Collaborative group (includes DWR)
Species. Contribute to the recovery and stability of native species populations and overall biotic community diversity.	Targeted species	Restored Habitat—total area (acres) with attributes (as specified) for threatened and endangered target species	To be developed—Conservation Strategy project tracking	± 1	DWR
Stressors. Reduce stressors related to the development and operation of the SPFC that negatively affect at-risk species.	Revetment	Revetment Removed to Increase Meander Potential and/or Natural Bank—total length (miles)	Exists in part—Sacramento and Feather Rivers; San Joaquin River is in progress; unnecessary revetment has not been identified systemwide	± 5	DWR (Northern Region Office and Oroville Field Division)
	Levees	Levees Relocated to Reconnect Floodplain or Improved to Eliminate Hydraulic Constraints on Restoration—total length (miles)	Exists in part—California Levee Database provides an inventory of levee locations, but lacks some levee dimensions; levees bordering reaches with insufficient capacity for more riparian habitat have not been identified	± 5	DWR
	Fish passage barriers	Fish Passage Barriers—priority barriers modified or removed	Exists—Passage Assessment Database and FMIO project tracking	± 5	Collaborative group (includes DWR)
	Invasive plants	Invasive Plant–Dominated Vegetation—total area reduced (acres) on DWR-maintained land/facilities	Exists—fine-scale vegetation mapping	± 5	DWR

Key: DWR = California Department of Water Resources; EAH = expected annual habitat; FMIO = Fish Migration Improvement Opportunities (DWR 2014); FROA = Floodplain Restoration Opportunity Analysis; SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic; UCD = University of California, Davis.

This page left blank intentionally.

the regional inventories that could be used to assess progress toward ecological objectives, anticipated frequency, and the agency conducting the inventory or survey.

These regional and systemwide inventories would also be used to assess the overall effectiveness of implemented actions in meeting the Strategy's goals. Fulfillment of the Conservation Strategy's goals would also be evaluated through focused studies, described in the following section. In particular, these research efforts could assess the benefits of ecosystem process and habitat restoration for targeted species.

8.1.3 Informing Management through Focused Studies

Data on the Central Valley's habitats, processes, species, and stressors have generally been sufficient for the planning and analyses conducted for the CVFPP, CVFPP PEIR, and this Conservation Strategy. However, some information that would assist future conservation and monitoring efforts is still missing or incomplete. The success and efficiency of future planning would be increased through greater understanding of some topics. Therefore, focused studies would be used to fill high-priority data gaps. Focused studies would also be conducted to confirm the benefits of restoration actions for targeted species (i.e., to monitor effectiveness).

Several of these data gaps have been identified during development of this Conservation Strategy and associated conservation plans for targeted species (Appendix G). For example, agricultural land managed with wildlife-friendly practices has not been mapped; thus, its extent is not known. Particularly important are gaps in data regarding existing conditions of metrics used for this Strategy's objectives. Data gaps also include the absence of inventory data on some physical or biological conditions (or a lack of related analyses), uncertainties about the population status of targeted species, and limitations in understanding of the ecological relationships of targeted species to ecosystem processes and habitats. Important data gaps are listed in Table 8-2.

In addition to these gaps, areas of uncertainty are identified in a set of Delta-focused conceptual models developed by the Delta Regional Ecosystem Restoration Implementation Plan to guide conservation in the Delta. These uncertainties are regarding numerous relationships among species, habitats, and ecosystem processes (with an emphasis on the Delta), including processes and habitats targeted by this Conservation Strategy.

In addition to filling data gaps, focused studies would increase understanding of the response of targeted habitats and species to management actions and thus may lead to improvements in the effectiveness of management actions. Examples of such studies include supplemental monitoring of plant or wildlife populations, or experimental management or restoration treatments.

Because most focused studies would address data gaps that affect other conservation programs as well, there are considerable opportunities for collaboration with other programs (e.g., with California EcoRestore or the SJRRP) or for data gaps to be filled by other programs (see Appendix J).

Table 8-2. Data Gaps Related to Existing Conditions for Ecological Objectives and Target Species

Target	Description of Data Gap	Size[1]	Significance[2]
Inundated Floodplain	Floodplain inundation potential is not available for December through May EAH outside of active floodplain.	Large	Moderate
	For river reaches not included in the FROA (DWR 2012a), GIS mapping of the area of connected floodplain (e.g., area between levees, or area between a levee and uplands on opposite bank) is not available (dependent on data availability for hydraulic modeling).	Moderate	Moderate
Riverine Geomorphic Processes	Natural banks (and SPFC and private revetment) have not been inventoried for the upper San Joaquin River (upstream of Merced River confluence) and its tributaries.	Large	High
	Unnecessary revetment has not been systematically identified systemwide.	Large	Moderate
	Comprehensive maps of historical channel locations are not available for the lower San Joaquin River or Feather River.	Moderate	Low
SRA Cover	Mapping of SRA components along the banks of the San Joaquin River and the lower reaches of its tributaries is incomplete.	Large	High
Riparian	The constraints of groundwater elevations and soils on riparian vegetation maintenance and restoration at specific locations have not been determined or inventoried. (This is of particular importance in the Upper San Joaquin River CPA.)	Large	Low
Marsh (and Other Wetland)	No data gaps have been identified.	–	–
Targeted Species	The presence of slough thistle in the Lower San Joaquin River CPA is not confirmed. (This species may no longer be present in any of the CPAs.)	Moderate	Moderate
	The quantity and distribution of SRA cover needed for recovery of target fish species has not been modeled or otherwise estimated.	Moderate	Moderate
	Delta button-celery habitat requirements for flow regime and soils are not well understood.	Large	Moderate
	For anadromous fish, the habitat value of woody vegetation planted in revetment, relative to SRA cover, is uncertain.	Large	Moderate
	The locations where greater connectivity of giant garter snake habitat is needed in the vicinity of the SPFC have not been identified.	Moderate	Moderate
	The population size and distribution of California black rails in the vicinity of the SPFC are unknown.	Large	Moderate
	The portion of existing marshes suitable for California black rail has not been determined.	Large	Moderate
	The extent to which least Bell's vireo populations are limited by habitat availability relative to other factors (e.g., nest parasitism) is unknown.	Large	Moderate
	The extent of riparian corridors needed for riparian brush rabbit and riparian wood rat recovery is imprecisely known.	Moderate	Moderate

Table 8-2. Data Gaps Related to Existing Conditions for Ecological Objectives and Target Species

Target	Description of Data Gap	Size[1]	Significance[2]
Fish Passage Barriers	The feasibility and cost of rectifying SPFC-related impediments to fish passage have not been fully determined.	Large	Low
Invasive Plants	No data gaps have been identified.	–	–

Key: CPA = Conservation Planning Area; EAH = expected annual habitat; FROA = Floodplain Restoration Opportunity Analysis (DWR 2012a); GIS = geographic information system; SPFC = State Plan of Flood Control; SRA = shaded riverine aquatic.

Notes:

[1] Size is the relative level of effort/expenditure required to fill the data gap.

[2] Significance is with regard to the effect on objectives and restoration actions: Lack of data for objective metrics was considered to have high significance, uncertainties with the potential to substantially affect the size of objectives were considered of moderate significance, and other data gaps were considered of moderate or low significance depending on their potential effect on conservation at a regional scale.

8.1.4 Implementation Tracking and Data Dissemination

For this Strategy, implementation tracking and data dissemination would serve three general purposes:

1. To monitor and document the effects and effectiveness of CVFPP and Conservation Strategy activities (which are primarily “projects”)

2. To allow agencies and the public to review the progress of Strategy implementation and compliance with associated regional permits

3. To allow access to and use of information to support adaptive management

These three purposes would be fulfilled by developing and maintaining a tracking and data-sharing system. This system would consist of two main data repositories with numerous related queries, reports, and data views to facilitate reporting, information sharing, and adaptive management. A conceptual depiction of the two data repositories is shown in Figure 8-2 and described below.

These data repositories would be developed specifically for the CVFPP. Each data repository would be designed and maintained to provide quality assurance and quality control of data, and for ease of access and use for evaluations. The repositories would eventually be accessible through the Internet, and graphic user interfaces could allow users to query data and generate a variety of reports based on queries. Although some data may be readily accessible only for DWR and other agencies implementing the Conservation Strategy, it is anticipated that reports and documents regarding implementation of the Strategy would be readily accessible to the public.

Project Data Repository

DWR intends to maintain data related to CVFPP activities in the project data repository. The project data repository contains information related to the planning, design, funding, environmental review, and permitting of projects implemented to further the goals of the

CVFPP. In addition to project attributes, this data repository could contain links to available project documents (e.g., digital copies of environmental documents and regulatory permits) as well as links to relevant GIS datasets.

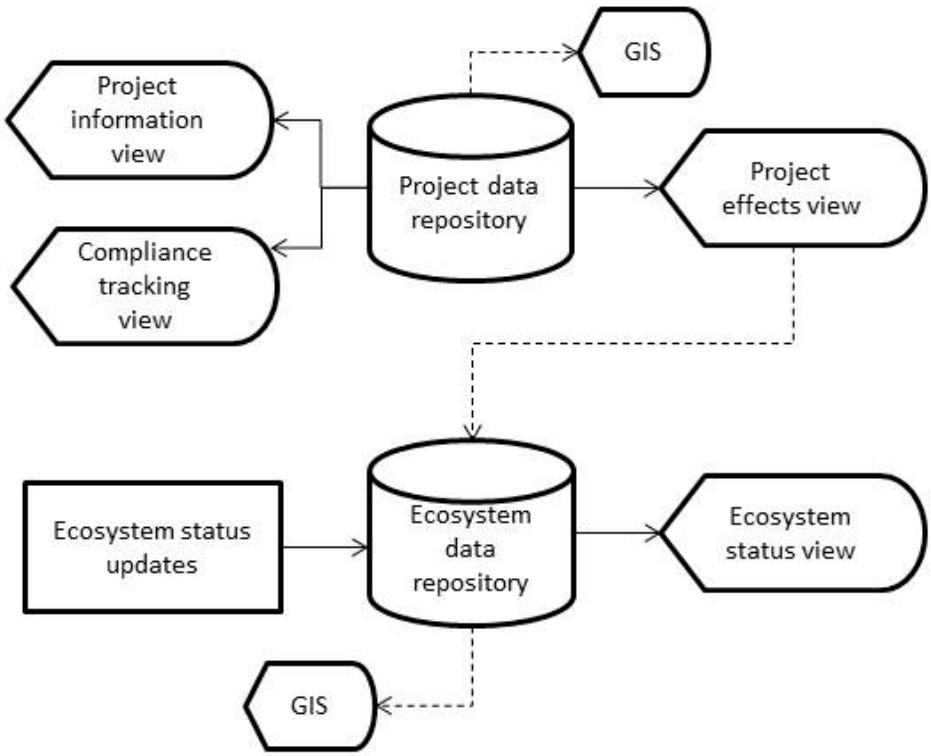


Figure 8-2. Conceptual Depiction of Data Organization in Tracking System

A prototype of this data repository, containing selected information, has been developed in Microsoft Access (MS Access) for DWR. This database provides a starting point for the project data repository; ultimately, the existing MS Access database could be enhanced to store additional project information and moved to a different database platform to facilitate shared network access by multiple concurrent users, and to improve stability, reliability, and functionality.

Initially, three specific data views, in the form of customizable queries and reports, would be created to facilitate review and interaction with data stored in the repository. Together, these views would allow for review of Conservation Strategy implementation and of compliance with associated regional permits. For example, similar to the HabiTrak database used by some regional HCP/NCCPs, the project data repository may be queried, through a project effects view (see below) to tabulate effects by habitat type, time period, and geographic unit (e.g., within a CPA, along a river corridor, or within the boundaries of an LMA's jurisdiction). These tabulations could allow users to review progress toward the Conservation Strategy's measurable objectives.

Each data view proposed for the project data repository is briefly described below.

Project Information View
The project information view would facilitate input, updates, and review of attribute information for all CVFPP projects, including project name, sponsor, location (with links to GIS), estimated costs, links to electronic copies of project documents, contact information, and similar information.

Compliance Tracking View
The compliance tracking view would facilitate input, updates, and review of avoidance and minimization measures and the provision of any compensatory mitigation required by environmental permits issued for CVFPP projects. It would also allocate mitigation credits to specific CVFPP projects and maintain a "balance sheet" of total available mitigation credits, by mitigation credit type (see also Section 7.0, "Regulatory Compliance and Regional Permitting"). The source of the data would likely be the compliance documentation for CVFPP activities covered by regional permits. This documentation (i.e., digital copies) would reside in the project data repository (or be accessible from it) as described above, under "Project Information View."

Project Effects View
The project effects view would facilitate input, updates, and review of the effects of CVFPP projects on ecosystem processes, habitats, species, and stressors that are targeted by this Conservation Strategy, as well as habitats and species covered by regional permits. The documented effects would include both adverse and beneficial effects. The units for most effects would be acreages or linear distances (e.g., feet of bank). Beneficial effects (e.g., the creation of habitat) would be linked to the ecosystem data repository (described below) and to costs to assess the value of various project types. Having a value estimate for projects would help prioritize spending on future projects and ensure that they yield the greatest value for the public dollars spent.

Ecosystem Data Repository
DWR intends to document the systemwide status of ecosystem processes, habitats, species, and stressors in the ecosystem data repository. This repository could be linked to the project data repository such that CVFPP projects having a net positive effect on ecosystem processes (e.g., by removing unnecessary bank revetment) would automatically propagate into the ecosystem data repository to update the current status (e.g., acreage or linear feet) of ecosystem processes, habitats, species, or stressors. However, the ecosystem data repository could also accommodate data from other sources, such as periodic, regional, or systemwide species surveys or vegetation/habitat mapping. These data would be collected at regular intervals as part of CVFPP implementation or by other programs (e.g., California EcoRestore). Where appropriate, data could be spatially referenced to facilitate particular spatial queries and comparisons (e.g., acreage of riparian habitat within a given CPA or systemwide), and the ecosystem data repository could accommodate storage of ecosystem data that do not have a spatial component (e.g., annual Chinook salmon escapement).

The ecosystem data repository would have a single view, described below.

Ecosystem Status View
The ecosystem status view would facilitate input, updates, and review of data characterizing the status and trends of ecosystem processes, habitats, species, and stressors. Through this view, it will be possible to incorporate ecosystem data not specifically related to a CVFPP action, and thus not automatically propagated into this data repository from the project data repository. It would also be possible to calculate a variety of ecosystem performance metrics that can be used to assess the effectiveness of the Conservation Strategy as well as to assess changes in specific metrics over time.

8.1.5 Evaluation Guidance

In addition to the results of monitoring and focused studies, implementation of this Conservation Strategy would be guided by input from other agencies and scientists. To obtain this guidance, the State has developed a proposed organizational structure that provides for:

- Agency engagement and coordination through the IAC
- Technical guidance from the Scientific Advisory Committee (SAC)

Each group's role, described below, is advisory. Unless otherwise stated, all decision-making authority and responsibility for adapting the Conservation Strategy would rest with DWR.

Interagency Advisory Committee
State and federal natural resource and regulatory agencies participating in the IAC would help guide implementation of this Strategy. The IAC would provide guidance on policy and technical issues and options for resolving these issues. It also would serve as a coordinating body that could identify opportunities for collaboration with other programs and efforts.

This committee would be a continuation of the existing IAC. Agencies participating in the IAC include CVFPB, CDFW, NMFS, SWRCB, USACE, and USFWS. Meeting frequency would be determined by DWR and the IAC; initially, meetings may be held quarterly.

Scientific Advisory Committee
Applying scientific expertise and rigor to adaptive management will be critical for the Conservation Strategy's long-term success and its political and public support. Therefore, implementation of this Conservation Strategy would be advised by an SAC.

The SAC would consist of experts in conservation biology, the ecology of Sacramento and San Joaquin Valley rivers and floodplains, and flood risk management policy and engineering. The membership of the SAC may be replaced at 5-year intervals. Meeting frequency would be determined by DWR; initially, meetings may be held quarterly.

DWR would identify a lead scientist to lead the SAC, and an outside entity such as the Delta Science Program would choose its members. The lead scientist would identify and prioritize technical issues. The SAC could provide guidance regarding higher-priority issues, review

project and Conservation Strategy reports, and make adaptive management recommendations. SAC guidance would be given to DWR and the IAC.

8.1.6 Reporting

Reports would be produced as needed to support adaptive management decisions and regulatory compliance. In particular, 5-year reports assessing implementation of the Conservation Strategy would be developed in conjunction with the CVFPP update process. The purpose of the 5-year reports would be to provide the information necessary to demonstrate to the public and regulatory agencies that the Conservation Strategy is being implemented as anticipated and objectives are being met to the extent feasible. These reports would summarize the activities of the previous 5 years. They would describe conservation activities and flood management activities that incorporate conservation or that affect targeted processes, habitats, or species and would summarize the monitored results of those activities. In addition, each report would provide a summary of cumulative progress toward the Conservation Strategy's objectives and would document issues that arise in implementing the Strategy. The 5-year reports also may document adaptive management evaluations made during the previous 5 years.

8.2 Funding Approach

Ecosystem improvements in the Central Valley flood system would be funded and implemented, where feasible, as part of implementing the CVFPP. Such improvements would be, in large part, a component of integrated, multi-benefit flood projects that are expected to be high priorities for State funding and expected to attract funding from other sources because of their multiple benefits, as further described below. DWR's guidelines for existing and future funding are likely to reflect the State's current multi-benefit investment priorities, but funding priorities are ultimately going to be established as part of the funding authorization and appropriation process.

Full implementation of the CVFPP will take 30 years or more; DWR is developing a long-term investment strategy and financing plan to support that effort. The CVFPP Investment Strategy will identify the recommended management actions and their prioritization to achieve the desired CVFPP goals and societal outcomes. Included in the Investment Strategy is a finance plan that builds on this by matching the management actions with financing mechanisms across federal, State, and local sources, both existing and proposed, that could be used to fund CVFPP actions. Several scenarios are described, and careful consideration of potential cost-shares and phasing is used to describe a targeted approach to funding multi-benefit projects. The CVFPP Investment Strategy is expected to be completed in late 2016 and accompany the CVFPP 2017 update. Information about long-term funding for the actions outlined in this Conservation Strategy will be available in the Investment Strategy.

In addition to planning for funding of Central Valley flood system improvements, DWR's Statewide Flood Management Planning program has produced a financing report, *California's Flood Future Phase I: Recommendations for Mapping the State's Flood Risk, Attachment I: Finance Strategies* (DWR 2013), that addresses flood management funding in a statewide context. The attachment presents recommendations about funding and investment strategies

needed to establish long-term sustainable flood risk management. It provides information about funds used historically for flood risk management in California, existing and proposed mechanisms for funding flood management, and the funding challenges facing flood management agencies.

Multi-benefit projects will attract funds that typically are not used for single-purpose flood management projects. For example, recent integrated floodplain enhancement projects at the mouth of the Tuolumne River (Dos Rios Ranch and Hidden Valley Ranch), which provided benefits related to flood management, ecosystem enhancement and conservation, and agriculture, secured funding from DWR, U.S. Department of Agriculture conservation programs, and the State's Wildlife Conservation Board.

In addition to future State and federal authorizations and State bond funds for conservation, examples of State and federal conservation programs that could provide funding for multi-benefit projects include the State's Wildlife Conservation Board programs, the Central Valley Project Improvement Act Restoration Fund (USBR), Land and Conservation Fund (multiple federal agencies), Cooperative Endangered Species Conservation Fund (USFWS), Restoration Partnership Grant Program (NMFS), Wetland Reserve Program (Natural Resources Conservation Service [NRCS]), and the Environmental Quality Incentives Program (NRCS). Some multi-benefit projects also may be eligible for grants from the State's Greenhouse Gas Reduction Fund.

Cost sharing with other conservation plans in the Sacramento and San Joaquin Valleys (e.g., California EcoRestore and the SJRRP) could also be an important source of funding for multi-benefit projects that is not available to single-purpose flood projects.

Overall, integrating ecosystem improvements into flood risk management actions is likely to increase public support and funding of those actions, giving DWR access to more funds for flood risk management in the future. Flood risk management actions can contribute to high-quality riverine environments that provide recreation, habitat, flood-compatible agriculture, and other beneficial attributes (including increased system resiliency and flexibility for future generations). Also, by helping reduce pressures on species and habitats along rivers, such improvements facilitate the participation of regulatory agencies and increase the support of environmental groups. More efficient regional permitting, in which fewer permits are needed for multiple projects, can reduce project delays (and thus costs) incurred by the permitting process and produces less expensive and more effective mitigation.

In the context of ecosystem restoration, budgets need to adequately fund both the initial costs and long-term costs of restoration projects (i.e., monitoring and management), and funding sources need to allow for funding of enhancement, monitoring, and management, including through the use of endowments. For land-based restoration, initial costs include those associated with land acquisition or easements, permitting, development of a restoration plan, preconstruction biological surveys to avoid unintended impacts on species and other resources, site construction or improvements to enable restoration, removal or suppression of invasive species, planting of desired vegetation, and initial maintenance and invasive species management to ensure successful establishment. For aquatic-based restoration, initial costs may include permitting,

engineering, and removal or modification of unnecessary revetment and barriers to fish passage. Ongoing costs for both types of restoration projects include long-term regular monitoring and management. Monitoring helps evaluate the health of the restoration project and identifies possible areas of concern before they become problems. Monitoring outcomes and related expenditures can also indicate which projects are providing the greatest value for the public dollars spent. Management includes controlling invasive species, irrigating or replanting if success criteria are not met, managing for public access (if appropriate), reducing the effects of dumping and other activities that damage restoration sites, aiding recovery from unplanned disturbances (such as accidental fires), and working with neighbors to reduce unintended off-site impacts caused by the restoration project.

8.3 Coordination and Collaboration to Integrate Conservation into Flood Management

This Strategy relies on the integration of ecosystem improvements with flood risk management in actions taken by DWR and other State and federal agencies, LMAs, local communities, and nongovernmental organizations. Coordination and collaboration among these organizations is therefore a key component of this Strategy's implementation.

This section describes how coordination and collaboration will support implementation of this Strategy. More specifically, it describes:

- The organizations who as partners in flood management and conservation would be engaged in coordination and collaboration
- How this Strategy would be applied during refinement of the CVFPP
- Ongoing programs that would be coordinated and collaborated with
- How this Strategy would be implemented in coordination and collaboration with other conservation plans

8.3.1 Partners in Flood Management and Conservation

Successful implementation of this Conservation Strategy, and the CVFPP in general, will rely on the collaboration of many different partners, both within DWR and among DWR and other public agencies and private organizations. Several DWR offices and programs are involved in integrated flood risk management:

- The Floodway Ecosystem Sustainability Office, Division of Flood Management, has primary responsibility for developing and implementing this Strategy, developing regional permitting strategies, and funding advance mitigation projects.
- The Delta Levees Program, within the Division of Flood Management, provides engineering assistance and funding to Delta reclamation districts to improve levees and

other flood protection facilities in a way that avoids environmental damages and enhances habitat.

- The Central Valley Flood Management Planning Program coordinated the successful development and adoption of the 2012 CVFPP. The program is now assisting in the planning and coordination of major implementation actions of the 2012 CVFPP, including State-led BWFSs, locally led RFMP efforts, and this Conservation Strategy.

- The Flood Maintenance Office is responsible for operating and maintaining the federally constructed flood control features in the Sacramento Valley. Maintenance includes planning, environmental permitting and coordination, and design, conducted through the Maintenance Support Branch. Field operations involve the Sutter Maintenance Yard and the Sacramento Maintenance Yard.

- The Flood Projects Office is responsible for the planning, design, and construction of structural and nonstructural flood control projects, including those sponsored by CVFPB, local agencies, and USACE. It is also responsible for implementing many of the statewide flood control grants programs.

- The Flood Protection Corridor Program funds nonstructural flood management projects, which include wildlife habitat enhancements and agricultural land preservation.

- The Hydrology and Flood Operations Office is responsible for directing DWR's flood and water supply forecasting operations, hydrology and climatology studies, emergency flood operations, and flood control project inspections and encroachment permitting.

- The Statewide Flood Management Planning program coordinates flood planning throughout California and integrates DWR's flood-related activities with its broader management of water resources (see discussion of the Division of Statewide Integrated Water Management in the following bulleted item).

- DWR's Division of Statewide Integrated Water Management produces the regularly updated California Water Plan, which provides a collaborative planning framework for a broad audience of decision makers, businesses, researchers, and others, enabling them to make informed decisions about California's water future. This plan, updated every 5 years, presents the status and trends of California's water-dependent natural resources; water supplies; and agricultural, urban, and environmental water demands for a range of plausible future scenarios. The flood management section in the 2013 update is based on an integrated water management approach that seeks a balance between exposure of people and property to flooding, the quality and functioning of ecosystems, and other considerations, effectively shifting the focus of flood management from a local to a systemwide context.

- DWR's Integrated Regional Water Management program is another important part of DWR's overall approach to water management. This program funds and supports regional planning and projects for the integrated management of water resources.

Many other key partners are involved in integrated flood risk management:

- CVFPB provides a structured public forum where all interests may express their views regarding flood management. The board regulates encroachments on project facilities, acts as the nonfederal sponsor for federal flood control projects in partnership with USACE, holds and manages flood-related properties on behalf of the State, and was granted the authority under the Central Valley Flood Protection Act of 2008 to adopt the 2012 CVFPP. CVFPB members are appointed by the governor.

- USACE has broad authorities to plan, design, construct, operate, inspect, and regulate federal flood control and environmental restoration facilities; participate in flood emergency response and recovery; establish inspection and O&M requirements; provide technical support to other federal, State, and local agencies; and conduct other activities. Its civil works, inspection, and regulatory offices are particularly involved in integrated flood risk management.

- Local implementing agencies, such as SAFCA and the San Joaquin Area Flood Control Agency, study, plan, and construct flood protection projects.

- LMAs are responsible for maintaining levees, channels, and other flood control structures outside of DWR's jurisdiction.

- State and federal wildlife agencies, such as CDFW, USFWS, and NMFS, provide environmental regulatory oversight, fisheries and wildlife expertise, and environmental data and analysis.

- Local, State, and federal agricultural agencies, such as RCDs, the California Department of Conservation, and NRCS, help landowners improve their agricultural production while improving other natural resources on their properties.

- Local land use authorities (cities and counties) plan and manage land uses within their jurisdictions.

- The California Department of Transportation plans, constructs, and maintains bridges across the Central Valley's rivers and tributaries, and the California High-Speed Rail Authority will install rail within the SPA. Work planned by these agencies can be paired with actions for managing flood risks, and the agencies could collaborate with DWR and partners on advance mitigation for projects.

- Private organizations, including nonprofit groups, advocate for integrated flood risk management projects and funding. Agricultural organizations provide input on ways to

improve agricultural stewardship, to reduce impacts from flood actions on adjacent lands, and to support conservation incentives for landowners. Conservation nonprofits assist in developing projects that involve real estate transactions and habitat restoration.

- Businesses and landowners provide input on issues that affect their operations and success. Some businesses, such as mitigation and conservation banks, are actively involved in facilitating regulatory permitting through habitat restoration projects.

Many of these partners are also involved in conservation planning efforts that overlap with the CVFPP (DWR 2012b). These planning efforts provide opportunities for DWR and other interests to collaborate and share costs on projects of mutual concern. Coordinated planning with these groups will also help reduce potential conflicts and more efficiently use public funds.

All of these organizations have a long history of working together, and many have made good progress in integrated natural resource management. Beyond CVFPP's early implementation projects, DWR flood management programs and other flood agencies have already begun incorporating environmental improvements into their activities. Programs such as the Flood System Operations and Maintenance Program, Delta Levees Program, and Fish Passage Improvement Program are staffed by engineers and environmental scientists who work side by side to minimize ecological impacts and improve both flood safety and ecological conditions. Local flood agencies, such as SAFCA, have environmental staff members who work alongside engineers on similar multi-benefit projects.

8.3.2 Coordination and Collaboration in CVFPP Refinement

The CVFPP is being refined by DWR offices and programs and other partners in flood management to develop a 2017 update. In part, these revisions are being guided by this Conservation Strategy as described below.

Guidance for Basin-Wide Feasibility Studies and Regional Flood Management Plans

The refinement of the CVFPP to achieve sustainable, integrated flood risk management is occurring primarily through three interrelated planning processes: development of BWFSs for the Sacramento and San Joaquin River Basins, creation of RFMPs for subdivisions of those river basins, and development of this Strategy.

This Strategy details the ecosystem enhancement priorities that can be addressed by the refined CVFPP implementation programs. These priorities can be applied to the BWFSs and RFMPs as described below:

- The Sacramento and San Joaquin BWFSs focus on technical analyses and evaluations that develop specific planning objectives, explore physical features for SPFC facility improvements, and compare physical improvements on a systemwide scale, considering their costs, effects, and benefits. The BWFSs will inform long-term financing and implementation strategies for the 2012 CVFPP and the 2017 update to the CVFPP. In developing the BWFSs, DWR is applying guidance and supporting information from this

Strategy to the development and assessment of designs, costs, and benefits associated with improving ecosystem functions.

- Locally led RFMPs will identify, describe, prioritize, and develop funding strategies for regional projects, consistent with their goals and objectives. In support of successful, effective, and well-funded plans, DWR will use this Strategy to highlight the permitting, flood risk management, ecosystem, and other benefits of integrating ecosystem restoration into projects identified in regional plans. DWR will subsequently review RFMPs during BWFS formulation—an opportunity for DWR to articulate and promote State interests to regional planners and stakeholders (e.g., by emphasizing the advantages of a regional permitting approach). During its review, DWR will develop an understanding of potential RFMP actions that could have local and systemwide hydraulic benefits and impacts, as well as an understanding of the overall benefits and impacts, cost-effectiveness, ecosystem restoration opportunities, local priority rankings, and local financing capabilities of these actions. Individual funding decisions for RFMP measures will be made in the context of policy guidelines and regulations established for implementation programs.

Corridor Management Plans

DWR, building on the RFMP process and with the support of a diverse workgroup of stakeholders, seeks to develop an array of flood risk management and ecosystem actions using Corridor Management Plans (CMPs). Promoted by the Federal Emergency Management Agency throughout the country, CMPs identify desirable, local, multi-benefit projects and guide the development of supporting information to move those projects toward implementation. Development of CMPs allows agencies and interested parties to organize around a variety of interests. Relationships, understandings, and tools (such as regional permitting mechanisms) developed during the RFMP process can then be leveraged to produce local solutions that incorporate integrated water management components and support local interests. For example, DWR has developed a CMP for the lower Feather River that will be used to provide long-term guidance for balancing habitat restoration, O&M, project implementation, and programmatic permitting in this area.

The content of a CMP can vary based on the goals of planning participants, but in general, developing a plan based on a consensus of stakeholders can lead to both short-term positive accomplishments and a long-term vision that serves multiple goals and attracts broad support, including outside funding sources.

8.3.3 Coordination and Collaboration with Ongoing Programs

Implementation of this Strategy, and the CVFPP as a whole, will be in coordination with existing programs, and opportunities for collaboration with existing programs will be sought. Coordination and collaboration with the following studies and programs would be particularly beneficial:

- **Central Valley Integrated Flood Management Study.** DWR and CVFPB are partnering as the nonfederal sponsors for this watershed study, which represents

USACE's effort to align its Central Valley projects and investigations with the State's development and implementation of the CVFPP. To complement CVFPP implementation, USACE will identify additional studies to refine federal interests and potentially support congressional authorization of recommended improvements or further studies. It will also identify additional legislative and implementation frameworks, processes, and tools to support effective long-term implementation of flood risk management as related to project permitting, systemwide crediting, and governance. USACE-led flood risk reduction and ecosystem restoration projects are a possible outcome of this planning process.

- **Delta Levees Program.** Through this program, DWR supports the maintenance and improvement of levees in the Delta. This program is required not only to fully mitigate the environmental impacts of flood management projects, but also to provide a net increase in fish and wildlife habitat. Consequently, like this Strategy, the Delta Levees Program is based on integrated flood management.

- **California EcoRestore.** This Conservation Strategy is consistent with EcoRestore, which is guiding restoration actions that improve the overall ecosystem in the Delta and improve habitat for threatened and endangered species.

- **Sacramento River General Reevaluation Report.** The general reevaluation will assess flood risk management capabilities and ecosystem restoration opportunities within the Sacramento River Flood Control Project. This effort is developing an array of alternatives for modifying the flood management system to address the need for integrated water resources management to provide flood risk management, ecosystem restoration, and water supply benefits.

- **San Joaquin River Restoration Program.** Data and opportunities identified by the SJRRP are being integrated into State plans. The SJRRP represents a comprehensive, long-term effort to restore flows to the San Joaquin River. This program would restore a self-sustaining Chinook salmon fishery in the river and reduce or avoid any adverse impacts from restoration flows on the water supply. The SJRRP elucidates challenges and potential opportunities for improving flood risk management and optimizing ecosystem benefits in the San Joaquin River region.

- **Lower San Joaquin River Feasibility Study.** This study is a cooperative effort among USACE, CVFPB, and the San Joaquin Area Flood Control Agency to determine the extent of federal interest in flood risk management and ecosystem restoration along the lower San Joaquin River. Study results will help identify needed improvements to help reach or exceed a 200-year-flood level of protection.

- **Central Valley Project–State Water Project Operations Criteria and Plan and Associated Biological Opinions.** NMFS and USFWS developed and published BOs that address the potential for Operations Criteria and Plan implementation to adversely affect federally listed fish. These agencies also developed Reasonable and Prudent Alternatives

(RPAs) to minimize potential impacts. The NMFS RPAs (NMFS 2009) describe actions that, if implemented, would result in not jeopardizing the continued existence of listed salmonids and green sturgeon. Many of these RPAs focus on maintaining flows in the Sacramento and San Joaquin Rivers and their tributaries to provide suitable habitat conditions for fish (e.g., water temperature and water depth). Several other RPAs focus on the restoration of habitat or fluvial-geomorphic processes (e.g., floodplain activation flows, sediment transport, erosion, and deposition) necessary to maintain and regenerate aquatic habitat elements for salmonids and green sturgeon.

8.3.4 Coordination and Collaboration with Other Regional Conservation Planning Efforts

This Conservation Strategy will be implemented alongside many other conservation efforts, some of which are in place and some of which are in progress. Existing regional conservation plans include large-scale conservation plans, NCCPs, HCPs, species recovery plans, and management plans for conserved lands. More than 30 conservation plans in California have related objectives, and 15 of these plans have a substantial geographic overlap with the SPFC and contain objectives for riverine aquatic, SRA cover, riparian, or floodplain wetlands (see Appendix J, “Existing Conservation Objectives from Other Plans”). Implementation of this Strategy is intended to complement these efforts and support their success.

DWR will continue to coordinate and, where possible, collaborate with these conservation efforts so that both this Strategy and related plans will be more successful. Coordinating implementation of the Conservation Strategy with other planning efforts provides greater opportunities for effective, integrated, landscape-level conservation contributing to the objectives of this Strategy, the CVFPP in its entirety, and other related plans.

This Strategy supports coordination and collaboration with related conservation plans in six ways:

1. Identifying and resolving potential conflicts with regional conservation plans during development of the CVFPP

2. Minimizing SPFC-related constraints on the success of other regional conservation plans in attaining their objectives

3. Collaborating on, and sharing the funding of, projects of common interest

4. Implementing conservation actions that complement, and do not preclude, those of other conservation plans (e.g., restoration projects that increase regional habitat connectivity)

5. Implementing conservation actions that contribute directly to the attainment of the objectives of other conservation plans

6. Participating in regional conservation plans, when such participation contributes to attainment of the Conservation Strategy’s objectives

Wildlife and natural resource agencies have limited staffing and funds, so they also encourage greater participation in existing plans. Appendix J, "Existing Conservation Objectives from Other Plans," describes completed and ongoing planning efforts that have regional, geographically based, or quantifiable conservation measures for species and habitats that may be relevant to Conservation Strategy implementation.

8.4 Outreach and Engagement

By investing its time and resources in transparent communication and collaboration, DWR intends to provide greater benefits to the people and ecosystems of the state. As described below, DWR is committed to actively sharing its work as it is developed, interacting with stakeholders and the public, and reporting on Conservation Strategy implementation. This section lists DWR's planned outreach and engagement efforts.

DWR will continue to solicit further input on the Conservation Strategy from stakeholders and provide additional materials and venues to ensure constructive communication with the public. Commitment to transparency will ensure that DWR's engagement efforts reach all interested and affected parties. DWR plans to continue to:

- Coordinate with related regional conservation planning efforts
- Develop and facilitate workshops as necessary for stakeholders and interested parties
- Create, distribute, and publish (e.g., on the DWR website) fact sheets, workshop notices, and reports of notable news
- Through the Teacher Floodplain Institute, help teachers understand the State's conservation work on river systems and floodplains
- Work on agricultural land stewardship strategies and engage agricultural organizations and landowners
- Develop and promote SHAs, tools used in advance mitigation planning, and CMPs in collaboration with the Sacramento River Forum and other organizations
- Engage nongovernmental groups to identify and pursue potential conservation opportunities
- Plan and facilitate working meetings within DWR and with USACE, USFWS, CDFW, NMFS, SWRCB, NRCS, the California Department of Conservation, the California Department of Food and Agriculture, and others

- Coordinate regularly with planning groups to ensure that they have current information and data pertaining to Conservation Strategy efforts, for use in their own regional or statewide planning efforts
- Provide targeted outreach to LMAs to ensure that their regional and systemwide needs are clearly understood
- Continue to look for opportunities to implement multi-benefit projects and programs that support them

This page left blank intentionally.

9.0 References

Section 1.0, "Introduction"

California Levees Roundtable. 2009. California Central Valley Flood System Improvement Framework. 27 February.

California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency. 2015. California Water Action Plan Implementation Report 2014–2018. Sacramento, California. Available at http://resources.ca.gov/docs/california_water_action_plan/CA_WAP_Impl_Rpt-150130.pdf. Accessed 11 January 2016.

California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency. 2016. California Water Action Plan, 2016 Update. Sacramento, California. Available at http://resources.ca.gov/docs /california_water_action_plan/Final_California_Water_Action_Plan.pdf.

Delta Stewardship Council. 2013. The Delta Plan. Sacramento, California. Available at deltacouncil.ca.gov/delta-plan-0. Accessed 11 February 2014.

[DWR] California Department of Water Resources. 2009. 2012 Central Valley Flood Protection Plan Environmental Stewardship Scope Definition Work Group Summary Report (Draft). Sacramento, California.

[DWR] California Department of Water Resources. 2010a. Environmental Stewardship Policy. Sacramento, California.

[DWR] California Department of Water Resources. 2010b. State Plan of Flood Control Descriptive Document. November. Sacramento, California.

[DWR] California Department of Water Resources. 2010c. Important Considerations for the Central Valley Flood Protection Plan Related to Sacramento–San Joaquin Valley Agriculture (Draft). Sacramento, California.

[DWR] California Department of Water Resources. 2012a. Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. 2012 Central Valley Flood Protection Plan Consolidated Final Program Environmental Impact Report. State Clearinghouse No. 2010102044. Sacramento, California.

[DWR] California Department of Water Resources. 2012c. Public Draft 2012 Central Valley Flood Protection Plan, Attachment 2: Conservation Framework. Sacramento, California.

Section 2.0, " Need for Improved Conservation of Rivers and Floodplains"

American Farmland Trust. 2007. Paving Paradise: A New Perspective on California Farmland Conversion. Davis, California.

[CDFG] California Department of Fish and Game. 2005. California Wildlife Conservation Challenges: California's Wildlife Action Plan. Prepared by University of California, Davis, Wildlife Health Center for the California Department of Fish and Game. Sacramento, California. Available at http://www.dfg.ca.gov/SWAP/2005/docs/SWAP-2005.pdf. Accessed 13 May 2014.

[CDFG] California Department of Fish and Game. 2011. Special Animals List.

[DWR] California Department of Water Resources. 2008. Managing an Uncertain Future. Climate Change Adaptation Strategies for California's Water. The Resources Agency, Sacramento, California.

[DWR] California Department of Water Resources. 2011. DWR_CVRMP_veg_merged. GIS data layer. Central Valley Riparian Mapping Project (CVRMP). August. Sacramento, California.

[DWR] California Department of Water Resources. 2012a. Public Draft 2012 Central Valley Flood Protection Plan, Attachment 9B: Status and Trends of Riparian and Riverine Ecosystems of the Systemwide Planning Area. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. Public Draft 2012 Central Valley Flood Protection Plan Attachment 9F: Floodplain Restoration Opportunity Analysis. Sacramento, California.

Lytle, D. A., and N. L. Poff. 2004. Adaptation to Natural Flow Regimes. Trends in Ecology & Evolution 19:94–100.

Naiman, R. J., H. Decamps, and M. Pollock. 1993. The Role of Riparian Corridors in Maintaining Regional Biodiversity. Ecological Applications 3:209–212.

NewFields and Cramer Fish Sciences. 2014. Central Valley Chinook Salmon Rearing Habitat Required to Satisfy the Anadromous Fish Restoration Program (AFRP) Doubling Goal. Sacramento, California.

[NMFS] National Marine Fisheries Service. 2014. 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 Central Valley Steelhead. July. California Central Valley Area Office, Sacramento, California.

[NOAA Fisheries] National Oceanic and Atmospheric Administration Fisheries. 2005. Distribution Information of Salmon and Steelhead Species in California. Available at http://www.nmfs.noaa.gov/gis/data/fishdist.htm. Accessed 17 February 2011.

[SJRRP] San Joaquin River Restoration Program. 2012. Minimum Floodplain Habitat Area for Spring and Fall-Run Chinook Salmon. November. Sacramento, California.

Staudinger, M. D., N. B. Grimm, A. Staudt, S. L. Carter, F. S. Chapin, P. Kareiva, M. Ruckelshaus, and B. A. Stein. 2012. Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services: Technical Input to the 2013 National Climate Assessment. Cooperative Report to the 2013 National Climate Assessment.

The Bay Institute. 1998. From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed. July. Novato, California.

The Bay Institute. 2003. Historical Extent of Riparian and Wetland Vegetation in California. Received via CD directly from The Bay Institute on 7 August, 2012. San Francisco, California.

Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley. Pages 71–176 *in* R. Brown (Editor), Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 179(1).

Section 3.0, "Guiding Principles and Goals"

[DWR] California Department of Water Resources. 2012a. Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. Public Draft 2012 Central Valley Flood Protection Plan, Attachment 2: Conservation Framework. Sacramento, California.

Section 4.0, "Targeted Processes, Habitats, Species, and Stressors"

Atwater, B. F., and C. W. Hedel. 1976. Distribution of Seed Plants with Respect to Tide Levels and Water Salinity in the Natural Tidal Marshes of the Northern San Francisco Bay Estuary, California. Open File Report 76-389. U.S. Geological Survey, Menlo Park, California.

Bossard, C. C., J. M. Randall, and M. C. Hoshovsky (Editors). 2000. Invasive Plants of California Wildlands. University of California Press, Berkeley, California.

California Interagency Wildlife Task Group. 2008. CWHR Version 8.2 Personal Computer Program. Sacramento, California.

California Native Plant Society. 2012. Inventory of Rare and Endangered Plants (Online Edition, v8-01a). Sacramento, California. Available at http://cnps.rareplants.cnps.org. Accessed 12 June 2012.

[Cal-IPC] California Invasive Plant Council. 2011a. The Impact of Invasive Plants. Available at http://www.cal-ipc.org/ip/definitions/impact.php. Accessed 15 March 2011.

[Cal-IPC] California Invasive Plant Council. 2011b. *Sesbania punicea* (Red Sesbania, Scarlet Wisteria) Plant Profile. Available at http://www.cal-ipc.org/ip/management /plant_profiles/Sesbania_punicea.php.

[Cal-IPC] California Invasive Plant Council. 2014. California Invasive Plant Inventory Online Database. Available at http://www.cal-ipc.org/paf. Accessed 28 October 2014.

[CDFG] California Department of Fish and Game. 2012. About the CNDDB. Available at https://www.wildlife.ca.gov/Data/CNDDB/About. Accessed 12 June 2012.

[CDFW] California Department of Fish and Wildlife. 2015. California State Wildlife Action Plan 2015 Update. Sacramento, California. Available at https://www.wildlife.ca.gov/SWAP/Final. Accessed 21 January 2016.

DiTomaso, J. M., and E. A. Healy. 2003. Aquatic and Riparian Weeds of the West. University of California Agriculture and Natural Resources Publication 3421.

DiTomaso, J. M., and E. A. Healy. 2007. Weeds of California and Other Western States. Two volumes. University of California Agriculture and Natural Resources Publication 3488.

[DWR] California Department of Water Resources. 2005. Fish Passage Improvement, Bulletin 250. Sacramento, California.

[DWR] California Department of Water Resources. 2010. State Plan of Flood Control Descriptive Document. November. Sacramento, California.

[DWR] California Department of Water Resources. 2012a. 2012 Central Valley Flood Protection Plan Consolidated Final Program Environmental Impact Report. State Clearinghouse No. 2010102044. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability. Sacramento, California.

[DWR] California Department of Water Resources. 2012c. Areas of Revetment and Riprap along Major River Reaches in California's Central Valley. GIS data layers delivered electronically via Ron Melcer, California Department of Water Resources, 2 September 2013.

[DWR] California Department of Water Resources. 2012d. California Levee Database. GIS data layer. Sacramento, California. Available at http://www.water.ca.gov/floodmgmt/lrafmo/fmb/fes/levee_database.cfm. Accessed 27 March 2014.

[DWR] California Department of Water Resources. 2014. Draft Central Valley Flood System Fish Migration Improvement Opportunities. FloodSAFE Environmental Stewardship and Statewide Resources Office (FESSRO). Environmental Restoration and Enhancement Branch, Fish Passage Improvement Program.

Fremier, A., E. Ginney, A. Merrill, M. Tompkins, J. Hart, and R. Swenson. 2008. Riparian Vegetation Conceptual Model. Delta Regional Ecosystem Restoration Implementation Plan. Sacramento, California. Available at http://www.science.calwater.ca.gov/pdf/drerip/DRERIP_riparian_veg_conceptual_model_final_101408.pdf. Accessed 17 June 2011.

Greco, S. E., A. K. Fremier, E. W. Larsen, and R. E. Plant. 2007. A Tool for Tracking Floodplain Age Land Surface Patterns on a Large Meandering River with Applications for Ecological Planning and Restoration Design. Landscape and Urban Planning 81:354–373.

Hagar, J. C. 1999. Influence of Riparian Buffer Width on Bird Assemblages in Western Oregon. Journal of Wildlife Management 63:484–496.

Hannon, S. J., C. A. Paszkowski, S. Boutin, J. DeGroot, S. E. Macdonald, M. Wheatley, and B. R. Eaton. 2002. Abundance and Species Composition of Amphibians, Small Mammals, and Songbirds in Riparian Forest Buffer Strips of Varying Widths in the Boreal Mixedwood of Alberta. Canadian Journal of Forest Research 32:1784–1800.

Heath, S., and G. Ballard. 2003. Patterns of Breeding Songbird Diversity and Occurrence in Riparian Habitats of the Eastern Sierra Nevada. *In* P. M. Faber (Editor), California Riparian Systems: Processes and Floodplain Management, Ecology, and Restoration, Riparian Habitat and Floodplains Conference. Riparian Habitat Joint Venture, Sacramento, California.

Hughes, F. M. R. 1997. Floodplain Biogeomorphology. Progress in Physical Geography 21:501–529.

Hupp, C. R., and W. R. Osterkamp. 1996. Riparian Vegetation and Fluvial Geomorphic Processes. Geomorphology 14:277–295.

Jeffres, C. A., J. J. Opperman, and P. B. Moyle. 2008. Ephemeral Floodplain Habitats Provide Best Growth Conditions for Juvenile Chinook Salmon in a California River. Environmental Biology of Fishes 83(4):449–458. Photograph reprinted with kind permission from Springer Science+Business Media.

Johannesson, H., and G. Parker. 1989. Linear Theory of River Meanders. Pages 181–214 *in* S. Ikeda and G. Parker (Editors), River Meandering. American Geophysical Union, Washington, D.C.

Keddy, P. A. 2000. Wetland Ecology Principles and Conservation. Cambridge University Press, New York, New York.

Kramer, G. 1988. Fresh Emergent Wetland. Pages 124–125 *in* K. E. Mayer and W. F. Laudenslayer, Jr. (Editors), A Guide to Wildlife Habitats of California. California Department of Forestry and Fire Protection, Sacramento, California.

Lindley, S. T., R. S. Schick, A. Agrawal, M. Goslin, T. E. Pearson, and E. Mora. 2006. Historical Population Structure of Central Valley Steelhead and Its Alteration by Dams. San Francisco Estuary and Watershed Science 4(1):1–19. Available at http://escholarship.org/uc/item/1ss794fc. Accessed 8 March 2011.

Lytle, D. A., and N. L. Poff. 2004. Adaptation to Natural Flow Regimes. Trends in Ecology & Evolution 19:94–100.

Mahoney, J. M., and S. B. Rood. 1998. Streamflow Requirements for Cottonwood Seedling Recruitment—An Integrative Model. Wetlands 18(4):634–645.

Naiman, R. J., H. Decamps, and M. Pollock. 1993. The Role of Riparian Corridors in Maintaining Regional Biodiversity. Ecological Applications 3:209–212.

Opperman, J. J. 2012. A Conceptual Model for Floodplains in the Sacramento–San Joaquin Delta. San Francisco Estuary & Watershed Science. John Muir Institute of the Environment, University of California, Davis, California.

Poff, N. L., and J. K. H. Zimmerman. 2010. Ecological Responses to Altered Flow Regimes: A Literature Review to Inform the Science and Management of Environmental Flows. Freshwater Biology 55:194–205.

[RHJV] Riparian Habitat Joint Venture. 2004. The Riparian Bird Conservation Plan: A Strategy for Reversing the Decline of Riparian Associated Birds in California. Version 2.0. PRBO Conservation Science, Stinson Beach, California.

Sawyer, J. O., T. Keeler-Wolf, and J. M. Evens. 2009. A Manual of California Vegetation. Second Edition. California Native Plant Society, Sacramento, California.

Scott, M. L., J. M. Friedman, and G. T. Auble. 1996. Fluvial Process and the Establishment of Bottomland Trees. Geomorphology 14:327–339.

Shuford, W. D., and T. Gardali (Editors). 2008. California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Intermediate Conservation Concern in California. Studies of Western Birds No. 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.

Stone, M. C., L. Chen, S. K. Mckay, J. Goreham, K. Acharya, C. Fischeniche, and A. B. Stone. 2013. Bending of Submerged Woody Riparian Vegetation as a Function of Hydraulic Flow Conditions. River Research Applications 29:195–205.

[TNC] The Nature Conservancy. 2007. Linking Biological Responses to River Processes: Implications for Conservation and Management of the Sacramento River—A Focal Species Approach. November. Chico, California. Prepared by Stillwater Sciences, Berkeley, California.

[USACE] U.S. Army Corps of Engineers. 2007. Bank Revetment Inventory, Sacramento River Bank Protection Project. Sacramento, California. Prepared by Stillwater Sciences, Berkeley, California.[USFWS] U.S. Fish and Wildlife Service. 1992. Shaded Riverine Aquatic Cover of the Sacramento River System: Classification as Resource Category 1 under the FWS Mitigation Policy. Portland, Oregon.

[USFWS] U.S. Fish and Wildlife Service. 2004. Impacts of Riprapping to Aquatic Organisms and River Functioning, Lower Sacramento River. Second Edition. Sacramento, California.

Vaghti, M. G., and S. E. Greco. 2007. Riparian Vegetation of the Great Valley. Pages 425–455 *in* M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr (Editors), Terrestrial Vegetation of California. University of California Press, Berkeley, California.

Ward, J. V., K. Tockner, U. Uehlinger, and F. Malard. 2001. Understanding Natural Patterns and Processes in River Corridors as the Basis for Effective River Restoration. Regulated Rivers: Research and Management 17:311–323.

Section 5.0, "Ecological Objectives"

[BANS-TAC] Bank Swallow Technical Advisory Committee. 2013. Bank Swallow (*Riparia riparia*) Conservation Strategy for the Sacramento River Watershed, California. Available at http://www.sacramentoriver.org/bans/bans_lib/BANSConsStrat _062813_final.pdf. Accessed 13 February 2014.

[CBDP] CALFED Bay-Delta Program. 2000. Ecosystem Restoration Program Plan. Volume II. Ecological Management Zone Visions. Technical Appendix to the Final Programmatic Environmental Impact Statement/Environmental Impact Report for the CALFED Program. July. Sacramento, California.

[CDFG] California Department of Fish and Game. 1992. Recovery Plan: Bank Swallow (*Riparia riparia*). Nongame Bird and Mammal Section Report 93.02. Nongame Bird and Mammal Section, Wildlife Management Division.

[CVJV] Central Valley Joint Venture. 2006. Central Valley Joint Venture Implementation Plan—Conserving Bird Habitat. U.S. Fish and Wildlife Service, Sacramento, California.

[DWR] California Department of Water Resources. 2010. State Plan of Flood Control Descriptive Document. November. Sacramento, California.

[DWR] California Department of Water Resources. 2011. Levee conditions developed by the Urban Levee Evaluation and Non-Urban Levee Evaluation Program. Delivered via file

transfer protocol by Marill Jacobson, GIS specialist, California Department of Water Resources, in August, 2011.

[DWR] California Department of Water Resources. 2012a. 2012 Central Valley Flood Protection Plan Consolidated Final Program Environmental Impact Report. State Clearinghouse No. 2010102044. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability. Sacramento, California.

[DWR] California Department of Water Resources. 2014a. Central Valley Flood System Fish Migration Improvement Opportunities. Sacramento, California.

[DWR] California Department of Water Resources. 2014b. Lower Feather River Corridor Management Plan. June. Division of Flood Management, Sacramento, California.

James, L. A., and M. B. Singer. 2008. Development of the Lower Sacramento Valley Flood-Control System: Historical Perspective. Natural Hazards Review 9(3):125–135.

James, L. A., M. B. Singer, S. Ghoshal, and M. Megison. 2009. Historical Channel Changes in the Lower Yuba and Feather Rivers, California: Long-Term Effects of Contrasting River-Management Strategies. Pages 57–81 *in* L. A. James, S. L. Rathburn, and G. R. Whittecar (Editors), Management and Restoration of Fluvial Systems with Broad Historical Changes and Human Impacts. Geological Society of America Special Paper 451.

[NMFS] National Marine Fisheries Service. 2014. 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 Central Valley Steelhead. July. California Central Valley Area Office, Sacramento, California.

[SFEI] San Francisco Estuary Institute. 2012. Sacramento–San Joaquin Historical Ecology Investigation: Exploring Pattern and Process. Available at http://www.sfei.org/sites/default/files/Delta_HistoricalEcologyStudy_SFEI_ASC_2012_lowres.pdf. Accessed 13 February 2014.

[SJRRP] San Joaquin River Restoration Program. 2011a. Attachment SRH-1DV: Vegetation Modeling of the San Joaquin River, Friant Dam to Merced River Confluence, California. Draft Geomorphology, Sediment Transport, and Vegetation Assessment Appendix; Program Environmental Impact Statement/Report. U.S. Bureau of Reclamation, Sacramento, California.

[SJRRP] San Joaquin River Restoration Program. 2011b. Reach 4B, Eastside Bypass, and Mariposa Bypass Channel and Structural Improvements Project: Initial Alternatives Technical Memorandum. U.S. Bureau of Reclamation, Sacramento, California.

[SJRRP] San Joaquin River Restoration Program. 2011c. San Joaquin River Restoration Program Draft Program Environmental Impact Statement/Environmental Impact Report.

[SJRRP] San Joaquin River Restoration Program. 2012a. Minimum Floodplain Habitat Area for Spring and Fall-Run Chinook Salmon. November. Sacramento, California.

[SJRRP] San Joaquin River Restoration Program. 2012b. Mendota Pool Bypass and Reach 2B Improvements Project: Project Description Technical Memorandum. U.S. Bureau of Reclamation, Sacramento, California.

[SJRRP] San Joaquin River Restoration Program. 2015. Revised Framework for Implementation. U.S. Bureau of Reclamation, Sacramento, California.

[SRAC] Sacramento River Advisory Council. 2003. Sacramento River Conservation Area Forum Handbook. The Resources Agency, State of California, Sacramento, California.

The Bay Institute. 1998. From the Sierra to the Sea: The Ecological History of the San Francisco–Bay Delta Watershed. July. Novato, California.

The Bay Institute. 2003. Historical Extent of Riparian and Wetland Vegetation in California. Received via CD directly from The Bay Institute on 7 August 2012. San Francisco, California.

[USACE] U.S. Army Corps of Engineers. 2007. Bank Revetment Inventory, Sacramento River Bank Protection Project. Sacramento, California. Prepared by Stillwater Sciences, Berkeley, California.

[USFWS] U.S. Fish and Wildlife Service. 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. Region 1, Portland, Oregon.

[USFWS] U.S. Fish and Wildlife Service. 1999. Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). Sacramento, California.

[USFWS] U.S. Fish and Wildlife Service. 2001. Final Restoration Plan for the Anadromous Fish Restoration Program: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California. Available at http://www.fws.gov/sacramento/fisheries /CAMP-Program/Home/Documents/Final_Restoration_Plan_for_the_AFRP.pdf. Accessed 9 September 2011.

Yuba County Water Agency (YCWA), Three Rivers Levee Improvement Agency (TRLIA), Marysville Levee Commission (MLC), and Sutter Butte Flood Control Agency (SBFCA). 2013. Draft Feather River Region Regional Flood Management Plan. Available at frrfmp.com. Accessed 13 February 2014.

Section 6.0, "Integrated Flood Risk Management and Conservation Approaches"

Beckwith, R., T. Greene, M. Sheely, L. Pierce, R. Padilla, J. Kleinfelter, and O. Al-Shafie. 2013. Technologies for Passing Fish at Large Dams. Draft. June. California Department of Water Resources, FloodSAFE Environmental Stewardship and Statewide Resources Office.

Brouder, S. M., and J. E. Hill. 1995. Winter Flooding of Ricefields Provides Waterfowl Habitat. California Agriculture 49(6):58–64.

California Levees Roundtable. 2009. California Central Valley Flood System Improvement Framework. 27 February.

[DWR] California Department of Water Resources. 1999. Woodson Bridge State Recreation Area Long-Term Solutions Study. Northern District.

[DWR] California Department of Water Resources. 2005. California Water Plan Update 2005, Volume 2: Resource Management Strategies. Sacramento, California.

[DWR] California Department of Water Resources. 2012a. 2012 Central Valley Flood Protection Plan Consolidated Final Program Environmental Impact Report. State Clearinghouse No. 2010102044. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. Central Valley Flood Protection Plan: A Path for Improving Public Safety, Environmental Stewardship, and Long-Term Economic Stability. Sacramento, California.

[DWR] California Department of Water Resources. 2012c. Public Draft 2012 Central Valley Flood Protection Plan Attachment 2: Conservation Framework. Sacramento, California.

[DWR] California Department of Water Resources. 2012d. Public Draft 2012 Central Valley Flood Protection Plan Attachment 9B: Status and Trends of Riparian and Riverine Ecosystems of the Systemwide Planning Area. Sacramento, California.

[DWR] California Department of Water Resources. 2012e. California Department of Water Resources Small Erosion Repair Program Manual. Sacramento, California.

[DWR] California Department of Water Resources. 2014. Central Valley Flood System Fish Migration Improvement Opportunities. Sacramento, California.

[Google] Google, Inc. 2014. Google Earth Version 7.1.2.2041 [software]. Aerial imagery from 10 August 1998 and 14 July 2003. Available at https://www.google.com/earth/. Accessed 21 June 2014.

Hart, J. A., and J. C. Hunter. 2004. Restoring Slough and River Banks with Biotechnical Bank Protection in the Sacramento–San Joaquin Delta. Ecological Restoration 22(4):262–268.

[NMFS] National Marine Fisheries Service. 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. Southwest Regional Office, Long Beach, California.

[SAFCA] Sacramento Area Flood Control Agency. 2008. Anticipatory Erosion Control Program: Sand Cove Streambank Restoration Program. Available at http://www.safca.org/protection/erosion.html. Accessed 22 June 2014.

Shields, F. D., A. J. Bowie, and C. M. Cooper. 1995. Control of Streambank Erosion Due to Bed Degradation with Vegetation and Structure. Water Resources Bulletin 31(3):475–489.

Sommer, T., B. Harrell, M. Nobriga, R. Brown, P. B. Moyle, W. J. Kimmerer, and L. Schemel. 2001. California's Yolo Bypass: Evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture. Fisheries 26:6–16.

[USACE] U.S. Army Corps of Engineers. 2014. Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams and Appurtenant Structures. ETL 1110-2-583.

Van Vuren, D. H., M. C. McGrann, and M. A. Ordeñana. 2013. Influence of Adjacent Crop Type on Occurrence of California Ground Squirrels along Levees in the Sacramento Valley, California. California Levee Vegetation Research Program, Sacramento, California.

[Western Shasta RCD] Western Shasta Resource Conservation District. 2014. Current Projects. Available at http://www.westernshastarcd.org/projects.html. Accessed 10 October 2014.

[Yolo County RCD] Yolo County Resource Conservation District. 2014a. Cache Creek Vegetation Management Program. Available at http://www.yolorcd.org/nodes/programs/projects/Cache_Creek_Veg_Management.htm. Accessed 10 October 2014.

[Yolo County RCD] Yolo County Resource Conservation District. 2014b. Habitat Restoration: Current Projects. Available at http://www.yolorcd.org/nodes/programs/habitat_restoration.htm. Accessed 10 October 2014.

Section 7.0, "Regulatory Compliance and Regional Permitting"

[DWR] California Department of Water Resources. 2012. 2012 Central Valley Flood Protection Plan Consolidated Final Program Environmental Impact Report. State Clearinghouse No. 2010102044. Sacramento, California.

Section 8.0, "Implementation"

[DWR] California Department of Water Resources. 2012a. Public Draft 2012 Central Valley Flood Protection Plan Attachment 9F: Floodplain Restoration Opportunity Analysis. Sacramento, California.

[DWR] California Department of Water Resources. 2012b. Public Draft 2012 Central Valley Flood Protection Plan, Attachment 9E: Existing Conservation Objectives from Other Plans. Sacramento, California.

[DWR] California Department of Water Resources. 2013. California's Flood Future: Recommendations for Mapping the State's Flood Risk, Attachment I: Finance Strategies. Public Review Draft. April. Sacramento, California.

[DWR] California Department of Water Resources. 2014. Central Valley Flood System Fish Migration Improvement Opportunities. Sacramento, California.

[NMFS] National Marine Fisheries Service. 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. Available at https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=21473. Accessed 15 July 2011.

[SJRRP] San Joaquin River Restoration Program. 2012. Minimum Floodplain Habitat Area for Spring and Fall-Run Chinook Salmon. November. Sacramento, California.

Section 11.0, "Glossary"

Carter, N. T. 2005. Flood Risk Management: Federal Role in Infrastructure. 26 October. Order Code RL33129. Congressional Research Service, Library of Congress.

[DWR] California Department of Water Resources. 2008. Draft FloodSAFE Strategic Plan. June. Sacramento, California.

[DWR] California Department of Water Resources. 2009. California Water Plan Update 2009—Integrated Water Management. Sacramento, California.

[DWR] California Department of Water Resources. 2010a. CVFPP Interim Progress Summary No. 1. April. Sacramento, California.

[DWR] California Department of Water Resources. 2010b. State Plan of Flood Control Descriptive Document. November. Sacramento, California.

Federal Emergency Management Agency. 2015. Definitions. Available at https://www.fema.gov/national-flood-insurance-program/definitions.

Holling, C. S. 1973. Resilience and stability of ecological systems. Annual Review of Ecology and Systematics 4:1–23.

Millennium Ecosystem Assessment. 2003. Ecosystems and Human Well-Being: A Framework for Assessment.

Sawyer, J. O., T. Keeler-Wolf, and J. M. Evens. 2009. A Manual of California Vegetation. Second Edition. California Native Plant Society, Sacramento, California.

Society for Ecological Restoration. 2004. SER International Primer on Ecological Restoration.

[USFWS] U.S. Fish and Wildlife Service. 2013. Sacramento Fish & Wildlife Office—Safe Harbor Agreements. 17 December. Available at http://www.fws.gov/sacramento/CP/Safe-Harbor-Program/cp_safe-harbor-prog.htm. Accessed 3 February 2014.

Vaghti, M. G., and S. E. Greco. 2007. Riparian Vegetation of the Great Valley. Pages 425–455 *in* M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr (Editors), Terrestrial Vegetation of California. University of California Press, Berkeley, California.

This page left blank intentionally.

10.0 Acronyms and Other Abbreviations

AB .....Assembly Bill
AFRP.....Anadromous Fish Restoration Program
BANS-TAC.....Bank Swallow Technical Advisory Committee
BMP .....best management practice
BO .....biological opinion
BWFS.....basin-wide feasibility study
Cal-IPC .....California Invasive Plant Council
CBDP .....CALFED Bay-Delta Program
CDFG.....California Department of Fish and Game
CDFW .....California Department of Fish and Wildlife
CEQA.....California Environmental Quality Act
CESA .....California Endangered Species Act
CFR.....Code of Federal Regulations
CMP .....Corridor Management Plan
CPA.....Conservation Planning Area
CRPR .....California Rare Plant Rank
CVFPB.....Central Valley Flood Protection Board
CVFPP .....Central Valley Flood Protection Plan
CVJV.....Central Valley Joint Venture
CWA .....Clean Water Act
Delta.....Sacramento–San Joaquin River Delta
DPS .....Distinct Population Segment
DWR .....California Department of Water Resources
EAH .....expected annual habitat
EC .....Engineering Circular
ESA.....federal Endangered Species Act
ESSDWG .....Environmental Stewardship Scope Definition Work Group

ESU .....Evolutionarily Significant Unit
ETL .....Engineering Technical Letter
FIP.....floodplain inundation potential
FMIO.....Fish Migration Improvement Opportunities
FROA.....Floodplain Restoration Opportunity Analysis
GIS .....geographic information system
HCP.....Habitat Conservation Plan
IAC.....Interagency Advisory Committee
LMA.....Local Maintaining Agency
LSAA .....Lake and Streambed Alteration Agreement
LWM.....large woody material
MLC.....Marysville Levee Commission
MS Access .....Microsoft Access
NCCP .....Natural Community Conservation Plan
NEPA .....National Environmental Policy Act
NMFS.....National Marine Fisheries Service
NOAA .....National Oceanic and Atmospheric Administration
NRCS .....Natural Resources Conservation Service
NWR .....National Wildlife Refuge
O&M .....operations and maintenance
PA .....Programmatic Agreement
PEIR.....Program Environmental Impact Report
RCD .....Resource Conservation District
RCIS.....regional conservation investment strategy
RFMP.....regional flood management plan
RGP.....Regional General Permit
RHJV.....Riparian Habitat Joint Venture
RM .....River Mile
RMA .....routine maintenance agreement
RPA.....Reasonable and Prudent Alternative
RWQCB.....Regional Water Quality Control Board

SAC.....Scientific Advisory Committee
SAFCA.....Sacramento Area Flood Control Agency
SBFCA.....Sutter Butte Flood Control Agency
SERP.....Small Erosion Repair Program
SFEI.....San Francisco Estuary Institute
SHA.....Safe Harbor Agreement
SJRRP.....San Joaquin River Restoration Program
SP.....State Park
SPA.....Systemwide Planning Area
SPFC.....State Plan of Flood Control
SRA.....shaded riverine aquatic
SRAC.....Sacramento River Advisory Council
State.....State of California (government)
Strategy.....Conservation Strategy
SWIF.....System-Wide Improvement Framework
SWRCB.....State Water Resources Control Board
TBD.....to be determined
TNC.....The Nature Conservancy
TRLIA..... Three Rivers Levee Improvement Agency
UCD.....University of California, Davis
USACE.....U.S. Army Corps of Engineers
USBR.....U.S. Bureau of Reclamation
USC.....United States Code
USFWS.....U.S. Fish and Wildlife Service
VMZ.....Vegetation Management Zone
YCWA.....Yuba County Water Agency

This page left blank intentionally.

11.0 Glossary

adaptive management	To use the results of new information gathered through monitoring and from other sources to adjust management strategies and practices.[6]
anadromous fish	Fish that spend a part of their life cycle in the sea and return to freshwater to spawn.
baseline	The current condition of a natural resource, or its condition at a time of assessment—used as a starting point against which future conditions can be measured or compared.
basin-wide feasibility studies (BWFSs)	The Sacramento and San Joaquin BWFSs focus on refining the improvements of the 2012 Central Valley Flood Protection Plan (CVFPP) through technical analyses and evaluations. These analyses and evaluations are done in two phases: Phase 1 focuses on developing specific planning objectives and exploring different physical features for system improvements; Phase 2 will evaluate and compare the physical improvement components of the CVFPP on a systemwide scale, considering their costs, effects, and benefits.
biotic community diversity	The taxonomic or functional richness (number) and equitability of abundance of species in and among communities (co-occurring assemblages of species).
bypass	An engineered wide and shallow channel or confined floodplain, usually flanked by levees, that periodically receives floodwaters to reduce the amount of flow in a river or stream.
capacity	See *conveyance capacity*.
Central Valley Flood Protection Board (CVFPB)	An agency (formerly known as the State of California Reclamation Board) created by the California Legislature in 1911 to carry out a comprehensive flood control plan

[6] Adapted from California Fish and Game Code, Section 2805(a).

	for the Sacramento and San Joaquin Rivers. CVFPB has jurisdiction throughout the Sacramento–San Joaquin Valley, which is synonymous with the drainage basins of the Central Valley and includes the Sacramento–San Joaquin Drainage District.
Central Valley Flood Protection Plan	A State plan that describes the challenges, opportunities, and vision for improving integrated flood management in the Central Valley. The CVFPP documents current and future risks associated with flooding and recommends improvements to the State-federal flood protection system to reduce the occurrence of major flooding and the consequences of flood damage that could result. The initial plan was submitted to CVFPB on 30 December 2011 and adopted 29 June 2012. It will be updated every 5 years.
conservation	The maintenance, enhancement, and restoration of populations, communities, and ecosystem functions to sustain the services, benefits, and values of public trust resources.
conservation planning area (CPA)	One of five subdivisions of the Systemwide Planning Area (SPA) that differs from other CPAs in regard to natural resources and CVFPP activities. Each CPA consists of one or more regional flood management plan regions and the adjoining upstream portions of the SPA.
conveyance capacity	The maximum rate of flowing water, usually expressed in cubic feet per second, that a river, canal, or bypass can carry without exceeding a threshold value, such as flood discharge, or without using the freeboard distance from the top of a levee. Freeboard is a factor of safety, usually expressed in feet above a flood level, used for purposes of floodplain management.
CVFPP work groups	Place-based (e.g., regional) and subject-based (e.g., topic) work groups chartered to develop content and content recommendations for the CVFPP. Work groups are integral to developing a broadly supported CVFPP that reflects State, federal, tribal, local, and regional perspectives and subject-matter expertise.

developed

An area of a community is developed if it is:[7]

A. A primarily urbanized, built-up area that is a minimum of 20 contiguous acres, has basic urban infrastructure, including roads, utilities, communications, and public facilities, to sustain industrial, residential, and commercial activities, and

   1. within which 75 percent or more of the parcels, tracts, or lots contain commercial, industrial, or residential structures or uses; or

   2. is a single parcel, tract, or lot in which 75 percent of the area contains existing commercial or industrial structures or uses; or

   3. is a subdivision developed at a density of at least two residential structures per acre within which 75 percent or more of the lots contain existing residential structures at the time the designation is adopted.

B. Undeveloped parcels, tracts, or lots, the combination of which is less than 20 acres and contiguous on at least three sides to areas meeting the criteria of paragraph (A) at the time the designation is adopted.

C. A subdivision that is a minimum of 20 contiguous acres that has obtained all necessary government approvals, provided that the actual "start of construction" of structures has occurred on at least 10 percent of the lots or remaining lots of a subdivision or 10 percent of the maximum building coverage or remaining building coverage allowed for a single-lot subdivision at the time the designation is adopted and construction of structures is underway. Residential subdivisions must meet the density criteria in paragraph (A)(3).

developed land cover/land use

Developed lands with more than one unit (or structure) per acre, and containing infrastructure and landscaping.

[7] 44 Code of Federal Regulations 59.1; California Government Code, Section 65007(c).

distributary	A river branch flowing away from the mainstem.
dynamic hydrologic and geomorphic processes	In the context of river systems, the dynamic processes of water flow subsurface, overland, and in rivers and the resulting entrainment, transport, and storage of sediment in river channels and on floodplains.
ecosystem	All the organisms in a given area that interact with the physical environment. The biotic and physical components in an ecosystem are interdependent, frequently with complex feedback loops. Among the physical components that sustain the biota of an ecosystem are the soil or substrate, topographic relief and aspect, atmosphere, weather and climate, hydrology, geomorphic processes, nutrient regime, and salinity regime.
ecosystem benefits	The goods and services that people derive directly or indirectly from ecosystem functions.
ecosystem functions	Intrinsic ecosystem characteristics related to the set of conditions and processes (such as primary productivity, food chain, and biogeochemical cycles) whereby an ecosystem maintains its integrity. Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy.[8]
ecosystem resiliency	The amount of disturbance that an ecosystem can withstand without changing self-organized processes and structures.[9]
ecosystem restoration	The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.[10]
environmental stewardship	The concept of responsibly managing and protecting natural resources (water, air, land, plants, and animals) and ecosystems in a sustainable manner that ensures they are available for future generations.
expected annual habitat (EAH)	EAH units represent the annual average of the area expected to be inundated in general or by flows meeting

[8] Millennium Ecosystem Assessment 2003.
[9] Holling 1973.
[10] Society for Ecological Restoration 2004.

	defined criteria for timing and duration (e.g., sustained spring flows) so as to provide habitat for a species (e.g., Chinook salmon).
fish passage barrier	A water management structure, such as a dam, weir, control structure, or water diversion, that blocks, delays, strands, or adversely influences anadromous fish as they migrate upstream or downstream. These structures can be total, temporal, or partial barriers depending on physical characteristics (e.g., height, hydraulic conditions affecting water depth and velocity, attraction flow, and physical deterioration); operation (e.g., diversion rate and timing and flashboard or gate operations); and relation to species' biological characteristics (e.g., mode of locomotion, species type, size, physical abilities, and fish condition).
flood	A general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property) from any of the following: • overflow of inland or tidal waters, or • unusual and rapid accumulation or runoff of surface waters from any source, or • mudflow, or • collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above.[11]
flood basin	A bowl-shaped, natural landform that historically received and retained or presently receives and retains floodwaters, or an engineered floodwater detention basin, excavated below grade or surrounded by levees.
flood control diagram	A flood management tool that defines, by date, the volume of reservoir capacity allocated for floodwater storage.

[11] Federal Emergency Management Agency 2015.

flood risk	The combined effect of the chance of flooding and the property that would be damaged if flooded.
flood system flexibility	Is the ability of a flood management system to adapt to changing conditions, such as changing hydrologic, social, political, regulatory, or ecological conditions. A more flexible flood system can provide adaptive capacity in the face of climate change and help make investments in local and regional flood protection more enduring in the face of future hydrological uncertainties.
flood system resiliency	Relates to the ability of the flood management system to continue to function and/or recover quickly after damaging floods. Increased flood system resiliency can be achieved through increasing the robustness of flood management improvements; adapting measures that reduce the time and cost of flood recovery; improving emergency preparedness, emergency response, and flood recovery planning; and improving system redundancy, particularly in high-risk areas.
floodplain	The active (or “connected”) floodplain is the geomorphic surface adjacent to the stream channel that is typically inundated on a regular basis (i.e., with a recurrence interval of about 2–10 years or less). It is the most extensive low-depositional surface, typically covered with fine overbank deposits, although gravel bar deposits may occur along some streams. The floodplain surface often contains abandoned channels or secondary channels (i.e., chutes). Historical floodplains that are no longer inundated because of channel incision, flow regime changes, or intervening levees are referred to as “inactive” or “disconnected” floodplains.
floodway	The channel of a stream and the portion of the adjoining floodplain required to reasonably provide for passage of the design flood (the selected flood against which protection is provided, or eventually will be provided, by means of flood protective or control works).

geomorphology	The study of the characteristics, origins, and development of landforms.
goals	As defined in the planning process for the CVFPP, a description of what the CVFPP will accomplish. Goals are broad and enduring values and the direction or desired conditions to be achieved. They do not prescribe specific actions.[12]
guiding principles	Principles that provide guidance on how the CVFPP will be developed and implemented.
improvement/improvement project	An action performed by USACE, in partnership with CVFPB, on SPFC facilities (federal only) to increase project performance beyond what has been authorized for the existing project. Improvement projects are cost-shared in accordance with their authorization (e.g., American River Common Features Project). *(USACE)*
integrated flood risk management	An approach to dealing with flood risk that recognizes the interconnection of flood management actions with broader water resources management and land use planning; the value of coordinating across geographic and agency boundaries; the need to evaluate opportunities and potential impacts from a system perspective; and the importance of environmental stewardship and sustainability.[13]
integrated water management	An approach to water management that combines flood risk management, water supply management, and ecosystem-oriented actions to deliver multiple benefits.
invasive plants	Plants that could adversely affect this Conservation Strategy's objectives or public safety through compromised operations and maintenance of the SPFC.
large woody material	Consists of logs, typically more than 4 inches in diameter and more than 6 feet long, lying in river or stream channels. This material provides valuable cover and resting habitat for fish.

[12] DWR 2010a.
[13] DWR 2008.

Local Maintaining Agency (LMA)	Any city, county, district, or other political subdivision of the State that is authorized to maintain levees. DWR maintains levees pursuant to California Water Code Sections 8361 and 12878, but is not considered an LMA.
maintenance	An action that is necessary to ensure the serviceability of SPFC facilities in times of floods (e.g., vegetation removal), but that is not taken during periods of high water. Maintenance of facilities is a nonfederal responsibility. The facilities of the SPFC are maintained by either DWR or LMAs, as described by laws and various other legally binding documents. Funds for maintenance are provided by the maintainers. *(USACE)*
metric	The means for measuring the extent to which objectives are (or can be) achieved. Some metrics are quantifiable (numerically), while others are qualitative in nature.
measurable objective	Defines what an action or plan will accomplish and includes components for quantity/proportion (how much) and time (when the objective should be accomplished).
modification/alteration	An action undertaken to change a facility so that it performs a new purpose, expands the authorized purpose beyond that intended at the time of construction, improves the authorized project performance, or extends services to new beneficiaries. Modification by the maintainers of the SPFC (e.g., the Three Rivers Levee Improvement Authority) may proceed upon CVFPB's issuance of an encroachment permit. Before issuing permits, CVFPB must secure a USACE permit under 33 United States Code 408. Congressionally authorized project modifications (e.g., Yolo Basin Wetlands Project) are performed by USACE in partnership with CVFPB or others. *(USACE)*
multi-benefit project	A project that is designed and implemented to achieve the objectives of both flood safety and ecosystem functions, while providing additional benefits as much as possible.
nonproject levee	Any levee that is not part of the SPFC (California Water Code, Section 9602[c]) or other State-federal or local-federal flood protection facilities. Nonproject levees are

	typically privately owned or under the authority of a local levee district.
non-SPFC levee	Any levee that is not part of the SPFC (California Water Code, Section 9602[c]). This includes State-federal levees outside the Sacramento and San Joaquin River watersheds and levees within the Sacramento and San Joaquin River watersheds that do not have (1) documented State assurances of nonfederal cooperation with the federal government or (2) State responsibility identified in California Water Code Section 8361.
nonstructural projects	Projects intended to reduce or eliminate susceptibility to flooding by preserving or increasing the flood-carrying capacity of floodways. These include such measures as constructing levees or setback levees, floodproofing structures, and zoning, designating, or acquiring flood-prone areas.[14]
objectives	Collectively, measures intended to define the overall accomplishments of the CVFPP. The objectives are not specific actions to achieve the goals, but rather quantitative overall measures of success of the plan.[15]
operation	An action taken during high water that is necessary to maintain the functionality of SPFC facilities (e.g., sandbagging). Operation of facilities is a nonfederal responsibility. The facilities of the SPFC are operated by either DWR or LMAs, as described by laws and various other legally binding documents. The costs of operation are funded by the operators. *(USACE)*
operations and maintenance (O&M)	The effort that must be expended to keep project facilities in good working condition so they continue to operate as designed—wear and tear on facilities that are not adequately maintained can reduce their capacity or make them more vulnerable to failure. Also, the management of adjustable features (e.g., flow rate, stage, reservoir storage) to achieve the desired conditions.

[14] California Water Code, Section 79068(a).
[15] DWR 2010a.

partners	Individuals, organizations, or agencies with direct responsibilities for activities and actions anticipated by the CVFPP.
project levee	Any levee that is a facility of the SPFC.[16]
public agency	Any city, city and county, county, or district organized, existing, and acting pursuant to the laws of this State.[17]
public safety	The prevention of, and protection of the general public from, events (such as natural and human-made disasters) that could significantly endanger, injure, or harm people, or cause damage.
rearing habitat	Instream habitat with food, shelter, and water velocity, depth, and quality conditions adequate for juvenile salmonids to survive, avoid predators, and grow.
reconstruction	An action (e.g., Sacramento Area Levee Reconstruction Project) that may be performed by USACE, in partnership with CVFPB, on SPFC facilities (federal only) to address impediments that prevent a project from performing as authorized, if the impediments are not the result of inadequate maintenance. The causes of impediments can be design or construction deficiencies, or long-term degradation of facilities that have exceeded their expected service lives. *(USACE)*
recovery	Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Endangered Species Act.[18]
rehabilitation	An action undertaken by USACE, on SPFC facilities, to restore flood-damaged flood control works to their predisaster condition at 100 percent of federal costs (e.g., Linda levee break restoration). Does not apply to lands, easements, rights-of-way, and relocations. Rehabilitation of nonfederal facilities (e.g., Delta levee restoration) is provided at 80 percent of federal costs. *(USACE)*

[16] California Water Code, Section 9602(c).
[17] California Water Code, Section 8402(d).
[18] 50 Code of Federal Regulations 402.02

repair	A corrective action needed to restore damaged SPFC facilities to operable condition (e.g., reshaping a levee crown to eliminate ruts). Repair of facilities is a nonfederal responsibility. The facilities of the SPFC are repaired by either DWR or LMAs, as described by laws and various other legally binding documents. The repairs are funded by the maintainers of the facility. *(USACE)*
residual risk	The portion of flood risk that remains after a flood control structure or works have been built. Risk remains because of the likelihood that the completed works' design could be surpassed by the intensity of a flood event, resulting in structural failure.[19]
resilience	The ability to recover from a catastrophic flood event; greater resilience reduces flood damages and recovery times and costs.
restore/restoration	An action to reestablish something to its original condition, or a former, original, normal, or unimpaired condition, to replace something that has been lost. The act of restoring; renewal, revival, or reestablishment. See also *ecosystem restoration*.
revetment	Erosion-resistant materials that reinforce and protect streambanks and levees.
riparian area	A transitional area between terrestrial and aquatic ecosystems, distinguished by gradients in biophysical conditions, ecological processes, and biota. These are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. Riparian areas include portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., they are zones of influence). Riparian areas are found adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines.
riparian habitat	As used in this Conservation Strategy, *riparian habitat* refers to the forest, woodland, and scrub vegetation

[19] Adapted from Carter 2005.

	characteristic of riparian areas in the Sacramento and San Joaquin Valleys (as described in Sawyer et al. 2009 and Vaghti and Greco 2007).
roughness	Roughness refers to the hydraulic roughness of a surface, which is determined by the height and arrangement of surface irregularities (including vegetation). Hydraulic roughness affects the velocity of flowing water and thus the conveyance of floodwater through a section of channel.
rural community	A city, town, or settlement outside of urban and urbanizing areas with an expected population of less than 10,000 within the next 10 years.
Sacramento River Flood Control Project	The core of the flood protection system along the Sacramento River and tributaries. The Sacramento River Flood Control Project includes most of the levees, weirs, control structures, bypass channels, and river channels that make up the SPFC. Approximately 980 miles of levees were involved in the project. Portions of these levees were originally constructed by local interests and were either included directly in the project without modification or modified to meet USACE project standards. The project was originally authorized by the Flood Control Act of 1917 and subsequently was modified and extended by the Flood Control Acts of 1928, 1937, and 1941. The State of California adopted and authorized the Sacramento River Flood Control Project in 1953.[20]
Sacramento–San Joaquin River Flood Management System	A flood management system that comprises all of the following: (a) the facilities of the SPFC as the plan may be amended by CVFPB and (b) any existing dam, levee, or other flood management facility that is not part of the SPFC if CVFPB determines, upon recommendation by DWR, that the facility does one or both of the following: (1) provides significant systemwide benefits for managing flood risks within the Sacramento–San Joaquin Valley or (2) includes project levees that protect a contiguous urban area of 10,000 or more residents within the Sacramento–San Joaquin Valley.[21]

[20] DWR 2010b.
[21] California Water Code, Sections 9602 and 9611.

Safe Harbor Agreement (SHA)	An agreement between a landowner and a regulatory agency that provides assurances that, if the landowner voluntarily enhances and maintains habitat for listed species on his or her property, the regulatory agency will not impose additional restrictions. The regulatory agency authorizes incidental take coverage for routine and ongoing activities on the property. This assures the landowner that he or she will be able to continue routine and ongoing activities, despite the presence of listed species. In addition, the regulatory agency authorizes the landowner to return the property to preagreement (baseline) conditions. In other words, a landowner can create habitat for a listed species, then remove the created habitat at the end of the agreement if he or she chooses to do so. SHAs cannot authorize incidental take for a landowner to go below baseline conditions.[22]
sensitive species	Species assigned a special status in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife, National Marine Fisheries Service, or U.S. Fish and Wildlife Service, because they are at risk of extinction or extirpation, or species that meet the criteria for such special status (used synonymously with “at-risk species”).
small community	A developed area with a population of less than 10,000.
shaded riverine aquatic (SRA) cover	The unique, near-shore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. Key attributes of this aquatic area are as follows: (1) the adjacent bank is composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (2) the water contains variable amounts of woody debris, such as leaves, logs, branches, and roots; often has substantial detritus; and has variable velocities, depths, and flows. SRA cover provides structural and functional integrity for several regionally important fish and wildlife species. It has drastically declined in area and become increasingly fragmented in the Central Valley.

[22] Adapted from U.S. Fish and Wildlife Service (USFWS) 2013.

State Plan of Flood Control (SPFC)	The State and federal flood control works, lands, programs, plans, policies, conditions, and mode of O&M of the Sacramento River Flood Control Project, described in California Water Code Section 8350, and of flood control projects in the Sacramento River and San Joaquin River watersheds, authorized pursuant to Article 2 (commencing with Section 12648) of Division 6, Part 6, Chapter 2, for which CVFPB or DWR has provided the assurances of nonfederal cooperation to the United States, and those facilities identified in California Water Code Section 8361.[23]
structural improvements	Projects that are intended to modify flood patterns and rely primarily on constructed components. These projects include measures such as levees, floodwalls, and improved channels.[24]
sustainable	Socially, environmentally, and financially feasible for an enduring period. In the context of the CVFPP, a sustainable project has the flexibility to adapt to potential future changes, such as climate change.
system	The Sacramento–San Joaquin River Flood Management System, as described in California Water Code Section 9611.
systemwide	Refers to the scale of an entire system (e.g., the flood management system within the Sacramento–San Joaquin River Flood Management System).
Systemwide Planning Area (SPA)	The geographic area that encompasses lands receiving flood damage reduction benefits from the existing SPFC facilities and operation of the Sacramento–San Joaquin River Flood Management System.
target	The specific entities with which goals are concerned and for which objectives have been developed.

[23] California Water Code, Section 9110(f).
[24] California Water Code, Section 79068(b).

transitory storage	The temporary and periodic storage of peak flood flows from adjacent rivers or waterways. Storage occurs in modified floodplain areas acquired through easement or fee title.
Tulare Lake Basin	The Tulare Lake Hydrologic Region, as defined in the *California Water Plan Update 2009*, prepared by DWR pursuant to Chapter 1 (commencing with Section 10004) of the California Water Code, Division 6, Part 1.5.[25]
urban area	A developed area in which there are 10,000 residents or more.[26]
vegetated revetment	Revetment reinforcing a streambank, on which vegetation has naturally recolonized after the bank's reinforcement.
watershed	The land area from which water drains into a stream, river, or reservoir.[27]
Weed Heuristics Invasive Population Prioritization for Eradication Tool	An existing GIS-based computational model (developed by DWR staff) to prioritize invasive plant infestations for treatment within region-scale, multi-infestation settings.

[25] DWR 2009; California Government Code, Section 65007(i).
[26] California Government Code, Section 65007(j).
[27] DWR 2009.

This page left blank intentionally.

12.0 Species Names

Bank swallow ..... *Riparia riparia*
Belted kingfisher ..... *Megaceryle alcyon*
Black-headed grosbeak ..... *Pheucticus melanocephalus*
Brazilian waterweed ..... *Egeria densa*
Bullock's oriole ..... *Icterus bullockii*
California black rail ..... *Laterallus jamaicensis coturniculus*
California buttonbush ..... *Cephalanthus occidentalis*
California Central Valley steelhead ..... *Oncorhynchus mykiss*
Cattails ..... *Typha* spp.
Chinook salmon ..... *Oncorhynchus tshawytscha*
Cottonwood ..... *Populus* spp.
Delta button-celery ..... *Eryngium racemosum*
Giant garter snake ..... *Thamnophis gigas*
Giant reed ..... *Arundo donax*
Greater sandhill crane ..... *Grus canadensis tabida*
Green sturgeon ..... *Acipenser medirostris*
Largemouth bass ..... *Micropterus salmoides*
Least Bell's vireo ..... *Vireo bellii pusillus*
Least bittern ..... *Ixobrychus exilis*
Lesser sandhill crane ..... *Grus canadensis canadensis*
Longfin smelt ..... *Spirinchus thaleichthys*
Mason's lilaeopsis ..... *Lilaeopsis masonii*
Mink ..... *Neovison vison*
Northern rough-winged swallow ..... *Stelgidopteryx serripennis*
Oregon ash ..... *Fraxinus latifolia*
Red sesbania ..... *Sesbania punicea*
Redhead ..... *Aythya americana*
Riparian brush rabbit ..... *Sylvilagus bachmani riparius*

Riparian woodrat.....*Neotoma fuscipes riparia*
River otter .....*Lontra canadensis*
Sacramento splittail.....*Pogonichthys macrolepidotus*
Saltcedar..... *Tamarix* spp.
Sandbar willow .....*Salix exigua*
Sanford's arrowhead .....*Sagittaria sanfordii*
Slough thistle ..... *Cirsium crassicaule*
Swainson's hawk .....*Buteo swainsoni*
Tricolored blackbird..... *Agelaius tricolor*
Tules.....*Schoenoplectus* spp.
Valley elderberry longhorn beetle .....*Desmocerus californicus dimorphus*
Valley oak .....*Quercus lobata*
Western burrowing owl..... *Athene cunicularia hypugaea*
Western pond turtle.....*Actinemys marmorata*
Western red bat .....*Lasiurus blossevillii*
Western yellow-billed cuckoo ..... *Coccyzus americanus occidentalis*
Willow.....*Salix* spp.
Willow flycatcher.....*Empidonax traillii brewsteri*
Yellow-breasted chat .....*Icteria virens*
Yellow-headed blackbird.....*Xanthocephalus xanthocephalus*
Yellow warbler.....*Dendroica petechia brewsteri*

13.0 Preparers

Management Team

Stacy Cepello
DWR
Office Chief

Sara Denzler
DWR
Program Manager II

Terri Gaines
DWR
Program Manager II

Ray McDowell
DWR
Program Manager II

Technical Input

Josh Brown
DWR
Environmental Scientist

David Carlson, Ph.D.
DWR
Program Manager II

Mark Chin
DWR
Environmental Scientist

Lori Clamurro-Chew
DWR
Program Manager I

Heidi Hall
DWR
Program Manager I

Adam Henderson
DWR
Senior Environmental Scientist

April McEwen
DWR
Environmental Scientist

Ron Melcer
DWR
Senior Environmental Scientist

Cassandra Musto
DWR
Associate Landscape Architect

Technical Support

Kristi Asmus
AECOM
Ecologist

Debra Bishop
H. T. Harvey & Associates
Principal

Gina Darin
DWR
Environmental Scientist

John Hunter, Ph.D.
H. T. Harvey & Associates
Associate Plant Ecologist

Sharon Kramer, Ph.D.
H. T. Harvey & Associates
Principal

Charles McClain
H. T. Harvey & Associates
Ecologist

Jim Merk
H. T. Harvey & Associates
Technical Editor

Rebecca Nuffer
H. T. Harvey & Associates
Field Biologist

Heather Ogston
H. T. Harvey & Associates
Technical Editor

Technical Review

Susan Sanders, Ph.D.
AECOM
Senior Wildlife Biologist

Scott Terrill, Ph.D.
H. T. Harvey & Associates
Principal

Technical Input (cont.)

Natasha Nelson
DWR
Program Manager I

Michael Roberts
DWR
Program Manager I

Technical Support (cont.)

Ellen Pimentel
H. T. Harvey & Associates
Associate Restoration Ecologist

Jeff Smith, Ph.D.
H. T. Harvey & Associates
Senior Ecologist

Bridget Sousa
H. T. Harvey & Associates
Ecologist

Matt Wacker
H. T. Harvey & Associates
Senior Ecologist

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES