Chapter 3.0 Considerations for Describing the Affected Environment and Environmental Consequences

The SJRRP study area is broadly defined to ensure evaluation of potential direct, indirect, and cumulative effects. The areas where direct, indirect, and cumulative effects may occur differ according to resource area; therefore, the geographic range described varies by resource. Resources are generally described in relatively more detail where direct effects may occur and in relatively less detail where indirect effects are anticipated. The information in this chapter was obtained from technical studies prepared by Reclamation and attached to this Draft PEIS/R. Additional information was obtained from published environmental and planning documents, books, journals articles, Web sites, field surveys, and communications with technical experts. Affected environment descriptions are organized geographically.

3.1 Study Area

The study area for this Draft PEIS/R includes areas that may be affected directly, indirectly, or cumulatively by implementing program alternatives. The study area has been broadly defined to ensure evaluation of potential effects within five geographic subareas:

- San Joaquin River upstream from Friant Dam, including Millerton Lake
- San Joaquin River from Friant Dam to the Merced River confluence (Restoration Area, which includes Reaches 1 through 5 and the flood bypasses, as shown on Figure 1-2)
- San Joaquin River from the Merced River to the Delta
- Delta
- CVP/SWP water service areas, including the Friant Division of the CVP

Operational impacts would result in all geographic subareas under all alternatives. Construction-related impacts would result in the Restoration Area under all action alternatives and in the San Joaquin River from the Merced River to the Delta under Alternatives B1, B2, C1, and C2 only. Construction-related impacts would not result in other geographic subareas. The geographic subareas are described briefly below.

3.1.1 San Joaquin River Upstream from Friant Dam

The San Joaquin River originates in the Sierra Nevada at an elevation of 12,000 feet above mean sea level (msl) (North American Vertical Datum (NAVD) 1988) (elevation 12,000). Millerton Lake, formed by Friant Dam, is the largest reservoir on the San Joaquin River. Wildlife habitat around the lake is fairly sparse, and the lake is surrounded by low hills. Inflow to Millerton Lake consists primarily of upper San Joaquin River flows, and is influenced by the operation of several upstream hydropower generation projects. Other inflows to Millerton Lake include local runoff, and Millerton Lake typically fills during late spring and early summer, when San Joaquin River flows are high because of snowmelt in the upper watershed. Friant Dam diverts much of the water from the San Joaquin River to contractors within the CVP Friant Division water service area. Annual water allocations and release schedules are developed with the intent of drawing reservoir storage to minimum levels by the end of September. The operation of Friant Dam changes storage levels in Millerton Lake, which in turn can influence resources affected by storage conditions and lake levels.

3.1.2 San Joaquin River from Friant Dam to Merced River

SJRRP restoration activities focus on this approximately 150-mile-long reach of the San Joaquin River, termed the Restoration Area. The river and flood bypasses within the Restoration Area are described as a series of physically and operationally distinct reaches, as shown on Figure 1-2 and described below.

Reach 1

Reach 1 begins at Friant Dam and continues approximately 37 miles downstream to Gravelly Ford. Reclamation makes releases from Friant Dam to maintain continuous flows past Gravelly Ford, providing deliveries to riparian water rights holders in Reach 1 under "holding contracts." The reach is divided into two subreaches, 1A and 1B. Reach 1A extends from Friant Dam to State Route (SR) 99. Reach 1B continues from SR 99 to Gravelly Ford. Reach 1 is the principal area identified for future salmon spawning, but has been extensively mined for instream gravel. Reach 1and is limited for sediment supply.

Reach 2

Reach 2 begins at Gravelly Ford and extends approximately 24 miles downstream to the Mendota Pool, continuing the boundary between Fresno and Madera counties. This reach is a meandering, low-gradient channel. Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches. Both Reach 2A and Reach 2B are dry in most months. Reach 2A is subject to extensive seepage losses. Reach 2B is a sandy channel with limited conveyance capacity.

Reach 3

Reach 3 begins at Mendota Dam and extends approximately 23 miles downstream to Sack Dam. Reach 3 conveys flows of up to 800 cfs from the Mendota Pool for diversion to the Arroyo Canal at Sack Dam, maintaining year-round flow in a meandering channel with a sandy bed. Flood flows from the Kings River are conveyed to Reach 3 via Fresno Slough and Mendota Dam. This reach continues the boundary between Fresno and

Madera counties. The sandy channel meanders through a predominantly agricultural area, and diversion structures are common in this reach.

Reach 4

Reach 4 is approximately 46 miles long, and is subdivided into three distinct subreaches. Reach 4A begins at Sack Dam and extends to the Sand Slough Control Structure. This subreach is dry in most months except under flood conditions. Reach 4B1 begins at the San Slough control structure and continues to the confluence of the San Joaquin River and the Mariposa Bypass. All flows reaching the Sand Slough Control Structure are diverted to the flood bypass system via the Sand Slough Bypass, leaving Reach 4B1 perennially dry for more than 40 years, with the exception of agricultural return flows. Reach 4B2 begins at the confluence of the Mariposa Bypass, where flood flows in the bypass system rejoin the mainstem San Joaquin River. Reach 4B2 extends to the confluence of the Eastside Bypass.

Reach 5

Reach 5 of the San Joaquin River extends approximately 18 miles from the confluence of the Eastside Bypass downstream to the Merced River confluence. This reach receives flows from Mud and Salt sloughs, channels that run through both agricultural and wildlife managements areas.

Fresno Slough/James Bypass

Fresno Slough, also referred to as the James Bypass, conveys flood flows in some years from the Kings River system in the Tulare Basin to the Mendota Pool. These flows are regulated by Pine Flat Dam.

Chowchilla Bypass and Tributaries

The Chowchilla Bypass Bifurcation Structure at the head of Reach 2B regulates the flow split between the San Joaquin River and the Chowchilla Bypass. The structure is operated depending on flows in the San Joaquin River, flows from the Kings River system via Fresno Slough, water demands in Mendota Pool, and seasonality. Tributaries to the Chowchilla Bypass include the Fresno River and Berenda Slough. The Chowchilla Bypass extends to the confluence of Ash Slough, which marks the beginning of the Eastside Bypass.

Eastside Bypass, Mariposa Bypass, and Tributaries

The Eastside Bypass extends from the confluence of Ash Slough and the Chowchilla Bypass to the confluence with the San Joaquin River at the head of Reach 5. It is subdivided into three reaches. Eastside Bypass Reach 1 extends from Ash Slough to the Sand Slough Bypass confluence, and receives flows from the Chowchilla River. Eastside Bypass Reach 2 extends from the Sand Slough Bypass confluence to the head of the Mariposa Bypass. Eastside Bypass Reach 3 extends from the head of the Mariposa Bypass to the head of Reach 5, and receives flows from Deadman, Owens, and Bear creeks. Eastside Bypass Reach 3 downstream from the confluence of Bear Creek to its confluence with Reach 5 is alternatively known as Bear Creek. The Mariposa Bypass extends from the Mariposa Bypass Bifurcation Structure to the head of Reach 4B2. A drop structure is located near the downstream end of the Mariposa Bypass that dissipates energy from flows before flows enter the mainstem San Joaquin River.

3.1.3 San Joaquin River from Merced River to the Sacramento-San Joaquin Delta

The San Joaquin River downstream from the Merced River confluence to the Delta receives inflow from several large rivers, including the Merced, Tuolumne, and Stanislaus rivers. These rivers flow west out of the Sierra Nevada Mountains to the San Joaquin River. The Merced, Tuolumne, and Stanislaus rivers each support anadromous fisheries, including fall-run Chinook salmon. The Merced River flows west out of the Sierra Nevada to its confluence with the San Joaquin River at the end of Reach 5. During high-flow events, a portion of Merced River flows is conveyed to the San Joaquin River through Merced Slough. The Tuolumne River flows approximately 150 miles to the San Joaquin River and hosts anadromous and other fisheries. The Stanislaus River flows into the San Joaquin River just upstream from Vernalis. Several smaller rivers join the San Joaquin River below the Stanislaus River confluence.

3.1.4 Sacramento-San Joaquin Delta

The Delta is a network of islands and channels at the confluence of the Sacramento and San Joaquin rivers. The Delta comprises an area of approximately 750,000 acres, receives runoff from a watershed that includes more than 40 percent of California’s land area, and accounts for approximately 42 percent of the State’s annual runoff (Water Education Foundation 1992). Tributaries that directly discharge into the Delta include the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers. The Delta supplies water for most of California’s agricultural production and many urban and industrial communities across the State.

In the Delta, the Federal CVP Jones and SWP Banks pumping plants move water from the Delta to a system of canals and reservoirs for agriculture, municipal and industrial (M&I), and environmental uses in the San Joaquin Valley; the San Francisco Bay Area (Bay Area), along the Central Coast; and portions of Southern California. Surface water resources in the Delta are influenced by the interaction of tributary inflows; tides; Delta hydrodynamics; regulatory requirements; and water management actions, such as reservoir releases, in-Delta diversions, and transfers.

The Delta also provides habitat for numerous plant, animal, and fish species, including several threatened or endangered species. The Delta serves as a migration path for all Central Valley anadromous species returning to their natal rivers to spawn; adult Chinook salmon move through the Delta during most months of the year.

3.1.5 Central Valley Project/State Water Project Water Service Areas

Federal, State, and local water service entities manage water supplies throughout the study area. The following sections describe CVP and SWP service areas and facilities that have the potential to be affected by implementation of program alternatives.

Central Valley Project Friant Division Water Service Area and Facilities

The CVP Friant Division was designed and is operated to support conjunctive water management. Reservoir facilities at Millerton Lake are part of the CVP Friant Division, and their operation affects flow in the San Joaquin River. Friant Dam is operated to supply water to agricultural and urban areas in the eastern San Joaquin Valley and to provide flood protection to downstream areas. The CVP Friant Division provides water to more than 1 million acres of irrigable land on the east side of the southern San Joaquin Valley, from near the Chowchilla River in the north to the Tehachapi Mountains in the south (Figure 1-1).

Reclamation holds most of the water rights on the San Joaquin River, allowing diversion of water at Friant Dam through purchase and exchange agreements with entities holding those rights when the project was developed. With the exception of flood control operations, water released from Friant Dam to the San Joaquin River is limited to that necessary to satisfy riparian water rights and holding contracts along the San Joaquin River between Friant Dam and Gravelly Ford. The highest priority agreement involving the largest amount of water requires annual delivery of approximately 840 TAF of water to the Mendota Pool to water right holders along the San Joaquin River. This obligation is typically met with water exported from the Delta via the DMC in accordance with San Joaquin River Exchange Contracts. If Delta water were not available to meet these commitments, Reclamation would have to release water from Friant Dam to meet these commitments.

Other Central Valley Project Service Areas and Facilities

Owned and operated by Reclamation, the CVP is the State's largest water supply and delivery system. The CVP supplies water to more than 250 long-term water contractors in the Central Valley, Santa Clara Valley, and Bay Area. Project purposes include flood control; navigation; water supply; fish and wildlife protection, restoration, and enhancement; and power generation. CVP facilities include 20 dams and reservoirs with a combined storage capacity of more than 11 million acre-feet (MAF), 39 pumping plants, 2 pumping-generating plants, 11 powerplants, and more than 500 miles of major canals and aqueducts. The CVP has three primary storage facilities in Northern California: Shasta (and its afterbay, Keswick), Trinity, and Folsom reservoirs. These primary CVP reservoirs have a total storage capacity of approximately 8 MAF. Major CVP storage facilities located south of the Delta include New Melones Reservoir on the Stanislaus River; Millerton Reservoir on the San Joaquin River; and San Luis Reservoir/O'Neill Forebay, which is a pumped-storage reservoir on the west side of the San Joaquin Valley shared with the SWP. Storage facilities south of the Delta provide 4 MAF of storage capacity for the CVP. Primary CVP and SWP storage facilities are shown on Figure 3-1.

The DMC conveys water from the Jones Pumping Plant in the south Delta to agricultural lands in the San Joaquin Valley. Water not delivered directly from the DMC is diverted at the O'Neill Pumping Plant and O'Neill Forebay for delivery via the San Luis Canal to CVP contractors in the San Joaquin Valley, or to storage in San Luis Reservoir for later use. Most of the rest of the water continues to the south Central Valley, with some water diverted to Santa Clara County. CVP/SWP water service areas are shown on Figure 1-1.

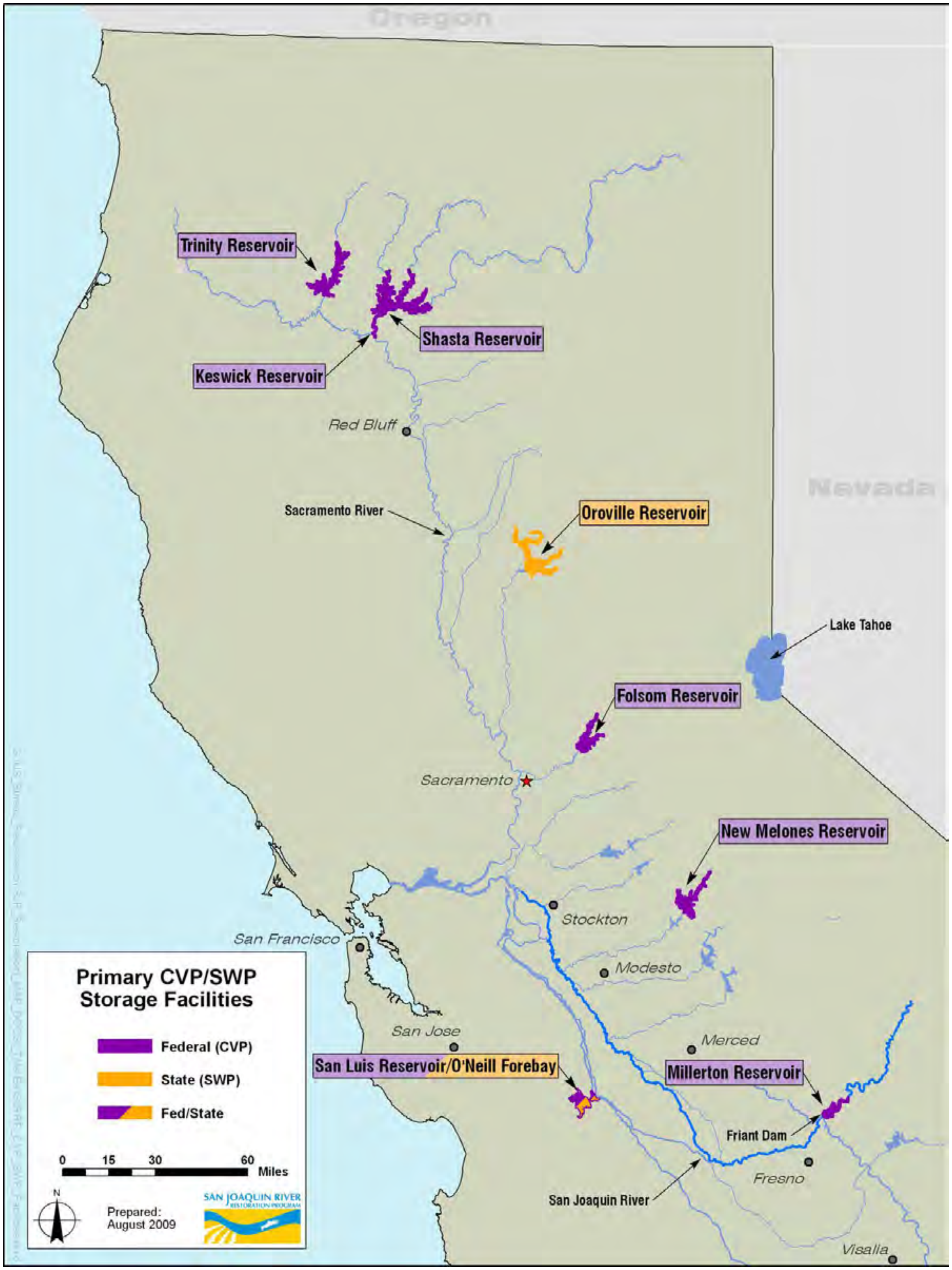


Figure 3-1.
Primary Central Valley Project and State Water Project Storage Facilities

State Water Project Service Areas and Facilities

The SWP is the largest State-built, multipurpose water project in the country. DWR operates and maintains the SWP, which conveys an annual average of 2.5 MAF of water through 17 pumping plants, 8 hydroelectric power plants, 32 storage facilities, and more than 660 miles of aqueducts and pipelines. The SWP stores and transfers water from the Feather River basin (Lake Oroville) and exports Delta flows to the San Joaquin Valley, Bay Area, coastal counties, and Southern California. A total of 29 contracting agencies receive water from the SWP.

In the south Delta, Banks Pumping Plant lifts water from the Clifton Court Forebay into Bethany Reservoir; from Bethany, water is delivered to the San Joaquin Valley and Southern California via the California Aqueduct or to south Bay Area users via the South Bay Aqueduct. The 444-mile-long California Aqueduct conveys water to agricultural lands of the San Joaquin Valley, and mainly urban regions of Southern California. Water is diverted from the aqueduct through the Gianelli Pumping-Generating Plant for storage in San Luis Reservoir until it is needed for later use. CVP/SWP water service areas are shown on Figure 1-1.

3.2 Chapter Contents and Definition of Terms

Chapters 4.0 through 25.0 include the environmental and regulatory setting for 21 resource topics, as well as discussions of methods, significance criteria, environmental impacts, and mitigation measures for direct and indirect impacts, organized by resource topic. Chapter 26.0 discusses cumulative effects, and Chapter 27.0 discusses other disclosures required by NEPA and CEQA. The NEPA/CEQA requirements are summarized in the following subsection, followed by an overview of the content of Chapters 4.0 through 25.0.

3.2.1 NEPA and CEQA Requirements

The NEPA/CEQA requirements for the environmental setting and consequences sections are similar, but not identical. These requirements are summarized below. This section also presents the organization and general assumptions used in the environmental analysis contained in this Draft PEIS/R. The reader is referred to the individual technical sections regarding specific assumptions, methodology, and significance criteria (thresholds of significance) used in the analyses.

Environmental Setting

CEQ Regulations specify that an EIS "shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of an impact, with less important material summarized, consolidated, or simply referenced" (40 CFR 1502.15).

Section 15125(a) of the CEQA Guidelines states that the environmental setting sections of an EIR "must include a description of the physical environment conditions in the vicinity of the project, as they exist at the time that the NOP is published, or if no NOP is published, at the time the environmental analysis commences from both a local and regional perspective. This environmental setting will normally constitute the baseline physical conditions by which the lead agency determines whether an impact is significant."

Environmental Consequences

The CEQ Regulations specify that a Federal agency preparing an EIS must consider the effects of the proposed action and alternatives on the environment; these include effects on ecological, aesthetic, historical, and cultural resources and economic, social, and health effects. Environmental effects are categorized as direct, indirect, and cumulative effects (defined below in Section 3.3.3). An EIS must also discuss possible conflicts with the objectives of Federal, State, regional, and local land use plans, policies, and controls for the area concerned; energy requirements and conservation potential; urban quality; the relationship between short-term uses of the environment and long-term productivity; and irreversible or irretrievable commitments of resources. An EIS must identify relevant, reasonable mitigation measures that are not already included in the proposed action or alternatives to the proposed action that could avoid, minimize, rectify, reduce, eliminate, or compensate for the project's adverse environmental effects (40 CFR 1502.14, 1502.16, 1508.8).

The State CEQA Guidelines explain that the environmental analysis for an EIR must evaluate impacts associated with the project and identify mitigation for any potentially significant impacts. All phases of a proposed project, including development and operation, are evaluated in the analysis. Section 15126.2 of the State CEQA Guidelines states:

> *An EIR shall identify and focus on the significant environmental effects of the proposed project. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published, or where no notice of preparation is published, at the time environmental analysis is commenced. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services. The EIR shall also analyze any significant environmental effects the project might cause by bringing development and people into the area affected.*

An EIR must also discuss inconsistencies between the proposed project and applicable general plans and regional plans (State CEQA Guidelines Section 15125(d)). An EIR must describe any feasible measures that could minimize significant adverse impacts, and the measures are to be fully enforceable through permit conditions, agreements, or other legally binding instruments (State CEQA Guidelines Section 15126.4(a)). Mitigation measures are not required for effects that are found to be less than significant. For Chapters 4.0 through 25.0, an "Impact Assessment Methodology" subsection is provided. This subsection describes the methods, processes, procedures, and/or assumptions used to formulate and conduct the impact analysis for each specific resource topic.

3.2.2 Significance Criteria

Significance criteria (or "thresholds of significance") are used to define the level at which an impact would be considered significant in accordance with CEQA. The thresholds applied in this joint NEPA/CEQA document encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and intensity of its effects, and also meet the more specific requirements of CEQA for significance thresholds.

Thresholds may be quantitative or qualitative; they may be based on agency or professional standards or on legislative or regulatory requirements that are relevant to the impact analysis. Generally, however, thresholds of significance are derived from Appendix G of the State CEQA Guidelines, as amended, and NEPA, where defined. Significance criteria used in this Draft PEIS/R are based on the checklist presented in Appendix G of the State CEQA Guidelines; factual or scientific information and data; and regulatory standards of Federal, State, regional, and local agencies. These thresholds also include the factors taken into account under NEPA to determine the significance of the action in terms of the context and the intensity of its effects.

An environmental document prepared to comply with CEQA must identify the significance of the environmental effects of a proposed project. Therefore, for each effect (impact), a conclusion is provided regarding its significance. A "„(s)ignificant effect on the environment' means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382).

3.2.3 Impact Comparisons and Definitions

Under CEQA, the environmental analysis compares the alternatives under consideration, including the No-Project Alternative (referred to in this Draft PEIS/R as the No-Action Alternative), to existing conditions, defined at the time when the NOP was published (August 22, 2007). Under NEPA, the effects of the alternatives under consideration, including the No-Action Alternative, are determined by comparing effects between alternatives and against effects from the No-Action Alternative. Consequently, baseline conditions differ between NEPA and CEQA. Under NEPA, the No-Action Alternative (i.e., expected future conditions without the project) is the baseline to which the action alternatives are compared, and the No-Action Alternative is compared to existing conditions. Under CEQA, existing conditions are the baseline to which all alternatives are compared.

Project impacts fall into the following categories:

- A **temporary impact** would occur only during construction. The environmental analysis addresses potentially significant impacts from the direct impact of construction at the project site, direct impact associated with site development, and indirect construction impacts associated with fill and wetland construction activities, construction traffic, etc.
- A **short-term impact** would last from the time construction ceases to within 3 years following construction.
- A **long-term impact** would last longer than 3 years following construction. In some cases, a long-term impact could be considered a permanent impact.
- A **direct impact** is an impact that would be caused by an action and would occur at the same time and place as the action.
- An **indirect impact** is an impact that would be caused by an action but would occur later in time, or at a distance that is removed from the project area (e.g., growth-inducing effects and other changes related to changes in land use patterns, and related effects on the physical environment), yet is reasonably foreseeable in the future.
- A **residual impact** is an impact that would remain after the application of mitigation.
- A **cumulative impact** is an impact taken together with other past, present, and probable future projects producing related impacts, or when two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. A cumulative impact occurs from the change in the environment which results from the incremental impact of a project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time. Cumulative impacts are discussed in Chapter 26.0, “Cumulative Impacts.”

Impacts (and associated mitigation measures as necessary) are listed numerically and sequentially throughout each section. A statement summarizing the impact precedes the discussion of each impact. The discussion that follows the summary statement includes the analysis on which a conclusion is based regarding the significance of the impact. If the discussion is succinct, it is included in its entirety in the summary statement, and is not provided separately.

As described in Chapter 2.0, “Description of Alternatives,” potential future changes due to climate change are reflected in the No-Action Alternative through a sea-level rise of 1 foot. Other potential changes, such as changes in precipitation and temperature, are explored in the Sensitivity of Future Central Valley Project and State Water Project

Operations to Potential Climate Change and associated Sea Level Rise Attachment to Appendix I, "Supplemental Hydrologic and Water Operations Analyses." Changes in long-term precipitation and temperature as a result of climate change could affect success of the implementation of the Settlement, and change the nature of impacts due to implementation of the alternatives. Chapter 7.0, "Climate Change," describes potential contributions to climate change that could result from implementing the alternatives.

3.2.4 Impact Levels

This Draft PEIS/R uses the following terminology based on CEQA to denote the significance of each environmental effect (impact), and includes consideration of the "context" of the action and the "intensity" (severity) of its effects in accordance with NEPA guidance (40 CFR 1508.27) (CEQ Regulations for implementing NEPA do not require significance determinations):

- **No impact** indicates that the construction, operation, and maintenance of the action alternatives would not have any direct or indirect impacts on the environment. It means that no change from existing conditions would result. This impact level does not require mitigation.

- A **beneficial impact** is one that would result in a beneficial change in the physical environment. This impact level does not require mitigation.

- **A less-than-significant impact** is one that would not result in a substantial or potentially substantial adverse change in the physical environment. This impact level does not require mitigation, even if applicable measures are available, under CEQA.

- A **significant impact** is defined by CEQA Section 21068 as one that would cause "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project." Levels of significance can vary by alternative, based on the setting and the nature of the change in the existing physical condition. Under CEQA, mitigation measures or alternatives to the proposed action must be provided, where applicable, to avoid or reduce the magnitude of significant impacts.

- A **potentially significant impact** is one that, if it were to occur, would be considered a significant impact as described above; however, the occurrence of the impact cannot be immediately determined with certainty. For CEQA purposes, a potentially significant impact is treated as if it were a significant impact. Therefore, under CEQA, mitigation measures or alternatives to the proposed action must be provided, where necessary and applicable, to avoid or reduce the magnitude of significant impacts.

- An impact may have a level of significance that is too uncertain to be reasonably determined, which would be designated **too speculative for meaningful consideration**, in accordance with State CEQA Guidelines Section 15145. Where some degree of evidence points to the reasonable potential for a significant effect, the PEIS/R may explain that a determination of significance is uncertain, but is still assumed to be "potentially significant," as described above. In other circumstances, after thorough investigation, the determination of significance may still be too speculative to be meaningful. This is an effect for which the degree of significance cannot be determined for specific reasons, such as because aspects of the impact itself are either unpredictable or the severity of consequences cannot be known at this time.

3.2.5 Mitigation Measures

Mitigation measures are presented, where feasible, to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts of the action alternatives, in accordance with the State CEQA Guidelines Section 15126.4 and NEPA regulations (40 CFR 1508.20). Mitigation measures are not required for impacts identified under the No-Action Alternative because approving agencies would not be required to obtain permits or agreements if the agencies chose not to approve the project. For these reasons, mitigation measures are not provided for the No-Action Alternative even if significant impacts may result. Furthermore, no mitigation measures are proposed when an impact conclusion is "**less than significant**," "**no impact**," or "**beneficial**."

Mitigation measures are identified for both project- and program-level actions, where appropriate. Mitigation measures are presented in their entirety for significant and potentially significant project-level impacts, in accordance with Section 15126.4 of the CEQA Guidelines, and are fully enforceable through permit conditions, agreements, or other legally binding instruments. For significant and potentially significant program-level actions, types of potential mitigation measures are identified. These two types of mitigation measures are described below.

Mitigation Measures for Project-Level Impacts

In accordance with Section 15126.4(a)(2 of the CEQA Guidelines, mitigation measures for project-level actions must be fully enforceable through permit conditions, agreements, or other legally binding instruments. Section 15370 of the CEQA Guidelines defines mitigation as follows:

- Avoiding the impact altogether by not taking a certain action or parts of an action
- Minimizing impacts by limiting the degree of magnitude of the action and its implementation
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action
- Compensating for the impacts by replacing or providing substitute resources or environments

In accordance with PRC Section 21081.6(a), if a State agency approves the proposed project actions, that agency would adopt a Mitigation Monitoring and Reporting Program (MMRP) at the time that it certifies the PEIR. The purpose of the MMRP is to ensure that the mitigation measures adopted as part of project approval would be complied with during project construction and implementation. The MMRP would identify each of the mitigation measures for project-level actions, and describe the party responsible for monitoring (Reclamation, DWR, or other, as appropriate), the time frame for implementation, and the program for monitoring compliance. Reclamation would be responsible for mitigation of impacts resulting from release of Interim and Restoration flows.

Mitigation Measures for Program-Level Impacts

The MMRP will also identify the program-level mitigation measures described in the following chapters. These mitigation measures provide broad, overview guidance on the nature and types of mitigation measures applicable to subsequent site-specific projects associated with actions described at a program level in this Draft PEIS/R. Findings of fact regarding significant effects of implementation would be addressed in the future project-level analyses and environmental documentation. During project-specific study of each program-level action, the program-level mitigation measures would be reevaluated for applicability based on project-specific information including findings of significance, and each measure would be refined to apply to the specific project or would be replaced with an equivalent measure. The final measures would then be incorporated into a project-specific MMRP. Actual implementation, monitoring, and reporting of the mitigation measures would be conducted under the purview of the project MMRP, and would be the responsibility of the project proponent for the site-specific project, as identified in the project-specific MMRP. The project proponent may include Reclamation, DWR, and other Federal, State, or local agencies. The project proponent may include lead agencies of future site-specific projects, and may or may not be members of the Implementing Agencies.

3.2.6 Significance After Mitigation

For each significant and potentially significant impact, following the presentation of proposed mitigation measures, the significance of the impact after mitigation is stated. Where sufficient feasible mitigation is not available to reduce impacts to a less-than-significant level, the impacts are identified as “significant and unavoidable.” Under CEQA, a project with significant and unavoidable impacts could proceed, but the CEQA lead agency would be required (i) to conclude in findings that there are no feasible means of substantially lessening or avoiding the significant impact in accordance with State CEQA Guidelines Section 15091(a)(3), and (ii) to prepare a statement of overriding considerations, in accordance with State CEQA Guidelines Section 15093, explaining why the CEQA lead agency would proceed with the project in spite of the potential for significant impacts. For the No-Action and action alternatives, significant and unavoidable impacts are also summarized in Chapter 27.0, “Other NEPA and CEQA Considerations.”

3.2.7 Relationship Between Short-Term Uses of the Environment and Maintenance and Enhancement of Long-Term Productivity

NEPA requires that an EIS include a discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. For the No-Action and action alternatives, this discussion is provided in Chapter 27.0, "Other NEPA and CEQA Considerations."

3.2.8 Irreversible and Irretrievable Commitments of Resources

NEPA requires that an EIS include a discussion of the irreversible and irretrievable commitments of resources that may be involved if the project is implemented. Similarly, the State CEQA Guidelines require a discussion of the significant irreversible environmental changes that would be involved if the project is implemented.

The irreversible and irretrievable commitment of resources is the permanent loss of resources for future or alternative purposes. Irreversible and irretrievable commitments of resources occur when resources cannot be recovered or recycled or when resources are consumed or reduced to unrecoverable forms. For the No-Action and action alternatives, irreversible and irretrievable commitments of resources are discussed in Section 27.3, "Irreversible and Irretrievable Commitments of Resources."

3.3 Resources Eliminated from Further Analysis

CEQA and the State CEQA Guidelines provide for the identification and elimination from detailed study the issues that are not significant or that have been covered by prior environmental review (PRC 21002.1, CEQA Guidelines Section 15143). The CEQ Regulations provide similar provisions (40 CFR 1501.7(a)(3)).

During initial scoping with the public and governmental agencies, and based on information obtained through literature review, agency correspondence, consultations, and field data collection, it was determined that no resource or issue areas could be eliminated from detailed study. Therefore, all resource areas covered by NEPA and CEQA are addressed in this Draft PEIS/R.

Chapter 4.0 Air Quality

This chapter describes the environmental and regulatory settings of air quality in the study area, as well as environmental consequences and mitigation, as they pertain to implementation of the program alternatives. The discussion of air quality existing conditions and the potential impacts of the program alternatives on air quality encompasses the San Joaquin River upstream from Friant Dam, the Restoration Area, the San Joaquin River from the Merced River to the Delta, the Delta, and within the Friant Division.

4.1 Environmental Setting

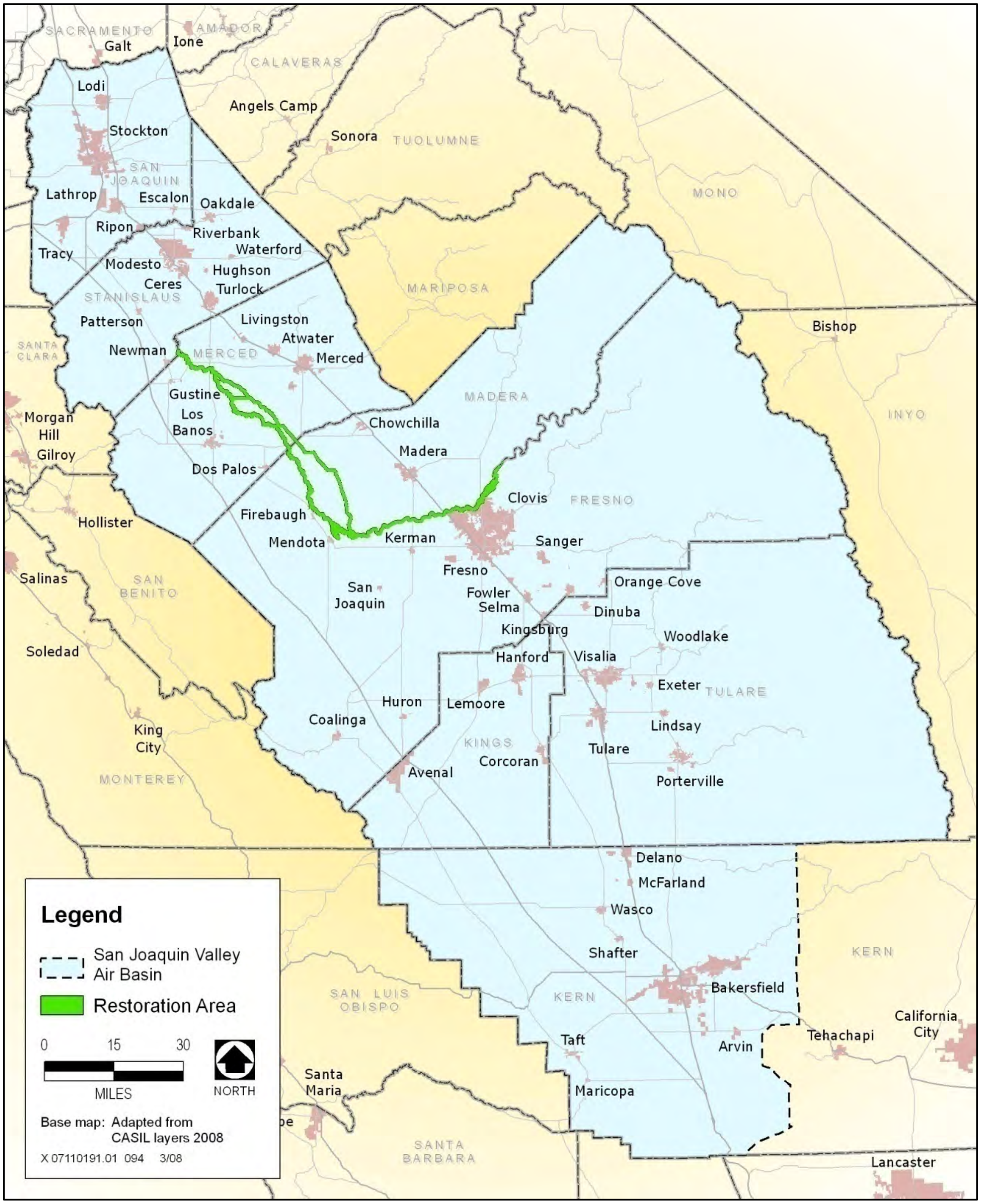
Ambient concentrations of air pollutants, contaminants, and odors are determined by the amount of emissions released by sources and the atmosphere's ability to transport and dilute such emissions. Natural factors that affect transport and dilution include terrain, wind, atmospheric stability, and sunlight. Therefore, existing air quality conditions in the area are determined by such natural factors as topography, meteorology, and climate, in addition to the amount of emissions released by existing sources.

4.1.1 Topography, Climate, and Meteorology

The Restoration Area is located in Fresno, Madera, and Merced counties, which are part of the San Joaquin Valley Air Basin (SJVAB), as shown in Figure 4-1. The SJVAB also comprises all of Kings, San Joaquin, Stanislaus, and Tulare counties and the valley portion of Kern County, including the Friant Division.

The SJVAB, which occupies the southern half of the Central Valley, is approximately 250 miles long and, on average, 35 miles wide. The SJVAB is a well-defined climatic region with distinct topographic features on three sides. The Coast Range, which has an average elevation of 3,000 feet, is located on the western border of the SJVAB. The San Emigdio Mountains, which are part of the Coast Range, and the Tehachapi Mountains, which are part of the Sierra Nevada, are both located on the south side of the SJVAB. The Sierra Nevada forms the eastern border of the SJVAB. The northernmost portion of the SJVAB is San Joaquin County. No topographic feature delineates the northern edge of the basin. The SJVAB can be considered a "bowl" open only to the north.

The SJVAB is basically flat with a downward gradient in terrain to the northwest. Air flows into the SJVAB through the Carquinez Strait, the only breach in the western mountain barrier, and moves across the Delta from the Bay Area. The mountains surrounding the SJVAB create a barrier to airflow, which leads to entrapment of air pollutants when meteorological conditions are unfavorable for transport and dilution. As a result, the SJVAB is highly susceptible to pollutant accumulation over time.



Source: Provided by MWH in 2008

Figure 4-1.
Restoration Area Within the San Joaquin Valley Air Basin

The inland Mediterranean climate type of the SJVAB is characterized by hot, dry summers and cool, rainy winters. The climate is a result of the topography and the strength and location of a semipermanent, subtropical high-pressure cell. During summer, the Pacific high-pressure cell is centered over the northeastern Pacific Ocean, resulting in stable meteorological conditions and a steady northwesterly wind flow. Cold ocean water upwells from below to the surface because of the northwesterly flow, producing a band of cold water off the California coast.

Daily summer high temperatures often exceed 100 degrees Fahrenheit (ºF), averaging in the low 90s in the north and high 90s in the south. In the entire SJVAB, daily summer high temperatures average 95ºF. Over the last 30 years, temperatures in the SJVAB averaged 90ºF or higher for 106 days a year, and 100ºF or higher for 40 days a year. The daily summer temperature variation can be as high as 30ºF (SJVAPCD 2002). In winter, the Pacific high-pressure cell weakens and shifts southward, resulting in wind flow offshore, the absence of upwelling, and storms. Average high temperatures in the winter are in the 50s, but lows in the 30s and 40s can occur on days with persistent fog and low cloudiness. The average daily low temperature in the winter is 45ºF (SJVAPCD 2002).

A majority of the precipitation in the SJVAB occurs as rainfall during winter storms. The rare occurrence of precipitation during the summer is in the form of convective rain showers. The amount of precipitation in the SJVAB decreases from north to south primarily because the Pacific storm track often passes through the northern portion of the SJVAB, while the southern portion remains protected by the Pacific high-pressure cell. Stockton in the north receives about 20 inches of precipitation per year, Fresno in the center receives about 10 inches per year, and Bakersfield at the southern end of the valley receives less than 6 inches per year. Average annual rainfall for the entire SJVAB is approximately 9.25 inches on the valley floor (SJVAPCD 2002).

The winds and unstable atmospheric conditions associated with the passage of winter storms result in periods of low air pollution and excellent visibility. Precipitation and fog tend to reduce or limit some pollutant concentrations. For instance, clouds and fog block sunlight, which is required to fuel photochemical reactions that form ozone. Because carbon monoxide (CO) is partially water-soluble, precipitation and fog also tend to reduce concentrations in the atmosphere. In addition, respirable particulate matter with an aerodynamic diameter of 10 micrometers or less (PM_{10}) can be washed from the atmosphere through wet deposition processes (e.g., rain). However, between winter storms, high pressure and light winds lead to the creation of low-level temperature inversions and stable atmospheric conditions resulting in the concentration of air pollutants (e.g., CO, PM_{10}).

Summer is considered the ozone season in the SJVAB. This season is characterized by poor air movement in the mornings and by longer daylight hours, which provide a plentiful amount of sunlight to fuel photochemical reactions between reactive organic gases (ROG) and oxides of nitrogen (NO_X), resulting in ozone formation. During the summer, wind speed and direction data indicate that summer wind usually originates at the north end of the San Joaquin Valley and flows in a south-southeasterly direction through Tehachapi Pass and into the Southeast Desert Air Basin (SJVAPCD 2002).

4.1.2 Criteria Air Pollutants

Concentrations of the air pollutants ozone, CO, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), PM_{10}, fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less ($PM_{2.5}$), and lead are used as indicators of ambient air quality conditions. Because these are the most prevalent air pollutants known to be deleterious to human health, and because extensive documentation is available on health-effects criteria for these pollutants, they are commonly referred to as "criteria air pollutants." Data on regional or local concentrations are not available for CO, NO_2, and SO_2 to describe a discernable long-term trend for these criteria pollutants. Long-term trends are provided for the criteria air pollutants where data are available.

Ozone

Ozone is a photochemical oxidant, a substance whose oxygen combines chemically with another substance in the presence of sunlight, and is the primary component of smog. Ozone is not directly emitted into the air, but is formed through complex chemical reactions between precursor emissions of ROGs and NO_X in the presence of sunlight. ROGs are volatile organic compounds that are photochemically reactive. ROG emissions result primarily from incomplete combustion and the evaporation of chemical solvents and fuels. NO_X are a group of gaseous compounds of nitrogen and oxygen that results from the combustion of fuels. A highly reactive molecule, ozone readily combines with many different components of the atmosphere. Consequently, high levels of ozone tend to exist only while high ROG and NO_X levels are present to sustain the ozone formation process. Once the precursors have been depleted, ozone levels rapidly decline. Because these reactions occur on a regional scale, ozone is a regional pollutant.

Ozone located in the upper atmosphere (stratosphere) acts in a beneficial manner by shielding the earth from harmful ultraviolet radiation that is emitted by the sun. However, Ozone located in the lower atmosphere (troposphere) is a major health and environmental concern. Meteorology and terrain play a major role in ozone formation. Generally, low wind speeds or stagnant air coupled with warm temperatures and clear skies provide the optimum conditions for formation. As a result, summer is generally the peak ozone season. Because of the reaction time involved, peak ozone concentrations often occur far downwind from the precursor emissions. In general, ozone concentrations over or near urban and rural areas reflect an interplay of emissions of ozone precursors, transport, meteorology, and atmospheric chemistry (Godish 2004).

The adverse health effects associated with exposure to ozone pertain primarily to the respiratory system. Scientific evidence indicates that ambient levels of ozone affect not only sensitive receptors, such as asthmatics and children, but healthy adults as well. Exposure to ambient levels of ozone ranging from 0.10 to 0.40 part per million (ppm) for 1 to 2 hours has been found to significantly alter lung functions by increasing respiratory rates and pulmonary resistance, decreasing tidal volumes (the amount of air inhaled and exhaled), and impairing respiratory mechanics. Ambient levels of ozone above 0.12 ppm are linked to symptomatic responses that include such symptoms as throat dryness, chest tightness, headache, and nausea. In addition to the above adverse health effects, evidence also exists relating ozone exposure to an increase in permeability of respiratory epithelia (tissues lining the respiratory tract); such increased permeability leads to an increased response of the respiratory system to challenges, and a decrease in the immune system's ability to defend against infection (Godish 2004).

From 1990 to 2006, the maximum peak 8-hour indicator decreased by 6 percent. However, ozone precursor emissions of ROGs and NO_X have decreased over the past several years because of more stringent motor vehicle standards and cleaner burning fuels. The ozone problem in the SJVAB ranks among the most severe in the State. The number of State and national 8-hour exceedence days has declined by 16 percent and 23 percent, respectively. Most of this progress has occurred since 2003. However, the number of exceedence days in 2005 and 2006 were among the lowest in this 17-year period (ARB 2007). Data from 2005 showing the trend in 3-year averages of 8-hour ozone data indicate that most of the Restoration Area now attains the national 8-hour ozone standard (ARB 2007).

Carbon Monoxide

CO is a colorless, odorless, and poisonous gas produced by incomplete burning of carbon in fuels, primarily from mobile (transportation) sources. About 77 percent of nationwide CO emissions are from mobile sources. The other 23 percent consists of CO emissions from wood-burning stoves, incinerators, and industrial sources. CO enters the bloodstream through the lungs by combining with hemoglobin, which normally supplies oxygen to the cells. However, CO combines with hemoglobin much more readily than oxygen does, resulting in a drastic reduction in the amount of oxygen available to the cells. Adverse health effects associated with exposure to CO concentrations include such symptoms as dizziness, headaches, and fatigue. CO exposure is especially harmful to individuals who suffer from cardiovascular and respiratory diseases (EPA 2008a).

The highest concentrations of CO are generally associated with cold, stagnant weather conditions that occur during the winter. In contrast to problems caused by ozone, which tends to be a regional pollutant, CO problems tend to be localized. Long-term trends are not available for CO levels as the SJVAB has reached attainment status and extensive data collection no longer occurs.

Nitrogen Dioxide

NO_2 is a brownish, highly reactive gas that is present in all urban environments. The major human-made sources of NO_2 are combustion devices, such as boilers, gas turbines, and mobile and stationary internal combustion engines. Combustion devices emit primarily nitric oxide (NO), which reacts through oxidation in the atmosphere to form NO_2 (EPA 2008a). The combined emissions of NO and NO_2 are referred to as NO_X and reported as equivalent NO_2. Because NO_2 is formed and depleted by reactions associated with ozone, the NO_2 concentration in a particular geographical area may not be representative of the local NO_X emission sources.

Because NO_2 has relatively low solubility in water, the principal site of toxicity is in the lower respiratory tract. The severity of adverse health effects depends primarily on the concentration inhaled rather than the duration of exposure. An individual may experience a variety of acute symptoms, including coughing, difficulty with breathing, vomiting, headache, and eye irritation during or shortly after exposure. After a period of approximately 4 to 12 hours, an exposed individual may experience chemical pneumonitis or pulmonary edema with breathing abnormalities, cough, cyanosis, chest pain, and rapid heartbeat. Severe, symptomatic NO_2 intoxication after acute exposure has been linked on occasion with prolonged respiratory impairment, with such symptoms as chronic bronchitis and decreased lung functions (EPA 2008a). Long-term trends are not available for NO_2 levels as the SJVAB has reached attainment status and extensive data collection no longer occurs.

Sulfur Dioxide

SO_2 is produced by such stationary sources as coal and oil combustion, steel mills, refineries, and pulp and paper mills. The major adverse health effects associated with SO_2 exposure pertain to the upper respiratory tract. SO_2 is a respiratory irritant, with constriction of the bronchioles occurring from inhalation of SO_2 at 5 ppm or more. On contact with the moist, mucous membranes, SO_2 produces sulfuric acid (H_2SO_3), which is a direct irritant. Concentration rather than duration of the exposure is an important determinant of respiratory effects. Exposure to high SO_2 concentrations may result in edema of the lungs or glottis and respiratory paralysis. Long-term trends are not available for SO_2 levels as the SJVAB has reached attainment status and extensive data collection no longer occurs.

Particulate Matter

Respirable particulate matter with an aerodynamic diameter of 10 micrometers or less is referred to as PM_{10}. PM_{10} consists of particulate matter emitted directly into the air, such as fugitive dust, soot, and smoke from mobile and stationary sources, construction operations, fires and natural windblown dust, and particulate matter formed in the atmosphere by condensation and/or transformation of SO_2 and ROGs (EPA 2008a). Fine particulate matter ($PM_{2.5}$) is a subgroup of PM_{10}, consisting of smaller particles that have an aerodynamic diameter of 2.5 micrometers or less (ARB 2007).

Adverse health effects associated with PM_{10} depend on the specific composition of the particulate matter. For example, health effects may be associated with metals, polycyclic aromatic hydrocarbons, and other toxic substances adsorbed onto fine particulate matter (referred to as the “piggybacking effect”), or with fine dust particles of silica or asbestos. Generally, adverse health effects associated with PM_{10} may result from both short-term and long-term exposure to elevated concentrations and may include breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular diseases, alterations to the immune system, carcinogenesis, and premature death (EPA 2008a). $PM_{2.5}$ poses an increased health risk because the particles can deposit deep in the lungs and may contain substances that are particularly harmful to human health.

Direct emissions of PM_{10} remained relatively unchanged in the SJVAB between 1975 and 2005 and are projected to remain unchanged through 2020. PM_{10} emissions in the SJVAB are dominated by emissions from area-wide sources, primarily fugitive dust from vehicle travel on unpaved and paved roads, waste burning, and residential fuel combustion. $PM_{2.5}$ emissions in the SJVAB are dominated by emissions from the same area-wide sources as PM_{10} (ARB 2007). National annual average $PM_{2.5}$ concentrations show a definite downward trend from 1999 through 2005. The State annual average concentrations remained relatively constant from 1999 through 2005, with a slight drop in 2004. The differences in trends are mainly due to differences in State and national monitoring methods.

Lead

Lead is a metal found naturally in the environment as well as in manufactured products. Major sources of lead emissions have historically been mobile and industrial sources. As a result of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.

Twenty years ago, mobile sources were the main contributor to ambient lead concentrations in the air. In the early 1970s, the U.S. Environmental Protection Agency (EPA) set national regulations to gradually reduce the lead content in gasoline. In 1975, unleaded gasoline was introduced for motor vehicles equipped with catalytic converters. EPA banned the use of leaded gasoline in highway vehicles in December 1995 (EPA 2008a).

As a result of EPA's regulatory efforts to remove lead from gasoline, emissions of lead from the transportation sector have declined dramatically (95 percent between 1980 and 1999), and levels of lead in the air decreased by 94 percent between 1980 and 1999. Transportation sources, primarily airplanes, now contribute only 13 percent of lead emissions. A National Health and Nutrition Examination Survey reported a 78 percent decrease in the levels of lead in people's blood between 1976 and 1991. This dramatic decline can be attributed to the move from leaded to unleaded gasoline (EPA 2008a).

The decrease in lead emissions and ambient lead concentrations over the past 25 years is California's most dramatic success story with regard to air quality management. The rapid decrease in lead concentrations can be attributed primarily to phasing out the lead in gasoline. This phase-out began during the 1970s, and subsequent California Air Resources Board (ARB) regulations have virtually eliminated all lead from gasoline now sold in California.

All areas of the State are currently designated as attainment for the State lead standard California Environmental Protection Agency (Cal/EPA) does not designate areas for the national lead standard). Although ambient lead standards are no longer violated, lead emissions from stationary sources still pose "hot spot" problems in some areas. As a result, ARB identified lead as a toxic air contaminant (TAC).

Monitoring Station Data and Attainment Area Designations

Criteria air pollutant concentrations are measured at several monitoring stations in the SJVAB. Three stations are near the Restoration Area. The closest is the North Villa Avenue station in the town of Clovis, approximately 5 miles south of the Restoration Area in Fresno County. The North Villa Avenue station measures ozone, CO, PM_{10}, $PM_{2.5}$, and NO_2. The next closest is the Pump Yard station, approximately 30 miles southeast of the Restoration Area in Madera County, which measures ozone and NO_X. The third closest is on the South Coffee Avenue station, approximately 15 miles northeast in Merced County, which measures ozone and NO_X. All these monitoring stations are at elevations similar to the Restoration Area. Table 4-1 summarizes air quality data from these stations for the most recent 3 years where data are available for pollutants of note, 2004 through 2006. For local concentrations, the data are not necessarily representative of the Restoration Area because of the distance from the monitor to the site, but the data give an approximate emissions level that would be similar to that around the Restoration Area.

Both ARB and EPA use this type of monitoring data in relation to applicable standards to designate area attainment status for criteria air pollutants. The purpose of these designations is to identify areas with air quality problems and thereby initiate planning efforts for improvement. The three basic designation categories are nonattainment, attainment, and unclassified.

A pollutant is designated “nonattainment” if there was at least one violation of a State standard for that pollutant in the area, and a pollutant is designated “attainment” if the State standard for that pollutant was not violated at any site in the area during a 3-year period. The category of “unclassified” is used in an area that cannot be classified on the basis of available information as meeting or not meeting standards. In addition, the California designations include a subcategory of the nonattainment designation, called nonattainment-transitional. The nonattainment-transitional designation is given to nonattainment areas that are progressing and nearing attainment. The most current attainment designations for the Restoration Area portion of the SJVAB are shown in Table 4-3 for each criteria air pollutant. The SJVAB is designated as being in nonattainment for the State 1-hour ozone standard and the national 8-hour ozone standard, as shown in Tables 4-1 and 4-2. In addition, the SJVAB is designated as being in nonattainment for the State 24-hour and annual PM_{10} standards, and the State annual $PM_{2.5}$ standard. The basin is also in nonattainment for the national 24-hour and annual PM_{10} standards and the 24-hour and annual $PM_{2.5}$ standards.

On July 6, 2006, EPA proposed redesignation for the SJVAB as a PM_{10} attainment area, based on the attainment of the national standard in the 2003 through 2005 period. EPA finalized approval of the attainment designation on October 17, 2006 (SJVAPCD 2008a). On September 25, 2008, EPA redesignated the San Joaquin Valley to attainment for the PM_{10} National Ambient Air Quality Standards (NAAQS) and approved the San Joaquin Valley Air Pollution Control District (SJVAPCD) PM_{10} Maintenance Plan.

Emission Sources

With respect to the emissions of criteria air pollutants within Fresno, Madera, and Merced counties, mobile sources are the largest contributor to the estimated annual average levels of CO and NO_X, accounting for approximately 70 percent, and 79 percent, respectively, of total emissions. Area-wide sources account for approximately 44 percent, 88 percent, and 73 percent of the total county ROG, PM_{10}, and $PM_{2.5}$ emissions, respectively (ARB 2008a).

Table 4-1.
Summary of Annual Ambient Air Quality Data (2004–2006) for Restoration Area

Item	2004			2005			2006		
	Fresno[1]	Madera[2]	Merced[3]	Fresno[1]	Madera[2]	Merced[3]	Fresno[1]	Madera[2]	Merced[3]
Ozone									
Maximum concentration (1-hr/8-hr, ppm)	0.126/ 0.103	0.097/ 0.084	0.114/ 0.109	0.127/ 0.096	0.095/ 0.081	0.100/ 0.093	0.127/ 0.096	0.113/ 0.095	0.102/ 0.091
Number of days State standard exceeded (1-hr)	18	3	14	32	1	6	37	4	4
Number of days national standard exceeded (1-hr/8-hr)	1/4	0/0	0/15	2/15	0/0	0/3	2/20	0/1	0/4
Nitrogen Dioxide (NO_2)									
Maximum concentration (1-hr, ppm)	0.069	0.053	0.059	0.079	0.057	0.062	0.069	0.051	0.062
Number of days State standard exceeded (1-hr)	0	0	0	0	0	0	0	0	0
Annual average (ppm)	0.014	0.010	0.011	0.014	0.010	0.011	0.014	0.011	0.010
Fine Particulate Matter ($PM_{2.5}$)									
Maximum concentration (μg/m^3) National/California[4]	62.5	–	–	77.0	–	–	65.8	–	–
Number of days national standard exceeded (measured[5])	0	–	–	2	–	–	1	–	–
State annual average (μg/m^3)	16.4	–	–	-	–	–	16.4	–	–
Respirable Particulate Matter (PM_{10})									
Maximum concentration (μg/m^3) National/California[4]	63.0/61.0	–	–	87.0/90.0	–	–	104.0/106.0	–	–
Number of days national standard exceeded (measured/calculated[5])	0/0	–	–	0/0	–	–	0/0	–	–
Number of days State standard exceeded (measured/calculated[5])	5/-	–	–	11/67.2	–	–	12/73.0	–	–

Table 4-1.
Summary of Annual Ambient Air Quality Data (2004–2006) for Restoration Area (contd.)

Item	2004			2005			2006		
	Fresno[1]	Madera[2]	Merced[3]	Fresno[1]	Madera[2]	Merced[3]	Fresno[1]	Madera[2]	Merced[3]
Carbon Monoxide (CO)									
Maximum concentration (1-hr/8-hr ppm) National/California[4]	3.9/1.70 (1.68)	–	–	3.1/2.30	–	–	3.6/2.23	–	–
Number of days State standard exceeded (8-hr)	0	–	–	0	–	–	0	–	–
Number of days national standard exceeded (1-hr/8-hr)	0/0	–	–	0/0	–	–	0/0	–	–

Sources: ARB 2008b, EPA 2008b

Notes:
[1] Measurements from the North Villa Avenue station in the town of Clovis (Fresno County).
[2] Measurements from the Pump Yard station (Madera County).
[3] Measurements from the South Coffee Avenue station (Merced County).
[4] State and national statistics may differ for the following reasons: State statistics are based on California-approved samplers, whereas national statistics are based on samplers using Federal reference or equivalent methods. State and national statistics may therefore be based on different samplers. State statistics are based on local conditions. National statistics are based on standard conditions. State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.
[5] Measured days are days that an actual measurement was greater than the level of the State daily standard or the national daily standard. Measurements are typically collected every 6 days. Calculated days are the estimated number of days that a measurement would have been greater than the level of the standard had measurements been collected every day. The number of days above the standard is not necessarily the number of violations of the standard for the year.

Key:
– = data not available
$\mu g/m^3$ = microgram per cubic meter
hr = hour
ppm = parts per million
State = State of California

Table 4-2.
Summary of Restoration Area Attainment Status Designations and Ambient Air Quality Standards

Pollutant	Averaging Time	California		National Standards [1]		
		Standards [2,3]	Attainment Status [4]	Primary [3,5]	Secondary [3,6]	Attainment Status [7]
Ozone	1-hour	0.09 ppm (180 $\mu g/m^3$)	Nonattainment (Severe)	–	–	–
	8-hour	0.07 ppm (137 $\mu g/m^3$)	–	0.08 ppm (157 $\mu g/m^3$)	Same as Primary Standard	Nonattainment (Serious) [8]
Carbon Monoxide (CO)	1-hour	20 ppm (23 mg/m^3)	Attainment (Fresno) Unclassified (Madera, Modesto)	35 ppm (40 mg/m^3)	–	Unclassifiable/Attainment
	8-hour	9 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)		
Nitrogen Dioxide (NO_2)[9]	Annual Arithmetic Mean	0.030 ppm (56 $\mu g/m^3$)	–	0.053 ppm (100 $\mu g/m^3$)	Same as Primary Standard	Unclassifiable/Attainment
	1-hour	0.18 ppm (338 $\mu g/m^3$)	Attainment	–		–
Sulfur Dioxide (SO_2)	Annual Arithmetic Mean	–	–	0.030 ppm (80 $\mu g/m^3$)	–	Unclassifiable/ Attainment
	24-hour	0.04 ppm (105 $\mu g/m^3$)	Attainment	0.14 ppm (365 $\mu g/m^3$)	–	
	3-hour	–	–	–	0.5 ppm (1,300 $\mu g/m^3$)	
	1-hour	0.25 ppm (655 $\mu g/m^3$)	Attainment	–	–	–
Respirable Particulate Matter (PM_{10})	Annual Arithmetic Mean	20 $\mu g/m^3$	Nonattainment	–	Same as Primary Standard	Attainment
	24-hour	50 $\mu g/m^3$		150 $\mu g/m^3$		
Fine Particulate Matter ($PM_{2.5}$)	Annual Arithmetic Mean	12 $\mu g/m^3$	Nonattainment	15 $\mu g/m^3$	Same as Primary Standard	Nonattainment[10]
	24-hour	–	–	35 $\mu g/m^3$		
Lead[11]	30-day Average	1.5 $\mu g/m^3$	Attainment	–	–	–
	Calendar Quarter	–	–	1.5 $\mu g/m^3$	Same as Primary Standard	Unclassifiable/Attainment
Sulfates	24-hour	25 $\mu g/m^3$	Attainment	No National Standards		
Hydrogen Sulfide	1-hour	0.03 ppm (42 $\mu g/m^3$)	Unclassified			
Vinyl Chloride[11]	24-hour	0.01 ppm (26 $\mu g/m^3$)	Unclassified/Attainment			
Visibility-Reducing Particle Matter	8-hour	Extinction coefficient of 0.23 per kilometer[12]	Unclassified	–		

Table 4-2.
Summary of Restoration Area Attainment Status Designations and Ambient Air Quality Standards (contd.)

Sources: SJVAPCD 2008b; ARB 2008c, 2008d; EPA 2008c

Notes:

[1] National standards (other than ozone, PM, and those based on annual averages or annual arithmetic means) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. The PM_{10} 24-hour standard is attained when 99 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. The $PM_{2.5}$ 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact the U.S. Environmental Protection Agency (EPA) for further clarification and current Federal policies.

[2] California standards for ozone, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM, and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. California Ambient Air Quality Standards are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

[3] Concentration expressed first in units in which it was promulgated (ppm or $\mu g/m^3$). Equivalent units given in parentheses are based on a reference temperature of 25 degrees Celsius (°C) and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[4] Unclassified: The data are incomplete and do not support a designation of attainment or nonattainment.
Attainment: The State standard for that pollutant was not violated at any site in the area during a 3-year period.
Nonattainment: There was a least one violation of a State standard for that pollutant in the area.

[5] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[6] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[7] Nonattainment: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.
Attainment: Any area that meets the national primary or secondary ambient air quality standard for the pollutant.
Unclassifiable: Any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

[8] On April 30, 2007, the Governing Board of the San Joaquin Valley Air Pollution Control District (SJVAPCD) voted to request EPA to reclassify the San Joaquin Valley Air Basin (SJVAB) as extreme nonattainment for the Federal 8-hour ozone standards. The California Air Resources Board, on June 14, 2007, approved this request. This request must be forwarded to EPA by the California Air Resources Board (ARB) and would become effective upon EPA final rulemaking after a notice and comment process; it is not yet in effect.

[9] On February 19, 2008, the Office of Administrative Law approved a new NO_2 ambient air quality standard, which lowers the 1-hr standard to 0.19 ppm and establishes a new annual standard of 0.030 ppm. These changes will become effective March 20, 2008.

[10] The SJVAB is designated nonattainment for the 1997 national $PM_{2.5}$ standards. EPA designations for the 2006 $PM_{2.5}$ standards will be finalized in December 2009. SJVAPCD has determined, as of the 2004–2006 $PM_{2.5}$ data, that the SJVAB has attained the 1997 24-hour $PM_{2.5}$ standard.

[11] ARB has identified lead and vinyl chloride as toxic air contaminants with no threshold of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

[12] Visibility of 10 miles or more (0.07–30 miles or more for Lake Tahoe) because of particles when the relative humidity is less than 70 percent

Key:
– = not applicable
$\mu g/m^3$ = microgram per cubic meter
mg/m^3 = milligram per cubic meter
ppm = parts per million

4.1.3 Toxic Air Contaminants

Concentrations of TACs, or in Federal terms, hazardous air pollutants (HAP), are also used as indicators of ambient air quality conditions. A TAC is defined as an air pollutant that may cause or contribute to an increase in mortality or serious illness, or that may pose a hazard to human health. TACs are usually present in minute quantities in the ambient air; however, their high toxicity or health risk may pose a threat to public health even at low concentrations.

According to the *California Almanac of Emissions and Air Quality* (ARB 2007), the majority of the estimated health risk from TACs can be attributed to relatively few compounds, the most important being PM from diesel-fueled engines (diesel PM). Diesel PM differs from other TACs in that it is not a single substance, but rather a complex mixture of hundreds of substances. Although diesel PM is emitted by diesel-fueled internal combustion engines, the composition of the emissions varies depending on engine type, operating conditions, fuel composition, lubricating oil, and whether an emission control system is present.

Unlike the other TACs, no ambient monitoring data are available for diesel PM because no routine measurement method currently exists. However, ARB has made preliminary concentration estimates based on a PM exposure method. This method uses the ARB emissions inventory's PM_{10} database, ambient PM_{10} monitoring data, and results from several studies to estimate concentrations of diesel PM. In addition to diesel PM, TACs for which data are available that pose the greatest existing ambient risk in California are benzene, 1,3-butadiene, acetaldehyde, carbon tetrachloride, hexavalent chromium, *para*-dichlorobenzene, formaldehyde, methylene chloride, and perchloroethylene.

Diesel PM poses the greatest health risk among these 10 TACs. Based on receptor modeling techniques, ARB estimated the diesel PM health risk in the SJVAB in 2000 to be 390 excess cancer cases per million people. Since 1990, the health risk of diesel PM in the SJVAB has been reduced by 50 percent. Overall, levels of most TACs have gone down since 1990 except for para-dichlorobenzene and formaldehyde (ARB 2007).

According to the ARB Community Health Air Pollution Information System, five major existing stationary sources of TACs are present within 3 miles of the Restoration Area (ARB 2008c). Vehicles on SRs 140, 165, 99, 41, and 152 are sources of diesel PM and other mobile source air toxics.

4.1.4 Odors

Odors are generally regarded as an annoyance rather than a health hazard. However, manifestations of a person's reaction to foul odors can range from psychological (e.g., irritation, anger, anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, headache).

The ability to detect odors varies considerably among the population and overall is quite subjective. Some individuals have the ability to smell very minute quantities of specific substances; others may not have the same sensitivity but may have sensitivities to odors of other substances. In addition, people may have different reactions to the same odor; an odor that is offensive to one person may be perfectly acceptable to another. It is important to also note that an unfamiliar odor is more easily detected and is more likely to cause complaints than a familiar one. This is because of the phenomenon known as odor fatigue, in which a person can become desensitized to almost any odor and recognition only occurs with an alteration in the intensity.

Quality and intensity are two properties present in any odor. The quality of an odor indicates the nature of the smell experience. For instance, if a person describes an odor as flowery or sweet, the person is describing the quality of the odor. Intensity refers to the strength of the odor. For example, a person may use the word strong to describe the intensity of an odor. Odor intensity depends on the odorant concentration in the air. When an odorous sample is progressively diluted, the odorant concentration decreases. As this occurs, the odor intensity weakens and eventually becomes so low that the detection or recognition of the odor is quite difficult. At some point during dilution, the concentration of the odorant reaches a detection threshold. An odorant concentration below the detection threshold means that the concentration in the air is not detectable by the average human.

Potential existing sources of odor include various agricultural activities in the vicinity of the Restoration Area, along the San Joaquin River from the Merced River to the Delta, in the Delta, and in the Friant Division (e.g., dairy operations, livestock operations, fertilizer use).

4.1.5 Existing Sensitive Receptors

Sensitive receptors are considered those with increased exposure to or risk from air pollutants. Sensitive receptors in and around the Restoration Area, along the San Joaquin River from the Merced River to the Delta, in the Delta, and in the Friant Division include residences, churches, schools, hospitals, parks, and golf courses.

4.2 Regulatory Setting

Air quality within the Restoration Area is regulated by EPA, ARB, the SJVAPCD; Fresno, Madera, and Merced counties; and the cities of Fresno and Firebaugh. Each of these agencies develops rules, regulations, policies, and/or goals to comply with applicable legislation. Although EPA regulations may not be superseded, both State and local regulations may be more stringent.

4.2.1 Federal

Federal laws and regulations pertaining to air quality are discussed below.

Criteria Air Pollutants

At the Federal level, EPA has been charged with implementing national air quality programs. EPA’s air quality mandates are drawn primarily from the Federal Clean Air Act (CAA), which was enacted in 1970. The most recent major amendments made by Congress were in 1990. The CAA required EPA to establish NAAQS. EPA has established primary and secondary NAAQSs for the following criteria air pollutants: ozone, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and lead.

Toxic Air Contaminants

EPA has programs for identifying and regulating TACs (HAPs). Title III of the Clean Air Act Amendments of 1990 (CAAA) directed EPA to promulgate National Emissions Standards for Hazardous Air Pollutants (NESHAP). The CAAA also required EPA to promulgate vehicle or fuel standards containing reasonable requirements that control toxic emissions. Performance criteria were established to limit mobile-source emissions of toxics, including benzene, formaldehyde, and 1,3-butadiene. In addition, Section 219 of the CAAA required the use of reformulated gasoline in selected areas with the most severe ozone nonattainment conditions to further reduce mobile-source emissions.

Odors

There are no Federal laws, regulations, or policies pertaining to odors.

Greenhouse Gases

With respect to greenhouse gases (GHGs), the U.S. Supreme Court ruled on April 2, 2007, that carbon dioxide (CO_2) is an air pollutant as defined under the CAA, and that EPA has the authority to regulate emissions of GHGs. However, there are no Federal laws, regulations, or policies regarding GHG emissions applicable to the proposed project at this time.

4.2.2 State of California

State laws and regulations pertaining to air quality are discussed below.

Criteria Air Pollutants

ARB is the agency responsible for coordination and oversight of State and local air pollution control programs in California and for implementing the California Clean Air Act (CCAA). The CCAA, which was adopted in 1988, required ARB to establish California Ambient Air Quality Standards (CAAQS). ARB has established CAAQSs for sulfates, hydrogen sulfide, vinyl chloride, visibility-reducing particulate matter, and the above-mentioned criteria air pollutants. In most cases, the CAAQSs are more stringent than the NAAQSs. Differences in the standards are generally explained by the health effects studies considered during the standard-setting process, and the interpretation of the studies. In addition, the CAAQSs incorporate a margin of safety to protect sensitive individuals.

The CCAA requires that all local air districts in the State endeavor to achieve and maintain CAAQSs by the earliest practical date. The act specifies that local air districts should focus particular attention on reducing the emissions from transportation and area-wide emission sources, and provides districts with the authority to regulate indirect sources.

ARB and local air pollution control districts are currently developing plans for meeting new national air quality standards for ozone and $PM_{2.5}$. The Draft Statewide Air Quality Plan was released in April 2007 (ARB 2008d).

Toxic Air Contaminants

TACs in California are primarily regulated through the Tanner Air Toxics Act (Assembly Bill (AB) 1807) and the Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588). AB 1807 sets forth a formal procedure for ARB to designate substances as TACs. Research, public participation, and scientific peer review must occur before ARB can designate a substance as a TAC. To date, ARB has identified more than 21 TACs and adopted EPA's list of HAPs as TACs. Most recently, diesel PM was added to the ARB list of TACs. ARB published the *Air Quality and Land Use Handbook: A Community Health Perspective*, which provides guidance concerning land use compatibility with TAC sources (ARB 2005). While not a law or adopted policy, the handbook offers advisory recommendations for siting sensitive receptors near uses associated with TACs, such as freeways and high-traffic roads, commercial distribution centers, rail yards, ports, refineries, dry cleaners, gasoline stations, and industrial facilities.

Odors

There are no State laws, regulations, or policies pertaining to odors.

Greenhouse Gases

See Chapter 7.0, "Climate Change," for a discussion of State laws and regulations pertaining to climate change and GHG emissions.

4.2.3 Regional and Local

Regional and local plans and policies pertaining to air quality are discussed below.

Criteria Air Pollutants

Regional and local goals and policies for criteria air pollutants include:

- **San Joaquin Valley Air Pollution Control District Agency Goal –** SJVAPCD seeks to improve air quality conditions in the SJVAB through a comprehensive program of planning, regulation, enforcement, technical innovation, and promotion of the understanding of air quality issues.

- **Guide for Assessing and Mitigating Air Quality Impacts –** In January 2002, SJVAPCD released a revision to the previously adopted guidelines document. This revised *Guide for Assessing and Mitigating Air Quality Impacts* (SJVAPCD 2002) is an advisory document that provides lead agencies, consultants, and project applicants with uniform procedures for addressing air quality in environmental documents.

- **Fresno County General Plan –** Section G: Air Quality of the Open Space, and Conservation Element of the County of Fresno General Plan states that the county will support and implement SJVAPCD programs in maintaining air quality within the county, and that the county will consider all air quality implications for new discretionary land use development and transportation infrastructure improvements (Policies OS-G.1 through OS-G.16) (Fresno County 2000b).

- **Madera County General Plan –** Section J, K, and L: Air Quality of Section 5: Agricultural and Natural Resources of the County of Madera General Plan states that the County will support and implement SJVAPCD programs in maintaining air quality within the county and that the county will shall integrate air quality planning into the transportation planning process. Section L discusses wood-burning operations and would not be applicable to the SJRPP (Policies 5.J.1 to 5.J.12, 5.K.1 through 5.K.5, and 5.L.1 through 5.L.2) (Madera County 1995).

- **Merced County General Plan –** The Merced County General Plan defers air quality policy making to the local air pollution control district (Merced County 1990). The Merced County Air Pollution Control District is the local district in this case.

- **City of Fresno General Plan –** The City of Fresno objective in Section G-1: Air Quality of the Resource Conservation Element is to "in cooperation with other jurisdictions and agencies in the SJVAB, take necessary actions to achieve and maintain compliance with State and national air quality standards" (City of Fresno 2002).

Toxic Air Contaminants

At the local level, air pollution control or management districts may adopt and enforce ARB control measures. Under SJVAPCD Regulations II and VII, all sources that possess the potential to emit TACs are required to obtain permits from the district. Permits may be granted to these operations if they are constructed and operated in accordance with applicable regulations, including new-source review standards and air toxics control measures. SJVAPCD limits emissions and public exposure to TACs through a number of programs. SJVAPCD prioritizes TAC-emitting stationary sources based on the quantity and toxicity of TAC emissions and the proximity of the facilities to sensitive receptors.

Odors

SJVAPCD has determined some common types of facilities that have been known to produce odors, including wastewater treatment facilities, chemical manufacturing plants, painting/coating operations, feed lots/dairies, composting facilities, landfills, and transfer stations. Any actions related to odors are based on citizen complaints to local governments and SJVAPCD.

4.3 Environmental Consequences and Mitigation Measures

The purpose of this section is to provide information about the environmental consequences of the program alternatives on air quality of the SJVAB, which includes the San Joaquin River upstream from Friant Dam, Restoration Area, the San Joaquin River from the Merced River to the Delta, the Delta, and the Friant Division, with the focus of the analysis within the Restoration Area where most impacts would occur. See Chapter 7.0, “Climate Change,” for a discussion of effects related to climate change and greenhouse gas (GHG) emissions. This section describes the methodology, criteria for determining significance of effects, and environmental consequences and mitigation measures associated with effects of each of the program alternatives. The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, “Description of Alternatives,” and summarized in Table 4-3. The impacts and mitigation measures are summarized in Table 4-4.

Table 4-3.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		Action Alternative					
			A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
Project-Level	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
Project-Level	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
Program-Level	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
Program-Level	Actions in Reach 4B1 to provide at least:	4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
Program-Level	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
Program-Level	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	New pumping infrastructure on the San Joaquin River					✓	✓
Program-Level	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:
[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.
[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 4-4.
Summary of Impacts and Mitigation Measures – Air Quality

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Air Quality: Program-Level				
AIR-1: Construction-Related Emissions of Criteria Air Pollutants and Precursors	No-Action	PSU	--	PSU
	A1	PS	AIR-1: Prepare Project-Level Quantitative Analysis of Construction-Related Emissions and Implement Measures to Minimize Emissions	PSU
	A2	PS		PSU
	B1	PS		PSU
	B2	PS		PSU
	C1	PS		PSU
	C2	PS		PSU
AIR-2: Operations-Related Emissions of Criteria Air Pollutants and Precursors	No-Action	PSU	--	PSU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
AIR-3: Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants	No-Action	PSU	--	PSU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
AIR-4: Exposure of Sensitive Receptors to Odor Emissions	No-Action	PSU	--	PSU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Table 4-4.
Summary of Impacts and Mitigation Measures – Air Quality (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Air Quality: Project-Level				
AIR-5: Construction-Related Emissions of Criteria Air Pollutants and Precursors	No-Action	PSU	--	PSU
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	No Impact	--	No Impact
	C2	No Impact	--	No Impact
AIR-6: Operations-Related Emissions of Criteria Air Pollutants and Precursors	No-Action	PSU	--	PSU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
AIR-7: Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants	No-Action	PSU	--	PSU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
AIR-8: Exposure of Sensitive Receptors to Odor Emissions	No-Action	PSU	--	PSU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Key:
-- = not applicable
LTS = less than significant
PS = potentially significant
PSU = potentially significant and unavoidable

4.3.1 Impact Assessment Methodology

Almost all increased pollutant emissions that would be associated with the action alternatives would be generated by construction-related activities. Construction emissions are described as temporary or "short term" in duration. These temporary and short-term emissions, especially emissions of criteria air pollutants (i.e., PM_{10}) and ozone precursors (e.g., ROG and NO_X), have the potential to represent a significant air quality impact.

Fugitive dust emissions are associated primarily with site preparation and excavation and vary as a function of such parameters as soil silt content, soil moisture, wind speed, acreage of disturbance area, and vehicle miles traveled on and off site. Emissions of ROG and NO_X are associated primarily with gas and diesel equipment and asphalt paving.

Several types of emissions are analyzed in this section: temporary and short-term emissions related to construction, long-term regional emissions related to operations, local emissions from mobile sources, and emissions of TAC. Regardless of emissions type, the method of analyzing emissions is consistent with recommendations of the SJVAPCD.

4.3.2 Significance Criteria

The thresholds of significance for impacts are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. Impacts on air quality would be significant if implementing an alternative would do any of the following:

- **Temporary or short-term construction-related emissions of criteria air pollutants or precursors –** Violate an air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations, as described below:

  - **PM_{10}.** Emissions would exceed the SJVACPD-recommended threshold of 15 tons per year (TPY), or SJVAPCD-required control measures in compliance with Regulation VIII, "Fugitive Dust PM_{10} Prohibitions," or other SJVAPCD-recommended mitigation measures applicable to the project would not be incorporated into project design or implemented during project construction.

  - **ROG and NO_X.** Emissions would exceed the SJVAPCD-recommended threshold of 10 TPY.

- **Long-term operation-related (regional) emissions of criteria air pollutants or precursors –** Violate an air quality standard or contribute substantially to an existing or projected air quality violation, expose sensitive receptors to substantial pollutant concentrations, or conflict with or obstruct implementation of the applicable air quality plan are described below:

- **PM_{10}.** Emissions would exceed the SJVACPD-recommended threshold of 15 TPY, or SJVAPCD-required control measures in compliance with Regulation VIII, “Fugitive Dust PM_{10} Prohibitions,” or other SJVAPCD-recommended mitigation measures applicable to the project would not be incorporated into project design or implemented during project operation.

- **ROG and NO_X.** Emissions would exceed the SJVAPCD-recommended threshold of 10 TPY.

- **Long-term operation-related (local) emissions of criteria air pollutants or precursors –** Violate any air quality standard or contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations (e.g., CO emissions exceeding the 1-hour standard of 20 ppm or the 8-hour standard of 9 ppm)

- **Temporary and short-term construction-related or long-term operation-related emissions of TACs –** Expose sensitive receptors to substantial pollutant concentrations (i.e., result in exposure to a TAC, as identified by ARB and/or EPA, at a level for which the risk of contracting cancer exceeds 10 in 1 million or for which the noncancer-risk hazard index exceeds 1 for the maximally exposed individual).

- **Odors –** Create objectionable odors affecting a substantial number of people in the short or long term. Specifically, locate receptors near an existing odor source where either one confirmed or three unconfirmed complaints per year, averaged over 3 years, have been received from either of the following:

  - Existing receptors as close as the project to the odor source

  - Existing receptors near a similar facility considering distance, frequency, and odor control. (This source applies where no nearby development currently exists, and for proposed odor sources near existing sensitive receptors.)

The General Conformity Rule, which addresses whether a project conforms to the State Implementation Plan (SIP) approved and promulgated under Section 110 of the CAA, applies to Federal actions that would generate emissions of criteria air pollutant or precursor emissions in nonattainment or maintenance areas. The SJVAB is currently designated as a serious nonattainment area with respect to the national 8-hour ozone standard. General conformity requirements would apply to actions where the total project-generated direct or indirect emissions would be equal to or exceed the applicable emissions levels, known as the *de minimis* thresholds, or would be greater than 10 percent of an area’s annual emissions budget, known as regionally significant thresholds. If either of the thresholds is exceeded, a conformity determination would be needed prior to project approval. Since quantification of emissions is not conducted at the program level, determining whether emissions would exceed *de minimis* thresholds and violate general conformity regulations would be too speculative for meaningful consideration. However, since a general conformity analysis may be conducted at any phase of a project before groundbreaking, it is therefore assumed that because this analysis would be required under law, and further environmental review would be conducted before individual project construction, a general conformity analysis would be conducted during subsequent individual project-level actions when construction-related emissions can be quantified.

4.3.3 Program-Level Impacts and Mitigation Measures

This section provides a program-level evaluation of the direct and indirect effects of implementing the program alternatives on air quality. These effects could occur in the Restoration Area, along the San Joaquin River between the Merced River and the Delta, or in the Delta during the modification, construction, maintenance, or operation of facilities, including the recapture of Interim and Restoration flows using existing facilities on the San Joaquin River between the Merced River and the Delta and constructing and operating potential new pumping infrastructure in this segment of the river. No program-level actions requiring construction activities or operations-related emissions are proposed upstream from Friant Dam or in the CVP/SWP water service areas. Therefore, those geographic areas are not discussed further in this section.

No-Action Alternative

No activities related to the Settlement would take place under the No-Action Alternative, but reasonably foreseeable future actions, and other projects associated with population growth and buildout of general plans by 2030, could impact the study area.

Impact AIR-1 (No-Action Alternative): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.*** Reasonably foreseeable future actions including the buildout of existing general plans by 2030 could generate temporary and short-term construction-related emissions of criteria air pollutants and precursors in the Restoration Area, along the lower San Joaquin River, and in the Delta (as discussed in Chapter 26, "Cumulative Impacts"). These projects would be subject to applicable air quality standards and be required to comply with those standards. Nonetheless, it may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. Therefore, in the Restoration Area, along the lower San Joaquin River, and in the Delta, temporary and short-term construction-related emissions of criteria air pollutants or precursors would be **potentially significant and unavoidable**.

Impact AIR-2 (No-Action Alternative): ***Operations-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.*** The USACE policy restricting levee vegetation could be implemented within the Restoration Area, along the San Joaquin River from the Merced River to the Delta, and within the Delta. However, the extent to which this policy would be implemented is not clear, and the resulting effects on air quality are too speculative for meaningful consideration. In the Delta, the Contra Costa Water District's Middle River Intake and Pump Station and the City of Stockton's Freeport Regional Water Supply Project would involve long-term operation-related emissions of criteria air pollutants and precursors. In addition, given projected increases in population within the study area and the buildout of existing general plans by 2030, numerous other undefined projects in the Restoration Area, along the lower San Joaquin

River, and in the Delta could emit criteria air pollutants and precursors. These projects would be subject to applicable air quality standards and be required to comply with those standards. Nonetheless, it may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. As a result, operations-related emissions of criteria air pollutants and precursors in the Restoration Area, along the lower San Joaquin River, and in the Delta would be **potentially significant and unavoidable**.

Impact AIR-3 (No-Action Alternative): ***Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants – Program-Level.*** The USACE policy restricting levee vegetation could be implemented within the Restoration Area, along the San Joaquin River from the Merced River to the Delta, and within the Delta. However, the extent to which this policy would be implemented is not clear, and the resulting effects on air quality are too speculative for meaningful consideration. In the Delta, the Contra Costa Water District's Middle River Intake and Pump Station and the City of Stockton's Freeport Regional Water Supply Project would involve long-term operation-related emissions of TACs. In addition, given projected increases in population within the study area and the buildout of existing general plans by 2030, numerous other undefined projects in the Restoration Area, along the lower San Joaquin River, and in the Delta could emit TACs precursors. These projects would be subject to applicable air quality standards and be required to comply with those standards. Nonetheless, it may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. As a result, operations-related emissions of criteria air pollutants and precursors in the Restoration Area, along the lower San Joaquin River, and in the Delta would be **potentially significant and unavoidable**.

Impact AIR-4 (No-Action Alternative): ***Exposure of Sensitive Receptors to Odor Emissions – Program-Level.*** Reasonably foreseeable future actions do not involve construction activities or operations, except implementation of the USACE policy regarding levee vegetation and two Delta water projects, as previously described. In addition, given projected increases in population within the study area and the buildout of existing general plans by 2030, other projects in the Restoration Area and along the lower San Joaquin River could expose sensitive receptors to odor emissions. These projects would be subject to applicable air quality standards and be required to comply with those standards. Nonetheless, it may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. Therefore, exposure of sensitive receptors to objectionable odors would be **potentially significant and unavoidable**.

Alternatives A1 Through C2

Program-level actions under Alternatives A1 through C2 would be implemented from 2010 to 2016, and would include various projects for which construction would take place within the Restoration Area. Separate environmental review would be completed for each plan and project to ensure detailed analysis of project elements, and mitigation would be provided as necessary. However, this program-level impact discussion outlines major air quality impacts that may be associated with construction activities and defines mitigation measures that would be implemented during future construction activities.

The construction and operation-related differences among program-level actions under the action alternatives are (1) Alternatives A2, B2, and C2 include more construction activities to increase Reach 4B1 channel capacity to at least 4,500 cfs (compared to at least 475 cfs under other action alternatives), (2) Alternatives B1, B2, C1, and C2 would recapture flows at existing facilities along the lower San Joaquin River as well as in the Delta, and (3) Alternatives C1 and C2 would have greater construction and long-term operational air quality impacts because they would include construction and operation of new pumping infrastructure on the lower San Joaquin River.

Alternative A1 would have the least air quality impacts and Alternative C2 would have the greatest air quality impacts. All action alternatives would have greater air quality impacts than the No-Action Alternative.

Impact AIR-1 (Alternatives A1 through C2): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.*** Temporary and short-term emissions related to Alternatives A1 through C2 construction activities occurring in the Restoration Area could produce criteria air pollutants in excess of SJVAPCD thresholds. Alternatives A2, B2, and C2 include more construction activities to increase Reach 4B1 channel capacity to at least 4,500 cfs (compared to at least 475 cfs with other action alternatives). This impact would be **potentially significant**.

Emissions would be generated by land disturbance and exhaust from construction equipment (e.g., bulldozers, excavators, haul trucks, and employee commutes). Specific project-level data about the amount and locations of this equipment are not available at this time; it can be reasonably assumed, however, that large earthmoving and restoration operations could exceed thresholds established by SJVAPCD (10 TPY for ROG and NO_X). To support this assumption, emissions modeling was conducted based on a conservative estimate of borrow material projected to be used in the construction of the two largest projects (bypass and levee infrastructure) in the Restoration Area under the action alternatives, and typical equipment levels needed to perform this construction. Conservative estimates of program emissions based on this analysis would be approximately 5 TPY of ROG, 40 TPY of NO_X, and 1,314 TPY of PM_{10} (see Appendix H, “Modeling,” for complete modeling methodology and results). Because these initial results for NO_X and PM_{10} are in excess of applicable thresholds, it is likely that Alternatives A1 through C2 would exceed these thresholds. In addition, SJVAPCD Regulation VIII requires all construction projects to implement fugitive-dust controls, and the program-level project description for Alternatives A1 through C2 does not include all applicable measures for fugitive-dust control that are recommended by SJVAPCD.

The duration of construction under these alternatives, and amount of equipment anticipated to be required, would most likely be of sufficient magnitude to cause applicable air district thresholds to be exceeded. As a result, implementation of Alternatives A1 through C2 would likely violate or contribute substantially to an existing or projected air quality violation, expose sensitive receptors to substantial pollutant concentrations, or conflict with air quality planning efforts in the short term. This impact would be significant.

Mitigation Measure AIR-1 (Alternatives A1 through C2): *Prepare Project-Level Quantitative Analysis of Construction-Related Emissions and Implement Measures to Minimize Emissions – Program-Level.* The project proponent will implement the measures described below for all future construction-related actions to quantify construction-related emissions for each future action, and identify and implement measures to reduce or minimize impacts.

The project proponent will obtain the necessary information to perform a complete quantitative project-level air emissions analysis as part of the subsequent environmental review for each construction project for which such review is required. The air quality analysis for each individual project will be based on the types, locations, numbers, and operations of equipment to be used; the amount and distance of material to be transported; and worker trips required. Each analysis will determine whether emissions exceed SJVAPCD standards and will require the project proponent to implement all emission reduction measures. The project proponent will incorporate the performance standards described below into all future project designs and adhere to them.

Reduction of Ozone Precursor Emissions During Construction. The project proponent will design future projects to comply with the following general mitigation requirements for construction emissions, as contained in SJVAPCD Rule 9510, “Indirect Source Review” (ISR):

- Exhaust emissions for construction equipment of greater than 50 horsepower that is used by, or associated with, the project will be reduced by 20 percent of the total NO_X and by 45 percent of the total PM_{10} exhaust emissions from the statewide average, as estimated by ARB. Construction emissions may be reduced on site by using add-on controls, cleaner fuels, or newer lower-emissions equipment, thus generating less pollution.
- Additional strategies for reducing construction emissions, including, but not limited to, the following:
  - Providing sufficient commercial electric power to the project site to avoid or minimize the use of portable electric generators.
  - Substituting electric-powered equipment for diesel engine-driven equipment.
  - Limiting the hours of operation of heavy-duty equipment and/or the amount of equipment used at any one time.
  - Minimizing idling time (e.g., 10-minute maximum).

- Replacing equipment that uses fossil fuels with electrically driven equivalents (provided that they are not run via a portable generator set).

Reduction of Particulate Emissions During Construction. The project proponent will design future projects to comply with SJVAPCD's Regulation VIII, "Fugitive Dust PM_{10} Prohibitions," and will implement all applicable control measures. Regulation VIII contains the following required control measures, among others:

- Prewater the site enough to limit visible dust emissions (VDE) to 20 percent opacity.
- Phase the work to reduce the amount of surface area disturbed at any one time.
- During active construction:
  - Apply enough water or chemical/organic stabilizers or suppressants to limit VDE to 20 percent opacity.
  - Construct and maintain wind barriers sufficient to limit VDE to 20 percent opacity.
  - Apply water or chemical/organic stabilizers or suppressants to unpaved access/haul roads and unpaved vehicle/equipment traffic areas in sufficient quantity to limit VDE to 20 percent opacity and meet the conditions of a stabilized unpaved road surface.
- Limit the speed of vehicles traveling on uncontrolled, unpaved access/haul roads within construction sites to a maximum of 15 miles per hour (mph).
- Post speed-limit signs meeting the standards of the U.S. and California departments of transportation at the entrance to each construction site's uncontrolled, unpaved access/haul road. Speed-limit signs will also be posted at least every 500 feet and will be readable in both directions of travel along uncontrolled, unpaved access/haul roads.
- When handling bulk materials:
  - Apply water or chemical/organic stabilizers or suppressants in sufficient quantity to limit VDE to 20 percent opacity.
  - Construct and maintain wind barriers sufficient to limit VDE to 20 percent opacity and with less than 50 percent porosity.
- When storing bulk materials:
  - Comply with the conditions for a stabilized surface, as listed above.

  - Cover bulk materials stored outdoors with tarps, plastic, or other suitable material and anchor the covers to prevent their removal by wind action.

  - Construct and maintain wind barriers that are sufficient to limit VDE to 20 percent opacity and that have less than 50 percent porosity. If using fences or wind barriers, apply water or chemical/organic stabilizers or suppressants to limit VDE to 20 percent opacity, or use a three-sided structure that is at least as high as the storage pile and has less than 50 percent porosity.

- Load all haul trucks such that the freeboard is not less than 6 inches when material is transported across any paved public-access road. Freeboard should be sufficient to limit VDE to 20-percent opacity.

- Apply enough water to the top of the load to limit VDE to 20 percent opacity.

- Cover haul trucks with a tarp or other suitable cover.

- Clean the interior of the cargo compartment or cover the cargo compartment before an empty truck leaves the site.

- Prevent carryout and trackout, or immediately remove carryout and trackout when it extends 50 feet or more from the nearest unpaved-surface exit point of a site.

- Clean up carryout and trackout using one of the following methods:

  - Manually sweeping and picking up.

  - Operating a rotary brush or broom accompanied or preceded by sufficient wetting to limit VDE to 20 percent opacity.

  - Operating a PM_{10}-efficient street sweeper that has a pickup efficiency of at least 80 percent.

  - Flushing with water, if curbs or gutters are not present and if using water would not result in a source of trackout material, adverse impacts on stormwater drainage systems, or violate any National Pollutant Discharge Elimination System permit program

- Submit a dust control plan to the Air Pollution Control Officer (APCO) before the start of any construction activity that would disturb 5 acres or more of surface area, or that would move, deposit, or relocate more than 2,500 cubic yards per day of bulk materials on at least 3 days. Do not begin construction activities until the APCO has approved or conditionally approved the dust control plan. Notify the APCO in writing, via fax or letter, within 10 days before earthmoving activities commence.

The project proponent will implement the following SJVAPCD-recommended enhanced and additional control measures for all construction phases to further reduce fugitive PM_{10} dust emissions:

- Install sandbags or other erosion control measures to prevent silt runoff to public roadways from adjacent project areas with a slope greater than 1 percent.
- Suspend excavation and grading activity when winds exceed 20 mph.

Reduction of Ozone Precursor Emissions During Construction. Compliance with SJVAPCD's Rule 9510 would result in a minimum 20 percent reduction in NO_X emissions from heavy-duty diesel equipment, compared with statewide average emissions. Implementing the ISR rule would also reduce emissions of ROG and PM_{10} exhaust from heavy-duty diesel equipment by 5 percent and 45 percent, respectively. All or part of the reductions may be based on the selection of onsite equipment and fuels. The remainder would result from offsite reductions achieved by paying fees that would be applied to other SJVAPCD programs that reduce the same pollutants, but at other sources. One such program involves replacing the engines in various types of diesel-powered portable industrial equipment with either cleaner diesel engines, or converting such equipment to electric motors.

Reduction of Particulate Emissions During Construction. The project proponent will comply with SJVAPCD Regulation VIII, as required by law. This mitigation measure includes additional SJVAPCD-recommended control measures that will further reduce particulate emissions. As a result, generation of construction-related dust (PM_{10} emissions) will be reduced below SJVAPCD levels of significance.

In summary, PM_{10} levels would be reduced below the significance threshold levels. However, without specific project-level information, construction emissions of ROG and NO_X are not quantifiable at this time, and it cannot be determined whether mitigation would reduce emissions to a less-than-significant level (e.g., emissions could still exceed 10 TPY even with the ISR reductions of 20 percent and 5 percent for NO_X and ROG, respectively).

Consequently, until further project-level analysis is completed, this impact after mitigation would be **potentially significant and unavoidable**.

Impact AIR-2 (Alternatives A1 through C2): *Operations-Related Emissions of Criteria Air Pollutants and Precursors – Program-Level.* Long-term operations-related emissions from mobile, area, and stationary sources associated with Alternatives A1 through C2 would not be expected to generate criteria air pollutants or precursors in excess of SJVAPCD thresholds because these stationary sources would be subject to SJVAPCD's permitting process for keeping emissions from equipment within acceptable limits. This impact would be **less than significant**.

In the Restoration Area, long-term operations under Alternatives A1 through C2 would not increase regional emissions of ROG, NO_X, PM_{10}, or local CO from mobile, stationary, or area sources. Operations-related maintenance activities and associated vehicle trips would increase by a negligible amount. The levee system would not be expected to require extensive vegetation maintenance or other activities that would result in a substantial net increase in emissions relative to existing conditions.

Interim and Restoration flows could be recaptured at existing Delta facilities. No new facilities, pumps, or diversion facilities would be constructed in the Delta and, therefore, no new sources of pollutants would be created for all alternatives, except Alternatives C1 and C2. Alternatives C1 and C2 would have greater construction and long-term operational air quality impacts because they would include new pumping infrastructure on the lower San Joaquin River. Stationary equipment would be subject to SJVAPCD's permitting process and best available control technology (BACT) and offset requirements. SJVAPCD's permitting process would keep emissions from equipment within acceptable limits. For these reasons, implementing program-level actions under Alternatives A1 through C2 would not violate or contribute substantially to an existing or projected air quality violation, expose sensitive receptors to substantial pollutant concentrations, or conflict with air quality planning efforts.

New stationary sources would not be created under Alternatives A1 through B2, and operations would not result in a substantial increase in long-term regional ROG, NO_X, or PM_{10}, or local CO emissions. Therefore, emissions would not be anticipated to violate an air quality standard, contribute substantially to an existing or projected air quality violation, or conflict with or obstruct implementation of ARB and SJVAPCD air planning efforts. This impact would be less than significant. Alternatives C1 and C2 would have greater construction and long-term operational air quality impacts because they would include new pumping infrastructure on the lower San Joaquin River. New stationary equipment such as existing recapture equipment and proposed additional pumping infrastructure would be subject to the SJVAPCD permitting process, BACT, and offset requirements. The SJVAPCD permitting process would keep emissions from equipment within acceptable limits. Thus, operating new pumping infrastructure would not violate or contribute substantially to an existing or projected air quality violation, expose sensitive receptors to substantial pollutant concentrations, or conflict with air quality planning effects. Because no new or modified stationary sources would exist, this impact would be less than significant.

Impact AIR-3 (Alternatives A1 through C2): ***Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants – Program-Level.*** Short- and long-term TAC emissions from mobile, area, and stationary sources associated with Alternatives A1 through C2 would not expose sensitive receptors to substantial pollutant concentrations in excess of SJVAPCD thresholds. This impact would be **less than significant**.

Separate discussions, as provided below, analyze the potential for sensitive receptors to be exposed to TACs from onsite sources during project construction, and the potential for exposure to TACs from operations-related sources.

Onsite Emissions from Construction Equipment. Individual construction projects from various program-level actions would result in short-term emissions of diesel PM, which is a TAC. Exhaust from off-road heavy-duty diesel equipment would emit diesel PM during site excavation, grading, and clearing; installation of utilities (e.g., water diversion infrastructure); materials transport and handling; and other miscellaneous activities. The potential cancer risk from inhaling diesel PM, as discussed below, outweighs the potential noncancer health impacts. SJVAPCD has not adopted a methodology for analyzing such impacts and has not recommended completing health risk assessments for construction-related TAC emissions, with a few exceptions (e.g., when the construction phase is the only phase of the project) (Reed, pers. comm., 2007).

The dose to which receptors are exposed is the primary factor used to determine health risk (i.e., the potential exposure to TACs to be compared to applicable standards). "Dose" is based on the concentration of one or more substances in the environment and the duration of exposure to the substance(s). Dose is positively correlated with time; a longer exposure period would result in a higher exposure level for the maximally exposed individual. Thus, the risks estimated for a maximally exposed individual are higher if a fixed exposure occurs over a longer period of time. According to the State Office of Environmental Health Hazard Assessment, health risk assessments, which determine the exposure of sensitive receptors to TAC emissions, should be based on a 70-year exposure period. Such assessments, however, should be limited to the period or duration of activities associated with the proposed project (Salinas, pers. comm., 2004).

The 6-year construction period restoration actions under the action alternatives would be much less than the 70-year period used for risk determination. In addition, construction equipment would often be located at a considerable distance from the nearest sensitive receptors and would not remain in one location for a substantial period of time. Off-road heavy-duty diesel equipment would be used only temporarily, and the highly dispersive properties of diesel PM (Zhu et al. 2002) would result in further reductions in exhaust emissions. As a result, project construction would not expose sensitive receptors to substantial emissions of TACs. This impact would be less than significant.

Onsite Stationary-Source Emissions from Project Operation. Implementation of Alternatives A1 through B2 would not result in any new stationary sources of pollution. Water flows would be recaptured from existing diversions and pump stations, and no other pumps or sources of emissions would be installed. New stationary equipment would be needed under implantation of Alternatives C1 and C2. Any stationary equipment such as existing recapture equipment and proposed additional pumping infrastructure would be subject to the SJVAPCD permitting process, BACT, and offset requirements. The SJVAPCD permitting process would keep emissions from equipment within acceptable limits. Thus, operating new pumping infrastructure would not violate or contribute substantially to an existing or projected air quality violation, expose sensitive receptors to substantial pollutant concentrations, or conflict with air quality planning effects. This impact would be less than significant.

Impact AIR-4 (Alternatives A1 through C2): ***Exposure of Sensitive Receptors to Odor Emissions – Program-Level.*** Short- and long-term odor emissions from mobile, area, and stationary sources associated with Alternatives A1 through C2 would not expose a substantial number of sensitive receptors to objectionable odors. This impact would be **less than significant**.

Occurrence and severity of odor impacts depend on numerous factors, including the nature, frequency, and intensity of the source; wind speed and direction; and the presence of sensitive receptors. Although offensive odors rarely cause any physical harm, they can be very unpleasant, leading to considerable distress and often generating citizen complaints to local governments and regulatory agencies.

Construction under Alternatives A1through C2 would generate odors through exhaust emissions from on site diesel equipment. Such emissions would be intermittent, would not remain in one location for long periods of time, and would dissipate from the source rapidly.

Long-term odor sources associated with the action alternatives would be related to evaporating water and anaerobic digestion processes caused by standing pools of water. In rare cases, these odors from the San Joaquin River could be detected at sensitive receptors located adjacent to the Restoration Area. However, these odors would be intermittent, infrequent, and negligible, and are natural odors that are considered pleasant by some. A hatchery may be constructed at some point along the river; however, the location and design of the hatchery is unknown at this time. Therefore, it is uncertain whether hatchery operations would result in substantial odors; for these reasons, determining the significance of odors related to the hatchery is too speculative for meaningful consideration. As a result, this impact is not evaluated further. Any impacts of constructing a new hatchery or expanding an existing hatchery would need to be addressed during environmental review of the proposed hatchery. No other sources of odors would be related to Alternatives A1 through C2, and no new receptors would be created by implementing these alternatives.

In summary, Alternatives A1through C2 would not introduce new, permanent odor-generating facilities, nor would it place receptors substantially closer to, or cause large exposure periods for, existing sources of odors, and a new hatchery would be subject to separate environmental review. Short-term odor sources would be intermittent and would dissipate rapidly from the source. Thus, short- and long-term odor impacts would be less than significant. Alternatives C1 and C2 would have greater construction and long-term operational air quality impacts because they would include new pumping infrastructure on the lower San Joaquin River and a conveyance tie-in to existing water conveyance facilities. Operation of new equipment would not violate or contribute substantially to an existing or projected air quality violation, expose sensitive receptors to substantial pollutant concentrations, or conflict with air quality planning effects. Therefore, this impact would be less than significant.

4.3.4 Project-Level Impacts and Mitigation Measures

This section provides a project-level evaluation of the direct and indirect effects of implementing the program alternatives. Project-level actions under the action alternatives would directly affect air quality by altering operations at existing pumping facilities to recapture Interim and Restoration flows in the Restoration Area and in the Delta. It also could affect air quality indirectly through an increase in traffic volumes associated with expanded recreation opportunities, collection of monitoring data, and actions to control and manage the spread of invasive species in the Restoration Area.

Actions identified in Appendix D, "Physical Monitoring and Management Plan," as potential immediate actions to address nonattainment of management objectives also were evaluated at a project level. Potential immediate actions are related to flow, seepage, capacity, native vegetation, and spawning gravel. Immediate actions include acquisition of additional water from willing sellers, reoperation of Friant Dam to reduce flows, site monitoring, the removal of obstructions/debris from channels, and actions to control and manage invasive species in the Restoration Area.

Other actions evaluated at a project level would not result in physical changes to air quality. These include reoperation of Mendota Dam, Chowchilla Bypass Bifurcation Structure, Eastside Bypass Bifurcation Structure, Mariposa Bypass Bifurcation Structure, and the Hills Ferry Barrier. The proposed changes to the operation of these structures involve a slight increase in vehicular trips but would have virtually no effect on air quality. Actions to obtain encroachment permits, water transfers, and long-term water rights also would not affect air quality. Impacts from potential increased emissions related indirectly to changes in water usage and farming practices are evaluated for the Friant Division.

No emissions would be generated by, or related to, reoperating Friant Dam (or other actions evaluated at the project-level) upstream from Friant Dam or in CVP/SWP water service areas outside of the Friant Division. Therefore, those geographic areas are not discussed further in this section.

No-Action Alternative

As described for program-level impacts of the No-Action Alternative, no construction activities related to the Settlement would take place under the No-Action Alternative, but reasonably foreseeable future actions, and other projects associated with population growth and buildout of general plans by 2030, could impact air quality.

Impact AIR-5 (No-Action Alternative): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Project-Level.*** Reasonably foreseeable future actions, and other projects associated with population growth and buildout of general plans by 2030, would emit temporary and short-term construction-related emissions of criteria air pollutants and precursors. It may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. As a result, temporary and short-term construction-related emissions of criteria air pollutants and precursors would be **potentially significant and unavoidable**.

Impact AIR-6 (No-Action Alternative): ***Operations-Related Emissions of Criteria Air Pollutants and Precursors – Project-Level.*** Reasonably foreseeable future actions, and other projects associated with population growth and buildout of general plans by 2030, would emit long-term operations-related emissions of criteria air pollutants and precursors. It may not be feasible to fully mitigate all impacts of some of these projects, and residual significant and unavoidable impacts could remain even after mitigation. As a result, long-term operations-related emissions of criteria air pollutants and precursors would be **potentially significant and unavoidable.**

Impact AIR-7 (No-Action Alternative): ***Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants – Project-Level.*** Reasonably foreseeable future actions, and other projects associated with population growth and buildout of general plans by 2030, would involve construction or operations, or both, and could expose sensitive receptors to TACs. It may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. As a result, exposure of sensitive receptors to substantial concentrations of TACs would be **potentially significant and unavoidable**.

Impact AIR-8 (No-Action Alternative): ***Exposure of Sensitive Receptors to Odor Emissions – Project-Level.*** Reasonably foreseeable future actions, and other projects associated with population growth and buildout of general plans by 2030, would involve construction or operations, or both, and could expose sensitive receptors to odor emissions. It may not be feasible to fully mitigate all impacts of some of these projects, and there could be residual significant and unavoidable impacts even after mitigation. As a result, exposure of sensitive receptors to odor emissions would be **potentially significant and unavoidable**.

Alternatives A1 Through C2

Project-level actions and associated impacts would be the same under all action alternatives, as described below.

Impact AIR-5 (Alternatives A1 through C2): ***Construction-Related Emissions of Criteria Air Pollutants and Precursors – Project-Level.*** No temporary or short-term construction-related emissions would occur as a result of the project-level actions. There would be **no impact**.

Impact AIR-6 (Alternatives A1 through C2): ***Operations-Related Emissions of Criteria Air Pollutants and Precursors – Project-Level.*** Pollutant emissions resulting from project-level actions under any action alternative would not exceed SJVAPCD standards. This impact would be **less than significant**.

Implementing Interim and Restoration flows under any action alternative would not result in any new stationary or area sources of criteria air pollutants or precursors. Interim and Restoration flows would be recaptured at existing facilities. No new facilities, pumps, or diversion facilities would be constructed and, therefore, no new sources of pollutants would be created, and emissions would remain within the range of those under historic operations. Stationary equipment such as existing water recapture equipment would be subject to SJVAPCD's permitting process, BACT, and offset requirements. SJVAPCD's permitting process would keep emissions from equipment within acceptable limits.

Recreational activities related to additional water flows may increase. However, the number of visitors expected to be drawn to the Restoration Area, although increased from current levels, would not be expected to be of a magnitude that would alter general traffic patterns on local roadways. Emissions associated with vehicle trips by existing and new users would be less than 10 TPY for ROG (0.9 TPY) and NO_X (1.24 TPY) and less than 15 TPY for PM_{10} (0.25 TPY) (see Appendix H, "Modeling" for modeling results). In addition, local residents are the most likely recreationists; therefore, any increase in regional emissions would be expected to be minor. Actions identified in Appendix D, "Physical Monitoring and Management Plan," such as increased vehicular use to monitor data or remove invasive plant species, would result in virtually no change as well.

Potential indirect effects of reoperating Friant Dam and water recapture include possible increased land fallowing in the Friant Division (estimated at less than 1,000 acres) and possible increased groundwater pumping to supplement surface water deliveries. Air quality impacts of these indirect effects include potential increased emissions of ROG, NO_X, and PM_{10}. In an effort to limit fugitive dust emissions from agricultural sources to achieve attainment of the PM_{10} NAAQS, SJVAPD promulgated Rule 8081 Agricultural Sources in November 2001 and amended the rule in September 2004. SJVAPD determined that limiting off-field agricultural sources would be sufficient to achieve attainment. Land fallowing is an on-field farming activity, and as such is exempt from Rule 8081. SJVAPD rulemaking is subject to CEQA review and the air quality evaluation prepared for Rule 8081 considered potential effects of PM_{10} emissions that could result from exempting on-field farming operations including land fallowing. It found that PM_{10} impacts on the air basin would be less than significant (SJVUAPCD 2004). Because the potential increase in land fallowing is not substantial, increased land fallowing as a result of the action alternatives is consistent with the SJVAPCD findings that PM_{10} impacts would be less than significant.

The other potential indirect effect, new or increased groundwater pumping, could increase emissions of ROG and NO_X. As discussed for facilities, pumps, and diversion facilities, new groundwater pumps or changes in groundwater pumping would be regulated by SJVAPCD. Because new pumps and increased pumping would be subject to the permitting process, BACT, and offset requirements, impacts resulting from ROG and NO_X emissions would be less than significant.

Because no new stationary or area sources would be created, and operations would not result in a substantial increase in long-term regional ROG, NO_X, and PM_{10}, emissions would not be anticipated to violate an air quality standard, contribute substantially to an existing or projected air quality violation, conflict with or obstruct implementation of ARB and SJVAPCD air planning efforts, or expose sensitive receptors to substantial pollutant concentrations. These direct and indirect impacts would be less than significant.

Impact AIR-7 (Alternatives A1 through C2): ***Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants – Project-Level.*** Pollutant emissions resulting from flow releases related to implementing any action alternative would not create substantial levels of TACs. This impact would be **less than significant**.

Implementing project-level flows under any action alternative would not result in any stationary or area sources of TACs. Because virtually no new stationary or area sources would be created, TAC emissions would not expose sensitive receptors to substantial pollutant concentrations. These direct and indirect impacts would be less than significant.

Impact AIR-8 (Alternatives A1 through C2): ***Exposure of Sensitive Receptors to Odor Emissions – Project-Level.*** Pollutant emissions resulting from project-level actions under the action alternatives would not create substantial and objectionable odors. This impact would be **less than significant**.

Implementing project-level flows under any action alternative would not result in any major stationary or area sources of odors. Any odors related to increasing flows, such as odors from decaying aquatic vegetation or areas of standing water, would be local and minor. Any odors would be intermittent and would decrease rapidly with distance. Because of the minor and localized nature of any created odors, sensitive receptors are not anticipated to be exposed to objectionable odor concentrations. These impacts would be less than significant.

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Chapter 5.0 Biological Resources – Fisheries

This chapter describes the environmental and regulatory settings of fisheries, as well as environmental consequences, as they pertain to implementing the program alternatives. Vegetation and wildlife are described separately in Chapter 6.0, "Biological Resources – Vegetation and Wildlife." The discussion of fisheries focuses on Reaches 1 through 5 of the Restoration Area, the San Joaquin River upstream and downstream from the Restoration Area, San Joaquin River tributaries, and the Delta. Fisheries are not discussed beyond these geographic areas because implementing the Settlement would not affect fisheries elsewhere. Supporting information is provided in Appendix K, "Biological Resources – Fisheries." The Conservation Strategy (fully described in Chapter 2.0, "Description of Alternatives"), which is included in the action alternatives, reduces each potentially significant impact to fisheries to a less-than-significant level, and precludes the need for mitigation measures. Throughout this chapter, species are referred to using their common name. At the first usage of a common name, the Latin name is also presented in parentheses.

This chapter was developed through review of scientific literature and existing data sources, primarily including the following:

- *San Joaquin River Restoration Study Background Report*, edited by McBain and Trush, December 2002
- *San Joaquin River Fishery and Aquatic Resources Inventory*, DFG, January 2007
- *Inland Fishes of California*, by Peter B. Moyle, 2002a
- USFWS Endangered Species Lists, April 2008
- *Distribution, Ecology, and Status of the Fishes of the San Joaquin River Drainage, California*, L.R. Brown and P.B. Moyle, 1993
- *Variation in Spring Nearshore Resident Fish Species Composition and Life Histories in the Lower Sacramento-San Joaquin Watershed and Delta (California)*, L.R. Brown and J.T. May, 2006

Additional simulation is being prepared to determine the impacts of the program alternatives under the 2008 USFWS CVP/SWP Operations BO and the 2009 NMFS CVP/SWP Operations BO. The results of this assessment may change the anticipated effects of the alternatives; however, the relative impacts and overall impact mechanisms are not anticipated to change with the results of this assessment. Results of the assessment will be provided in the Final PEIS/R.

5.1 Historical Perspective

The San Joaquin River was historically an alluvial river downstream from the present-day Friant Dam, with several morphological transitions that delineate the SJRRP-defined river reaches in the Restoration Area. Within this broader, historical alluvial river context, the channel in Reach 1 was gravel-bedded, with bedrock exposures that controlled river gradient, and the river often comprised multiple channels because of periodic migration and avulsion during large floods. In Reaches 2 through 5, the river was sand-bedded, meandering, and, in some reaches, had multiple channels. Reaches 3 through 5 were also noted for flood basins adjacent to the river that extensive tule marsh habitat and sloughs. Riparian vegetation varied between the reaches, with patchy riparian vegetation in Reach 1, more extensive but narrow riparian forests in Reaches 2 and 3, and extensive tule marsh and natural riparian levees in Reaches 3 through 5. Floodplains and flood basins were vast and seasonally inundated, which allowed fish access to high-quality ephemeral aquatic habitat.

Significant changes in physical (fluvial geomorphic) processes, and substantial reductions in streamflows in the San Joaquin River since the construction of Friant Dam, have resulted in large-scale alterations to the river channel and associated aquatic, riparian, and floodplain habitats. These changes have affected various aquatic species that rely on both off-channel aquatic habitats and adjacent upland habitats.

5.1.1 Historical Aquatic Habitat Conditions

Historical aquatic habitat conditions of San Joaquin River fisheries are described below.

Flows

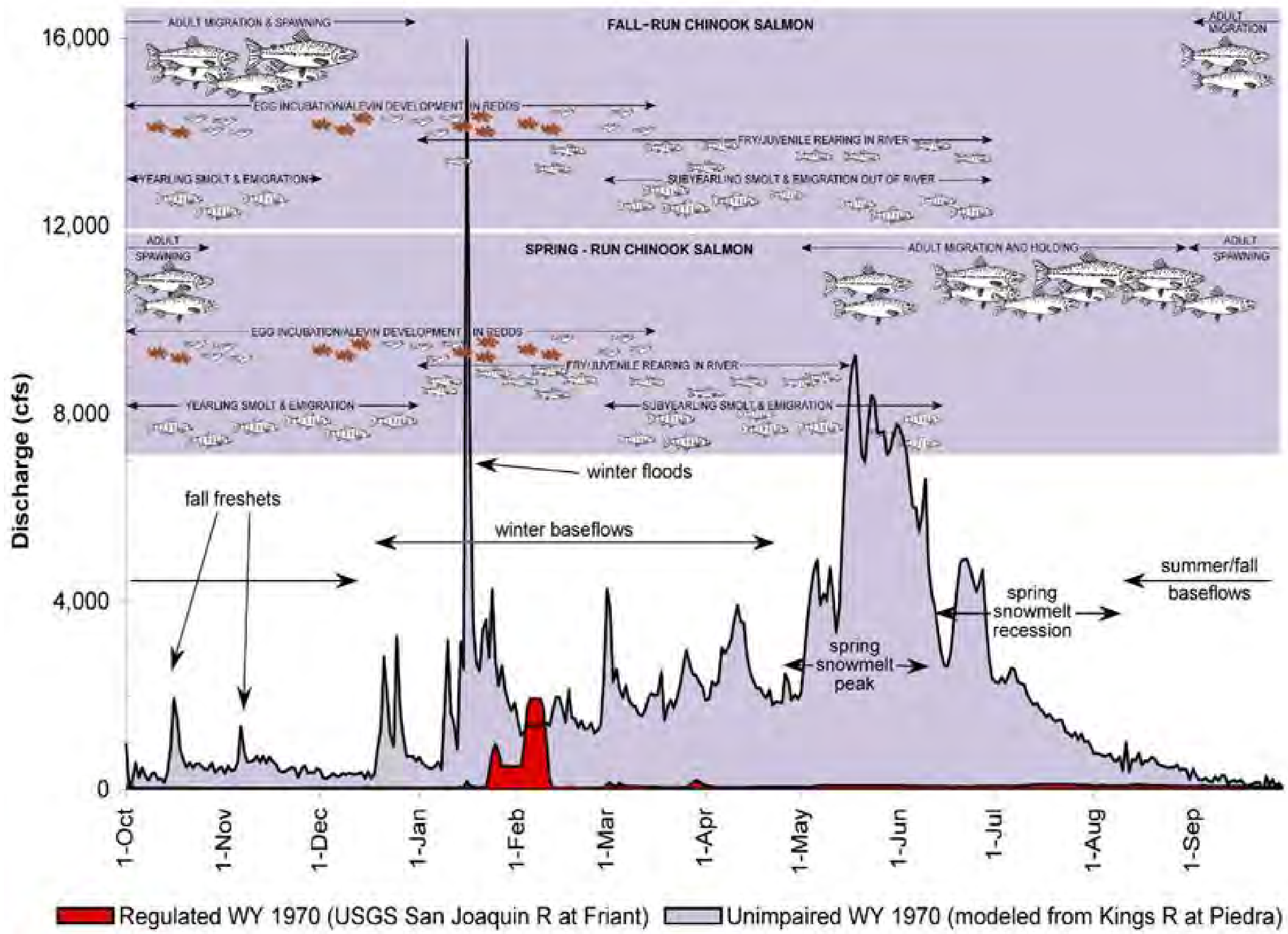
Typical of Central Valley rivers and a semiarid climate, the natural or “unimpaired” flow regime of the San Joaquin River historically varied greatly in the magnitude, timing, duration, and frequency of streamflows, both interannually and seasonally. Variability in streamflows created conditions that partially helped sustain multiple salmonid life history trajectories and the life history phases of numerous resident native fish species and other aquatic species.

It is unclear whether adult fall-run Chinook salmon (*Oncorhynchus tshawytscha*) in the San Joaquin River historically required fall freshets (rain-driven floods) for migration, but it is likely that fall freshets would have increased adult survival and spawning success. Winter flood events may have partially distributed juvenile spring-run Chinook into downstream reaches and onto floodplains where habitat was available for overwintering and rearing. Spring snowmelt floods and subsequent gradual increases in water temperatures that accompanied the snowmelt recession likely encouraged smolting of juvenile fall-run and spring-run Chinook salmon (*O. tshawytscha*), providing cues for downstream migration.

High spring flows created conditions needed for spawning and rearing by resident native fishes, both in the river channel and on inundated floodplains. All native resident fish species in the San Joaquin River spawn in the late winter or spring when water has been historically abundant in the system (Moyle 2002a, Marchetti and Moyle 2001).

Sacramento splittail (*Pogonichthys macrolepidotus*), for example, spawn and begin rearing on inundated floodplains between February and May (Moyle 2002a), and would likely have been historically abundant in the Restoration Area when high flows provided suitable habitat.

The unimpaired hydrograph had five distinct components: fall freshets, winter baseflows and winter floods, snowmelt peak flows, a snowmelt recession limb, and summer-fall baseflows (Figure 5-1).



Source: McBain and Trush 2002.

Key: cfs = cubic feet per second
R = river
USGS = U.S. Geological Survey
WY = water year

Figure 5-1.
Annual Unimpaired Hydrograph of San Joaquin River at Friant (modeled) and Regulated Flows at Friant (measured) for Approximately Average Water Year Conditions

River Habitat

After completion of Friant Dam, and resulting downstream changes in flow and sediment dynamics, the frequency and distribution of habitat types and microhabitat features of the San Joaquin River changed substantially compared to historical conditions. Prior to the construction of Friant Dam, Reach 1 consisted of braided channels and side channels, which were likely very important spawning areas, and provided high-quality fry and juvenile rearing habitat (McBain and Trush 2002). In the unconfined valley reaches, the river flowed through an extensive flood basin that had frequent prolonged inundation, particularly during the spring snowmelt runoff period. Numerous sloughs, oxbows, and high-flow scour channels (in addition to the flood basins and tule marshes) likely provided enormous amounts of rearing habitat for salmonids, Sacramento splittail, and other native fishes during winter and spring (McBain and Trush 2002).

The historically variable flow regime of the San Joaquin River caused spatial and temporal differences in sediment transport, scour, and deposition on alternate bar features to create morphologic and hydraulic complexity, which in turn produced diverse, high-quality aquatic habitat for salmon and other aquatic species, as described below:

- **Deep pools –** Provided holding habitat for adult salmonids and preferred habitat for other native fishes.

- **Natural hydraulic conditions in riffles and pool tails –** Provided preferred spawning conditions for salmonids and other native fishes.

- **Permeable, frequently mobilized gravels –** Supported high invertebrate production and preferred (but variable) conditions for spawning and egg incubation by salmonids and other native fishes.

- **Cobble substrates along slack-water bar surfaces and in shallow backwater zones behind point bars –** Provided winter and spring rearing habitat for juvenile salmonids and other native fishes.

- **Inundated bar and floodplain surfaces during high flows –** Provided velocity refugia for many aquatic species and high-quality ephemeral rearing habitat for juvenile salmonids.

- **Abundant primary and secondary production areas on the surface of gravels and cobbles, on woody debris, and on floodplains –** Provided abundant forage and prey (food) resources for fish and other aquatic species.

- **Abundant large organic debris (logs, root wads) and high rates of nutrient input (leaf litter, salmon carcasses) –** Provided structurally diverse habitat for many fish and other aquatic species (e.g., western pond turtles) and a primary source of nutrients for lower trophic levels.

Water Quality

Water quality in the San Joaquin River has likely changed in many locations; however, the level of change relative to historic conditions is unknown because of the paucity of data. Anecdotal evidence suggests the San Joaquin River provided high-quality habitat conditions for native fish, including anadromous salmonid populations. Perhaps the best description of historical water quality in the upper river is from Blake (1857, as cited in Yoshiyama et al. 1996), who described the San Joaquin River in the vicinity of Millerton, in July, as "remarkably pure and clear, and very cold." Cold, clear snowmelt runoff flowing from the granitic upper basins of the southern Sierra Nevada likely provided optimal conditions for freshwater life-history stages of salmonids in the upper San Joaquin River, and for production of invertebrates, the primary food resource for salmonids. The abundant cold water in the upper San Joaquin River presumably had high (saturated) dissolved oxygen (DO) concentrations, low salinity, and neutral pH levels. Suspended sediment and turbidity levels were likely low, even during high runoff events, because of the predominantly granitic geology in the upper San Joaquin River basin, as well as relatively low rates of primary productivity (algae growth). Because of the limited amount of historical temperature data available in the Restoration Area, it is unknown how late into spring and summer that river water temperatures would have been low enough to support salmonids and other native cold-water fishes. Even during periods of unsuitably high water temperatures, local artesian springs, groundwater seeps, and riparian wetlands may have provided local water temperature refugia.

5.1.2 Historical Fish Communities

Fish communities in the San Joaquin River basin have changed markedly in the last 150 years. Before Euro-American settlement, the river supported a distinctive native fish fauna that had evolved in relative isolation over a period of several million years. These native fish assemblages were adapted to widely fluctuating riverine conditions, ranging from large winter and spring floods to warm, low, summer flows. These environmental conditions resulted in a broad diversity of fish species that included both cold-water anadromous salmonids, and cold-water and warm-water resident fish species.

Moyle (2002a) has described the following four fish assemblages for the Central Valley:

- Rainbow trout
- California roach
- Pikeminnow-hardhead-sucker
- Deep-bodied fish

These assemblages are naturally separated to some degree by elevation. It should be recognized, however, that local variations in stream gradient, water temperature, and other important habitat features commonly blur the distinctions between these fish assemblages, resulting in deviation from generalized distribution patterns and overlap of species from one assemblage to another. Nevertheless, the assemblages are helpful in describing California's fish communities, and the assemblages highlight the influence of physical and chemical habitat features on the structure and distribution of these communities.

The rainbow trout, California roach, and pikeminnow-hardhead-sucker assemblages generally inhabit portions of the river flowing through high and mid-elevation mountains and foothills. The deep-bodied fish assemblage previously occupied San Joaquin and Sacramento valley flood reaches, lakes, and floodplain habitats, but native fish species in this assemblage are now extinct (e.g., thicktail chub (*Gila crassicauda*)), extirpated (e.g., Sacramento perch (*Archoplites interruptus*)), or are substantially reduced in abundance and distribution because of the drastic changes that have occurred in these ecosystems (Moyle 2002a). The habitats once occupied by this assemblage are now inhabited primarily by nonnative fish species. These assemblages are described in more detail below, along with anadromous salmonids that formerly used the Restoration Area during the freshwater portion of their life cycle.

Rainbow Trout Assemblage

The higher gradient, upper portions of the San Joaquin River flow out of the Sierra Nevada Range and historically supported fish adapted to swift water velocities, high gradient habitats, such as riffles, relatively cool temperatures (less than approximately 70 °F), and high DO concentrations (Moyle 2002a). The dominant native fish found in these sections (upstream from Friant Dam and the upper part of Reach 1 of the Restoration Area) was rainbow trout *(O. mykiss)*, with riffle sculpin *(Cottus gulosus)*, Sacramento sucker *(Catostomus occidentalis)*, and speckled dace *(Rhinichthys osculus)* also occurring commonly in this assemblage. California roach *(Lavinia symmetricus)* is also a part of this assemblage in some streams. Rainbow trout, and to a lesser extent the other species in this assemblage, are adapted to living in coarse substrates with dense riparian vegetation that provides cover and shade, and habitats formed by instream large woody debris. Most of these species feed on aquatic and terrestrial invertebrates, although larger trout will prey opportunistically on other fish. This assemblage was historically dominant in the San Joaquin River and tributaries upstream from present-day Friant Dam, and it is likely that fishes in this assemblage also occurred in the upper portion of Reach 1. Chinook salmon and steelhead *(O. mykiss)* also co-occurred with the rainbow trout assemblage upstream to impassable barriers, and this area likely contained the majority of spring-run Chinook holding and spawning habitat and steelhead spawning habitat (see the Anadromous Salmonids section, below). Other fish species that may have overlapped with this assemblage included Pacific lamprey *(Lampetra tridentata*), Kern brook lamprey (*L. hubbsi*) and threespine stickleback (*Gasterosteus aculeatus*) (McBain and Trush 2002).

California Roach Assemblage

The California roach assemblage is adapted to the low DO concentrations and high temperatures (up to approximately 86°F) that seasonally occur in intermittent lower-foothill tributaries to the San Joaquin River (corresponding to tributary sections in Reach 1). The California roach is the dominant species in this assemblage, although Sacramento suckers, Sacramento pikeminnow *(Ptychocheilus grandis)*, and other cyprinid species occasionally spawn in intermittent streams during the winter and spring. Accordingly, the distribution of the California roach assemblage may be largely coincident with the pikeminnow-hardhead-sucker assemblage. It is also likely that steelhead and possibly Chinook salmon occasionally spawned in the lower portions of some intermittent streams (Maslin et al. 1997).

Pikeminnow-Hardhead-Sucker Assemblage

The pikeminnow-hardhead-sucker assemblage historically occupied the mainstem portions of the San Joaquin River flowing through the lower foothills (corresponding to the upper portion of mainstem Reach 1). Habitats within these sections range from deep, rocky pools to wide shallow riffles. Species within this assemblage were adapted to low flows and warm-water temperatures in summer, infrequent large floods and cold-water temperatures in winter, and high flows of long duration during the spring snowmelt period. The primary species in this assemblage were Sacramento pikeminnow, Sacramento sucker, and hardhead (*Mylopharodon conocephalus*). Tule perch (*Hysterocarpus traski traski*), speckled dace, California roach, riffle sculpin, prickly sculpin (*Cottus asper*), threespine stickleback, and rainbow trout were also occasionally found in this assemblage. Anadromous Chinook salmon, steelhead, Pacific lamprey, and Kern brook lamprey spawned in this zone, and rearing juvenile Chinook salmon, steelhead, and lamprey were part of the assemblage. Historically, white sturgeon *(Acipenser transmontanus)* may also have been found in portions of the river with this fish assemblage. Green sturgeon (*A. medirostris*), if historically present, would have also occurred with this assemblage.

Deep-Bodied Fish Assemblage

The deep-bodied fish assemblage generally occupied the lower gradient, valley-bottom portions of the San Joaquin River where flows were generally slower and water temperatures were often higher than upstream habitats (corresponding to Restoration Area Reaches 2 through 5, and downstream from the Restoration Area). Some of the native species in this group, such as Sacramento perch, thicktail chub, and tule perch, were adapted to warm, shallow, low-velocity backwaters with thick aquatic vegetation, while others, such as hitch (*Lavinia exilicauda*), Sacramento blackfish (*Orthodon microlepidotus*), and Sacramento splittail were adapted to large, open, sluggish mainstem river channels. Large Sacramento pikeminnows and suckers were also abundant in this zone, migrating into tributaries to spawn (Moyle 2002a). Adult Chinook salmon and steelhead migrated through this zone to spawn farther upstream, and their juveniles passed through this zone while migrating downstream to the ocean. Extended rearing by salmonids on large floodplains likely occurred when flows in late winter or spring were high enough to inundate the floodplain for several weeks. Species in this assemblage were particularly well adapted to the once-abundant floodplain habitat found on the valley floor. Floodplains provided refuge from high flows, productive foraging habitat, and protection from larger predatory fish that inhabited adjacent deep water habitats (Moyle 2002a, Sommer et al. 2001). Sacramento splittail, Sacramento blackfish, and possibly thicktail chub spawned in the inundated floodplains (Moyle 2002a). Moyle suggests that the huge, shallow lakes in the San Joaquin Valley (e.g., Tulare, Buena Vista, Kern lakes) that historically drained the Kern, Tulare, Kaweah, and Kings rivers were perhaps the most productive year-round habitat for this assemblage (Moyle 2002a). These lakes supported large populations of Sacramento perch, thicktail chub, Sacramento blackfish, Sacramento pikeminnow, and Sacramento suckers. Indigenous tribes and early Euro-American settlers were sustained year-round by harvesting these abundant fish (Moyle 2002a).

Anadromous Salmonids

Salmon were an important part of the cultures of many indigenous tribes living in the Central Valley; tribes in this region attained some of the highest pre-European-settlement population densities in North America (Yoshiyama 1999). In the mid-1800s, particularly during the California Gold Rush, salmon gained the attention of early European settlers, and commercial harvest of salmon in the Sacramento and San Joaquin rivers soon became one of California's major industries (Yoshiyama 1999).

In the San Joaquin River, spring-run Chinook salmon historically spawned as far upstream as the present site of Mammoth Pool Reservoir, where their upstream migration was historically blocked by a natural velocity barrier (P. Bartholomew, pers. com., as cited in Yoshiyama et al. 1996). Fall-run Chinook salmon generally spawned lower in the watershed than spring-run Chinook salmon (DFG 1957). The San Joaquin River historically supported large runs of spring-run Chinook salmon; DFG (1990, as cited in Yoshiyama et al. 1996) suggested that this run was one of the largest Chinook salmon runs in any river on the Pacific Coast, with an annual escapement possibly ranging from 200,000 to 500,000. Construction of Friant Dam began in 1939 and was completed in 1942, which blocked access to upstream habitat. Nevertheless, runs of 30,000 to 56,000 spring-run Chinook salmon were reported in the years after Friant Dam was constructed (Yoshiyama et al. 1998), with salmon holding in the pools and spawning in riffles downstream from the dam. Millerton Lake began filling in 1944, and in the late 1940s increasing amounts of water were diverted into canals to support agriculture. Flows into the mainstem San Joaquin River were reduced to a point that the river ran dry in the vicinity of Gravelly Ford, approximately 38.5 miles downstream from Friant Dam. By 1950, spring-run Chinook salmon were extirpated from the San Joaquin River (Fry 1961).

Although the San Joaquin River also supported fall-run Chinook salmon, they historically composed a smaller portion of the river's salmon population (Moyle 2002a). By the 1920s, reduced autumn flows in the mainstem San Joaquin River nearly eliminated the fall-run Chinook salmon, although a small run did persist. DFG currently operates an artificial fish barrier on the San Joaquin River to direct migrating adult salmon into the Merced River and prevent them from entering the upper San Joaquin River. Despite the barrier, fall-run Chinook salmon occasionally stray up the San Joaquin River, especially during wet years. Although data are limited, DFG (1991, as cited in Brown 1996) reported that 2,300 fall-run Chinook salmon of Merced River origin strayed up the San Joaquin River during 1988, 322 in 1989, and 280 in 1990. Each of these years was relatively dry; it is likely that more adult fall-run Chinook salmon would attempt to stray upstream during wet years.

Steelhead are believed to have been historically abundant in the San Joaquin River, although little detailed information on their distribution and abundance is available (Lindley et al. 2006, McEwan 2001). In large river systems where steelhead still occur, they are almost always distributed higher in a watershed than Chinook salmon (Voight and Gale 1998, as cited in McEwan 2001, Yoshiyama et al. 1996). Therefore, steelhead may have spawned at least as far upstream as the natural barrier located at the present-day site of Mammoth Pool, and in the upper reaches of San Joaquin River tributaries. Modeling of potential steelhead habitat by Lindley et al. (2006) suggests that a portion of the upper San Joaquin River basin historically supported an independent steelhead population. However, much of the habitat downstream from this population's modeled distribution may have been unsuitable for rearing because of high summer water temperatures (Lindley et al. 2006). Lindley et al. (2006) concluded that suitable steelhead habitat existed historically in all major San Joaquin River tributaries, although to a lesser degree than in stream systems in the Cascades, Coast Range, and northern Sierra Nevada. Steelhead are historically documented in the Tuolumne and Kings river systems (McEwan 2001).

Steelhead abundance and distribution in the San Joaquin River basin have substantially decreased (McEwan 2001), and steelhead have been extirpated from the Restoration Area for the same reasons as described above for salmon. Based on their review of factors contributing to steelhead declines in the Central Valley, McEwan and Jackson (1996) concluded that basin-wide population declines were related to water development and flow management that resulted in habitat loss. Dams have blocked access to historical spawning and rearing habitat in upstream, forcing steelhead to spawn and rear in the lower portion of the rivers where water temperatures are often high enough to be lethal (Yoshiyama et al. 1996, McEwan 2001, Lindley et al. 2006). Steelhead continue to persist in low numbers in the Stanislaus, Tuolumne, and, possibly, Merced river systems (McEwan 2001, Zimmerman et al. 2008).

5.2 Environmental Setting

This environmental setting section describes effects of general environmental conditions on fish. This section also describes the aquatic habitat and distributions of native and introduced fish species found in the San Joaquin River upstream from Friant Dam, in the Restoration Area, in the San Joaquin River between the Merced River and the Delta, in the three main San Joaquin River tributary rivers, and in the Delta. Greater detail is provided to describe conditions in the Restoration Area.

5.2.1 General Environmental Conditions Affecting Fish

The effects of general environmental conditions on fish are described below. These conditions include water temperature, suspended sediment and turbidity, predation, food web support, hybridization, competition, and disease.

Water Temperature

Most fish maintain body temperatures that closely match their environment (Brown and Moyle 1993). As a result, water temperature has a strong influence on almost every fish life-history stage, including metabolism, growth and development, timing of life-history events, and susceptibility to disease. These effects may vary depending on a fish's prior thermal history (i.e., acclimation). Reduced growth, reduced reproductive success, inhibited movement, and mortality of fish can occur when water temperature exceeds the metabolic tolerance of a particular life stage (Hughes et al. 1978, Bjornn and Reiser 1991).

In the San Joaquin River, water temperature is primarily a concern for native fish that thrive in cooler water, such as salmon, steelhead, and rainbow trout (Bjornn and Reiser 1991), and for those that require cooler water for specific life stages (Moyle 2002a). Summer water temperatures in many Central Valley streams regularly exceed 77°F (Moyle 2002a). Sustained periods of increased water temperature can impact behavioral and biological functions of all fish in the San Joaquin River system, including special-status species and others that are relatively tolerant of warm temperatures.

Suspended Sediment and Turbidity

Suspended sediments such as clay, silt, organic matter, plankton and other microscopic organisms cause turbidity in water that can interfere with photosynthetic primary productivity, water temperature, DO, and fish feeding habits.

Turbidity generally reduces the efficiency of piscivorous (fish-eating) and planktivorous (plankton-eating) fish in finding and capturing their prey (Henley et al. 2000). Higher turbidity may occasionally favor the survival of young fish by protecting them from predators (Burton 1985, Van Oosten 1945) at the expense of reduced growth rates for sight-feeding fish (Newcombe and MacDonald 1991, Newcombe and Jensen 1996).

During high-flow events, high concentrations of suspended sediment can temporarily bury stream substrates that provide habitat for aquatic invertebrates, an important food source for many special-status species and other native fishes. Sediment that falls out of suspension may also reduce the quality of spawning substrates, and has the potential to entomb or suffocate (cut off oxygen supply) eggs and larvae in stream gravels. Other common effects of suspended sediment on fish include reduced avoidance or alarm reactions, displacement from key habitats, physiological stress and respiratory impairment, damage to gills, reduced tolerance to disease and toxicants, and direct mortality at very high levels (Newcombe and Jensen 1996, Bash et al. 2001).

In addition to the direct effects on fishes, indirect effects of suspended sediment are related to contaminant transport. Suspended sediments are associated with nutrient loading to the water column as well as sorption of many contaminants (e.g., polar organics, cationic metal forms).

Predation

Predation impact mechanisms include changes in ecosystem structure that increase prey vulnerability or increase predator feeding efficiency. Several physical impact mechanisms may contribute to increased predation, including alterations in flow regime, removal of riparian cover, organism diversion, changes in turbidity, and reduced habitat heterogeneity. Increased prey vulnerability may also be associated with other environmental conditions, including water temperature conditions, flow diversions, change in water surface level, increased pollutant concentration, and fishing (Spence et al. 1996). These mechanisms generally alter predator-prey relationships by disrupting or reducing cover, space, and refuge.

Infrastructure or operational elements of the water conveyance system may also lead to behavioral changes, metabolic disruption, or other biological and ecological outcomes that increase prey vulnerability to predators. Increased water temperatures or other environmental conditions may place increased metabolic demands on susceptible groups of fish and hinder their flight response or capability to take refuge from threats by predation (Spence et al. 1996). Reductions in shaded riverine aquatic cover will potentially expose fish to increased risk of capture by avian or terrestrial predators.

Food Web Support

Food web support includes nutrient availability and cycling, food production, and food availability. Physical and chemical processes occurring in an ecosystem provide the structure in which biological constituents can develop; thus, organisms that provide the food base for fish species are affected by the same environmental conditions that affect the representative fish species. Food web support is essential to maintain species diversity, abundance, and distribution within an aquatic community.

Changes in other environmental conditions, such as riparian vegetation, flow, channel morphology, water quality, instream habitat components, pollution inputs, and floodplain and off-channel habitat access, can impact nutrient cycling, food availability, and food web dynamics (Murphy and Meehan 1991, Spence et al. 1996).

Hybridization

Hybridization can occur when there is a shift in temporal (timing) or spatial (area) habitat use between two closely related species or even subspecies and evolutionarily significant units (as in the case for Chinook salmon in the Central Valley). This phenomenon can lead to loss of unique genetic composition, reduced genetic fitness, and reduced reproductive success (Allendorf et al. 2001). Hybridization can pose a potentially serious conservation problem through loss of distinct, native, or potentially adaptive genetic components or lineages (Stephens and May 2007).

Hybridization can occur through water diversions that entrain and transfer fish (along with water) from one drainage to another (Moyle 2002a). Habitat modifications can also serve as important factors contributing to increases in hybridization rates (Rhymer and Simberloff 1996).

Competition

Competition between species occurs when individuals or populations have overlapping needs for limited resources (Pianka 1988). Competition is generally expressed either through aggressive behavior, in which one individual or species prevents another from using a particular resource, or through exploitative behavior, when one individual or species is more efficient at using a particular resource (Moyle et al. 1986).

Changes in temperature, flow, habitat elements, and food availability can all impact the level of interspecific (between species) and intraspecific (within a species) competition (Spence et al. 1996). Water diversions that may introduce nonnative species to a given habitat may increase the potential for competition in aquatic systems. Changes in water temperature can affect interspecific interactions through shifts in resource exploitation efficiency (Reeves et al. 1987). Changes in flow regime may alter the available prey base, and may also result in increased interspecific and intraspecific competition for suitable rearing feeding, spawning, and refuge habitats, with one individual or population becoming more proficient at exploiting a particular resource.

Disease

Diseases in fish can occur as a result from naturally occurring pathogens within a river system, as a result of transmission through infected fish that are transferred into the system, or as a result of synergistic effects between environmental stressors that support favorable disease transmission conditions. Diseased fish may experience direct mortality, or may be subject to other sublethal effects, such as impaired performance leading to reduced feeding and reproductive success, increased susceptibility to other environmental stressors, increased vulnerability to predation, and decreased competitive capabilities (Stewart 1991, Spence et al. 1996). The susceptibility of fish to disease is greatly influenced by water temperature, as is the number and virulence of pathogens and occurrence of infective life stages of parasites (Spence et al. 1996). Other factors, such as DO levels, pollution, population density, and species and life stage, also influence the likelihood of a fish becoming infected with a certain disease.

Changes in flow or riparian vegetation that trigger large increases in water temperature may decrease the resistance of a fish or species to a particular disease. In addition, increases in water temperatures may work synergistically with other environmental stressors to cause diseases to occur in fish that would otherwise be absent. Transfers of fish or water from one basin to another or from a hatchery to a natural system could introduce a new pathogen to a particular system, and fish present in that system may be susceptible to becoming infected. Alternately, fish transplanted from a hatchery or other natural system that are otherwise healthy could become susceptible to infection by pathogens found in the new environment.

5.2.2 San Joaquin River Upstream from Friant Dam

This section summarizes existing aquatic habitat conditions and fish species present in this portion of the study area.

Aquatic Habitat

Aquatic habitat upstream from Friant Dam, including Millerton Lake, consists of small headwater creeks and larger steep-gradient streams that flow into a complex network of lakes and reservoirs associated with hydroelectric projects (see Chapter 19.0, “Power and Energy”).

The San Joaquin River basin upstream from Millerton Lake consists of granitic soils with low mineral and nutrient content. The reservoir, therefore, is likely to have low productivity. Nine miles of river stretch from Millerton Lake upstream to Kerckhoff Dam. In this section of the river, the San Joaquin flows at 15 cfs in dry water years and 25 cfs in normal water years, as mandated by the Federal Energy Regulatory Commission (FERC), with additional unregulated releases during high flows (PG&E 1999). The river channel bed in this section is bedrock with an overall average gradient of about 1 percent, and has many long narrow pools and an occasional steep cascade.

Millerton Lake, formed by Friant Dam in the lower foothills of the Sierras, is the largest reservoir on the San Joaquin River. Most of Millerton Lake becomes thermally stratified during the spring and, therefore, supports a two-stage fishery, with cold-water species residing in deep water and warm-water species inhabiting surface waters and shallow areas near shore. The most upstream portion of Millerton Lake does not stratify because of its relatively shallow depths and turbulent inflow from the San Joaquin River.

Water-level fluctuations resulting from reservoir management are perhaps the most significant factor affecting reservoir fish. Because of large fluctuations in water levels, shoreline habitat in the reservoir is vegetated only in spring and early summer of wetter years, when rising water levels inundate terrestrial plants that have colonized near-shore environments. Water level fluctuations have a direct effect on black bass species, such as largemouth bass (*Micropterus salmoides*) and spotted bass (*M. punctulatus)*, which construct nests for their eggs in shallow water habitat (Kohler et al. 1993, Thorton et al. 1990, Aasen and Henry 1980). Falling water levels expose nests to wave action or dewater them entirely, while rising water levels may expose the nests to cold water that kills the eggs or slows their development.

Fish

Many introduced species inhabit the San Joaquin River upstream from Friant Dam. Millerton Lake and other waterways in this region are popular fishing destinations. The principal game species include spotted bass, largemouth bass, smallmouth bass (*M. dolomieu*) (these three species are collectively referred to as black bass), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), and striped bass (*Morone saxatilis*). The principal forage species for most of the game fishes is threadfin shad (*Dorosoma petenense*). American shad (*Alosa sapidissima*), which was introduced to Millerton Lake in the 1950s, is an important prey item for adult striped bass. The Millerton Lake population of American shad is the only known successfully spawning, landlocked population of this species (PG&E 1986, 2001). Several native nongame species have been collected from Millerton Lake, including Sacramento sucker, Sacramento pikeminnow, Sacramento blackfish, hitch, hardhead, and white sturgeon. However, most of the native species have been extirpated in recent years (Mitchell, DFG, pers. com. 2006).

The San Joaquin River between Kerckhoff Dam and Millerton Lake contains spawning habitat for American shad and striped bass. Native fish species in this section of the river include hardhead, Sacramento pikeminnow, Sacramento sucker, and rainbow trout. Nonnative fish species include smallmouth bass and green sunfish (*L. cyanellus*). Kern brook lamprey, the only fish species endemic to the San Joaquin River basin, has also been reported as potentially present in this section, although its current status in the area is uncertain (Wang 1986). Upstream tributaries host remnant populations of native species, including Sacramento sucker, Sacramento pikeminnow, and hardhead in Willow Creek, and Sacramento sucker and hitch in Fine Gold Creek.

5.2.3 San Joaquin River from Friant Dam to Merced River

This section summarizes aspects of the current aquatic habitat and the distribution of fish found in the five reaches of the Restoration Area and the Restoration Area bypasses. The Restoration Area encompasses the San Joaquin River from Friant Dam downstream to the confluence with the Merced River. A recent, comprehensive evaluation of aquatic habitat in the Restoration Area has not been performed; information presented in this section is compiled from existing information.

Aquatic Habitat

Aquatic habitat conditions vary spatially and temporally throughout the five river reaches and the flood bypasses in this area because of differences in habitat availability and connectivity, water quantity and quality, channel morphology, and predation risks. Throughout the area, physical barriers, reaches with poor water quality or no surface flow, and the presence of false migration pathways have reduced habitat connectivity for anadromous and resident native fishes. Significant structures in the Restoration Area that are impediments to both upstream and downstream fish movement include the following:

- Seasonally deployed weir located at Hills Ferry (Hills Ferry Barrier), just upstream from the confluence with the Merced River, to direct migrating adult salmonids into the Merced River and prevent them from entering the San Joaquin River; the Hills Ferry Barrier has been operated by DFG since 1992.
- Eastside Bypass drop structure near its confluence with the San Joaquin River.
- Mariposa Bypass drop structure near its confluence with the San Joaquin River.
- San Joaquin River Headgate Structure at the Sand Slough Control Structure.
- Sack Dam, a diversion dam for Arroyo Canal.
- Mendota Dam, delivery point of the DMC and diversion point for several irrigation canals and pumps.
- Radial gates and control structure on the Chowchilla Bypass Bifurcation Structure.
- At least one earthen diversion dam just downstream from Gravelly Ford.
- Friant Dam, primary storage dam on the San Joaquin River and upper limit of potential salmonid migration.

In addition to barriers, false migration pathways may impede fish movement in the Restoration Area. False migration pathways lead fish away from habitats that would support survival and growth. False pathways also affect both upstream and downstream fish movement. During upstream movement, flow may attract fish into drains and bypasses that do not provide habitat because spawning substrate or cover, food availability, water temperatures, DO concentrations, salinity, and other environmental conditions are unsuitable.

The San Joaquin River also has an extensive system of bypasses and canals that divert and carry water around the mainstem San Joaquin River channel. Bypasses may not have environmental conditions that support movement of fish to downstream habitat, especially if flow entering the bypass becomes discontinuous and fish are stranded. Canals generally do not provide habitat that can sustain populations of most fish species, and frequently end in irrigated agricultural fields.

Potential false pathways created by the bypass and canal systems are Salt Slough, Mud Slough, Bear Creek, Ash Slough, Berenda Slough, Dry Creek, Fresno River, Lone Willow Slough, Mariposa Bypass, Eastside Bypass, Arroyo Canal, Main Canal, other canals, and Little Dry Creek (see Chapter 2.0, "Description of Alternatives" for a map of the Restoration Area, including many of these pathways). Gravel mining ponds in Reach 1 may also be minor false pathways that can confuse downstream and upstream migrating fish and delay migration.

Most aquatic habitat in the bypasses is temporary, and its duration depends on flood flows. The bypasses are largely devoid of aquatic and riparian habitat because of hydraulic conveyance maintenance efforts (McBain and Trush 2002). Portions of the Eastside Bypass near Merced National Wildlife Refuge are reportedly wet year-round, but it is unknown whether these areas support fish. Although the bypasses provide very little perennial aquatic habitat, fish and other aquatic species may be present in the bypasses during wet conditions, including high-flow periods when a portion of the San Joaquin River flow is routed into the bypass system.

Many changes have occurred to channel morphology in the Restoration Area, with the most pronounced as follows:

- **Reach 1 –** In-channel and floodplain pits and exposed gravel bars and floodplains created by instream gravel mining in Reach 1 have impeded coarse sediment routing, reduced native fish habitat, increased river water temperatures, and increased habitat for nonnative species. As has been demonstrated on the Tuolumne River, these pits provide habitat conducive to nonnative predatory fish species such as largemouth and smallmouth (EA Engineering 1991). Gravel pits have also converted what was historically lotic habitat to lentic habitat, which may provide habitat for Sacramento pikeminnow. In addition, in Reach 1, riparian encroachment has occurred, channels have been incised, mobilization of bed material is less frequent, and possible filling of gravel interstices with fine sediment has likely occurred.

- **Reaches 2 Through 5 –** Habitat conditions for fish in Reaches 2 through 5 have been substantially modified by levee/dike construction, agricultural encroachment, and water diversions. These changes have reduced the quantity of floodplain habitat, as well as reducing main channel habitat complexity and the quantity and quality of off-channel habitat in these reaches. Much of this floodplain habitat has been isolated from the river by dikes and levees, and the remaining floodplain habitat is rarely inundated under current hydrologic conditions.

Important factors and processes affecting aquatic habitat throughout the Restoration Area, including channel migration and avulsion, spawning gravels and sedimentation, habitat heterogeneity, river flow, and benthic macroinvertebrates and algal communities are described in more detail below.

Channel Migration and Avulsion. In the past, channel migration and avulsion were critical processes for creating and maintaining habitat for salmonids and many native fish species, as well as for riparian regeneration and recruiting large woody debris into the channel. Agricultural conversion has reduced the amount of floodplains, and levees and dikes have further isolated historical floodplains from the channel. Additionally, bank protection along channel margins and the reduced flow regime have stabilized the channel, reduced bank erosion, reduced lateral migration, and greatly reduced the processes that create complex side channels and high-flow scour channels. Undercut banks, riparian vegetation, and recruitment of large woody debris have all been reduced or eliminated as a consequence of channel stabilization, and the corresponding habitat benefits realized by these processes have been largely eliminated. See Appendix N, "Geomorphology, Sediment, and Vegetation Assessment," for a more detailed analysis of channel changes over time.

Reduced channel migration has eliminated off-channel habitats, reduced complex side channels, and reduced instream habitat complexity for native fish species. The loss of undercut banks and large woody debris reduces cover and velocity refuge for salmonids and many other native fish species, increasing exposure to predation and high flows. The loss of riparian vegetation recruitment may contribute to increased stream temperatures, and reduced complexity during the now rare periods of floodplain inundation. Current conditions have minimized and mostly eliminated meander migration and oxbow creation.

Spawning Gravels and Sedimentation. Friant Dam has eliminated sediment supply from the upper watershed to the San Joaquin River downstream from the dam. Small particles on the bed surface, such as spawning gravels less than 32 millimeters (mm), have likely been mobilized and deposited downstream since dam construction. The larger particles that were not mobilized remained to form an armor layer, protecting smaller gravels from being exposed to mobilization. The formation of an armor layer and blocked sediment supply has likely reduced the amount of suitable spawning habitat in Reach 1 relative to historical conditions. Although spawning gravel in the Restoration Area is no longer used by anadromous salmonids, it may still provide spawning habitat for other gravel-nesting fish species, including resident rainbow trout and lamprey species.

Several historical and recent estimates of salmonid spawning gravel quantity have been made in the Restoration Area (Table 5-1). Clark (1942) conducted detailed surveys of the San Joaquin River for available spawning gravel, although it is not clear which criteria were used to determine suitability. An estimated 417,000 square feet of suitable spawning gravel was found in 26 miles of channel between SR 41 and the Kerckhoff Powerhouse (14 miles upstream from Friant Dam), where most spawning was historically observed (Table 5-1). Friant Dam inundated 36 percent of this estimated spawning gravel, leaving about 266,800 square feet of suitable spawning gravel in the channel in the section between SR 41 and Friant Dam. In 1943, an estimate was made of 1,000,000 square feet of suitable spawning gravel at a flow of 350 cfs in the section of river between Gravelly Ford and Friant Dam (38 miles of channel) (Fry and Hughes 1958, as cited in Cain 1997). In 1957, Ehlers (R. Ehlers, pers. com. with J. Cain, as cited in Cain 1997) estimated that over twice as much (2,600,000 square feet) spawning gravel occurred in the same reach, only 70 percent of which (1,820,000 square feet) was suitable for spawning (Table 5-1). By the late 1950s, DFG (1957) was concerned that heavy silt and sand deposited by gravel mining operations was damaging the last of the available suitable spawning habitat, which at that time DFG believed was confined to the 13 miles below Friant Dam (Reach 1 upstream from Highway 41).

Table 5-1.
Summary of Anadromous Salmonid Spawning Habitat Estimates in Reach 1 of Restoration Area

Source	Survey Year	Extent of Survey	Estimated Total (square feet)	Estimated Suitable (square feet)
Clark (1942)	1942	Highway 41 to Kerckhoff Powerhouse	417,000	266,800[1]
Fry and Hughes (1958)	1943	Gravelly Ford to Friant Dam	1,000,000[2]	None
Ehlers, pers. com. (in Cain 1997)	1957	Gravelly Ford to Friant Dam	2,600,000	1,820,000[3]
Cain (1997)	1996	Gravelly Ford to Friant Dam	303,000	none
Jones and Stokes Assoc./Entrix (in McBain and Trush 2002)	2001	Friant Dam to Skaggs Bridge	773,000[4]	408,000[4 5]
Stillwater Sciences (in McBain and Trush 2002)	2002	Friant Dam to Highway 99 Bridge	357,000[6]	281,400[1 6]

Notes:
[1] Spawning habitat between Highway 41 and Friant Dam
[2] Estimated at 350 cfs; therefore, incorporated hydraulic suitability
[3] Seventy percent of 2,600,000 square feet was suitable; presumed criterion was quality (limit of fine sediment in gravel)
[4] Included gravel beyond the baseflow channel (e.g., on point bars); probable over-estimate
[5] Based on portion of spawning gravel with less than 40 percent fines (ocular estimate)
[6] Incorporated hydraulic suitability at potential spawning baseflows

Key:
cfs = cubic feet per second
pers. com. = personal communication

More recently, Cain (1997) estimated a total of 303,000 square feet of spawning gravel between Gravelly Ford and Friant Dam (Table 5-1). Most riffles in Reach 1 were described as having suitable gravels, and Cain (1997) attributed the decline of spawning gravel in Reach 1 to effects of Friant Dam, gravel mining operations, and riparian vegetation encroachment. In summer and fall 2000, surveys were conducted of potential spawning gravel in the upper San Joaquin River. Areas considered suitable were delineated, recorded on aerial photos, and transferred to a geographic information system (GIS). These surveys estimated 773,000 square feet of spawning habitat for salmon and steelhead available between Friant Dam and Skaggs Bridge, of which 408,000 square feet contained less than 40 percent fines based on ocular estimates (Table 5-1).

In spring 2002, a second survey was conducted to map suitable spawning gravel Friant Dam to SR 99. Spawning habitat suitability was based on the depth, velocity, and substrate requirements for Chinook salmon and steelhead (McBain and Trush 2002). Thirty-nine riffles were observed in the 12 miles of river between Friant Dam and Highway 41, and an additional 26 riffles were observed in the 12 miles of river between Highway 41 and Highway 99. Many riffles comprised two or more subpatches, often varying in substrate quality and hydraulic suitability. Over 357,000 square feet of suitable spawning gravel were delineated between Friant Dam and the Highway 99 Bridge; approximately 281,400 square feet of suitable spawning gravel occurred between Highway 41 and Friant Dam (Table 5-1). Riffles were infrequent and typically small, with an average area of 5,500 square feet. Many riffles were adjacent to suitable rearing habitat, particularly upstream from SR 41, but very few riffles were adjacent to suitable holding habitat. Substrate was generally well-rounded, with low embeddedness, and low fines. A high proportion of coarse sand (greater than 0.08 inches) appeared to occur upstream from SR 41, and a higher proportion of fine sand (less than 0.08 inches) downstream from Highway 41 (McBain and Trush 2002).

Between Friant Dam and Highway 41 (12 miles of channel), historical estimates of spawning gravel quantity of 266,800 square feet (Clark 1942) are similar to the most recent estimates of 281,400 square feet (based on 2002 surveys, and assuming use of similar suitability criteria). Examining Reach 1 (38 miles of channel), historical estimates of 1,000,000 square feet and 1,820,000 square feet (Ehlers, pers. com., Fry and Hughes 1958, both as cited in Cain 1997) are significantly greater than recent estimates of 303,000 square feet (Cain 1997). The various spawning gravel surveys are somewhat difficult to compare because of differing (or unknown) suitability criteria and methods; therefore, a conclusion cannot be confidently made regarding the degree of spawning habitat loss. However, an assessment by McBain and Trush (2002), based on review of historical photographs and other evidence, indicates that significant loss of suitable spawning habitat has occurred.

In addition to altering spawning gravel dynamics, the presence of Friant Dam has likely changed sedimentation rates in areas outside the main river channel, such as floodplains and side channels. Reduced frequencies of overbank flow, combined with reduced suspended sediment concentrations, may serve to extend the life span of off-channel habitats. The extent to which this is offset by any increase in sediment loading from agricultural runoff is difficult to determine because of a lack of data. Reduced sediment loading may have had particularly significant effects on oxbow lakes, which are disconnected from the mainstem and thus may only aggrade (fill in) during the largest, most infrequent overbank flow events. Reduced bedload under postdam conditions may be less likely to generate closed off-channel habitat areas (oxbow lakes and sloughs). In addition to locally affecting meander migration rates, gravel bar dynamics can also regulate the connectivity of off-channel habitat to the mainstem, and thus alter its quality for fish and other aquatic species.

Habitat Heterogeneity. Increased aquatic habitat heterogeneity has been linked with increased species diversity of stream fishes and the food webs that support them (Power 1992). A key component of habitat heterogeneity is variability in physical structure (i.e., flow, depth, and substrate particle size), with individual habitat units serving as microhabitats within the larger stream channel. A heterogeneous stream channel has a high diversity of microhabitats, and can support a greater diversity of aquatic species.

Impact mechanisms that affect instream microhabitat diversity are those that cause changes in the complexity of channel structure. Inputs of fine sediment may reduce the range of substrate particle size on the surface of the channel bed, thereby reducing overall heterogeneity. Removing or adding instream woody material (IWM) or other structural elements changes the total diversity and abundance of in-channel microhabitats that can support aquatic species. Substantial changes in flow can raise the water surface (i.e., stage) and increase the length of shoreline that interacts with riparian vegetation and other complex shoreline habitat elements. Changes in flow also affect lateral and vertical connectivity and interactions of groundwater and surface water, which can in turn affect microhabitat conditions such as water temperature and quality.

Other environmental conditions that can affect the quality of instream microhabitat include water quality parameters such as temperature, pollution, and turbidity, all of which can influence available habitat area by restricting or increasing access to preferred microhabitats.

Riparian vegetation shades the stream surface, helps regulate river corridor microclimates, provides instream and overhead cover for fish, and provides inputs of IWM, nutrients, and terrestrial invertebrates that support the riverine food web and serve as important food sources for fish. Changes in the amount of shaded riverine aquatic habitat and vegetation have a direct influence on the amount of nearshore habitat for most life stages of special-status fish and other fish species.

A dense overhead riparian canopy shades the stream channel and provides visual cover for fish to avoid predation by avian or terrestrial predators. Changes in the amount of shade alter the amount of solar radiation that reaches the stream, thus affecting seasonal and diel water temperature and primary productivity (Beschta et al. 1987). Downed riparian trees that fall into the channel form an important source of long-term physical aquatic habitat structure. IWM provides visual cover, feeding stations, and physical structures where fish tend to congregate. Localized scour and deposition associated with IWM in streams creates habitat heterogeneity that forms an important component of ecological diversity in aquatic systems (Bisson et al. 1987, Bilby and Ward 1991).

Floodplains influence both the delivery and transport of materials within a system and serve as a source for nutrient uptake, biological productivity, and habitat refuge. Floodplains are a source of stored materials for transport and delivery during high flows, retain materials in transport from the main channel, serve as the structural element for subsurface flow, and reduce water velocity which allows for increased retention of materials (Spence et al. 1996).

Because inundated floodplains have continuous contact with the water column, yet have less water velocity compared to the main channel, they generally have high rates of nutrient uptake and high rates of primary and secondary production (Cooper 1990). When floodplains are inundated during periodic high flows, fish are able to access additional habitat and use this habitat for refuge from high-velocity water in the main channel, and for spawning, rearing, and foraging. In addition, fish may experience higher growth and survival rates as a consequence of the increased productivity in floodplain habitats (Henning et al. 2006, Sommer et al. 2001). Flooded vegetation is particularly used by hardhead larvae and post larvae; Sacramento splittail adult, egg, larval, and juvenile life stages; and rainbow trout larvae and juveniles. Backwater habitat with vegetative cover is frequently used by black bass of all life stages.

River Flow. Alterations in the flow regime can affect the timing, duration, and amount of floodplain habitat that is accessible to fish and, thus, can impact opportunities for increased production, growth and survival. In addition, alterations in the flow regime may increase the potential for stranding as these habitats become dewatered and fish become trapped in vegetation, substrate, or topographic depressions lacking egress. Flow magnitude (i.e., discharge), flow timing, and the duration of flow changes are fundamental environmental conditions for growth, reproductive success, and survival of river fishes and other riverine aquatic species. Flow directly affects most other environmental conditions in rivers, including water temperature, water quality, geomorphic processes, and habitat quantity, quality, and connectivity. These conditions in turn affect many biological interactions. Conversely, the amount of flow is directly affected by diversions and other water operations in regulated systems.

Foodweb Support. Benthic macroinvertebrates and algal communities are poorly documented in the San Joaquin River (Brown 1996). However, it is certain that modifications to habitat and introduction of nonnative species (e.g., crayfish) have substantially impacted the native macroinvertebrate and algal communities (Brown 1996).

Existing gravel substrates and riffles in Reach 1 create productive habitat for benthic invertebrates. Analysis of benthic macroinvertebrate samples collected in Reach 1 in May 2002 suggests that taxa likely to be included in juvenile salmonid diets (mayflies and chironomids, and possibly Trichoptera, Lepidoptera, and Crustacea) were more abundant in Reach 1 (Stillwater Sciences 2003) than in a comparable gravel-bedded reach on the Tuolumne River (TID/MID 1991). Both *Tricorythodes* sp. and *Baetis* sp. were the most common mayflies in both rivers, and densities were much greater in the San Joaquin River than in the Tuolumne River. Both of these genera have a high propensity to drift and are likely to be important components of fish diets. A comparison of nondrifting macroinvertebrate densities also suggests similar, if not greater, densities of prey items likely to be consumed by juvenile fish in gravel-bedded reaches of the San Joaquin River relative to those in the Tuolumne River (Stillwater Sciences 2003).

The availability of potential drifting benthic macroinvertebrates in Reach 5 and in the San Joaquin River downstream from the Merced River confluence was evaluated in May 2002 (Stillwater Sciences 2003). Compared to the relatively high density of benthic macroinvertebrates in Reach 1, densities were lower in Reach 5 and farther downstream.

Increased fine sediment from gravel mining operations may reduce invertebrate production by filling interstitial spaces between substrate particles (Chutter 1969, Bourassa and Morin 1995). The unstable sand substrates and extreme flow variability in Reach 2 and Reach 4 are not likely to support high invertebrate densities. Poor water quality in Reach 5 may also be limiting aquatic production. Inundated floodplains that support riparian vegetation and wetlands are also a primary source of nutrients that propagate through the ecosystem. Floodplain habitats typically produce small invertebrates with short life cycles, such as chironomids and cladocerans (McBain and Trush 2002). No information is available on invertebrate production from Restoration Area floodplains.

The introduction of nonnative species can alter food webs and be detrimental to native species assemblages. Invasive fish species may alter food webs and have profound consequences for native species, including increased competition for resources, direct predation, and habitat or behavior interference (Moyle 2002a). Some nonnative fish species have habitat requirements that overlap with those of native species. These species may be more aggressive and territorial than native species and result in their exclusion from certain habitats. Nonnative fish species in the San Joaquin River and Delta that feed primarily on fish include largemouth bass, smallmouth bass, green sunfish, warmouth (*Lepomis gulosus*), black crappie, and striped bass. Because of their small size and weaker swimming abilities, larval and early life stages of fish are particularly vulnerable to predation.

The loss of salmon from the San Joaquin River Restoration Area has altered the riverine food web. After spawning, adult Chinook salmon carcasses remain in the stream corridor to decompose, and are an important food and nutrient source within a watershed (Cederholm et al. 1999, Thomas et al. 2003). Decomposing salmon carcasses are recognized as a source of marine-derived nutrients that play an important role in the ecology of Pacific Northwest streams (Hicks et al. 2005). Carcass nutrients can affect the productivity of terrestrial vegetation as well as algal and macroinvertebrate communities (Bilby et al. 2003, Nagasaka et al. 2006), which in turn serve as food sources for most juvenile and many adult fish species.

Fish

Fish assemblages currently found in the San Joaquin River are the result of substantial changes to the physical environment, combined with more than a century of nonnative species introductions. Areas where unique and highly endemic fish assemblages once occurred are now inhabited by assemblages composed primarily of introduced species. Primary environmental conditions that currently influence native fish species abundance and distribution (and frequently favor nonnative species) include the following:

- Highly altered flow regimes and substantial flow reductions
- Substantial reductions in the frequency, magnitude, and duration of floodplain inundation
- Isolation of floodplains from the river channel resulting from channelization and levee construction
- Changes in sediment supply and transport
- Habitat fragmentation caused by physical barriers
- Creation of false migration pathways by flow diversions
- Reduced quantity and quality of riparian habitat, including increased prevalence of invasive exotic vegetation
- Degraded water quality
- Dewatered stream reaches

Of the approximately 21 native fish species historically present in the San Joaquin River, at least 8 are now uncommon, rare, or extinct, and an entire fish assemblage – the deep-bodied fish assemblage (e.g., Sacramento splittail, Sacramento blackfish) has been largely replaced by nonnative warm-water fish species (e.g., carp, catfish) (Moyle 2002a). Warm-water fish assemblages, comprised many nonnative species such as black bass species and sunfish species, appear better adapted to current, disturbed habitat conditions than native assemblages. However, habitat conditions in Reach 1 (slightly higher gradient, cooler water temperatures, and higher water velocities) seem to have restricted many introduced species from colonizing Reach 1. The occurrence of fish species within the Restoration Area is described below by reach.

Reach 1. Studies conducted from 2003 through 2005 by DFG and Reclamation, inventoried recent fish distributions in the Restoration Area (DFG 2007). Native fish species captured in Reach 1A included rainbow trout, Sacramento sucker, threespine stickleback, lamprey species, sculpin species, and Sacramento pikeminnow (DFG 2007). No native fish species were captured in Reach 1B during the DFG/Reclamation inventory. Although these species were not detected in Reach 1 from 2003 through 2005, earlier investigations report occurrence in Reach 1 of riffle sculpin (Brown and Moyle 1993), prickly sculpin (Saiki 1984, Brown and Moyle 1993, Moyle 2002a), hardhead (Saiki 1984, Moyle et al. 1989, Brown and Moyle 1993, Mayden et al. 1991, as cited in Moyle 2002a), tule perch (Saiki 1984, Brown and Moyle 1993, Moyle 2002a), and fall-run Chinook salmon (Yoshiyama et al. 1998, DFG 1991, as cited in McBain and Trush 2002, Moyle 2002a).

The following introduced fish species were captured in Reach 1A: green sunfish, western mosquitofish (*Gambusia affinis*), largemouth bass, redear sunfish (*Lepomis microlophus*), brown bullhead (*Ameiurus nebulosus*), black crappie, bluegill, channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), golden shiner (*Notemigonus crysoleucas*), kokanee (*Oncorhynchus nerka*), and spotted bass. The introduced fish species captured in Reach 1B were bluegill, green sunfish, redear sunfish, and spotted bass (DFG 2007).

Reach 2. In general, species diversity increases downstream, while species composition shifts from native species to nonnative species (DFG 2007). Much of Reach 2 is typically dry; thus, fish populations are confined to the upper part of Reach 2 upstream from Gravelly Ford, and to Mendota Pool in the lower part of Reach 2, with restricted fish migration between these habitats. The only native species recently found in this reach is hitch (Jones and Stokes 1987, as cited in DFG 2007). All native species known to occur historically in Reach 1 were also known to persist in Reaches 2 through 5, with the exception of rainbow trout and perhaps riffle sculpin. The current nonnative species composition in Reach 2 is the same as that in Reach 1, with the addition of white crappie (*Pomoxis annularis*), threadfin shad, fathead minnow (*Pimephales promelas*), white catfish (*Ameiurus catus*), and striped bass (Saiki 1984, Moyle 2002a, DFG 2007).

Reach 3. Recent accounts document the presence in Reach 3 of the following native fish species: prickly sculpin, hitch, Sacramento blackfish, and tule perch (Saiki 1984, Brown and Moyle 1993, Moyle 2002a, DFG 2007). Nonnative fish species present in Reach 3 include all of those documented in Reaches 1 and 2, as well as inland silverside (*Menidia beryllina*) and red shiner (*Cyprinella lutrensis*) (Saiki 1984, Brown and Moyle 1993, Moyle 2002a, DFG 2007).

Reach 4. Because Reach 4 is dry much of the time, only a single fish species (inland silverside) has been documented in Reach 4 in the past 25 years (Saiki 1984, DFG 2007).

Reach 5. Native species recently documented in Reach 5 include Sacramento sucker, prickly sculpin, hitch, Sacramento blackfish, Sacramento pikeminnow, Sacramento splittail, and tule perch. All nonnative species present upstream from Reach 5 are also present in this reach. Pumpkinseed (*Lepomis gibbosus*) and spotted bass have also been detected recently in Reach 5 (Saiki 1984, Brown and Moyle 1993, Moyle 2002a, DFG 2007).

The current distributions of white sturgeon, green sturgeon, river lamprey (*Lampetra ayresii*), Kern brook lamprey, and western brook lamprey (*L. richardsoni*) within the Restoration Area are unknown.

Bypass System. The occurrence of fish in the bypasses depends on the routing of flood flows through the bypass system. When water is present, fish of all life stages may enter the bypasses from upstream diversion points such as the Chowchilla Bypass Bifurcation Structure and Sand Slough Control Structure. Information on fish species that may use temporary aquatic habitat in the bypasses is not available. However, it is assumed that any species present near the diversion points could be routed into the bypasses along with flood flows.

5.2.4 San Joaquin River from Merced River to Delta

Aquatic habitat and fish presently found in the San Joaquin River from the confluence with the Merced River to the Delta are discussed below.

Aquatic Habitat

The San Joaquin River downstream from Reach 5 has physical habitat and water quality conditions similar to those found in Reach 5, with increased flows provided by major tributaries, including the Merced, Tuolumne, Stanislaus, and Calaveras rivers. Water management in the San Joaquin River focuses on diversion of water out of streams and rivers into canals for agricultural use, with some of the applied water returned as agricultural drainage (Brown and May 2006). Flood control levees closely border much of the river but are set back in places, creating some off-channel aquatic habitat areas when inundated.

Fish

Fish species presently inhabiting the San Joaquin River from the confluence with the Merced River to the Delta, including anadromous salmonids, other native species, and nonnative species, are discussed in the following sections.

Anadromous Salmonids. Currently, the San Joaquin River downstream from the Merced River confluence provides transitory habitat for migrating fall-run Chinook salmon and steelhead, both as adults and juveniles, as they move upstream to tributaries, or downstream towards the Delta.

Native Fish Species. Brown and May (2006) summarized presence/absence of fish species in the San Joaquin River downstream from the Merced River confluence using spring seining data collected from 1994 through 2002 by the USFWS Interagency Ecological Program (IEP) and by the Turlock and Modesto irrigation districts (ID). Native species present in the San Joaquin River include Sacramento sucker, Sacramento pikeminnow, Sacramento splittail, tule perch, prickly sculpin, Sacramento blackfish, and hardhead (Brown and May 2006). Splittail are listed as a California State species of special concern largely because of the reduction in valley floor habitat once occupied by this species. Splittail move into the mainstem San Joaquin River during wet years, but today are mostly resident in the Delta and San Francisco Estuary (Moyle 2002a). Hardhead are also listed as a California State species of special concern primarily because of their reduced numbers and increasingly isolated populations throughout California streams. Historical records indicate that they were once present in most streams in the San Joaquin drainage (Reeves 1964), but today a number of the populations have disappeared (Brown and Moyle 1993). Additionally, fall-run Chinook salmon, steelhead, California roach, threespine stickleback, lamprey, and hitch are also known to occur. The fall-run Chinook salmon population is supported in part by hatchery stock in the Merced River. In addition, California roach, threespine stickleback, lamprey, and hitch are likely inhabitants of this portion of the river, although they were not detected during the springtime monitoring efforts summarized by Brown and May (2006). Each of these native species is also present in the Restoration Area.

Moyle and Light (1996) suggested that nonnative piscivorous fish are most likely to alter fish assemblages. Largemouth bass are documented predators of outmigrating juvenile anadromous salmonids (TID/MID 1992). They may also play the role of keystone predator (i.e., species that may increase biodiversity by preventing any one species from becoming dominant) in many aquatic environments because of broad environmental tolerances and their ability to forage on a wide variety of prey under many conditions. Smallmouth bass may primarily affect hardhead through competition for food resources, and may prey on juvenile cyprinids. Striped bass may be an important predator on immature life stages of river lamprey and Sacramento splittail. Inland silversides may feed on eggs and larvae of Sacramento splittail and other fish species in floodplain spawning areas. Native species expected to be the most sensitive to predation by nonnative predators include juvenile hardhead and Sacramento splittail.

Changes in predator success due to increased abundance and vulnerability of prey may occur at newly constructed or altered diversion intakes or passage structures. Many predatory fish may be more successful at locations where prey fish are artificially concentrated or stressed, such as at dams or salvage and hatchery release sites (Buchanan et al. 1981, Pickard et al. 1982). High predation rates are known to occur below small dams, such as the Red Bluff Diversion Dam (RBDD) in the Sacramento River and Sack Dam in the Restoration Area. As fish pass over small dams, they are subject to conditions that may disorient them, making them highly susceptible to predation by fish or birds. In addition, deep pool habitats tend to form immediately downstream from such dams, creating conditions that promote congregation of Sacramento pikeminnow, striped bass, and other predators. Tucker et al. (1998) showed high rates of predation by Sacramento pikeminnow and striped bass on juvenile salmon below the RBDD.

Vegetation or other cover may provide optimal habitat for vulnerable fish life stages while reducing capture rates of predators. Aquatic vegetative cover as low as 15 percent has been reported to limit largemouth bass foraging success in experimental trials (Savino and Stein 1982).

Nonnative Fish Species. Nonnative fish reported in the San Joaquin River between the Merced River confluence and the Delta include red shiner, inland silverside, threadfin shad, western mosquitofish, fathead minnow, black bass species, bigscale logperch (*Percina macrolepida*), bluegill, white crappie, striped bass, redear sunfish, common carp, goldfish, black bullhead (*Ameiurus melas*), channel catfish, and green sunfish (Brown and May 2006). Golden shiner, black crappie, white catfish, and warmouth are also likely in the mainstem San Joaquin River downstream from the Merced River confluence.

5.2.5 San Joaquin River Tributaries

Aquatic habitat and fish presently found in the three main San Joaquin River tributaries, the Merced, Tuolumne, and Stanislaus rivers, are discussed below.

Aquatic Habitat

The Merced River is accessible to anadromous fish for the first 51 river miles upstream from the San Joaquin River confluence, with access terminating at Crocker-Huffman

Dam (USFWS 2001). Most spawning occurs within a few miles of the dam. Aquatic habitats in the Tuolumne River downstream from LaGrange Dam are influenced by several factors, many of them related to former gold mining activities and gravel mining (McBain and Trush 2000). In the Stanislaus River, fall-run Chinook salmon spawn in a 23-mile stretch of the Stanislaus downstream from Goodwin Dam, but most spawning occurs in the first 10 miles below the dam.

Fish

Fall-run Chinook salmon inhabit the Merced, Tuolumne, and Stanislaus rivers, supported in part by hatchery stock in the Merced River. The average annual spawning escapement (1952 through 2005) for the three major San Joaquin River tributaries was an estimated 19,100 adults. Since 1952, fall-run Chinook salmon populations in the San Joaquin River basin have fluctuated widely, with a distinct periodicity that generally corresponds to periods of drought and wet conditions. Recent escapement estimates in 2006 and 2007 indicate another period of severe declines, presumably unrelated to drought, with a near-record low escapement in 2007 (DFG 2008). Steelhead are still present in low numbers in the Tuolumne, Stanislaus, and possibly the Merced river systems below the major dams (McEwan 2001, Zimmerman et al. 2008), but escapement estimates are not available.

5.2.6 Sacramento-San Joaquin Delta

The aquatic habitat and fish presently found in the Delta are discussed below.

Aquatic Habitat

The historical Delta consisted of low-lying islands and marshes that flooded during high spring flows. More than 95 percent of the original tidal marshes have been leveed and filled, resulting in loss of aquatic habitat (USGS 2007). The current Delta consists of islands, generally below sea level, surrounded by levees to keep out water. Inflow of freshwater into the Delta has been substantially reduced by water diversions, mostly to support agriculture. Dredging and other physical changes have altered water flow patterns and salinity (USGS 2007). Nonnative species are changing the Delta's ecology by altering its food webs. All of these changes have had substantial effects on the Delta's biological resources, including marked declines in the abundance of many native fish and invertebrate species (Greiner et al. 2007).

Delta flow refers to the timing, volume and circulation patterns of water flowing through the Delta. The natural Delta flow patterns have been radically altered by dredging, construction of levees, storage reservoirs and major diversions (Kimmerer 2004). Current flow patterns often result in harmful distributions of Delta fishes. For example, the Jones Pumping Plant and Banks Pumping Plant diversions in the south Delta export such large volumes of water that the tidally averaged flow of water in channels leading away from the pumps is often upstream. These reverse flows disrupt the natural downstream movements from the south Delta of young fish of several important Delta species, including delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthyes*), Chinook salmon, and striped bass (Monsen et al. 2007, Kimmerer 2004).

Delta outflow establishes the location in the Delta of the low salinity zone (LSZ), an area that historically has had high prey densities and other favorable habitat conditions for rearing juvenile delta smelt, striped bass, and other fish species. The LSZ is often referenced by X2 and is measured in kilometers. X2 is measured as the distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand (ppt), is largely determined by Delta outflow, and is often used to index the location of the LSZ (Kimmerer 2004). The LSZ is believed to provide the best combination of habitat quality when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers. When Delta outflow is low, X2 is located in the relatively narrow channel of these rivers, and at higher outflows, it moves downstream into more open waters.

In addition, habitat quality and quantity are affected when inflow and exports change the distribution of fish in the Delta because the Delta varies greatly among regions in habitat quality and quantity. For most fish species, habitat quality in the south Delta is believed to be poor. For instance, turbidity in the south Delta is low, which is considered to reduce the quality of this habitat for delta smelt and other species (Feyrer 2004, Feyrer and Healey 200,3 Feyrer et al. 2007, Monsen et al. 2007,Nobriga et al. 2008). Therefore, circulation patterns that cause fish to move to the south Delta are likely to adversely affect the populations.

All environmental conditions affecting fish are generally likely to be less favorable in the south Delta than other parts of the Delta. Nobriga et al. (2008) showed that very low summer abundances of delta smelt in the south Delta are related to significantly higher water temperatures and water clarity in the south Delta than other areas of the Delta. Increased water clarity may increase predation risks and reduce feeding success of planktivorous fish such as delta smelt. Entrainment risk is much higher in the south Delta because of the large volumes of water exported by the Jones and Banks pumping plants (Kimmerer 2008). In experimental releases, survival of fall-run Chinook salmon smolts migrating from the San Joaquin River was lower for smolts moving through the Delta via the channels south of the San Joaquin River than for those remaining in the river channel (SJRGA 2001 through 2009, Brandes and McLain 2001).

Fish

The Delta contains freshwater fishes (e.g., hitch, Sacramento blackfish, pikeminnow), fish that live nowhere else in the system (e.g., delta smelt), anadromous fishes that spend part of their life cycle there (e.g., white sturgeon, Chinook salmon, steelhead, longfin smelt, Pacific lamprey), adult marine fishes and those that spend juvenile stages there (e.g., staghorn sculpin (*Leptocottus armatus*), starry flounder (*Platichthys stellatus*)), and freshwater species that can tolerate high salinities (e.g., Sacramento perch, tule perch, Sacramento splittail, prickly sculpin) (Moyle 2002a).

Recently, abundances of pelagic fishes in the Delta have markedly declined (IEP 2005). The abundance indices for 2002 through 2004 include record lows for delta smelt and near-record lows for longfin smelt and threadfin shad (IEP 2005). The Delta has become a suboptimal environment for native fishes because of diversions, pollution, physical modifications, and exotic species invasions (Moyle 2002a). Introduced species have the potential to greatly alter the Delta ecosystem and threaten native species through competition for resources, direct predation, complex food web effects, hybridization, habitat interference, and the spread of new diseases (Moyle 2002a).

Direct losses of salmonids occur from a variety of mortality agents within the Delta, including entrainment at the CVP and SWP pumps near Tracy, predation in pump forebays, predation within the Delta, and fish salvage operations at the pumping facilities. Recognizing the importance of reducing mortality caused by CVP and SWP exports in the south Delta, the Vernalis Adaptive Management Program (VAMP) was developed to investigate Chinook salmon smolt survival during outmigration through the Delta in April and May, in response to alterations in San Joaquin River flows at Vernalis (U.S. Geological Survey (USGS) station 11-303500) and CVP and SWP exports. As part of VAMP, in years when spring flow in the San Joaquin River is less than 7,000 cfs, a temporary barrier is placed at the Head of Old River to prevent outmigrating San Joaquin River basin salmon from migrating directly down the Old River channel toward the pumps.

Delta flow patterns affect migration of adult salmonids to upstream spawning areas and tributaries as well as juvenile outmigration. River discharge is an important migration cue for adult salmonids attempting to enter their natal streams to spawn, and increases in discharge may improve water quality and habitat conditions in the Delta. Low DO concentrations may cause delays in the onset of upstream migration until later in the fall when DO concentrations improve.

The distribution of fish in the Delta is determined by tidal flows, tidally averaged (nontidal) net flows, and directed swimming of the fish. The largest flows in the Delta are tidal flows, which far exceed other flows in most Delta channels. The tidal flows tend to move small, weak-swimming fish, such as fish larvae, upstream and downstream, dispersing them into neighboring channels, but without imparting any net directional movement to the fish (Kimmerer and Nobriga 2008). Nontidal flows determine the net direction of water movement (i.e., net flows) and of fish larvae and other weak swimmers suspended in the water (Kimmerer 2008, Kimmerer and Nobriga 2008, Monsen et al. 2007). Outmigrating salmon and steelhead smolts, although capable of much more directed swimming than larvae, may also follow net flows through the Delta (NMFS 2009, Kimmerer and Nobriga 2008). Movements of stronger swimmers, including the upstream migrating adults of delta smelt, Chinook salmon, steelhead and other species, are behaviorally directed. However, the movements of these fish are likely influenced by net flows, which provide olfactory and other environmental cues that direct their behavior (USFWS 2008, Kimmerer 2008, Mesick 2001).

San Joaquin River inflow and diversion rates at the Jones and Banks pumping plants strongly affect net flow patterns in the San Joaquin River side of the Delta, thereby influencing how fish are distributed with respect to the south Delta, and how long the fish remain there (NMFS 2009, Kimmerer and Nobriga 2008, Monsen et al. 2007, Feyrer and Healey 2003, Mesick 2001). Diversions at the Jones and Banks pumping plants export such large volumes that water often flows upstream in channels leading away from the pumps, such as at Old and Middle rivers (USFWS 2008, Monsen et al. 2007). San Joaquin River inflow and reverse Old and Middle river flows generally have counteracting effects on the distribution of fish: (1) higher inflows tend to result in movement of fish larvae away from the south Delta and reduced passage time of smolts emigrating from the San Joaquin River, and (2) higher reverse flows tend to result in movement of the fish towards the south Delta (NMFS 2009, USFWS 2008, Kimmerer and Nobriga 2008). These flows are also likely to indirectly affect upstream migrating adult fish, with high reverse flows leading to increased straying away from the main channel of the San Joaquin River towards the south Delta (USFWS 2008, Kimmerer and Nobriga 2008, Mesick 2001).

5.3 Regulatory Setting

This section presents the applicable Federal, State, and local laws and regulations associated with fisheries in the study area.

5.3.1 Federal

Federal laws and regulations pertaining to aquatic resources in the study area are summarized briefly below. More detail on regulatory compliance procedures for the SJRRP can be found in the *Regulatory Compliance Strategy Plan Technical Memorandum* (SJRRP 2007).

Clean Water Act Sections 401 and 404

The Clean Water Act (CWA) is the major Federal legislation governing the water quality aspects of the project. The objective of the act is “to restore and maintain the chemical, physical, and biological integrity of the nation’s waters.” The CWA establishes the basic structure for regulating discharge of pollutants into the waters of the United States and gives EPA the authority to implement pollution control programs, such as setting wastewater standards for industries. In certain states such as California, EPA has delegated authority to State agencies.

Section 303 of the CWA requires states to adopt water quality standards for all surface waters of the United States. The three major components of water quality standards are designated users, water quality criteria, and antidegradation policy. Section 303(d) of the CWA requires states and authorized Native American tribes to develop a list of water-quality-impaired segments of waterways. The list includes waters that do not meet water quality standards necessary to support the beneficial uses of a waterway, even after point sources of pollution have had minimum required levels of pollution control technology installed. Only waters impaired by “pollutants” (e.g., clean sediments, nutrients such as nitrogen and phosphorus, pathogens, acids/bases, temperature, metals, cyanide, and synthetic organic chemicals (EPA 2002)), not those impaired by other types of “pollution” (e.g., altered flow, channel modification), are to be included on the list.

Section 303(d) of the CWA also requires states to maintain a list of impaired water bodies so that a total maximum daily load (TMDL) can be established A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. It establishes the allowable pollutant loadings or other quantifiable parameters (e.g., pH, temperature) for a water body and thereby provides the basis for establishing water-quality-based controls. The calculation for establishing TMDLs for each water body must include a margin of safety to ensure that the water body can be used for the purposes of state designation. Additionally, the calculation also must account for seasonal variation in water quality (EPA 2002). The Central Valley RWQCB develops TMDLs for the San Joaquin River (see discussion on the Porter-Cologne Water Quality Control Act below).

Section 401 of the CWA requires Federal agencies to obtain certification from the state or Native American tribes before issuing permits that would result in increased pollutant loads to a water body. The certification is issued only if such increased loads would not cause or contribute to exceedences of water quality standards.

Section 402 created the National Pollutant Discharge Elimination System (NPDES) permit program. This program covers point sources of pollution discharging into a surface water body.

A permit must be obtained from USACE under Section 404 for the discharge of dredged or fill material into “waters of the United States, including wetlands.” Waters of the United States include wetlands and lakes, rivers, streams, and their tributaries. Wetlands are defined for regulatory purposes as areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and, under normal circumstances do support, vegetation typically adapted for life in saturated soil conditions.

Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act (RHA) (33 USC 401 et seq.) requires authorization from USACE for construction of any structure over, in, or under navigable waters of the United States.

Endangered Species Act

The ESA protects and promotes recovery of threatened and endangered species. Section 4 of the ESA outlines a process to list species in danger of becoming extinct. Section 9 of the ESA prohibits take of any threatened or endangered species, including harm associated with habitat modifications. Section 7 and Section 10 of the ESA provide for exemptions on take prohibitions. Under the ESA, the definition of “take” is to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” USFWS has also interpreted the definition of “harm” to include significant habitat modification that could result in take. If it is likely that implementing any actions from the Settlement would result in take of a Federally listed species, a Federal interagency consultation, under Section 7 of the ESA, is required. USFWS is responsible for protecting terrestrial and nonanadromous fish species, and the NMFS is responsible for protecting anadromous fish.

Experimental population status is required for successful reintroduction of Chinook salmon into the Restoration Area of the San Joaquin River. Section 10 of the ESA allows the establishment and maintenance of experimental populations. The Secretary may authorize the release (and related transportation) of any population (including eggs, propagules, or individuals) of an endangered species or a threatened species outside the current range of such species if the Secretary determines that such release will further the conservation of such species. Before authorizing the release of any experimental population, the Secretary must identify the population and determine, on the basis of the best available information, whether or not such population is essential to the continued existence of an endangered species or a threatened species.

A Section 10(a)1(A) permit is required to collect individuals from the source population that will be reintroduced as the experimental population. Under Section 10(j), a reintroduced populations established outside the species' current range, but within its historical range can be designated as "experimental." Section 10(j) allows flexibility in managing an experimental population as threatened, regardless of its designation elsewhere in its range. In addition, experimental populations are classified as either "essential" or "nonessential." Experimental populations considered to be "essential" are those required for the continued existence of the species and are treated as a threatened species; special rules may allow take. Experimental populations considered nonessential are also treated as a threatened species, but if the species is located outside an NWR or a National Park, it is treated as a species proposed for listing.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act provides for the conservation and management of fisheries, with particular attention to anadromous species.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA), as amended in 1964, was enacted to protect fish and wildlife when Federal actions result in the control or modification of a natural stream or body of water. The statute requires Federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources. Consultation and coordination with USFWS and State fish and game agencies are required to address ways to conserve fish and wildlife resources by preventing loss of and damage to fish and wildlife resources, as well as to further develop and improve these resources.

Executive Orders

Several EOs have been issued providing direction to Federal agencies regarding invasive species, floodplain management, and protection of wetlands, as discussed below:

- **EO 13112: Invasive Species –** This EO directs all Federal agencies to prevent and control introductions of invasive nonnative species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. As directed by this EO, a national invasive species management plan guides Federal actions to prevent, control, and minimize invasive species and their impacts (NISC 2008). To support implementation of this plan, USACE has recently released a memorandum describing the *U.S. Army Corps of Engineers Invasive Species Policy* (USACE 2009). This policy includes addressing invasive species effects in impact analysis for civil works projects.

- **EO 11988: Floodplain Management** – This EO requires Federal agencies to provide leadership and take action to (1) avoid development in the base (100-year) floodplain, (2) reduce the hazards and risk associated with floods, (3) minimize the effect of floods on human safety, health, and welfare, and (4) restore and preserve the natural and beneficial values of the base floodplain.

- **EO 11990: Protection of Wetlands –** This EO directs Federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in implementing civil works.

Central Valley Project Improvement Act

(See Chapter 13.0, “Hydrology – Surface Water Supplies and Facilities Operations.”)

San Joaquin River Agreement

(See Chapter 13.0, “Hydrology – Surface Water Supplies and Facilities Operations.”)

National Wildlife Refuge Complex Comprehensive Conservation Plans

The USFWS San Luis NWR Complex includes the San Luis NWR, Merced NWR, San Joaquin River NWR, and Grasslands Wildlife Management Area (WMA). These refuges comprised wetlands, grasslands, riparian habitats, and agricultural fields. The management goals and objectives for each refuge, which include managing and providing habitat for endangered and sensitive species, are set forth in 15-year Comprehensive Conservation Plans (CCP) prepared by USFWS pursuant to the National Wildlife Refuge System Improvement Act of October 1997.

5.3.2 State

State laws and regulations pertaining to fisheries are discussed below.

California Water Code

The California Water Code authorizes the SWRCB to allocate surface water rights and permit diversion and use of water throughout the State. SWRCB considers effects on fisheries as part of its permitting process. Division 7 of the California Water Code, known as the Porter-Cologne Water Quality Control Act, regulates activities that affect water quality.

California Endangered Species Act

Pursuant to the California Endangered Species Act (CESA) and Section 2081 of the California Fish and Game Code, a permit from DFG is required for projects that could result in the take of a species that is State-listed as threatened or endangered. Under CESA, “take” is defined as an activity that would directly or indirectly kill an individual of a species, but the definition does not include “harm” or “harass,” as the Federal ESA does. As a result, the threshold for take is higher under CESA than under the Federal ESA.

California Fish and Game Code

Several sections of the California Fish and Game Code provide environmental protections applicable to the Restoration Area:

- **Section 1602—Streambed Alteration –** Diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources are subject to regulation by DFG, pursuant to Section 1602 of the California Fish and Game Code.

- **Fully Protected Species Under California Fish and Game Code –** Protection of fully protected species is described in four sections of the California Fish and Game Code that list 37 fully protected species (California Fish and Game Code Sections 3511, 4700, 5050, and 5515). These statutes prohibit take or possession at any time of fully protected species.

California Department of Fish and Game Species Designations

DFG maintains an informal list of species called "species of special concern." These are broadly defined as plant and wildlife species that are of concern to DFG because of population declines and restricted distributions and/or because they are associated with habitats that are declining in California. These species are inventoried in the California Natural Diversity Database (CNDDB) regardless of their legal status. Impacts on species of special concern may be considered significant.

California Code of Regulations, Title 23

Under Title 23, the CVFPB cooperates with Federal, State, and local governments in establishing, planning, constructing, operating, and maintaining flood control works in the Central Valley. CVFPB is required to enforce appropriate standards for the construction, maintenance, and protection of adopted flood control plans that will best protect the public from floods along the Sacramento and San Joaquin rivers and their tributaries. CVFPB issues encroachment permits to maintain the integrity and safety of flood control project levees and floodways.

State Lands Commission

The State Lands Commission has exclusive jurisdiction over all ungranted tidelands and submerged lands owned by the State, and the beds of navigable rivers, sloughs, and lakes. A project cannot use these State lands unless a lease is first obtained from the State Lands Commission.

5.3.3 Regional and Local

Regional and local plans and policies pertaining to fisheries are discussed below.

San Joaquin River Parkway Master Plan

The *San Joaquin River Parkway Master Plan* is a regional resource management plan for the San Joaquin River area between Friant Dam and SR 99. The San Joaquin River Conservancy (SJRC), a regionally governed agency created by the State, is charged with implementing the *San Joaquin River Parkway Master Plan* (2000). The plan's main tenets include the protection of natural resources, public education, and the promotion of low-impact recreation use of the river corridor.

County Plans

As required by State law, counties in the Restoration Area have developed their own general plans. At a minimum, these documents must address the topics of land use, transportation, housing, conservation, open space, noise, and safety. These documents serve as statements of county goals, policies, standards, and implementation programs for the physical development of a county, and include the *Fresno County General Plan Policy Document* (2000), the *Madera County General Plan Policy Document* (1995), and the *Merced County General Plan* (2000).

San Joaquin County Multi-Species Habitat Conservation and Open Space Plan

The San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, approved and adopted in November 2000, includes compensation measures to offset the effects of development on special-status plant, fish, and wildlife species throughout San Joaquin County (SJCOG 2000), downstream from the Restoration Area, and including portions of the lower San Joaquin River.

5.4 Environmental Consequences and Mitigation Measures

The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, “Description of Alternatives,” and summarized in Table 5-2. Impacts to fisheries and associated mitigation measures are summarized in Table 5-3.

Table 5-2.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		A1	A2	B1	B2	C1	C2
			Action Alternative					
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
		4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
		New pumping infrastructure on the San Joaquin River					✓	✓
	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:

[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.

[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 5-3.
Summary of Environmental Consequences – Fisheries

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources- Fisheries: Program-Level				
FSH-1: Changes in Water Temperatures in the San Joaquin River Between Friant Dam and the Merced River	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-2: Changes in Pollutant Discharge in the San Joaquin River Between Friant Dam and the Merced River	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-3: Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-4: Construction-Related Changes in Habitat Conditions in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-5: Displacement from Preferred or Required Habitat, Injury, or Mortality in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-6: Changes in Habitat Conditions in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-7: Changes in Diversions and Entrainment in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial

Table 5-3.
Summary of Environmental Consequences – Fisheries (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources- Fisheries: Program-Level (continued)				
FSH-8: Changes in Predation Levels in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-9: Changes in Food Web Support in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-10: Effects to Fall-Run Chinook Salmon from Hybridization Resulting from Reintroduction of Spring-Run Chinook Salmon to the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-11: Effects of Disease on Fisheries in the San Joaquin River Between the Merced River and the Delta	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-12: Changes in Diversions and Entrainment in the San Joaquin River Between the Merced River and the Delta	No-Action	No Impact	--	No Impact
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-13: Changes in Water Temperatures in the San Joaquin River Between the Merced River and the Delta	No-Action	No Impact	--	No Impact
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Table 5-3.
Summary of Environmental Consequences – Fisheries (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources- Fisheries: Program-Level (continued)				
FSH-14: Displacement from Preferred or Required Habitat, Injury, or Mortality in the San Joaquin River Between Merced River and the Delta	No-Action	No Impact	--	No Impact
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
Biological Resources- Fisheries: Project-Level				
FSH-15: Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Upstream from Friant Dam	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-16: Changes in Pollutant Discharge and Mobilization in the San Joaquin River Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	No Impact	--	No Impact
	C2	No Impact	--	No Impact
FSH-17: Changes in Sediment Discharge and Turbidity in the San Joaquin River Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-18: Changes in Fish Habitat Conditions in the San Joaquin River Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-19: Changes in Diversions and Entrainment in the San Joaquin River Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-20: Changes in Predation Levels in the San Joaquin River Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial

Table 5-3.
Summary of Environmental Consequences – Fisheries (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources- Fisheries: Project-Level (continued)				
FSH-21: Changes in Food Web Support in the San Joaquin River Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-22: Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Between Friant Dam and the Merced River	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-23: Changes in Pollutant Discharge and Mobilization in the San Joaquin River Between Friant Dam and the Merced River	No-Action	PS	--	PS
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-24: Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River	No-Action	PS	--	PS
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-25: Changes in Fish Habitat Conditions in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-26: Changes in Diversions and Entrainment in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-27: Changes in Predation Levels in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial

Table 5-3.
Summary of Environmental Consequences – Fisheries (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources- Fisheries: Project-Level (continued)				
FSH-28: Changes in Food Web Support in the San Joaquin River Between Friant Dam and the Merced River	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-29: Effects of Disease on Fisheries in the San Joaquin River Between the Merced River and the Delta	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-30: Changes in Chinook Salmon and Steelhead Habitat in the Merced, Tuolumne, and Stanislaus Rivers	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-31: Changes in Water Temperatures and Dissolved Oxygen Concentrations in the Delta	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-32: Changes in Pollutant Discharge and Mobilization in the Delta	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-33: Changes in Sediment Discharge and Turbidity in the Delta	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-34: Changes in Fish Habitat Conditions in the Delta	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial

Table 5-3.
Summary of Environmental Consequences – Fisheries (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources- Fisheries: Project-Level (continued)				
FSH-35: Changes in Diversions and Entrainment in the Delta	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-36: Changes in Predation Levels in the Delta	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
FSH-37: Changes in Food Web Support in the Delta	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-38: Salinity Changes in the Delta	No-Action	PS	--	PS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
FSH-39: Changes to Delta Inflow and Flow Patterns in the Delta	No-Action	PS	--	PS
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial

Key:
-- = not applicable
Delta = Sacramento-San Joaquin Delta
LTS = less than significant
PS = potentially significant

5.4.1 Impact Assessment Methodology

The fisheries resource impact assessment describes the potential beneficial and adverse impacts of each program alternative on fishes and their habitat in the study area. The assessment was based largely on qualitative evaluations of the response of representative fish species to changes in environmental conditions projected to occur as a result of the implementation, operation, and maintenance of actions associated with each program alternative. Impacts were determined by comparing conditions that would occur under each action alternative to the conditions that would occur under the No-Action Alternative.

The program- and project-level impacts assessments are based on evaluations ranging from quantitative simulations (e.g., modeled spawning production of largemouth bass in Millerton Lake) to qualitative and general evaluations of probable scenarios (e.g., potential changes in environmental conditions that would render an environment unsuitable relative to the environmental tolerance or requirements of a fish species). Information on most of the program-level actions has not yet been sufficiently developed to allow meaningful and accurate descriptions that would support more than a general qualitative assessment. Therefore, the program-level impacts assessment is qualitative. Environmental impacts of implementing the program-level actions would be evaluated in greater detail, as necessary, in project-specific environmental compliance documents. Information currently available for project-level actions is sufficient to support a more detailed, project-level impacts assessment.

Data sources used for the impacts assessments include modeled flow; reservoir operations and electrical conductivity (EC) (CalSim-II); modeled Delta flow patterns (DSM II); modeled river water temperature in the Restoration Area (SJR5Q); information on existing facilities, operations, and environmental conditions; and information on environmental requirements and tolerances of representative fish species. Additional information on the models and their results can be found in Appendix H.

Impacts were evaluated based on the temporal and spatial presence of fish life stages (e.g., spawning adult, egg, juvenile) for which impact mechanisms and environmental requirements or tolerances are sufficiently understood to support an assessment. The methods used varied by geographic area, species, life stage, and environmental conditions, and depended largely on the amount of available information. An important consideration in evaluating the potential impacts of the alternatives on fish species was that fish life stages vary greatly in their vulnerability to change in environmental conditions. Therefore, impacts were evaluated with respect to the life cycle timing and spatial distribution of each life stage.

The impacts assessment for fisheries is divided into five geographic areas:

- San Joaquin River upstream from Friant Dam
- San Joaquin River from Friant Dam to the Merced River
- San Joaquin River from the Merced River to the Delta
- San Joaquin River tributaries (Merced, Tuolumne, and Stanislaus rivers)
- Delta

Impacts on fisheries in the CVP/SWP service areas would be negligible under each alternative, and are not considered further.

Each geographic area includes a unique combination of existing representative species and environmental conditions. The following discussion provides an overview of the use of representative species and environmental conditions, followed by a description of the specific methods that was used within each geographic area.

Representative Species

The use of representative species for this impact assessment allows a focused assessment while representing fish community responses to the full range of environmental conditions that are likely to be affected by the program alternatives. Representative species and populations were selected for assessment because they meet one of the following criteria: (1) they are native species whose populations in California are declining and have received a special-status designation by Federal or State resource agencies, or (2) they are recreationally important game fish species.

Representative special-status species are as follows:

- River lamprey
- Kern brook lamprey
- Hardhead
- Sacramento splittail
- Chinook salmon, including Central Valley fall-/late fall-, and spring-runs, and Sacramento River winter-run
- Central Valley steelhead
- Southern distinct population segment (DPS) of the North American green sturgeon
- Delta smelt
- Longfin smelt

Representative game fish species are as follows:

- Largemouth bass
- Smallmouth bass
- Spotted bass
- Striped bass
- Rainbow trout
- White sturgeon

In addition to their special status or recreational importance, the representative species were also deemed to be appropriate species for this impact assessment because they are collectively distributed over the range of aquatic habitat types that occur in the fisheries impact assessment area (i.e., reservoir, river, and estuary). They also have a wide range of life history strategies and environmental requirements, and depend on habitat conditions and ecological processes that are sensitive to a range of potentially affected environmental conditions. Several of the representative species chosen for assessment may thus be considered “umbrella species” for which impacts are generally representative of the range of potential impacts on other species, both native and nonnative, with similar habitat requirements.

All of the special-status species selected for assessment are native species. Of the game fish assessment species, only rainbow trout and white sturgeon are native species.

An additional assessment will be conducted in compliance with the ESA and CESA and the Magnuson-Stevens Act (Essential Fish Habitat) for all Federal and State protected species.

The representative species selected for assessment in each geographic area are shown in Table 5-4. Each life stage may be present in specific geographic areas during certain times of the year. The geographic distribution and timing of each life stage of the assessment species are shown in Appendix K, “Biological Resources – Fisheries.”

Table 5-4.
Fish Species Considered in PEIS/R Impacts Assessment, by Geographic Area

	River Lamprey	Kern Brook Lamprey	Hardhead	Sacramento Splittail	Fall-/Late Fall-Run Chinook Salmon	Winter-Run Chinook Salmon	Spring-Run Chinook Salmon	Central Valley Steelhead	Sturgeon[1]	Delta Smelt	Longfin Smelt	Black Bass[2]	Striped Bass	Rainbow Trout
Millerton Lake and San Joaquin River upstream from Millerton		X	X									X	X	X
San Joaquin River from Friant Dam to Merced River		X	X	X								X	X	X
San Joaquin River from Merced River to Delta	X		X	X	X			X				X	X	X
Delta	X			X	X	X	X	X	X	X	X	X	X	

Notes:
[1] Includes North American green sturgeon (southern distinct population) and white sturgeon
[2] Includes largemouth bass, smallmouth bass, and spotted bass

Key:
Delta = Sacramento-San Joaquin Delta
PEIS/R = Program Environmental Impact Statement/Report

Potential impacts to representative special-status and game fishes were evaluated based on the expected response of a fish species or life stage to changes in environmental conditions as they pertain to essential behaviors or phases of the species’ life cycles.

Environmental Conditions

Three general categories of environmental conditions were used in this impact assessment: (1) water temperature and water quality, (2) physical processes/conditions, and (3) biological interactions. Each category consists of multiple environmental factors that can affect the aquatic ecosystem, and can result in direct and indirect impacts on the representative fish species and other fishes.

Specific conditions relating to changing water levels at Millerton Lake were addressed in analyses of impacts on largemouth, smallmouth, and spotted bass (also referred to as black bass). These include shallow-water habitat surface area, rate of water level changes, water temperatures, egg incubation rates as a function of temperature, substrate conditioning factors, and opportunities for shoreline vegetation development. These factors were included in a black bass spawning production model to simulate spawning production under different reservoir operating alternatives. Changes in elevations at other CVP and SWP reservoirs would be too small to cause substantial effects on reservoir fisheries. Furthermore, changes to these other reservoirs were based on multiple operational factors that cannot all be captured in modeling and, coupled with the relatively minor changes, were considered to be too speculative for meaningful consideration. Therefore, they are not discussed further.

Beyond more direct effects on fish, water temperature also controls other ecosystem components such as feeding, disease, oxygen solubility, and the chemical equilibria and activity of pollutants known to affect fish and other aquatic organisms. These conditions were not assessed in detail because of a lack of data on these complex interactions. This assessment focused on the direct effects of temperatures on fish survival and mortality.

San Joaquin River Upstream from Friant Dam

Impacts of the program alternatives on habitat in the San Joaquin River upstream from Friant Dam were evaluated by calculating changes in river channel length that would be inundated by the reservoir at the annual maximum water level, and were expressed as length of habitat lost or gained. The impacts were based on changes in reservoir elevations and river channel elevations. Operations modeling results were used with Millerton Lake bathymetric data to estimate water level changes.

The effects of the program alternatives on Millerton Lake fisheries were evaluated by identifying expected environmental changes caused by actions, and evaluating impacts of these changes on four Millerton Lake and three San Joaquin River fish species (Table 5-5).

**Table 5-5.
Environmental Conditions for Each Representative Fish Species in Millerton Lake and Upper San Joaquin River**

Environmental Conditions	Kern Brook Lamprey		Hard-head		Black Bass[1]		Striped Bass				Rainbow Trout	
	Spawning/Incubation	Juvenile/Adult Rearing	Spawning/Incubation	Juvenile/Adult Rearing	Spawning/Incubation	Juvenile/Adult Rearing	Adult Migration/Foraging	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration	Spawning/Incubation	Juvenile/Adult Rearing
Water Temperature					●	●						
Pollutants												
Turbidity												
Geomorphic Processes												
Aquatic, Riparian, and Floodplain Habitat	○	○		○	●	●	○	○	○		○	○
Aquatic Habitat Connectivity												
Diversions												
River Flow												
Reservoir Surface Level	●	●		●	●	●	○	○	○		○	○
Predation					○	○						
Food Resources and Food Web Support					○	○	○		○			
Hybridization												
Competition												
Disease												

Notes:
● Impact mechanism is well understood, applicable to species' distribution in the assessment area, and information is available for assessment.
○ Applicable to species' distribution in the assessment area, but impact mechanism is uncertain and/or information available for assessment is incomplete.
[1] Largemouth bass, smallmouth bass, and spotted bass.

Key:
Delta = Sacramento-San Joaquin Delta

Many of the impacts on environmental conditions could not be directly quantified, but were inferred from quantifiable impacts on the following habitat factors: (1) surface area of shallow water, (2) surface area of open water habitat, (3) fluctuations in water levels, and (4) water temperatures. Operations modeling results were used with Millerton Lake bathymetric data to estimate changes in surface area of open water habitat, surface area of shallow water habitat, and water-level fluctuations. Evaluation of changes in Millerton Lake was limited to April through September because this is the most active spawning, incubation, feeding, and growth period for the selected species. Changes in water temperatures were estimated in the shallow water habitat based on water temperature model results.

Shallow water habitat analyses were conducted for black bass, which reside primarily in the shallow water margins of reservoirs. Mean surface area between the reservoir surface and the 15-foot depth contour, which is the approximate lower margin of the principal spawning and rearing habitat of the largemouth bass (Mitchell 1982, Stuber et al. 1982), was computed for each alternative. The surface areas were computed only for April through September, since most spawning for these species occurs from April through June, and the most critical months for successful rearing are April through September (Moyle 2002a, Mitchell 1982, Aasen and Henry 1980).

Water-level fluctuations affect the spawning success of largemouth bass and spotted bass because these species spawn in shallow water (Thorton et al. 1990, McMahon et al. 1984, Mitchell 1982, Stuber et al. 1982). Mean quarter-month increases and decreases in water levels were computed for the alternatives because the time required for hatching largemouth and spotted bass eggs exposed to water temperature conditions that typically occur during spring in Millerton Lake is approximately a quarter-month (Knoteck and Orth 1998, Mitchell 1982).

Results of the reservoir habitat analyses were combined with known habitat requirements of the selected reservoir species to assess species-specific impacts of the program alternatives. For striped bass, impact analyses were based on general information about projected reservoir surface areas and inundation zones of the program alternatives, including inundation of spawning habitat.

For largemouth bass and spotted bass, a spawning production model was developed to evaluate reservoir surface elevations, shallow water surface areas, and water temperatures for each alternative. The model simulated spawning production of these species under each alternative. The model outputs an index of total reservoir production rather than a true production estimate. Results for largemouth bass were used to determine likely impacts of the alternatives on smallmouth bass spawning because, with the exception of water temperatures, the two species have similar habitat requirements. The spawning production model is described in detail in Appendix K, “Biological Resources – Fisheries.”

San Joaquin River from Friant Dam to Delta

Impacts of the program alternatives on fisheries in the mainstem San Joaquin River were evaluated by determining expected changes to environmental conditions of potential importance to fish, and evaluating impacts of these changes on the fish species selected for assessment. Environmental conditions considered for assessing impacts on representative fish in the San Joaquin River from Friant Dam to the Merced River confluence, and in the San Joaquin River from the Merced River confluence to the Delta are shown in Tables 5-6 and 5-7 respectively.

Table 5-6. Environmental Conditions for Each Representative Fish Species in San Joaquin River from Friant Dam to Merced River

Environmental Conditions	River Lamprey				Kern Brook Lamprey		Hardhead		Sacramento Splittail				Black Bass[1]		Striped Bass				Rainbow Trout	
	Adult Spawning Migration	Spawning/Incubation	Juvenile Rearing	Subadult Migration	Spawning/Incubation	Juvenile/Adult Rearing	Spawning/Incubation	Juvenile/Adult Rearing	Adult migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Spawning/Incubation	Juvenile/Adult Rearing	Adult Migration/Foraging	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration	Spawning/Incubation	Juvenile/Adult Rearing
Water Temperature					○	○			○	●	○	○							●	●
Pollutants	○	○	○	○	○	○	○	○	○	○	○	○			○	○	○	○	○	○
Turbidity								○			○								○	○
Geomorphic Processes					○	○	○												●	
Aquatic, Riparian, and Floodplain Habitat					○	○	○	○	○	●	○	○	○	○	○	○	○		○	○
Aquatic Habitat Connectivity									●			●			●			●		
Diversions				○		●		○	●	○		●								
River Flow																				
Delta Flow																				
Reservoir Surface Level																				
Predation						○		○			○	○					○			●
Food Resources and Food Web Support			○			○		○			○	○		○			○			●
Hybridization																			○	
Competition																				
Disease																				

Notes:
● Impact mechanism is well understood, applicable to species' distribution in the assessment area, and information is available for assessment.
○ Applicable to species' distribution in the assessment area, but impact mechanism is uncertain and/or information available for assessment is incomplete.
[1] Includes largemouth bass, smallmouth bass, and spotted bass.

Table 5-7.
Environmental Conditions for Each Representative Fish Species in San Joaquin River from Merced River to Delta

Environmental Conditions	River Lamprey				Hard-head		Sacramento Splittail				Fall-Run Chinook Salmon				Central Valley Steelhead				Black Bass[1]		Striped Bass			
	Adult Spawning Migration	Spawning/Incubation	Juvenile Rearing	Adult Downstream Migration	Spawning/Incubation	Juvenile/Adult Rearing	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Spawning/Incubation	Juvenile/Adult Rearing	Adult Migration/Foraging	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration
Water Temperature							○	●	○	○			○	○			○	○						
Pollutants	○	○	○	○	○	○	○	○	○	○	○		○	○	○		○	○				○	○	○
Turbidity					○	○			○					○			○	○						
Geomorphic Processes					○																			
Aquatic, Riparian and Floodplain Habitat					○	○	○	●	○	○			○				○		○	○	○	○	○	
Aquatic Habitat Connectivity	○			○			●			●	●										●			●
Diversions						○	●	○	○	●				●				●						
River Flow													○	○			○	○						
Delta Flow																								
Reservoir Surface Level																								
Predation						○			○	○													○	
Food Resources and Food Web Support			○			○			○	○										○			○	
Hybridization												○				○								
Competition												○												
Disease												○				○								

Notes:
● Impact mechanism is well understood, applicable to species' distribution in the assessment area, and information is available for assessment.
○ Applicable to species' distribution in the assessment area, but impact mechanism is uncertain and/or information available for assessment is incomplete.
[1] Includes largemouth bass, smallmouth bass, and spotted bass.
Key: Delta = Sacramento-San Joaquin Delta

Potential impacts of the program alternatives on river fishes were assessed using information on the current distribution of representative fish species in the Restoration Area, and San Joaquin River from the confluence with the Merced River to the Delta, together with available information on existing and projected future conditions that influence fish distribution, abundance, and habitat suitability for key life stages.

Data from numerical simulation modeling were available to support the assessment. The SJR5Q water temperature model was used to provide simulated water temperature for the San Joaquin River in the Restoration Area. CalSim-II was used to provide simulated data on reservoir operations, river discharge, and EC in the San Joaquin River from Friant Dam to the Delta; river flow in the Merced, Tuolumne, and Stanislaus rivers; and pumping from existing and proposed pumping infrastructure on the San Joaquin River and in the south Delta. Characterization of species response was predicated on assumptions about environmental conditions that may or may not persist in light of accelerated climate change. Climate change impacts on San Joaquin River water temperatures were considered under the No-Action Alternative by analyzing projected increases in mean annual and summer (June to August) air temperatures for the Restoration Area using downscaled data and Global Circulation Model (GCM) ensemble predictions to provide a range of air temperatures that could be related to the SJR5Q model output and preferred water temperatures by fish communities.

Specific methods used to assess fisheries impacts in the mainstem San Joaquin River are described below for each environmental condition or group of conditions.

Water Temperature and Water Quality. Water temperature and water quality plan a key role in the survival, reproductive success, and growth of fishes in the San Joaquin River.

Potential impacts of changes in water temperature on fish in the Restoration Area were evaluated using modeled water temperature data for each Restoration water year type from the SJR5Q river temperature model (Appendix H, “Modeling”). Relative effects were assessed by comparing modeled water temperature under each alternative to modeled baseline conditions for both the future (2030) and existing conditions (2005 level of development (LOD)) scenarios. Modeled mean period water temperatures for each water year type were compared to information on fish distribution and water temperature suitability for each fish life stage.

For this assessment, “suitable” refers to the environmental conditions that enable fish to persist (i.e., that support the species or life stage) without causing or contributing to stresses that would substantially reduce the probability of survival, reproduction, or the viability of gametes (i.e., eggs and sperm). Suitable water temperatures are those which do not cause or contribute to acute or chronic stresses that would significantly reduce survival or reproductive success of the assessment species. Available information on suitable water temperatures for the representative fish species and life stages is presented Appendix K, “Biological Resources – Fisheries.”

Modeled water temperature data were not generated for the mainstem San Joaquin River downstream from the Merced River. Potential water temperature impacts on fish in the San Joaquin River downstream from the Merced River were assessed by evaluating potential changes in downstream river water temperature, if any, that would result from water flowing into this river section from upstream. This evaluation was based on comparing simulated water temperature from the San Joaquin River, upstream from the Merced River, with empirical water temperature data from gage locations in the mainstem San Joaquin River.

Levels of pollutants in the river are affected by several factors, including spills of toxic substances during construction activities, cleanup of spill sites, existing concentrations of salts and agricultural chemicals in the substrate of currently dry reaches in the Restoration Area, and input from agricultural drainage and groundwater. However, existing conditions and program-level actions related to pollutants have not been clearly defined to allow a detailed assessment of changes in pollutant levels. Effects on fish that may result from changes in pollutant levels are therefore evaluated based on the likely impacts of increased San Joaquin River flows, assuming dilution would result in long-term improvement in water quality conditions. Simulated EC data from the CalSim-II model were used to evaluate potential trends in overall river water quality in the Restoration Area and downstream from the Merced River confluence. Relative impacts were assessed by comparing modeled parameters for each program alternative to existing conditions. Empirical data describing existing baseline conditions were available for some water quality parameters. Modeled EC was used to describe projected future conditions in 2030 (see Appendix H, “Modeling”).

Physical Processes and Conditions. Potential effects of the program alternatives on physical processes and conditions that may impact representative river fish species were assessed by evaluating the potential for actions to cause changes in aquatic habitat that the representative species depend on for survival. These impacts were considered in the Restoration Area and San Joaquin River from the Merced River to the Delta.

Geomorphic Processes. The assessment of potential impacts on fish resulting from changes in geomorphic processes was based on an evaluation of how the program alternatives would affect geomorphic processes and, in turn, affect fish and their habitats in the San Joaquin River. The assessment focused on drivers and controls of geomorphic function to evaluate how potential changes in geomorphic function could cause impacts on fish and their habitat. Behavioral impacts on fish were also evaluated by incorporating a qualitative assessment of how potential changes in a particular aspect of geomorphic function might impact the behavioral response of fish. Fish habitat suitability was evaluated from the standpoint of habitat presence, absence, or persistence resulting from channel adjustments to actions.

Because many of the potential impacts would result from program-level actions for which detailed information is not currently available (e.g., increasing channel capacity in Reach 2B and Reach 4B), the assessment of impacts related to geomorphic processes was qualitative, based on information on existing channel geomorphology, and fish habitat requirements, general principles in fluvial geomorphology, and interpretation of previous analyses. The primary source for background and supporting information for the assessment of project effects on geomorphic processes is the *San Joaquin River Restoration Study Background Report* (McBain and Trush 2002), which presents a comprehensive review of regional geology and channel form and function, and provides estimates of the discharge required to initiate sediment transport in each reach. Additional supporting information, including refined estimates of sediment transport capacity in Reach 1, was derived from *Draft Restoration Strategies for the San Joaquin River* (Stillwater Sciences 2003). Additionally, the flow release schedule from Exhibit B of the Settlement formed the basis for assessing potential changes in geomorphic processes because Interim and Restoration flows would be the most important Settlement actions to affect geomorphic processes pertaining to fish in the Restoration Area.

Aquatic, Riparian, and Floodplain Habitat. Impacts of the program alternatives on San Joaquin River aquatic, riparian, and floodplain habitat in the Restoration Area were evaluated by calculating expected changes in the length of continuously wetted river channel relative to the No-Action Alternative, expressed as length of habitat gained in each subreach (Table 5-8). Expected changes were determined using GIS to calculate existing wetted channel length under typical (nonflood) existing Friant Dam releases, and compared to expected length of wetted channel under Interim and Restoration flows. It was assumed for purposes of this assessment that Restoration Flows would be sufficient to provide a contiguous wetted channel in the Restoration Area in all months in each Restoration water year type.

Table 5-8.
Summary of Wetted Length by Reach of San Joaquin River in Restoration Area

Reach	Reach Length (miles)	Wetted Under Existing Conditions[1] (Y/N)	Wetted Under Program Alternatives (Y/N)
1A	24.3	Y	Y
1B	14.2	Y	Y
2A	12.9	N	Y
2B	11.3	N	Y
3	22.8	Y	Y
4A	13.5	Y	Y
4B1	21.3	N	Y
4B2	11.4	Y	Y
5	17.8	Y	Y
Total Length (miles)	**149.5**	**104.0**	**149.5**

Note:
[1] Information based on McBain and Trush, 2002
Key:
N = No
Y = Yes

Data on the relative changes in the areas of aquatic, riparian, and floodplain habitat under the program alternatives were not available for the assessment. The assessment is based on the assumed relationship between wetted river channel length and the amount of instream and off-channel (e.g., floodplain) habitat available for fish under the range of Restoration Flow releases. Assumptions regarding the availability of floodplain, riparian, and off-channel habitat for the representative fishes are based largely on expert reports prepared during Settlement studies.

In Normal-Dry, Normal-Wet, and Wet years, Spring Rise and Pulse Flows in March and April are expected to "… provide supplemental edge and side channel habitats and floodplain inundation for two to three weeks to allow for spawning of native fishes and rearing of juvenile salmon and other native fishes under highly productive conditions." (Moyle 2005). In wetter years, the geomorphic pulse flow (8,000 cfs) is expected to prepare the seedbed for cottonwoods (Kondolf 2005). Vegetation recruitment flows of approximately 4,000 cfs (3,000 to 6,000 cfs) combined with the high spring pulse recommended for wetter years are intended to disperse seeds and facilitate seed germination in the target zone of 2 to 6.5 feet above the summer base flow water level, and to reduce vegetation encroachment in the low-flow channel (Kondolf 2005).

In general, it is assumed that habitat quantity and quality for all representative fish species, including special-status and game fishes, increase with increasing flow at the flow ranges that would generally occur in the San Joaquin River (i.e., nonflood-flow events), and that wetted channel length can be used as a general indicator of habitat quantity and quality. The general, qualitative effects of increased habitat quantity and quality were evaluated for each representative fish species life stage to determine potential impacts of the action alternatives.

Aquatic Habitat Connectivity. Impacts of the action alternatives on aquatic habitat connectivity in the San Joaquin River were evaluated similar to impacts on aquatic, riparian, and floodplain habitat. The assessment was based on GIS-derived calculations of the expected change in the length of continuously wetted river channel in the Restoration Area (Table 5-8) that would result from implementation of the Settlement. It is assumed that Restoration Flows would provide contiguously connected aquatic habitat from Friant Dam to the Merced River, and that habitat connectivity in the San Joaquin River from the Merced River confluence to the Delta would not be substantially affected by the action alternatives.

Program-level actions to improve or provide fish passage at existing or potential physical structures were assumed to provide additional increases in riverine habitat connectivity in the Restoration Area relative to conditions under the No-Action Alternative. Actions to provide fish passage and improve habitat connectivity in the Restoration Area include the following:

- Construction of the Mendota Pool Bypass Channel
- Barrier removal and modification to improve movement past structures

- Barrier and fish screen installation to improve movement toward suitable habitats and reduced entrainment
- Habitat restoration to improve connectivity and conditions for movement to upstream and downstream habitats
- Seasonal barriers or screens to reduce entry by fish into false migration pathways and minimize the potential for stranding of migratory and anadromous fish
- Modifications to road crossings to improve passage to upstream reaches
- Trapping and hauling of fish to upstream and downstream reaches, as necessary

Existing fish passage barriers and impediments are listed in Table 5-9.

Table 5-9.
Existing Barriers and Impediments to Fish Migration in Restoration Area

Location	Structure Type	Description
Hills Ferry	Seasonal weir	Directs Chinook salmon into Merced River
Eastside Bypass	Drop structure	Near its confluence with San Joaquin River
Mariposa Bypass	Drop structure	Near its confluence with San Joaquin River
Sand Slough	Headgates	Sand Slough Control Structure
Eastside Bypass	Drop structure	Upper end, near its confluence with San Joaquin River
Sack Dam	Diversion dam	Feeds Arroyo Canal
Mendota Dam	Diversion dam	Delivery point for Delta-Mendota Canal
Chowchilla Bypass Bifurcation Structure	Radial gates	Control structure for Chowchilla Bypass
Gravelly Ford	Earthen diversion dam	Diversion dam just downstream from Gravelly Ford
Friant Dam	Primary storage dam	Upper limit of potential salmonid migration

Source: McBain and Trush, 2002.

The general, qualitative effects of increased aquatic habitat connectivity were evaluated for each representative fish species and/or life stage to determine potential impacts of the program alternatives. The assessment focused on potential impacts to special-status anadromous or migratory fish species, with the assumption that a contiguous wetted river channel and provision of fish passage at instream structures would provide access to preferred or required habitat.

Diversions. The assessment of diversion impacts on fish was based on an evaluation of expected changes in the structure and operation of water diversions in the Restoration Area, including use of existing facilities for the recapture of Interim and Restoration flows in the Restoration Area and in the San Joaquin River downstream from the Merced River, as well as potential screening of existing diversion facilities in the Restoration Area.

Existing water diversions in the San Joaquin River are listed in Table 5-10, and include large diversions and control structures such as the Arroyo Canal and Chowchilla Bypass Bifurcation Structure and many small diversions and pumps.

Table 5-10.
Diversions and Pumps Located on San Joaquin River from Friant Dam to Delta

Geographic Area	Reach	Number of Diversions and Pumps
San Joaquin River from Friant Dam to the Merced River[1]	1A	70
	1B	13
	2A	6
	2B	23
	3	6
	4A	4
	4B1	9
	4B2	1
	5	4
San Joaquin River from Merced River to Delta[2]	River Mile 118.8 to the Delta	19

Sources:
[1] *Data source: McBain and Trush 2002*
[2] *Data source: SWRCB 2009*

Key:
Delta = Sacramento-San Joaquin Delta

Data on the intake configuration (i.e., screened or unscreened), operational parameters of most small diversions, and effects on fish from diversions of all sizes and configurations were not available for this assessment. Published studies and reviews of potential diversion-related effects on fish provided some general guidelines that were considered in the PEIS/R impacts assessment.

In a review of the literature on fish screens, Moyle (2002b) found evidence that introduced (nonnative) fishes and abundant native fishes (e.g., Sacramento sucker) tend to be the most common species entrained in small (less than 40 cfs) diversions. However, the same review concluded that population-level impacts of diversion losses cannot currently be assessed because of a lack of quantitative information. Currently, there are no known generally applicable study results quantifying losses of juvenile salmonids or other fishes in relation to diversion type or volume, and there are insufficient data with which to predict (i.e., model) such losses (Moyle 2002b, Moyle and Israel 2005).

The fisheries assessment relied on a general, qualitative evaluation of the expected impacts on fish from the range of potential actions to modify diversion intakes in the Restoration Area, and reduce potential fish entrainment. These include actions such as screening the Arroyo Canal and Chowchilla Bypass Bifurcation Structure, as well as potential installation or modification of fish screens at small diversions throughout the Restoration Area. Prevention of diversion-related loss would primarily benefit migratory species, including Sacramento splittail and striped bass. Larval and juvenile life stages are generally more susceptible than adults to the effects of screening and diversion. Therefore, the assessment is focused on potential impacts to larvae and juveniles, with the assumption that fish screen installation or modification would reduce entrainment losses of these species and life stages. The general, qualitative impacts of reduced entrainment losses were evaluated to determine potential impacts of the actions.

Newly installed or modified fish screens would be compliant with NMFS and DFG criteria, which were established to prevent entrainment or impingement of juvenile anadromous salmonids. Entrainment is defined as the voluntary or involuntary movement of fish through, under, or around a fish screen resulting in loss of fish from the population. Impingement occurs when facility operations cause fish to be pinned to the surface of a fish screen.

The NMFS and DFG criteria require that fish screens must be constructed of material with openings less than 3/32 inches (2.38 mm) and an open area of at least 27 percent (NMFS 1997, DFG 2000). Screens must be designed to function properly through the full range of hydraulic conditions expected at a diversion intake during the periods of juvenile Chinook salmon and steelhead migration, and be capable of handling debris and sedimentation (NMFS 1997). Additional considerations include screen orientation and intake design specifications so that hydraulic conditions at the screen face do not create an impingement hazard or cause other adverse effects to fish.

River Flow. Within the San Joaquin River from Friant Dam to the Delta, changes in river flow under the action alternatives would drive changes in the environmental conditions previously described. Therefore, the assessment of potential river flow impacts is not separately described for these geographic areas.

Biological Interactions. Potential impacts of the program alternatives on biological interactions that may impact representative river fish species were assessed by evaluating the potential for the program alternatives to cause changes in environmental conditions. These changes in environmental conditions could, in turn, influence the way these species interact with their environment and with other species. These impacts were primarily considered in the Restoration Area and the San Joaquin River downstream from the Merced River confluence. The potential impacts of the alternatives on conditions that may affect biological interactions in the three major San Joaquin River tributaries (Merced, Tuolumne, and Stanislaus rivers) were also assessed for the Chinook salmon and steelhead populations that exist in those rivers.

Predation. The assessment of predation-related impacts evaluated the potential for the program alternatives to create or modify environmental conditions that could increase or decrease the vulnerability of special-status fishes, particularly egg, larval, and juvenile life stages, to predation by piscivorous fish and possibly other aquatic, avian, or terrestrial predators.

The assessment is qualitative, based on potential changes in predator-prey interactions that could result from altered distribution, abundance, and behavior of predatory fishes and prey fishes. Additionally, the evaluation looks at potential changes in other environmental conditions such as food (prey) resources, competition, and water temperature that can affect predator-prey interactions. The assessment also considered the potential for increased or decreased predator success and the availability and suitability of predator habitat due to changes in prey vulnerability and aquatic habitat characteristics that could result from implementation, operation, and maintenance of the program actions.

Operation of new or existing pumping facilities could increase the potential for attracting or pulling fish to the facilities, entraining the fish in the pumps and canals, and entraining some percentage in the Mendota Pool. From the Mendota Pool, predatory fish originating from the San Joaquin River downstream from the Merced River confluence could enter the San Joaquin River in the Restoration Area.

Food Resources and Food Web Support. The assessment of potential fisheries impacts related to food resources and food web support qualitatively evaluated the potential impacts of the alternatives on primary and secondary production, nutrient input, and other environmental processes and conditions that could increase or decrease food availability for the representative fish species. For this assessment, actions were assumed to create and improve aquatic and riparian habitat, increase aquatic production, and nutrient input from terrestrial sources. In addition, increased river flows and connectivity were assumed to improve nutrient transport and cycling in the San Joaquin River. Potential impacts of human-caused nutrient loading were addressed separately in the assessment of impacts related to pollutants. The assessment also considered the impacts of Chinook salmon reintroduction, and the resulting input of ocean-derived nutrients provided by Chinook salmon carcasses.

Competition. Potential fisheries impacts related to competition were assessed by evaluating the potential effects of the program alternatives on environmental conditions that could increase or decrease competitive interactions among the representative fish species. The assessment was qualitative, based on potential changes in competition that could result from altered distribution, abundance, and behavior of all fishes in the San Joaquin River, as well as potential changes in other environmental conditions such as habitat quantity and quality, food resources, and water temperature that can affect competitive interactions. Water diversions that alter the abundance or proportion of nonnative fish species relative to native species may also increase the potential for competition in aquatic systems.

Some nonnative fish species have habitat requirements that overlap with those of native special-status species. Nonnative species may be more aggressive and territorial than native species and result in the exclusion of native species from their habitats. Many nonnative species, such as green sunfish, also tolerate very high water temperatures and are better able than native fishes to persist in water with low DO, high turbidity, and pollutants (Moyle 2002a). Green sunfish are among the nonnative species that currently occur at relatively high abundance in the Restoration Area (DFG 2007).

The predicted flow increases in the San Joaquin River from the Merced River confluence to the Delta resulting from the release of both Interim and Restoration flows would increase the amount of instream habitat available to the representative species, and could reduce interspecific (between species) and intraspecific (within species) competition, especially during spring, when modeled flow increases are largest (Appendix H, "Modeling") and migrating juvenile fall-run Chinook salmon and steelhead are most abundant in this section of the river.

Disease. Potential fisheries impacts resulting from disease were assessed by evaluating the potential impacts of the program alternatives on environmental conditions that could increase or decrease the incidence and impacts of disease on the representative fish species.

The assessment was qualitative, based on potential changes in disease transmission vectors, virulence, and fish susceptibility that could result from altered distribution, abundance, and behavior of all fishes in the San Joaquin River. This assessment was also based on potential changes in other environmental conditions, such as habitat quantity and quality, pollutants, and water temperature that can affect disease transmission and the impacts of disease on the representative fish species.

Actions to implement Interim and Restoration flows, provide fish passage throughout the Restoration Area, and improve aquatic habitat conditions would provide access to the Restoration Area by fishes currently restricted to downstream portions of the San Joaquin River, including San Joaquin River basin fall-run Chinook salmon and steelhead. Restored habitat connectivity could increase the potential for disease transmission among formerly isolated populations, including the hatchery-supplemented resident rainbow trout in Reach 1 of the Restoration Area, and the Central Valley steelhead that occupy the lower San Joaquin River and tributaries. The parasite *Myxobolus cerebralis*, which causes whirling disease in salmonids, including rainbow trout, steelhead, and Chinook salmon, poses a risk to salmonid populations in the San Joaquin River. This parasite relies on tubifex worms (*Tubifex tubifex*) as an intermediate host (Bergersen and Anderson 1997), and is a concern for the San Joaquin River because there is a tubifex worm farm located in Reach 1A (Jones and Stokes 2002).

San Joaquin River Tributaries (Merced, Tuolumne, and Stanislaus Rivers)

The Merced, Tuolumne, and Stanislaus rivers are the three main tributaries to the lower San Joaquin River. Each tributary supports populations of fall-run Chinook salmon and Central Valley steelhead.

River Flow. The effects on tributary fish resulting from implementing the Settlement are evaluated by comparing flows in the tributaries with and without the action alternatives in place. Flows on the tributaries are predominantly controlled by three factors, including the following:

- **Vernalis Water Quality Standard –** The Vernalis water quality standard is an EC requirement of 700 micromhos per centimeter (cm) and 1,000 micromhos/cm for the irrigation (April to August) and nonirrigation (September through March) seasons, respectively. If estimated EC does not meet the Vernalis water quality standard, releases are made from New Melones Reservoir on the Stanislaus River to mix with the San Joaquin River to meet the Vernalis Water Quality standard.

- **Vernalis Adaptive Management Program –** VAMP is an experimental and management program designed to protect San Joaquin River juvenile Chinook salmon as they migrate to and through the Delta. VAMP is also set up to determine how survival rates change in response to alterations in San Joaquin River flows and CVP/SWP exports with the installation of the Head of Old River Barrier. VAMP employs an adaptive management strategy to use current knowledge of hydrology and environmental conditions to protect Chinook salmon smolts, while gathering information to allow more efficient protection in the future. VAMP specifies a 31-day pulse flow during the 61-day window of April and May to coincide with fish movement in the area.

- **Local tributary operations –** The major reservoirs on the tributary rivers all operate for local requirements, including flood management and water supply. The rules governing operation of these reservoirs to meet these requirements are based on reservoir storage at any given time. For example, flood management rules typically require releases during periods of high inflows. Reservoir storage at the start of the high inflow period dictates when a reservoir will reach the flood control storage limit, thus changing releases made from the reservoir to meet flood management objectives.

Because all three tributary rivers share the responsibility of meeting VAMP flow requirements, the increase in the San Joaquin River flows caused by Interim and Restoration flows could cause changes in operations on all three tributaries. Only the New Melones Reservoir on the Stanislaus River is operated to meet the Vernalis water quality standard. Criteria for determining impacts to tributary fish in this Draft PEIS/R were based on the flows in each tributary that are believed to provide the maximum habitat for each life stage of Chinook salmon and Central Valley steelhead. These flows, identified in Table 5-11, were identified by NMFS based on several sources, including two instream flow incremental methodology studies conducted to calculate maximum weighted usable area of habitat for each life stage (USFWS 1993, 1995), and studies conducted for FERC relicensing projects (Erin Strange, pers. com 2011).

Table 5-11.
Tributary Flows Assumed to Provide Maximum Habitat

Time Frame	Life Stage	Flow (cfs)
Merced River Chinook Salmon/Steehead[1]		
October 1 – December 31	Spawning	400
January 1 – March 15	Incubation/fry rearing	400
March 16 – June 15	Juvenile Rearing/Migration	1,500
June 15 – October 31	Juvenile rearing/Adult (steelhead)	250
Tuolumne River Chinook Salmon[2]		
October 1 – April 30	Spawning/Incubation/Fry Rearing	275
February 1 – October 31	Juvenile Rearing	150
January 1 – June 30	Juvenile Migration	1,100
Tuolumne River Steelhead[2]		
January 1 – December 31	All life stages	275
March 15 – June 30	Juvenile Migration	1,100
Stanislaus River Chinook Salmon[3]		
October 15 – December 31	Spawning	300
January 1 – February 28	Incubation/Fry Rearing	300
February 15 – March 15	Juvenile Rearing	200
March 15 – June 30	Juvenile Migration	2,000
Stanislaus River Steelhead[3]		
November 1 – Feb 28	Spawning	200
January 1 – March 31	Incubation/Fry Rearing	200
January 1 – December 31	Juvenile Rearing	150
March 15 – June 30	Juvenile Migration	2,000

Sources: USFWS 1993 and 1995, Erin Strange pers. com. 2011

Notes:

[1] Because information is limited on steelhead, flows needed for Chinook salmon and steelhead are combined. Flows are based on information from the 1997 spawning habitat instream flow assessment and flow recommendations from the Anadromous Fish Restoration Program.

[2] Flows are based on the Stanislaus River Instream Flow Incremental Methodology report, and from results of the California Department of Fish and Game Chinook model.

[3] Flows are based on the Stanislaus River Instream Flow Incremental Methodology report, and from the 2009 Operations Criteria and Plan Biological Opinion– below-normal year

Key:
cfs = cubic feet per second

Hybridization. Potential fisheries impacts related to hybridization were assessed by evaluating potential impacts of the alternatives on genetic mixing between hatchery or out-of-basin fish stocks and wild (i.e., naturally reproducing) populations native to the San Joaquin River. Hybridization can reduce fitness through loss of distinct, native, or potentially adaptive genetic components or lineages (Stephens and May 2007). Impacts related to hybridization have been identified in salmonid species as a result of interbasin transfers and straying of hatchery-reared anadromous salmonids (Weitkamp et al. 1995). The rainbow trout population in the Restoration Area is supplemented by hatchery production and is currently restricted to the upstream portion of Reach 1 during all but the wettest years by unsuitably high summer water temperatures and the lack of a wetted channel downstream from Gravelly Ford (head of Reach 2A). Because rainbow trout in the Restoration Area do not have regular access to the ocean, they are not considered to be anadromous, and are thus distinct from Central Valley steelhead populations that occur in the lower San Joaquin River, the major San Joaquin tributaries, and Delta.

Actions to implement Interim and Restoration flows would provide fish passage throughout the Restoration Area, and actions to improve aquatic habitat conditions would provide access of anadromous and migratory fishes to suitable habitat in the San Joaquin River upstream from the Merced River confluence. With implementation of these actions, the existing population of resident rainbow trout would have access to the ocean and could interbreed with Central Valley steelhead that currently occur in the lower mainstem San Joaquin River and its major tributaries. However, the rainbow trout currently stocked in the major reservoirs, and upstream from the reservoirs on the Merced, Tuolumne, and Stanislaus rivers, are also of hatchery origin and have been documented to hybridize with steelhead in the rivers below the dams. Zimmerman et al. (2008) found that the lower Tuolumne and Stanislaus rivers are already dominated by resident rainbow trout progeny.

Reintroduction of spring-run Chinook salmon is a high-priority Restoration action, and its implementation could result in spring-run Chinook salmon reintroduced from out-of-basin straying and subsequent intraspecific (within a species) hybridization with San Joaquin River fall-run Chinook salmon. Potential impacts of hybridization on nonsalmonid fishes were not considered in this assessment because inadequate information is available for an evaluation without undue speculation. Because spring-run Chinook salmon do not currently occur in the San Joaquin basin, reintroduced spring-run Chinook salmon would originate from out-of-basin stock that is still to be determined. The spawning periods of spring-run and fall-run Chinook salmon in the Central Valley typically overlap during October (Appendix K, “Biological Resources – Fisheries”), during which hybridization between reintroduced spring-run and San Joaquin River basin fall-run Chinook salmon could occur in the Merced, Tuolumne, and Stanislaus rivers.

It was assumed for the impacts assessment that reintroduction of fall-run Chinook salmon would likely occur passively as a result of “straying” by fall-run Chinook salmon from the major San Joaquin River tributaries into the San Joaquin River upstream from the Merced River confluence, as passage and flows permitted. Because the reestablished fall-run Chinook salmon would likely be from existing San Joaquin River basin populations, it was assumed that no hybridization of distinct fall-run Chinook salmon populations would occur. In addition, the alternatives include the potential for continued operation of the temporary fish barrier at Hills Ferry near the Merced River confluence to seasonally restrict access by fall-run Chinook to the San Joaquin River in the Restoration Area.

For Chinook salmon and steelhead, NMFS has defined a “viable population” as an independent (i.e., self-sustaining) population that has a negligible risk of extinction because of threats from demographic variation, local environmental variation, and genetic diversity changes that may occur over a 100-year time frame (McElhany et al. 2000). Building on this concept, Lindley et al. (2007) quantitatively assessed Chinook salmon and steelhead population viability using quantitative extinction models, population growth rates, occurrence of catastrophic events, and degree of hatchery influence. These techniques can be used to analyze the viability of existing populations and set numeric population targets for restoration and recovery. However, no data are currently available to support a quantitative analysis of the potential impacts of hybridization or hatchery influence on fall-run Chinook salmon or Central Valley steelhead in the San Joaquin River; therefore, this assessment relied on a general, qualitative evaluation of the likelihood of hybridization.

Competition. The potential for increased competition for Chinook salmon spawning habitat in the Merced, Tuolumne, and Stanislaus rivers could occur following reintroduction of spring-run and fall-run Chinook salmon to the upper San Joaquin River. This impact was assessed by evaluating the potential for reintroduced spring-run Chinook salmon to stray into the Merced, Tuolumne, or Stanislaus rivers and superimpose their redds (i.e., nests) on those of fall-run Chinook salmon during spawning. The assessment of potential impacts because of redd superimposition was conducted only for the existing population of San Joaquin River basin fall-run Chinook salmon.

Redd superimposition occurs when spawning fish construct new redds on top of preexisting redds such that the eggs in the preexisting redd are either destroyed or buried under fine sediment that prevents most of the fry from emerging. Redd superimposition by fall-run Chinook salmon has been reported in the Tuolumne River (TID/MID 1991) and in the Stanislaus River (Mesick 2001). However, it is unlikely that superimposition of fall-run Chinook salmon redds by reintroduced spring-run Chinook salmon would occur in the Merced, Tuolumne, or Stanislaus rivers because spring-run Chinook salmon spawn before most fall-run, and the peak spawning periods of the two runs have a short duration overlap (see Appendix K, “Biological Resources – Fisheries”). Furthermore, recent research indicates that redd superimposition is currently unlikely to limit adult Chinook salmon recruitment in these San Joaquin River tributaries because many more fry are produced at high densities of spawners than can be sustained by the available rearing habitat (Mesick and Marston 2007).

Disease. Reintroduced spring-run Chinook salmon, which may include or be supplemented by fish from an out-of-basin hatchery, could stray into the Merced, Tuolumne, and Stanislaus rivers and increase the potential for the introduction and spread of hatchery-borne disease into San Joaquin River basin Chinook salmon populations.

Sacramento-San Joaquin Delta

The action alternatives are expected to have relatively little effect on the environmental conditions of potential importance to the eight Delta fish species selected for assessment (Table 5-12). However, the action alternatives are expected to affect distributions of the fish and, thus, the environmental conditions to which they are exposed. The south Delta is the portion of the Delta where fish distributions would be most directly affected by the program alternatives because changes in San Joaquin River flow and diversions at Jones and Banks pumping plants would occur in the south Delta. While physical impacts to the central Delta would also occur from Interim and Restoration flows reaching the Delta, and any recapture of those flows through Delta exports in the south Delta, these impacts would not be as pronounced, and are covered entirely through the focus on south Delta impacts.

Table 5-12.
Environmental Conditions Included in Impact Assessment for Each Representative Species, by Life Stage, in Sacramento-San Joaquin Delta

Environmental Conditions	Sacramento Splittail				Chinook salmon				Central Valley Steelhead				Sturgeon[1]				Delta Smelt			Longfin Smelt			Striped Bass			
	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration	Spawning/Incubation	Larval Rearing	Juvenile/Adult Rearing	Spawning/Incubation	Larval Rearing	Juvenile/Adult Rearing	Adult migration/Foraging	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration
Water Temperature	○	○	○	○	●			●	●			○	○		○	○	○	○	○	○	○	○	○	○	○	○
Pollutants	○	○	○	○	○			○	○			○			○	○	○	○	○	○	○	○	○	○	○	○
Turbidity			○					○				○			○		○	○	○	○	○	○	○		○	○
Geomorphic Processes																										
Aquatic, Riparian, and Floodplain Habitat	○	○	○	○				○				○			○	○	○	○	○	○	○	○	○	○	○	○
Aquatic Habitat Connectivity																										
Diversions	●	○	○	●				●				●			○	○	●	●	●	●	●	●			●	●
River Flow																										
Delta Flow	○	○	○	○	●			●	●			●	○		○	○	●	●	●	●	●	●	○	●	●	●
Reservoir Surface Level																										
Predation		○	○	○				●				○			○	○	○	○	○	○	○	○			○	○

Table 5-12.
Environmental Conditions Included in Impact Assessment for Each Representative Species, by Life Stage, in Sacramento-San Joaquin Delta (contd.)

Environmental Conditions	Sacramento Splittail				Chinook salmon				Central Valley Steelhead				Sturgeon[1]				Delta Smelt			Longfin Smelt			Striped Bass			
	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Juvenile Rearing	Juvenile Migration	Adult Migration	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration	Spawning/Incubation	Larval Rearing	Juvenile/Adult Rearing	Spawning/Incubation	Larval Rearing	Juvenile/Adult Rearing	Adult migration/Foraging	Spawning/Incubation	Larval/Juvenile Rearing	Juvenile Migration
Food Resources and Food Web Support	○	○	○	○				○				○			○	○	○	○	○	○	○	○	○		○	○
Hybridization																										
Competition																										
Disease																										

Notes:

● Impact mechanism is well understood, applicable to species' distribution in the assessment area, and information is available for assessment.

○ Applicable to species' distribution in the assessment area, but impact mechanism is uncertain and/or information available for assessment is incomplete.

[1] Includes North American green sturgeon (Southern DPS) and white sturgeon.

The expected effects of program alternatives on the flow patterns was quantified using CalSim-II operations model predictions of San Joaquin River flow at Vernalis and combined Old and Middle rivers flow. The ratio of San Joaquin River inflow to reverse Old and Middle rivers flow was used evaluate the net effect of these flows. Increases in the ratio were considered to reduce the probability of fish entering or remaining in the south Delta. The ratios were computed only for months and years when Old and Middle rivers flow were negative (i.e., reversed) because only negative flows moved fish towards the south Delta.

The most important potential impacts of the program alternatives on Delta fishes beyond the south Delta would be changes in Delta outflow and X2. X2, the distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 ppt, is largely determined by Delta outflow and is often used to index the location of the LSZ (Kimmerer 2004). The LSZ is an area of favorable habitat conditions for early life stages of Delta fish species such Delta smelt and striped bass and longfin smelt larvae (Kimmerer et al. 2009, Feyrer et al. 2007, Kimmerer 2004). If San Joaquin River inflow is high, and not offset by Jones and Banks pumping plant exports, Delta outflow and X2 could be significantly affected. CalSim-II modeling was used to evaluate the effects on X2.

5.4.2 Significance Criteria

The thresholds of significance for impacts are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. Effects on fish would be considered significant if implementation, operation, or maintenance of program actions included in alternatives would do the following:

- Have a substantial adverse impact, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by DFG, USFWS or NMFS.
- Interfere substantially with the movement of any native resident or migratory fish.
- Cause production and/or discharge of materials that pose a hazard to fish.
- Result in displacement of spawning fish such that year-class strength of any Federal or State special-status fish species or any commercially important fish species is substantially reduced.
- Substantially reduce the abundance, either directly or by reducing the amount or quality of habitat, of any life stage of a Federal or State special-status species or any commercially important fish species.
- Adversely modify designated critical habitat for any Federally listed species.

In general, impacts on most nonnative fishes are not likely to be significant because their populations typically are large and resilient and the potential for population-level impacts is therefore low. However, some nonnative fishes have considerable recreational and commercial importance in parts of the fisheries impact assessment area (e.g., largemouth bass and striped bass in Millerton Lake), and adverse impacts on these populations could be important.

5.4.3 Program-Level Impacts and Mitigation Measures

The potential responses of representative fish species and resulting impacts that may occur as a consequence of the implementation of program-level actions under the program alternatives are described below. The Conservation Strategy (fully described in Chapter 2.0, "Description of Alternatives") reduces impacts of the action alternatives that could otherwise be potentially significant to a less-than-significant level, and precludes the need for mitigation measures. Program-level impacts are described separately for each geographic area.

No-Action Alternative

The No-Action Alternative includes existing facilities, conditions, and land uses, as well as reasonably foreseeable actions and conditions expected to occur in the study area by 2030, independent of the Settlement. Mitigation is not required for potentially significant or significant environmental effects under the No-Action Alternative; therefore, no mitigation is proposed.

San Joaquin River Upstream from Friant Dam. No impacts would occur to fisheries in the San Joaquin River upstream from Friant Dam under the No-Action Alternative.

San Joaquin River from Friant Dam to Merced River. Under the No-Action Alternative, the Settlement would not be implemented. Impacts to aquatic habitat and fish in this area that would potentially occur under the No-Action Alternative would stem from (1) global climate change projected to drive future increases in mean summer and mean annual air temperatures, (2) implementation of reasonably foreseeable projects, including enforcement of the USACE policy on levee vegetation (USACE 2007), and (3) continuation of ongoing system-wide operations and maintenance.

Impact FSH-1 (No-Action Alternative): ***Changes in Water Temperatures in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Projected future increases in mean summer and mean annual air temperatures because of global climate change through 2030 are expected to increase water temperatures in the downstream portions of Reach 1 and the wetted portions of Reach 2, particularly during summer and fall, which could affect cold-water species (e.g., rainbow trout) and other representative species (e.g., hardhead, Kern Brook lamprey, black bass) found in wetted portions of Reaches 1 and 2. This impact would be **potentially significant**.

Although climate change impacts have not yet been included in the SJR5Q model, projected increases in air temperatures from 2041 through 2060 have been modeled using available downscaled data (12 kilometer (km) by 12 km grid) and indicate a 2 to 4°F increase in annual mean air temperature for the Restoration Area using an ensemble of three GCMs (i.e., CSIRO-MK3.0, MIROC3.2 (medres), and UKMO-HadCM3) across low (B1), medium (A1B), and high (A1) emissions scenarios (TNC 2009). Summer (June through August) air temperatures are projected to increase 3 to 7.5°F from 2041 through 2060, across low, medium, and high emissions scenarios for the ensemble GCM run. While seasonal water temperatures in the upstream end of Reach 1, near Friant Dam, are currently within the suitable or preferred temperature range for rainbow trout, hardhead, Kern brook lamprey, and black bass, as defined by Moyle (2002a), summer water temperatures in the downstream end of Reach 1 and the wetted portions of Reach 2 exceed species suitability ranges (see Appendix K, "Biological Resources – Fisheries") during the warmest months of the year (July and August), and may be higher or of longer duration because of climate change effects realized by 2030. Spawning temperature requirements for Sacramento splittail would continue to be met during Wet and Normal-Wet water year conditions when inundated floodplain habitat becomes available in Reaches 3 through 5.

Overall, although the No-Action Alternative would continue to support the existing fish community structure for representative special-status fish (e.g., Kern brook lamprey, hardhead, and Sacramento splittail) and game species (e.g., black bass, striped bass, and rainbow trout), future water temperatures under the climate change scenarios described above would not support the presence of cold-water fish in the downstream portions of Reach 1 and the wetted portions of Reach 2, particularly during midsummer months (July – August) when water temperatures are warmest. Therefore, projected air and water temperature increases because of global climate change within the San Joaquin River from Friant Dam to the Merced River would be potentially significant.

Impact FSH-2 (No-Action Alternative): ***Changes in Pollutant Discharge in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Under the No-Action Alternative, potential increased discharges and nonpoint source runoff of agricultural pollutants because of the planned Grasslands Bypass Project extension may impair reproduction or other essential behaviors of special-status and game fish species found in Reach 5 of the Restoration Area (e.g., Sacramento splittail, black bass, and striped bass). This impact would be **potentially significant**.

No existing water quality impairments have been identified within Reaches 1 and 2 (Friant Dam to Mendota Dam) that may affect special-status fish (e.g., Kern brook lamprey and hardhead) or game species (i.e., black bass, striped bass, and rainbow trout). However, Reaches 4 and 5 are currently 303(d)-listed for mineral contaminants (e.g., arsenic, boron), mercury, and pesticides (e.g., chlorpyrifos, 1,1,1-Trichloro-2, 2-bis(4-chlorophenyl)ethane (DDT), diazinon, Group A pesticides, unknown toxicity). The scheduled implementation of TMDLs for the pollutants discussed above from 2011 through 2021 may potentially reduce pollutant levels introduced by the Grasslands Bypass Project extension. However, although the affected special-status species in Reaches 4 and 5 have been found to be relatively tolerant of environmental degradation (Brown 2000), potential impacts may occur at even low pollutant levels, ranging from olfactory and neurological impairment to direct toxicity (Moore and Waring 1996). Therefore, these impacts would be potentially significant.

Impact FSH-3 (No-Action Alternative): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Under the No-Action Alternative, potential increased discharges and nonpoint source runoff of suspended sediments because of the planned Grassland Bypass Project extension may affect special-status and game fish species found in Reach 5 of the Restoration Area (e.g., Sacramento splittail, black bass, and striped bass). This impact would be **potentially significant**.

No existing water quality impairments have been identified within the study reaches related to sedimentation/siltation and recent DFG (2007) monitoring data collected during seasonal habitat and fish sampling surveys from 2003 through 2005 indicate relatively low turbidity in upstream reaches (Reach 1 with a mean of 1 to 2 nephelometric turbidity units (NTU), Reach 2 with a mean around 5 NTU). However, DFG (2007) surveys indicate higher turbidity levels (mean of 20 to 35 NTU) downstream from agricultural inputs from Bear Creek, and Salt and Mud sloughs in Reaches 4 and 5. Potential direct impacts of turbidity and suspended sediment on fish include reduced avoidance or alarm reactions, displacement from key habitats, physiological stress and respiratory impairment, gill damage, reduced tolerance to disease and toxicants, and direct mortality (Newcombe and Jensen 1996, Bash et al. 2001). The scheduled implementation of TMDLs for the pollutants discussed above between 2011 and 2021 may potentially reduce pollutant levels introduced by the Grassland Bypass Project extension. However, although the affected special-status species in Reaches 4 and 5 have been found to be relatively tolerant to high turbidity (Brown 2000), existing water quality impairments (Central Valley RWQCB 2009) may be related to contaminant sorption on suspended sediments, which can cause a range of impacts ranging from olfactory and neurological impairment to direct toxicity (Moore and Waring 1996). Therefore, these impacts would be potentially significant.

San Joaquin River from Merced River to the Delta. No impacts are anticipated to aquatic resources in the San Joaquin River between the Merced River confluence and the Delta resulting from the No-Action Alternative.

San Joaquin River Tributaries. No impacts are anticipated to aquatic resources in the San Joaquin River tributaries resulting from the No-Action Alternative.

Sacramento-San Joaquin Delta. All changes in Delta operations and diversions, as well as potential impacts associated with the operational changes, are discussed in the subsequent section on project-level impacts. These effects, however, are also applicable in the context of the program-level analysis.

Alternatives A1 and A2

Under Alternatives A1 and A2, potential program-level fisheries impacts would be related to the implementation, operation, and maintenance of the program-level actions.

San Joaquin River Upstream from Friant Dam. All changes in reservoir operations and any associated impacts of the operational changes are project-level, and are discussed in the subsequent section on project-level impacts.

San Joaquin River from Friant Dam to Merced River. Program-level impacts of Alternatives A1 and A2 in the Restoration Area are described below.

Impact FSH-1 (Alternatives A1 and A2): ***Changes in Water Temperatures in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Individual program-level actions could have short- or long-term effects on water temperatures in the Restoration Area associated with construction or operation. However, implementing special-status fish conservation measures PL-1, CVS-1, CVS-2, EFH-1, and EFH-2 of the Conservation Strategy would minimize or prevent potential adverse effects on special-status fish species. This impact would be **less than significant.**

Impact FSH-2 (Alternatives A1 and A2): ***Changes in Pollutant Discharge in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Construction activities within the stream channel, along the riverbank, and in adjacent floodplains have the potential to introduce hazardous materials into receiving waters supporting representative special-status and game fish species. Common materials used at restoration and construction sites include petroleum-based fuels and lubricants, paints, and fertilizers and herbicides that may be used during site replanting. Many of these substances can kill fish through exposure to lethal concentrations or exposure to nonlethal levels that cause physiological stress, impairment of essential behaviors, and increased susceptibility to other sources of mortality. However, implementing special-status fish conservation measures PL-1, CVS-1, CVS-2, EFH-1, and EFH-2 of the Conservation Strategy would minimize or prevent potential adverse effects on special-status fish species. This impact would be **less than significant.**

Impact FSH-3 (Alternatives A1 and A2): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Construction activities within the channel, along the riverbank, and in adjacent floodplains have the potential to introduce sediments into receiving waters supporting representative special-status and game fish species. Implementing conservation measures PL-1, CVS-1, CVS-2, EFH-1, and EFH-2 identified for special-status fish in the Conservation Strategy would offset potential adverse impacts. This impact would be **less than significant**.

Impact FSH-4 (Alternatives A1 and A2): ***Construction-Related Changes in Habitat Conditions in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** All fish in the Restoration Area would be subject to potential effects related to geomorphic processes as a consequence of channel alterations during and following Restoration actions. Short-term impacts would be related to temporary habitat loss and displacement of representative fish species as the channel adjusted to a new baseline geometry, slope, and channel capacity. As the San Joaquin River channel adjusted to program-level actions, long-term benefits to representative fish species in the Restoration Area would be realized as aquatic and floodplain habitat developed and connectivity improved in response to channel adjustment. This impact would be **less than significant** and **beneficial**.

The majority of changes in geomorphic processes would result from Restoration actions in Reaches 2B and 4B that are intended to improve conveyance of Restoration and flood flows. After a brief period of channel adjustment following construction, the channel would be expected to stabilize at a new equilibrium, where aquatic habitat stability and quality are relatively high. Therefore, this impact would be beneficial in the long term.

Construction of the Mendota Pool Bypass would likely have an effect on geomorphic processes, and in turn on aquatic and riparian habitats that support the representative special-status and game fish species. However, the Mendota Pool Bypass would include one or more grade control structures or other design features to control bedform and create stable and suitable habitat conditions for fish in the vicinity. The Mendota Pool Bypass would be similar to a meander bend cut-off, the net result of which would be a steeper channel because the length of the channel traversed for a given degree of elevation would have been reduced. Channel steepening may result in enhanced sediment transport capacity for a given discharge and commensurate head-cutting of the channel bed. However, as described in Chapter 2.0, "Description of Alternatives," the Mendota Pool Bypass would include one or more grade control structures to control bedform and create stable and suitable habitat conditions for fish in the vicinity. The resulting impact on the representative fish species would be less than significant.

Impact FSH-5 (Alternatives A1 and A2): ***Displacement from Preferred or Required Habitat, Injury, or Mortality in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Construction activities within the channel, along the riverbank, and in adjacent floodplains have the potential to displace representative special-status and game fish species from preferred or required habitats. During construction and other activities to restore instream, riparian, and floodplain habitat in the Restoration Area under Alternatives A1 and A2, representative special-status and game fish species and other fish would be subject to temporary displacement from preferred habitats or habitats required for performing essential behaviors such as spawning or feeding. Representative fish and other fish could also be injured or killed if crushed by heavy equipment or placement of fill, or through stranding in dewatered construction areas. However, implementing special-status fish conservation measures PL-1, CVS-1, CVS-2, EFH-1, and EFH-2 in the Conservation Strategy would offset potential adverse effects on special-status fish species. This impact would be **less than significant.**

Impact FSH-6 (Alternatives A1 and A2): ***Changes in Habitat Conditions in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Actions implemented under Alternatives A1 and A2 are expected to increase the quantity and quality of instream, riparian, and floodplain habitat over the long term, providing benefits to all fish species, including the representative special-status and game fishes. The primary mechanisms for improving habitat conditions for fish in the Restoration Area would be creation of new floodplain, riparian, and aquatic habitats; improvement of aquatic habitat conditions; and improved access to existing floodplain and aquatic habitat. This impact would be **less than significant** and **beneficial**.

Improvement of existing floodplain habitat and creation of new floodplains would benefit native fishes requiring floodplains for spawning and early rearing, and would improve ecosystem functions such as primary and secondary production, thus providing benefits to all fish in the river. Sacramento splittail recruitment success, in particular, is largely dependent on the availability of flooded spawning habitat. Adult, larval, and juvenile life stages of Sacramento splittail would benefit from an increased area of floodplain habitat that would become inundated for at least 4 weeks during the February through June spawning period. Floodplain habitat offers abundant, high-quality food and low predator densities to increase juvenile growth.

Improvements to aquatic habitat, including creation of pools and instream cover, would provide enhanced habitat for juvenile and adult rearing, feeding, and spawning for representative fish species and most other fishes. Enhanced spawning gravel in Reach 1 of the Restoration Area would provide additional habitat suitable for spawning and incubation by rainbow trout, lamprey, and other gravel-spawning species. Removing or modifying barriers that restrict fish movement would increase access to available habitat in all reaches of the Restoration Area, particularly for migratory species such as Sacramento splittail and striped bass.

Overall, these and other habitat improvement actions would result in less than significant and beneficial impacts on the representative special-status and game fish species and most other fish species. This impact would be less than significant and beneficial.

Impact FSH-7 (Alternatives A1 and A2): ***Changes in Diversions and Entrainment in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Restoration actions implemented under Alternatives A1 and A2 could include improving existing fish screens and installing new fish screens at Arroyo Canal, the Chowchilla Bypass Bifurcation Structure, and at small pumps and diversions throughout the Restoration Area. This impact would be **less than significant** and **beneficial**.

Poorly screened or unscreened pumps and diversions in the Restoration Area currently entrain or impinge the representative special-status and game fishes, and result in desiccation or increased exposure to predation. Properly designed, installed, and functioning fish screens would reduce entrainment and impingement losses of representative special-status and game fish, particularly migratory species (e.g., Sacramento splittail, striped bass). Juvenile life stages are generally more susceptible than adults to the effects of screening and diversion and would likely benefit most. Eggs and larvae too small to be protected by fish screens would continue to be lost to diversion, but these effects would not likely be significant. It is assumed that the magnitude and timing of water diversions from the Restoration Area would not change under Alternative A1 relative to environmental baseline conditions and, thus, no changes in entrainment and impingement attributable to diversion volume are expected. The effect of this action would be less than significant and beneficial.

Impact FSH-8 (Alternatives A1 and A2): ***Changes in Predation Levels in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Restoration actions implemented under Alternatives A1 and A2, including construction of fish passage structures and restoration of side channels and backwater habitat, could increase predation risk for representative special-status fish, especially juvenile life stages. However, implementing special-status fish conservation measures of the Conservation Strategy would offset potential adverse effects on special-status fish species. Restoration actions implemented under Alternatives A1 and A2, including isolating or filling gravel pits in Reach 1 and restoring floodplain habitat would benefit most life stages of each of the representative special-status fish species in the Restoration Area. This impact would be **less than significant** and **beneficial**.

Increased predation at fish passage facilities or passage structures could occur if conditions were favorable for predators lying in wait for juvenile fish that may become injured or disoriented as they passed through or over the passage facility or structure. Restoration of side channels and backwaters could also increase predation risk for representative special-status species and some game fish species (e.g., rainbow trout) by increasing the amount or quality of habitat for piscivorous fish such as black bass. These quiet water habitats provide preferred habitat for predatory fish species and could increase their populations. Implementing conservation measures CVS-1, CVS-2, EFH-1and EFH-2 in the Conservation Strategy would reduce the effects of this impact to less than significant.

Improved instream and floodplain habitat conditions and isolating or filling gravel pits in Reach 1 would likely reduce largemouth bass populations and subsequently decrease predation on representative special-status fish species. Restored floodplain habitat would increase spawning opportunities for Sacramento splittail, which would help that species withstand predation pressure. In particular, hardhead and Sacramento splittail would be expected to benefit from these actions. The effect of these actions on representative special-status fish species would be beneficial.

Impact FSH-9 (Alternatives A1 and A2): ***Changes in Food Web Support in the San Joaquin River Between Friant Dam and the Merced River – Program-Level.*** Actions to restore and improve riparian and aquatic habitat would increase benthic and terrestrial food organism production. Reintroduction of spring- and fall-run Chinook salmon to the San Joaquin River from Friant Dam to the Merced River would provide nutrient inputs via Chinook salmon carcasses at the spawning areas in Reach 1. The resulting improvements to food web support would be **less than significant** and **beneficial**.

The program actions are expected to result in an increase in the quantity, quality, and accessibility of food resources for representative special-status species and some representative game fish species. Restored floodplains would especially benefit Sacramento splittail by allowing them access to food resources before spawning and during larval development. This could lead to increases in Sacramento splittail production and overall abundance. The reintroduction of Chinook salmon would increase nutrient input to the river (via carcasses), leading to improved river food web support and associated benefits to all of the representative fish species. Increased abundance and diversity of aquatic and riparian vegetation through restoration and reconnection of floodplains with the river channel would lead to increased secondary aquatic production, providing invertebrate food resources relied on by most life stages of the representative fish species. These effects would be less than significant and beneficial.

San Joaquin River from Merced River to the Delta. Program-level impacts of Alternatives A1 and A2 in the San Joaquin River from the Merced River to the Delta, including potential impacts to fisheries in the Merced, Tuolumne, and Stanislaus rivers, are described below.

Impact FSH-10 (Alternatives A1 and A2): ***Effects to Fall-Run Chinook Salmon from Hybridization Resulting from Reintroduction of Spring-Run Chinook Salmon to the Restoration Area – Program-Level.*** Reintroduction of spring- and fall-run Chinook salmon to the Restoration Area could result in compromised genetic integrity and fitness of wild Chinook salmon stock in the major San Joaquin River tributaries via hybridization. However, because holding habitat is minimal for spring-run Chinook salmon in the San Joaquin River tributaries, the likelihood of genetic introgression is substantially reduced. Additionally, fall-run Chinook are already considered genetically compromised. Therefore, this impact would be **less than significant**.

Reintroduction of spring-run Chinook salmon could result in compromised genetic integrity and fitness of wild fall-run Chinook salmon stocks in the Merced, Tuolumne, and Stanislaus rivers if interbreeding between wild and hatchery fish occurred. Spring-run Chinook salmon tend to spawn between August and October, while fall-run Chinook salmon generally spawn from October through December. Therefore, there is potential for some degree of hybridization between the two runs. However, holding habitat is minimal for spring-run Chinook salmon in the tributaries; therefore, survival to spawning is likely to be reduced, thus reducing the degree of potential interbreeding. Additionally, a stock selection plan is being drafted by the Fisheries Management Work Group, along with a Genetics Management Plan, to help minimize potential genetic impacts to salmonids in the San Joaquin River and its tributaries. This impact would be less than significant.

Impact FSH-11 (Alternatives A1 and A2): ***Effects of Disease on Fisheries in the San Joaquin River Between the Merced River and the Delta – Program-Level.*** Reintroduced spring-run Chinook salmon could serve as disease sources and result in a disease outbreak among wild fall-run Chinook salmon in the major San Joaquin River tributaries. Disease organisms could be carried by broodstock from sources in the Sacramento River basin, or by hatchery fish used to supplement the reintroduced spring-run Chinook salmon population. This could lead to direct mortality or reduced fecundity for the tributary populations of fall-run Chinook salmon because of disease. Implementing conservation measure SRCS-1 in the Conservation Strategy would reduce this impact to **less than significant**.

Alternatives B1 and B2

Impacts under Alternatives B1 and B2 would include those described above for Alternatives A1 and A2. Under Alternatives B1 and B2, additional impacts would occur in the San Joaquin River between the Merced River and Delta associated with the recapture of water at existing pumping facilities. The additional impacts under Alternatives B1 and B2 are described below.

Impact FSH-12 (Alternatives B1 and B2): ***Changes in Diversions and Entrainment in the San Joaquin River Between the Merced River and the Delta – Program-Level.*** Alternatives B1 and B2 include recapture of Interim and Restoration flows from the San Joaquin River between the Merced River and the Delta at existing pumping facilities. Increased pumping at these locations may increase the potential for entrainment of juveniles of representative fish species into the pumps and canals, resulting in losses because of mortality, or displacement from suitable habitat. Additionally, it could reduce attraction flow for fall-run Chinook salmon and Central Valley steelhead to the tributaries. Existing CVP-contractor diversion facilities in this area include existing or planned fish screens. All diversion facilities would be operated in accordance with existing operating criteria, prevailing and relevant laws, regulations, BOs, and court orders in place at the time the program-level actions were performed. This impact would be **less than significant**.

Because the volume of flow diverted for recapture may increase relative to baseline conditions, there would be potential for increased diversion losses of all representative fish species present in the San Joaquin River downstream from the Restoration Area. Potential adverse impacts may include increased impingement at screened intakes and/or increased entrainment at intakes. Entrainment rates would depend on a variety of factors, such as the configuration and operational parameters of the pumping facilities, the configuration of fish screens and intake structures, and the velocity and direction of flow at or near the intakes.

Migratory species found in the San Joaquin River downstream from the Merced River, including Sacramento splittail, fall-run Chinook salmon, Central Valley steelhead, and striped bass, are particularly vulnerable to the effects of pumping and diversions. Larvae, juveniles, and smolts (of salmon and steelhead) are vulnerable to entrainment and screen impingement. Diversion facilities also provide habitat and increased feeding opportunities for predatory fish. Increased pumping rates at existing facilities in the San Joaquin River under Alternatives B1 and B2 would potentially increase the numbers of fall-run Chinook salmon and steelhead lost to predation at pumping infrastructure. However, pumping would not be increased above that already allowed under the existing permits or, if changes are to be made to the permitted rates, a new permit would be obtained or the existing permit modified, in which steps to protect Chinook salmon and steelhead (approved by NMFS) would be established as appropriate.

Impact FSH-13 (Alternatives B1 and B2): ***Changes in Water Temperatures in the San Joaquin River Between the Merced River and the Delta – Program-Level.*** Water temperature in the San Joaquin River between the Merced River and the Delta is typically in equilibrium with air temperature during the hottest summer months, but not at other times of the year, such as spring and fall. It is possible that cool water inputs to the mainstem San Joaquin River from the tributary rivers would be affected by the withdrawal of water that would occur at new pumping infrastructure, potentially resulting in downstream increases in water temperature during nonsummer months, compared with the current condition. However, this potential impact would be minimized by mixing cool water from the tributary rivers with flows in the mainstem San Joaquin River, including Interim and Restoration flows from the Restoration Area. Therefore, this impact would be **less than significant**.

Alternatives C1 and C2

Impacts under Alternatives C1 and C2 would include those described above for Alternatives A1 and A2. Under Alternatives C1 and C2, similar impacts would occur in the San Joaquin River between the Merced River and Delta associated with the operation of existing pumping infrastructure to recapture water. Additional impacts would also occur under Alternatives C1 and C2 in the San Joaquin River between the Merced River and Delta associated with the constructing and operating new pumping infrastructure to recapture water. The additional impacts under Alternative C1 and C2 are described below.

Impact FSH-12 (Alternatives C1 and C2): ***Changes in Diversions and Entrainment in the San Joaquin River Between the Merced River and the Delta – Program-Level.*** This impact would be similar to, but greater than, Impact FSH-12 under Alternatives B1 and B2, because potential diversions would be greater under Alternatives C1 and C2, resulting in greater potential for related fish mortalities. Existing CVP-contractor diversion facilities in this area include existing or planned fish screens. All diversion facilities would be constructed and operated in accordance with existing operating criteria, prevailing and relevant laws, regulations, BOs, and court orders in place at the time the program action was performed. This would include constructing a fish screen at any new diversion facility consistent with NMFS and DFG standards for fish screens that reduce entrainment and predation. Therefore, this impact would be **less than significant**.

Impact FSH-13 (Alternatives C1 and C2): ***Changes in Water Temperatures in the San Joaquin River Between the Merced River and the Delta – Program-Level.*** Water temperature in the San Joaquin River between the Merced River and the Delta is typically in equilibrium with air temperature during the hottest summer months, but not at other times of the year, such as spring and fall. It is possible that cool water inputs to the mainstem San Joaquin River from the tributary river would be affected by the withdrawal of water that would occur at new pumping infrastructure, potentially resulting in downstream increases in water temperature during nonsummer months, compared with the current condition. However, this potential impact would be minimized by mixing cool water from the tributary river with flows in the mainstem San Joaquin River, including Interim and Restoration flows from the Restoration Area. Therefore, this impact would be **less than significant**.

Impact FSH-14 (Alternatives C1 and C2): ***Displacement from Preferred or Required Habitat, Injury, or Mortality in the San Joaquin River Between Merced River and the Delta – Program-Level.*** Similar to impact FSH-5, construction activities within the channel, along the riverbank, and in adjacent floodplains have the potential to displace representative special-status and game fish species from preferred or required habitats. During construction of new pumping infrastructure under Alternatives C1 and C2 in the San Joaquin River between the Merced River and Delta, representative special-status and game fish species could also be injured or killed if crushed by heavy equipment or placement of fill, or by stranding in dewatered construction areas. However, implementing special-status fish conservation measures PL-1, CVS-1, CVS-2, EFH-1, and EFH-2 in the Conservation Strategy would offset potential adverse effects on special-status fish species. This impact would be **less than significant.**

5.4.4 Project-Level Impacts and Mitigation Measures

This section describes the potential responses of representative fish species and resulting impacts that may occur under each program alternative. Implementing the Conservation Strategy (fully described in Chapter 2.0, "Description of Alternatives") would reduce impacts of the action alternatives that could otherwise be potentially significant to a less-than-significant level, and would preclude the need for mitigation measures. Potential project-level impacts are described separately for each geographic area.

No-Action Alternative

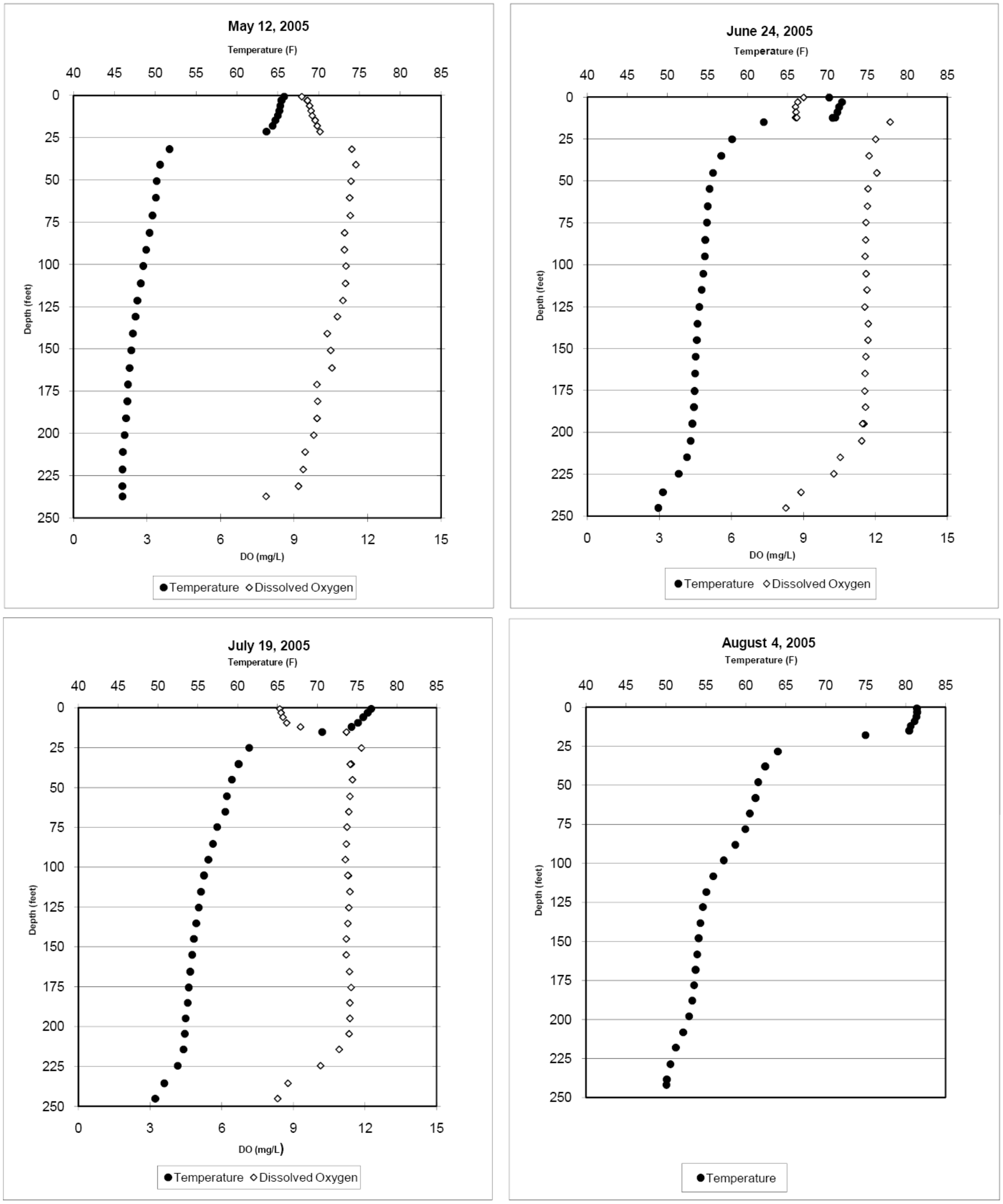
Project-level impacts resulting from the No-Action Alternative would include the program-level impacts (see preceding section). Additional impacts could occur under the No-Action Alternative in Millerton Lake and the Delta, as described below. Other impacts, as described for the action alternatives (including impact FSH-15 through impact FSH-21), would not occur under the No-Action Alternative and are not discussed below.

San Joaquin River Upstream from Friant Dam. Impacts in the San Joaquin River upstream from Friant Dam under the No-Action Alternative would include water temperature changes because of climate change, as described below.

Impact FSH-15 (No-Action Alternative): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Water temperatures in Millerton Lake and the San Joaquin River upstream from the reservoir are expected to increase by 2030, which could adversely affect rainbow trout, hardhead, and Kern brook lamprey, which reside in the San Joaquin River. This impact would be **potentially significant**.

Most of Millerton Lake becomes thermally stratified during spring and summer and, therefore, potentially supports a two-stage fishery: (1) cold-water species that reside in deep water and (2) warm-water species that inhabit surface waters and shallow areas near shore. Figure 5-2 shows monthly water temperature and DO profiles for late spring and summer 2005, measured about a half-mile upstream from Friant Dam. A strong thermocline (the boundary between different water temperatures) was present at a depth of about 25 feet in late May. The thermocline moved up in the water column 10 feet during June and July and began moving down again in late summer. Complete mixing of the water column likely occurs during winter. DO levels were high throughout the water column in most of the year (Figure 5-2), but in November, the simulated DO concentration was less than 2.5 milligrams per liter below a depth of about 175 feet. Such low DO levels are stressful to most species of fish, but Millerton Lake fish could easily avoid this hypoxic (i.e., lacking oxygen) water layer, particularly because water temperatures throughout the water column are mild in November. Because the open water habitat of Millerton Lake has a broad range of water temperature and DO conditions, these two environmental factors are unlikely to limit striped bass or other species that inhabit the open-water habitat. Spring and summer water temperatures in upper Millerton Lake and the mouth of the San Joaquin River, where striped bass spawn, are generally cooler than surface water temperatures in most of the reservoir.

The suitability of Millerton Lake's shallow-water habitat for largemouth bass and spotted bass would potentially be affected by changes in reservoir water temperatures. Eggs are the most sensitive life stage in part because they are unable to swim away if water temperatures are unsuitable. Largemouth and spotted bass deposit their eggs in shallow water nests. They spawn during spring, when the level of the reservoir typically rises; therefore, the nests may be exposed to the cold water in or below the thermocline before the eggs hatch or the larvae leave the nest. Cold water slows the development times of the eggs and larvae and, because eggs and larvae are highly vulnerable to predation or infection by fungi, a longer development time greatly reduces survival (Knoteck and Orth 1998). At water temperatures below about 59°F, the eggs may not survive (Stuber et al. 1982).

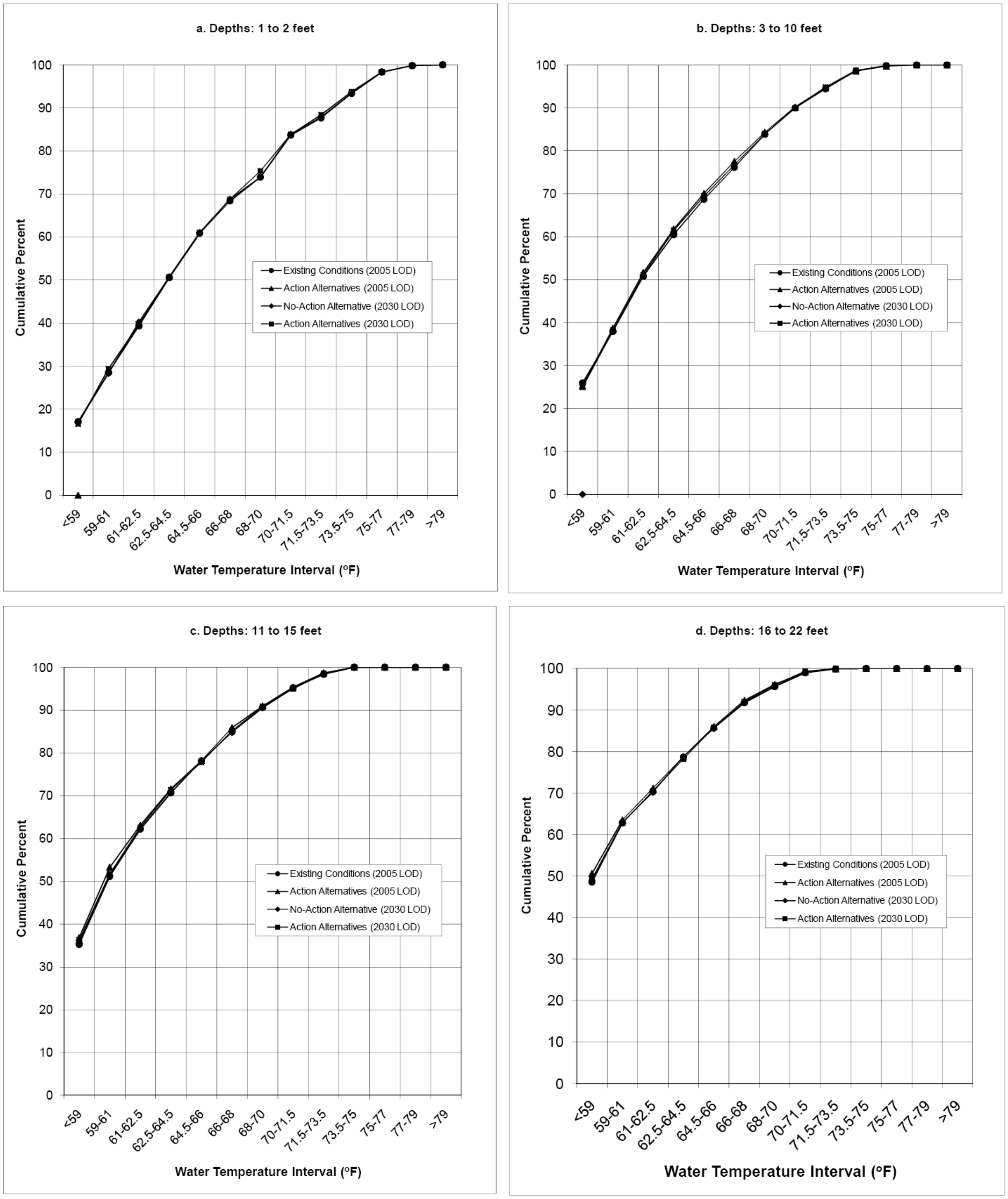


Key: DO = dissolved oxygen
mg/L = milligrams per liter

Figure 5-2.
Millerton Lake Water Temperature and Dissolved Oxygen

Effects on shallow water temperature in Millerton Lake resulting from the program alternatives were evaluated for the March-through-June spawning period. Figure 5-3 shows cumulative percentages of the simulated water temperatures in four shallow-water layers for existing conditions (2005 LOD) and the No-Action Alternative (2030 LOD). The first three water layers correspond to the typical range of spawning depths for largemouth bass (surface to about 15 feet), and all four layers correspond to the typical range of spawning depths for spotted bass (surface to about 22 feet). from March through June, only about 18 percent of simulated water temperatures in the surface layer of the reservoir (1 to 2 feet of depth) were too cold for spawning (less than 59°F), whereas almost 50 percent of the simulated water temperatures in the deepest water layer of shallow water habitat (16 to 22 feet of depth) were too cold. There are essentially no differences between the existing conditions and the No-Action Alternative in the simulated water temperatures, which indicates that the No-Action Alternative would have no effect on water temperatures in the spawning habitat. Shallow-water habitat in Millerton Lake is expected to have adequate DO concentrations for fish under these conditions.

However, water temperatures in Millerton Lake and the San Joaquin River upstream from the reservoir are expected to increase by 2030, which could adversely affect rainbow trout, hardhead, and Kern brook lamprey, which reside in the San Joaquin River. Three GCM that model air temperatures for 2041 through 2060 predict a range of increases in annual average air temperature of 2.5 to 5°F for the region where Millerton Lake and the San Joaquin River upstream from the reservoir are located (TNC 2009). Average summer air temperature is expected to rise as much as 8°F. Summer water temperatures in the San Joaquin River upstream from the reservoir are currently stressful to cold-water species such as rainbow trout, and may be stressful for hardhead and Kern brook lamprey. The predicted increases in air temperature are expected to produce even more stressful water temperature conditions in the river by 2030. Surface water temperatures are also expected to rise in Millerton Lake, but most of the species in the reservoir are warm-water species that would likely not be adversely affected by the expected water temperature increases or potential associated decreases in DO concentrations. Reservoir species such as striped bass that are adapted to cooler water temperatures reside in the open water of the reservoir, where a wide range of water temperatures would be available because of temperature stratification. Therefore, this impact would be potentially significant.



Key: LOD = level of development

Figure 5-3.

Cumulative Frequencies of March Through June Simulated Water Temperatures at Four Depths

San Joaquin River from Friant Dam to Merced River. Impacts in the Restoration Area under the No-Action Alternative would be the same as described previously for program-level impacts.

Impact FSH-22 (No-Action Alternative): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** This impact is the same as Impact FSH-1 (No-Action Alternative), previously described for program-level impacts. This impact would be **potentially significant**.

Impact FSH-23 (No-Action Alternative): ***Changes in Pollutant Discharge and Mobilization in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** This impact is the same as Impact FSH-2 (No-Action Alternative), previously described for program-level impacts. This impact would be **potentially significant**.

Impact FSH-24 (No-Action Alternative): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** This impact is the same as Impact FSH-3 (No-Action Alternative), previously described for program-level impacts. This impact would be **potentially significant**.

Sacramento-San Joaquin Delta. Impacts in the Delta under the No-Action Alternative would include water temperature, salinity, and flow changes because of climate change, as described below.

Impact FSH-31 (No-Action Alternative): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the Delta – Project-Level.*** Water temperatures in the Delta are expected to increase by 2030, which could adversely affect cold-water fish species, including Central Valley fall-run Chinook salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley steelhead, and other special-status species that use the Delta, including white and green sturgeon, longfin smelt, and delta smelt. This impact would be **potentially significant**.

Three GCMs that model air temperatures from 2041 through 2060 predict a range of increases in annual average air temperature of 1 to 4°F for the region where the Delta is located (TNC 2009). Average summer air temperature is expected to rise as much as 5.5°F during that period, and could lead to lower DO concentrations. Water temperatures in the Delta are currently often stressful to salmon and steelhead adults and smolts during their migrations through the Delta, and these warm temperatures are believed to be stressful to the other special-status species as well, especially during summer. The predicted increases in air temperature are expected to produce even more stressful water temperature conditions in the Delta by 2030.

Impact FSH-38 (No-Action Alternative): ***Salinity Changes in the Delta – Project-Level.*** Average sea level is expected to rise about 1 foot by 2030, which would cause increased salinities in the Delta. Delta smelt and longfin smelt both spawn in the fresher water portions of the Delta, and delta smelt remain in areas with low salinities throughout their life cycle. Increased salinity would likely be stressful to delta smelt and longfin smelt, particularly during their egg and larval stages. This impact would be **potentially significant**.

Impact FSH-39 (No-Action Alternative): ***Changes to Delta Inflow and Flow Patterns in the Delta – Project-Level.*** Inflow from the major tributaries of the Delta is expected to increase during winter months and decrease during spring and early summer because of reduced snowpack associated with global climate change. The changes in seasonal inflows are likely to adversely affect Central Valley fall-run Chinook salmon, Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley steelhead green sturgeon, Sacramento splittail, longfin smelt, and delta smelt. This impact would be **potentially significant**.

Spawning migrations and other life cycle processes of the species listed above are adapted to high spring flows in tributaries and into the Delta, resulting from snowpack melting. Reductions in these flows would likely have adverse effects on several life stages. In addition, a greater frequency of very high winter flow could destroy salmon and steelhead redds in the rivers and flush resident species from the Delta, causing high mortalities.

Alternatives A1 through C2

Under Alternatives A1 through C2, potential impacts on fisheries could result from implementing Interim and Restoration flows and other project-level actions.

San Joaquin River Upstream from Friant Dam. Potential project-level impacts of Alternatives A1 through C2 in the vicinity of Millerton Lake are described below.

Impact FSH-15 (Alternatives A1 Through C2): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Upstream from Friant Dam – Project-Level.*** No appreciable are changes anticipated under Alternatives A1 through C2 to water temperature and DO concentrations in the San Joaquin River upstream from Friant Dam. This impact would be **less than significant**.

As previously described (and shown in Figure 5-2), most of Millerton Lake becomes thermally stratified during spring and summer and, therefore, potentially supports a two-stage fishery: (1) cold-water species that reside in deep water and (2) warm-water species that inhabit surface waters and shallow areas near shore. The suitability of Millerton Lake’s shallow-water habitat for largemouth bass and spotted bass is potentially affected by changes in reservoir water temperatures. Effects on shallow-water temperature in Millerton Lake resulting from the program alternatives were evaluated for the March-through-June spawning period. Figure 5-3 shows cumulative percentages of the simulated water temperatures in four shallow-water layers for the program alternatives. The first three water layers correspond to the typical range of spawning depths for largemouth bass (surface to about 15 feet) and all four layers correspond to the typical range of spawning depths for spotted bass (surface to about 22 feet). As previously described for the No-Action Alternative, from March through June, only about 18 percent of simulated water temperatures in the surface layer of the reservoir (1 to 2 feet of depth) were too cold for spawning (less than 59°F), whereas almost 50 percent of the simulated water temperatures in the deepest water layer of shallow-water habitat (16 to 22 feet of depth) were too cold. There are essentially no differences among the program alternatives in the simulated water temperatures, which indicates that Alternatives A1 through C2 would have no effect on water temperatures in the spawning habitat. Shallow-water habitat in Millerton Lake is expected to have adequate DO concentrations for fish these conditions.

Alternatives A1 through C2 are expected to have no effect on water temperatures and DO in the San Joaquin River upstream from Millerton Lake. Potential changes in water temperature and DO concentrations would be less than significant.

Impact FSH-16 (Alternatives A1 through C2): ***Changes in Pollutant Discharge and Mobilization in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Under Alternatives A1 through C2, no impacts to fish in Millerton Lake or the San Joaquin River upstream from the reservoir would be expected to result from pollutants. No construction activities are associated with the Settlement in the watershed upstream from Friant Dam, and operational changes from reoperating Friant Dam would not introduce pollutants to Millerton Lake. There would be **no impact**.

Impact FSH-17 (Alternatives A1 through C2): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Reoperation of Friant Dam would change reservoir levels and could increase the timing, rates, and magnitude of reservoir drawdown during certain seasons. Since Millerton Lake already experiences similar drawdowns, with commensurate effects on turbidity, it is not expected that turbidity would increase significantly by reoperating Friant Dam. Similarly, reoperation of Friant Dam would cause reservoir levels to vary somewhat where the San Joaquin River flows into Millerton Lake, but changes to turbidity would be minimal. Therefore, impacts on reservoir and riverine fish resulting from turbidity caused by reoperation of Friant Dam would be **less than significant**.

Impact FSH-18 (Alternatives A1 through C2): ***Changes in Fish Habitat Conditions in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Changes in reservoir surface levels predicted for Alternatives A1 through C2 are expected to increase the quality of and quantity of habitat for representative species upstream from Friant Dam, including spotted bass, hardhead, rainbow trout, Kern brook lamprey, largemouth bass, smallmouth bass, and striped bass. This impact would be **less than significant** and **beneficial**.

The most likely effect on habitat connectivity would stem from reoperations that resulted in a decrease in reservoir surface level that exposed a barrier to migration in a previously inundated portion of the channel of the San Joaquin River or other tributary of the reservoir. No such barrier is known to exist in the inundated channels of the reservoir tributaries. The specific effects on representative species upstream from Friant Dam, including spotted bass, hardhead, rainbow trout, Kern brook lamprey, largemouth bass, smallmouth bass, and striped bass, are described below.

Spotted Bass, Hardhead, Rainbow Trout, and Kern Brook Lamprey Habitat. Changes in reservoir surface levels predicted for Alternatives A1 through C2 are expected to increase the quality of shallow-water reservoir habitat for spotted bass, and the length of riverine habitat for hardhead, rainbow trout, and Kern brook lamprey. These changes would be less than significant and beneficial.

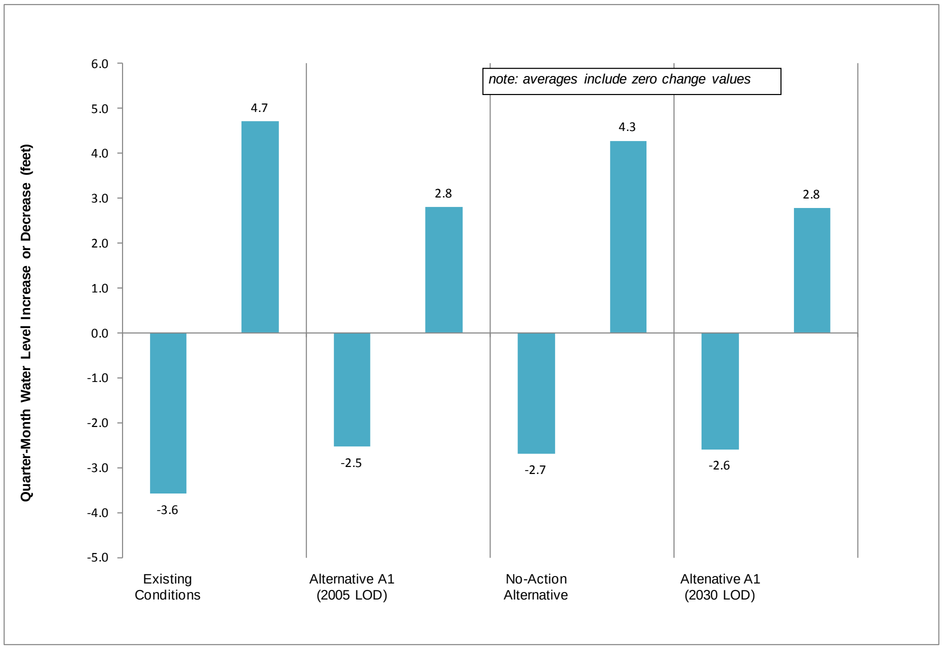
Reservoir surface level has a substantial effect on fish habitat in Millerton Lake and would be affected by Alternatives A1 through C2. Reservoir surface level also affects river habitat in the upper San Joaquin River because changes in reservoir level affect inundation of the river channel.

Alternatives A1 through C2 are predicted to cause a decrease in the mean annual maximum reservoir surface elevation of about 12 feet. This change was determined to cause an increase of about a half-mile in the length of channel of the upper San Joaquin River, which would not be inundated as frequently by the reservoir; this represents about 5 percent of the reach between Kerckhoff Reservoir and Millerton Lake. Hardhead, rainbow trout, and Kern brook lamprey, which inhabit this reach of the river, would likely benefit from the increase in riverine habitat conditions.

Shallow-water habitat, quantified as the mean surface area from the shoreline to a depth of 15 feet from April through September, would be reduced from 400 to 394 acres by Alternatives A1 through C2, a reduction of 1.5 percent.

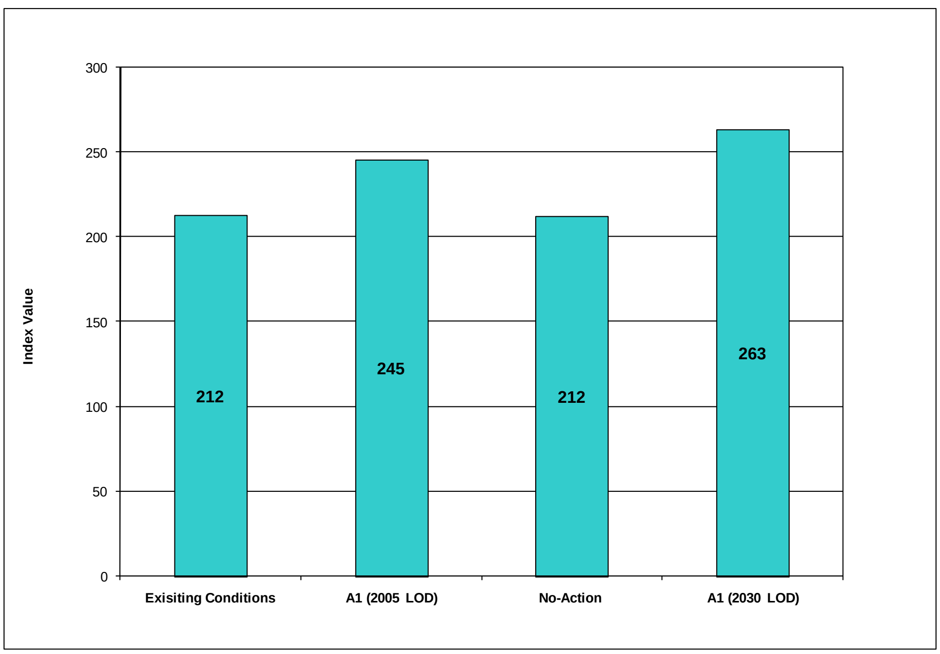
Figure 5-4 shows the mean changes over a quarter-month in surface elevation of Millerton Lake for April through June, the spawning period, under existing conditions, the No-Action Alternative, and Alternatives A1 through C2 for both the 2005 LOD and 2030 LOD. The expected increases in surface elevation are much smaller for Alternatives A1 through C2 than for existing conditions, and the mean reductions are greater for Alternatives A1 through C2 (2005 LOD). Water-level fluctuations could have both positive and negative effects on shallow-water habitat for fish (Thorton et al. 1990); the net effect differs among the analysis species.

For spotted bass, the combined effects of the reduction in shallow-water habitat surface area, changes in surface-level fluctuations, and minor water temperature changes were integrated using the spotted bass spawning production model to simulate a spawning production index for existing conditions, the No-Action Alternative, and Alternatives A1 through C2 for both the 2005 LOD and 2030 LOD. Modeling results indicated that Alternatives A1 through C2 would increase spotted bass spawning production 16 percent under the 2005 LOD and 24 percent under the 2030 LOD (Figure 5-5). The enhancement was greater for the 2030 LOD than for the 2005 LOD. Because Alternative A1 is predicted to have almost no effect on water temperatures, and little effect on the surface area of shallow-water habitat, the predicted increase in spawning production can be largely attributed to reductions in water-level fluctuations. These results indicate that the changes in reservoir surface levels expected for Alternatives A1 through C2 would benefit spotted bass.



Note: A1 is a surrogate for Alternatives A2 through C2, because there is no difference between all action alternatives.
Key: LOD = level of development

Figure 5-4.
Mean Increases and Reductions in Water Levels from April Through June for Program Alternatives



Note: A1 is a surrogate for Alternatives A2 through C2, because there is no difference between all action alternatives.
Key: LOD = level of development

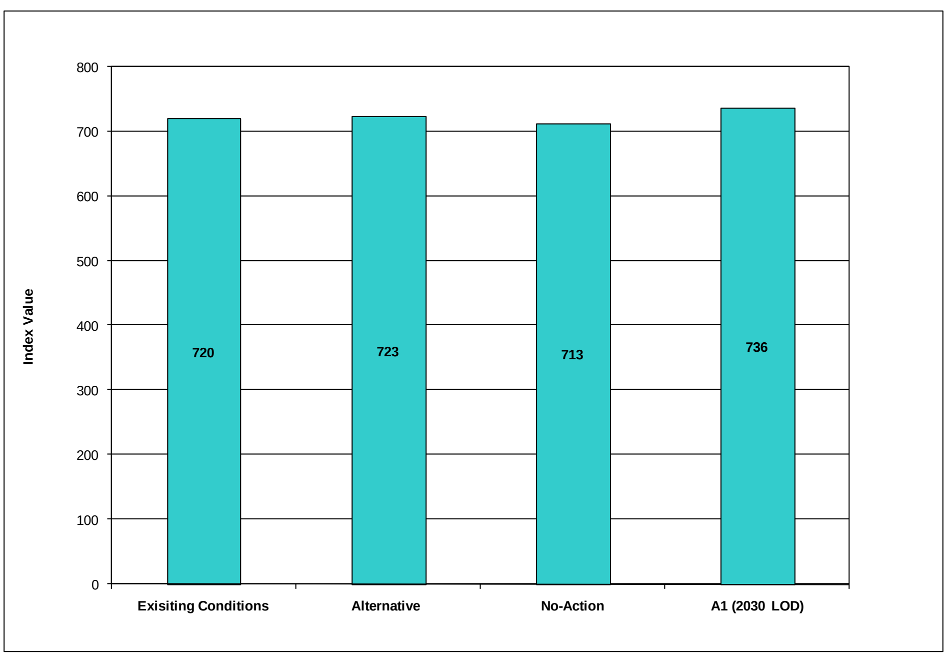
Figure 5-5.
Millerton Lake Mean Annual Spotted Bass Spawning Index, 1987 – 2003 Simulations, for Program Alternatives

Largemouth Bass and Smallmouth Bass Habitat. Changes in reservoir surface levels predicted for Alternatives A1 through C2 are expected to have little effect on the surface area or quality of shallow-water reservoir habitat for largemouth bass and smallmouth bass, but a minor increase in habitat for spawning. This impact would be less than significant and beneficial.

The potential effects of predicted changes in reservoir surface level changes for Alternatives A1 through C2 on the surface area of shallow-water habitat and surface level fluctuations would be as previously described. Many of the effects of these habitat changes on largemouth bass and smallmouth bass would be similar to those for spotted bass. However, spotted bass use a larger range of depths for spawning than largemouth bass and smallmouth bass, so effects on spawning production may differ.

Results of the spawning production model simulations for largemouth bass indicate that Alternatives A1 through C2 would have a minor effect on largemouth bass spawning production (Figure 5-6). Smallmouth bass have reservoir habitat requirements very similar to those of largemouth bass, except that smallmouth bass prefer cooler water temperatures; therefore, effects on smallmouth bass spawning production of Alternative A1 are expected to be similar to those for largemouth bass.

Alternatives A1 through C2 are expected to result in a minor reduction in surface area of shallow-water habitat for largemouth bass and smallmouth bass, and a minor increase in spawning production. The impact would be less than significant and beneficial.



A1 is a surrogate for Alternatives A2 through C2, because there is no difference between all action alternatives.
Key: LOD = level of development

Figure 5-6.
Millerton Lake Mean Annual Largemouth Bass Spawning Index, 1987 – 2003 Simulations

*Striped Bass Habitat***.** Changes in reservoir surface levels predicted for Alternatives A1 through C2 are expected to reduce the surface area of reservoir open-water habitat for striped bass and improve the quality of striped bass spawning habitat at the mouth of the San Joaquin River in upper Millerton Lake. Alternatives A1 through C2 are also expected to affect food web support for striped bass. The expected net impact on striped bass from these changes would be less than significant and beneficial.

Open water habitat of Millerton Lake, quantified as mean reservoir surface area from April through September, would be reduced by Alternatives A1 through C2. The mean surface area of open-water habitat would be reduced from about 3,883 to 3,605 acres, a reduction of 7 percent. Of the fish species selected for analysis, striped bass would be the most likely to be affected by this change.

Alternatives A1 through C2 are also expected to cause a small increase in the length of San Joaquin River channel not inundated by the reservoir, which would likely provide slightly improved spawning conditions for striped bass. Overall, the net impact on striped bass from these changes would be less than significant and beneficial.

Impact FSH-19 (Alternatives A1 Through C2): ***Changes in Diversions and Entrainment in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Changes in diversions and entrainment of fish in Millerton Lake or the San Joaquin River upstream from the reservoir from reoperation of Friant Dam under Alternatives A1 through C2 would be **less than significant**.

No studies have been conducted on entrainment of fish at Friant Dam, but it is likely that small, open-water species, particularly threadfin shad, do experience entrainment at the dam. Juvenile striped bass and American shad could also be affected. Because reoperation of Friant Dam under Alternatives A1 through C2 would change the reservoir storage release schedule, it would likely change the entrainment rate of these fish. However, this effect is expected to be small and not a substantial change from existing conditions. Consequently, this impact would be less than significant.

Impact FSH-20 (Alternatives A1 Through C2): ***Changes in Predation Levels in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Friant Dam reoperation on surface-level fluctuations of Millerton Lake is likely to have both slightly positive and negative effects on predation on some species and no effect on others. This impact would be **less than significant** and **beneficial**.

Alternatives A1 through C2 are expected to reduce the amplitude of water level fluctuations in the shallow-water habitat (Figure 5-4). There are a number of different mechanisms by which water level fluctuations increase or reduce predation on eggs, larvae, or juveniles in shallow-water habitat (Table 5-13). The net effect of the potential impacts and benefits is uncertain but likely includes both positive and negative effects on spotted bass, largemouth bass, and smallmouth bass. This impact would be less than significant and beneficial.

Table 5-13.
Potential Effects of Increased Water-Level Fluctuations on Predation Risk and Food Web Support for Largemouth Bass, Spotted Bass, and Smallmouth Bass

Increased water level fluctuations increase predation risk
Young largemouth, spotted, and smallmouth bass sheltering in inundated terrestrial vegetation and other nearshore refuges forced from shelter (falling water level)
Guard males forced from nests by risk of exposure to surface (falling water level) or intrusion of cold water (rising water level)
Nests near water surface exposed to predation by birds and other terrestrial predators (falling water level)
Development of eggs and larvae slowed by intrusion of cold water, increasing time of exposure to high predation risk (rising water level)
Increased water level fluctuations reduce predation risk
Increased availability of inundated terrestrial vegetation used as shelter by young largemouth, spotted, and smallmouth bass (rising water level)
Increased water level fluctuations reduce food web support
Unstable water levels interfere with development of diverse community of invertebrates (falling or rising water levels)
Muddy/silty substrates at lower reservoir depths have poor habitat quality for invertebrate prey species (falling water levels)
Increased water level fluctuations increase food web support
Inundated terrestrial vegetation provides excellent food web support for all life stages of black bass (rising water level)
Small prey fish of older largemouth, spotted, and smallmouth bass that shelter in inundated terrestrial vegetation and other nearshore refuges forced from shelter (falling water level)

Impact FSH-21 (Alternatives A1 Through C2): ***Changes in Food Web Support in the San Joaquin River Upstream from Friant Dam – Project-Level.*** Effects of Friant Dam reoperation on surface area, mean depth, and surface-level fluctuations of Millerton Lake are likely to have both slightly positive and negative effects on food web support for fish species in Millerton Lake, and no effect on fish species in the San Joaquin River upstream from the reservoir. This impact would be **less than significant** and **beneficial**.

Alternatives A1 through C2 are expected to reduce the surface area of open-water habitat in Millerton Lake. The effect of this reduction on the food web is uncertain. A reduction in surface area reduces the habitat space for plankton, which forms the base of the open-water food web. However, a reduction in the mean depth, which would result from the reduction in surface area, potentially enhances plankton productivity. Lake sediments are an important source of nutrients for the plankton, and a reduction in mean depth would make a greater area of sediments available to a given volume of water. This relationship is incorporated in Ryder's "morpho-edaphic index," which predicts that, other factors being equal, shallow lakes produce more fish than deep lakes (Thorton et al. 1990). These conflicting potential effects are expected to cancel out; therefore, the net effect of Alternatives A1 through C2 on food web support in the open-water habitat of Millerton Lake is expected to be less than significant.

The net impact to food resources and food web support in the shallow-water habitat of the reservoir resulting from Alternatives A1 through C2 is also uncertain. Alternatives A1 through C2 are predicted to cause a small decrease in total surface area of shallow-water habitat, which would be expected to cause a slight decrease in total food production. Alternatives A1 through C2 are also predicted to cause a decrease in water level fluctuations. As for predation, there are a number of different mechanisms by which changes in water level fluctuations may increase or decrease food web support for largemouth bass, spotted bass, and smallmouth bass. These conflicting potential effects are expected to cancel out; therefore, the net effect of Alternatives A1 through C2 on food web support of shallow water habitat in Millerton Lake is expected to be less than significant and beneficial.

San Joaquin River from Friant Dam to Merced River. Potential project-level impacts of Alternatives A1 through C2 in the Restoration Area are described below.

Impact FSH-22 (Alternatives A1 Through C2): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** Interim and Restoration flows have the potential to reduce water temperatures in the San Joaquin River from Friant Dam to the Merced River most of the time. The effects of water temperature changes on fisheries would be **less than significant**.

Based on SJR5Q model results, spring and early summer (May and June) water temperatures in Reach 1 would be approximately 5°F lower under Alternatives A1 through C2 than under the No-Action Alternative (modeled average water temperature at the SR 41 and Gravelly Ford) (see Appendix H, “Modeling”). In the wetted portions of Reaches 2 and 3, spring and early summer (May and June) water temperatures would be 3 to 5°F lower, with little to no expected differences in water temperatures during the warmest months (July and August). Midwinter (December – January) water temperatures in Reaches 2 and 3 would be approximately 3°F lower under Alternatives A1 through C2 than under the No-Action Alternative (modeled average water temperature at the Mendota Pool and Sack Dam). Water temperatures in Reaches 4 and 5 would be 1 to 2°F lower than the No-Action Alternative during spring and early summer and similar to the No-Action Alternative during other months (modeled average water temperature at the Mariposa Bypass Return, Salt Slough, and the Merced River confluence) (see Appendix H, “Modeling”).

Under a 2005 LOD, water temperatures in Reaches 1 and 2 during spring are already below representative special-status fish species preferences, and the further reduction in water temperatures anticipated under the action alternatives would not provide additional benefits in these reaches. However, during the warmest summer months (July and August) in all reaches, decreased water temperatures under the action alternatives would be beneficial. Under a 2030 LOD, given the projected increases in mean annual and seasonal air temperatures based on currently modeled climate change scenarios, the potential decreased water temperatures (and associated potential increase in DO concentrations) in all reaches during the warmest months (June and August) would be a beneficial impact of the action alternatives.

Impact FSH-23 (Alternatives A1 Through C2): ***Changes in Pollutant Discharge and Mobilization in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** Interim and Restoration flows have the potential to impact the concentration of agricultural discharges of pollutants from Friant Dam to the Merced River, but would not be anticipated to mobilize existing pollutants. Continued discharges and nonpoint source runoff of agricultural pollutants may affect special-status and game fish species found within Reaches 3 through 5 (e.g., Sacramento splittail, black bass, striped bass) (see Appendix K, “Biological Resources – Fisheries”). This impact would be **less than significant** and **beneficial**.

The additional water provided to the San Joaquin River through the Restoration Flows is expected to dilute existing levels of pollutants from agricultural runoff currently found in the river. While this dilution of pollutants would be beneficial, it is not expected to reduce pollutants to levels that significantly improve conditions for fish species.

Pollutants from agricultural runoff currently found in the river include mineral contaminants (e.g., arsenic, boron), mercury, and pesticides (e.g., chlorpyrifos, DDT, diazinon, Group A pesticides). Model results for EC as a surrogate for water quality indicate little to no difference between existing conditions and all action alternatives across all water year types for Reaches 1 and 2 (modeled average EC at Mendota Dam) and Reach 4 (modeled average EC at Eastside Bypass confluence), while EC in Reach 3 (modeled average EC at Sack Dam) and Reach 5 (modeled average EC at the Merced River confluence) (see Appendix H, “Modeling”) would decrease as a result of the action alternatives from October through April. The dilution effect would benefit the river but not to a level that would significantly improve conditions for fish species. Therefore, this impact would be less than significant and beneficial.

Interim and Restoration flows are not expected to impact the San Joaquin River from Friant Dam to the Merced River by mobilizing pollutants. Interim and Restoration flows could be recaptured at the East Bear Creek Unit of the San Luis NWR. The San Luis NWR is known to contain high deposits of selenium and salts from agricultural drainage flows that were captured there in the early 1970s. Return flows to the San Joaquin River from the East Bear Creek Unit may contain pollutants that can harm fish. However, the East Bear Creek Unit would receive delivery of Interim and Restoration flows in lieu of existing CVP supplies, and would therefore not result in an increase in the quantity or quality of existing return flows. Thus, this impact would be less than significant.

Impact FSH-24 (Alternatives A1 Through C2): ***Changes in Sediment Discharge and Turbidity in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** Interim and Restoration flows are expected to affect the concentration of suspended sediment and turbidity from Friant Dam to the Merced River. Initial Interim Flows may cause an initial temporary increase in suspended sediment and turbidity in the San Joaquin River through short-term bed and bank scour of previously immobile material. Conversely, continued Interim and Restoration flows would dilute existing levels of suspended sediment and turbidity from agricultural runoff currently found in the river. This impact would be **less than significant** and **beneficial**.

While Interim Flow releases may cause an initial temporary increase in suspended sediment and turbidity in the San Joaquin River through short-term bed and bank scour of previously immobile material, the Interim Flow ramping period would occur during spring (March through April) when suspended sediment and turbidity are naturally higher. Additionally, the Interim Flows would be implemented using a smoothed, continuous-line hydrograph to minimize transitions between low and high flows (see Chapter 2.0, "Description of Alternatives"). Therefore, the potential impact of suspended sediment and turbidity on fisheries from Interim Flows would be less than significant. Restoration Flows are expected to have less suspended sediment and turbidity than Interim Flows as channel and sediments begin to equilibrate after the initial flow increases. Overall, these effects would be less than significant.

Interim and Restoration flows have the potential to impact the concentration of agricultural discharges of suspended sediment from Friant Dam to the Merced River. Continued discharges and nonpoint source runoff of suspended sediments may increase turbidity and affect special-status and game fish species found within Reaches 3 through 5 (i.e., Sacramento splittail, black bass, and striped bass). The additional water provided to the San Joaquin River through the proposed Interim and Restoration flows is expected to dilute existing levels of suspended sediment and turbidity from agricultural runoff currently found in the river. While this dilution would be beneficial, it is not expected to reduce suspended sediment or turbidity to a level that would significantly improve conditions for representative fish species. This impact would be beneficial.

Impact FSH-25 (Alternatives A1 Through C2): ***Changes in Fish Habitat Conditions in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** Interim and Restoration flows would increase the quantity and quality of aquatic and riparian habitats and benefit all representative fish species in the Restoration Area. Interim and Restoration flows would increase flow in the channel throughout the year during most water year types, therefore increasing in-channel and floodplain habitat and bed movement. This increase in habitat availability would lead to increased fish abundance and survival. Habitat quality would also be affected directly and indirectly by changes in geomorphic processes, in-channel connectivity, food resources, and predation associated with Interim and Restoration flows. Therefore, the potential impact of Interim and Restoration flows on aquatic and riparian habitat conditions would be less than significant and beneficial to fisheries from Friant Dam to the Merced River. This impact would be **less than significant** and **beneficial**.

Interim and Restoration flows in Dry through Wet years (based on Restoration water year types) would result in perennial flow in the entire Restoration Area, particularly Reaches 2A, 2B, and 4B1, which currently experience dry conditions during some or all water year types. Perennial streamflow would vastly improve instream and riparian habitat conditions for representative fish species from Friant Dam to the Merced River during all but Critical-Low years. Increased flow would increase the quantity and quality of floodplain habitat, riparian habitat, and in-channel aquatic habitat in all reaches of the Restoration Area, although this increase has not yet been quantified.

Year-round continuous baseflow in the river would provide habitat connectivity and remove some barriers that restrict fish movement, thus increasing available habitat in all reaches of the Restoration Area, particularly in Reaches 2 and 4. Increased flow during the migration of Sacramento splittail and striped bass would improve access to habitat. Sacramento splittail in particular would benefit from increased access to floodplain habitats.

The effects of Interim Flows on geomorphic processes, and in turn on aquatic and riparian habitat and fish behavior, are likely to be minimal in comparison to Restoration Flows, because the volume of discharge would be limited by channel capacity under current conditions. However, if Interim Flows were as high as 2,200 cfs, appreciable bed scour and sediment transport may occur in the sandbedded portions of the channel in the Restoration Area (McBain and Trush 2002). If Interim Flows are as high as 8,000 cfs, sediment transport would likely occur in Reach 1 (Stillwater Sciences 2003, Kondolf 2005). In either of these cases, the effects of Interim Flows would be similar to the effects of the Restoration Flows.

The initial transport of fine sediment stored in the bed and banks of Reach 1 during Interim Flows could have short-term effects on sediment transport capacity and channel form that in turn may impact habitat for representative fish species. The effects would be most pronounced in Reach 2A, where transported fine sediment would be most likely to eventually be deposited and result in channel form changes. Initially, there would be a period of transient adjustment in channel form and consequent aquatic and riparian habitat that would slow over time to a more stable condition.

Under Restoration Flows, it is likely that seasonal sediment-transporting flows would occur relatively frequently in Reach 1, and in turn initiate a sustained sequence of channel-forming processes that maintain both aquatic and riparian habitat. Sediment transport in Reaches 2, 3, 4, and 5 would likely be continuous under Restoration Flows, because sand-bedded rivers typically remain in a state of constant sediment transport (McBain and Trush 2002). However, in Reach 2B, vegetation that has established in the channel would likely limit the capacity of flow to transport sediment because of increased roughness. The magnitude of Interim and Restoration flows would likely be too low to appreciably scour any riparian vegetation that was established in the channel bed in Reach 2B or any other reaches in the Restoration Area.

Overall, under Alternatives A1 through C2, seasonal sediment transport represents a more normative condition compared to the No-Action Alternative and existing conditions. As a result, mature riparian vegetation would establish, habitat heterogeneity would increase, and connectivity between habitats preferable to representative fish species and multiple life stages would most likely increase. The long-term effect of channel adjustment to Restoration Flows should be beneficial to all fish in the Restoration Area. The reestablishment of seasonally timed geomorphic processes should result in more aquatic habitat heterogeneity, quality, and connectivity. Recovery and reestablishment of riparian vegetation, especially large trees, should be a direct result of geomorphic processes that were established because of Restoration Flows, and in turn would benefit representative fish species.

Restoration Flows would reestablish regular transport and routing of coarse sediment (particles greater than 4 mm diameter) stored in the bed and banks of the San Joaquin River below Friant Dam. The construction of Friant Dam has cut off the majority of the coarse sediment supply, which would otherwise originate from upstream. However, the increase in flows, with the exception of the Spring Rise and Pulse Flows, is not expected to result in transport of materials beyond the current amount. The spring pulse flows are intended to improve habitat conditions for salmonids and other native fishes through various factors which include providing flows sufficient to initiate fluvial geomorphic processes (i.e., mobilizing and flushing spawning gravels in wetter years, and providing flows sufficient for riparian seedbed preparation, seeding establishment, and prevention of vegetation encroachment in wetter years.

Impact FSH-26 (Alternatives A1 Through C2): ***Changes in Diversions and Entrainment in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** The operation of existing diversion facilities to recapture Interim and Restoration flows in the Restoration Area could potentially adversely affect representative fish species (e.g., hardhead, Sacramento splittail, and striped bass), none of which are listed under the ESA or CESA in the Restoration Area. Recapture at these existing facilities would occur on a temporary basis only, and would not substantially interfere with the movement of migratory fish. This impact would be **less than significant**.

Several diversion facilities may be used to recapture Interim and Restoration flows in the Restoration Area on a temporary basis. These diversions include the Mendota Pool and the East Bear Creek Unit of the San Luis NWR. Recapture at Mendota Pool would replace supplies normally delivered to Mendota Pool from the Delta-Mendota Canal, and would therefore not increase diversions or associated impacts to representative fish species. Recapture at the East Bear Creek Unit would replace supplies not normally delivered from the river, and could therefore increase diversions by up to 60 cfs at this location. Additional diversion at this location could increase the risk of representative fish mortality through direct mortality, entrainment, and impingement (although it should be noted that the assumption that diversion losses increase as the volume of diverted flow increases is not strongly supported by research (Reclamation 1997)). Increased diversions would primarily affect migrating species, including Sacramento splittail, by altering water velocity at or near diversion intakes. Juvenile life stages are generally more susceptible than adults to the effects of diversions. However, the relatively small quantity of water anticipated to be diverted, and the temporary nature of these diversions, would not substantially interfere with the movement of migratory fish in Reach 5. Therefore, this impact would be less than significant.

Impact FSH-27 (Alternatives A1 Through C2): ***Changes in Predation Levels in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** Interim and Restoration flows would reduce predation by nonnative fishes in the Restoration Area by creating in-channel conditions that favor native fish species over nonnative species. This impact would be **less than significant** and **beneficial**.

Representative special-status species sensitive to predation by nonnative predators include larval and juvenile hardhead and Sacramento splittail. While no quantitative assessment of predation has been conducted in the Restoration Area, given the large populations of nonnative fish in the reach (DFG 2007), predation pressures on representative special-status fish species and other native fishes are believed to be considerable under current conditions. Interim and Restoration flows would improve instream and floodplain habitat conditions, which would benefit most life stages of the representative fish species in the Restoration Area. The release of Interim and Restoration flows would result in increases in the quantity, quality, and velocity of water downstream from Friant Dam, and generally reduce water temperatures, especially in Reach 1. This would shift habitat conditions away from the warmer and slower water habitat favored by nonnative predators and increase habitat suitability for native species, in effect, moving nonnative predatory fish farther downstream. These effects would be less than significant and beneficial for representative special-status species.

Impact FSH-28 (Alternatives A1 Through C2): ***Changes in Food Web Support in the San Joaquin River Between Friant Dam and the Merced River – Project-Level.*** Interim and Restoration flows would lead to improved food resources and food web support conditions for all representative fish species and other fishes. This impact would be **less than significant** and **beneficial**.

The improved conditions would result from improved riparian and channel habitat for benthic and terrestrial food organism production; increased abundance and diversity of aquatic and riparian vegetation leading to increased primary and secondary aquatic production; enhanced perennial streamflow flushing of fine sediment from substrate, thereby increasing benthic macroinvertebrate production; inundation of floodplains improving feeding opportunities for fish outside the main channel; and increased nutrient input from salmon carcasses, which would improve marine-origin nutrient load and in-river food web support. These effects would be less than significant and beneficial.

San Joaquin River from Merced River to the Delta. Because the San Joaquin River between the Merced River and the Delta conveys regular flows under existing conditions, the project-level actions would have few effects on fisheries in this geographic area. The potential project-level impacts of Alternatives A1 through C2 in this area include transfer of disease between currently isolated fish populations, and potential changes in Chinook salmon and steelhead habitat in the Merced, Tuolumne, and Stanislaus rivers, as described below.

Impact FSH-29 (Alternatives A1 Through C2): ***Effects of Disease on Fisheries in the San Joaquin River Between the Merced River and the Delta – Project-Level.*** Implementing Interim and Restoration flows would provide access by San Joaquin Basin fall-run Chinook salmon and steelhead to all reaches of the San Joaquin River from Friant Dam to the Merced River. The restoration of connectivity between these currently isolated populations has the potential to increase the risk of disease transmission, which could result in mortality or reduced fitness of San Joaquin Basin fall-run Chinook salmon and steelhead. However, given the current rate of straying in the San Joaquin system, this impact would be **less than significant**.

The parasite *Myxobolus cerebralis*, which causes whirling disease in salmonids, poses a risk to salmonid populations in the San Joaquin River and tributaries. This parasite uses tubifex worms as an intermediate host, and has the potential, albeit a very low risk, to originate from the tubifex worm farm located in Reach 1A and infect fall-run Chinook salmon and steelhead entering Reach 1A from the lower San Joaquin River. Transmission of this or other diseases borne by the resident hatchery rainbow trout to fall-run Chinook salmon and steelhead in the lower San Joaquin River could also occur if infected rainbow trout move downstream following the release of Interim and Restoration flows. The resulting effects on wild populations of fall-run Chinook salmon and steelhead in the lower San Joaquin River and tributaries would be potentially significant.

Impact FSH-30 (Alternatives A1 Through C2): *Changes in Chinook Salmon and Steelhead Habitat in the Merced, Tuolumne, and Stanislaus Rivers – Project-Level.* Under the action alternatives, flows in the San Joaquin River tributaries and associated Chinook salmon and steelhead habitat would be similar to or greater than under the No-Action Alternative under all potential hydrologic conditions. This impact would be **less than significant**.

With Interim and Restoration flows in the mainstem San Joaquin River, the response of the water supply system needs to meet the regulatory and operational requirements of the system. As described in the methodology section, VAMP flow requirements at Vernalis and the Vernalis water quality standard are the predominant factors controlling operations on the tributaries in response to flows on the mainstem San Joaquin River, as follows:

- **Vernalis Water Quality Standard –** Interim or Restoration flows would improve water quality conditions in the San Joaquin River upstream from the Stanislaus River, thereby reducing required releases from New Melones Reservoir on the Stanislaus River pursuant to SWRCB Water Right Decision 1641 (D-1641) to achieve the Vernalis water quality standard. The Merced and Tuolumne rivers, as previously mentioned, are not required to make releases to meet the Vernalis water quality standard.

- **VAMP Flow Requirements –** Interim and Restoration flows may contribute to VAMP flow requirements at Vernalis on the mainstem San Joaquin River, indirectly reducing tributary releases required for VAMP in late April and early May. These reduced releases in April and May would result in higher tributary reservoir storage, which would affect local operations on the tributaries at a later time in the year. Tributary releases to meet VAMP flow requirements at Vernalis would be affected in one of two ways, as follows:

    - During conditions when Interim and Restoration flows contribute toward meeting the same VAMP flow requirements at Vernalis that would have been in place under the No-Action Alterative, required releases from tributary reservoirs could be reduced.

- During conditions when Interim and Restoration flows would cause higher VAMP flow requirements at Vernalis than would have been in place under the No-Action Alterative, releases from tributary reservoirs would be required to meet the VAMP flow requirements at Vernalis.

Reservoir releases in the Merced, Tuolumne, and Stanislaus rivers in response to flow requirements at Vernalis and the Vernalis water quality standard are tempered by tributary-specific operational requirements, including flood management and water supply. The Stanislaus Operations Group, which was established as a tool to allow NMFS and Reclamation to hear advice and recommendations and to discuss upcoming operations related to river conditions, has the ability to determine whether additional flow needs to be released from New Melones Dam to meet the Vernalis water quality standard; this group also works with the Water Operations Management Team to meet fisheries needs in the Stanislaus River.

Under the action alternatives, flows on the tributaries almost always either meet the target flows (as shown in Appendix K, "Biological Resources – Fisheries") or, if not, then do not change from the No-Action Alternative or existing conditions. Flows on the tributaries would meet the target flows, as follows:

- **Merced River** – In April of above-normal water years (San Joaquin Valley 60-20-20 Index), Merced River flows under the action alternatives are lower than under the No-Action Alternative and existing conditions. The decreases in flow in the Merced River that would occur in April of above normal water years caused by the reservoirs refilling, would improve the ability to fill the reservoir occurring under the conditions in the action alternatives. This refilling of the reservoir would provide cooler water for release later in the year than would otherwise be available.

- **Tuolumne River** – Flows in the Tuolumne River would meet target flows under the action alternatives.

- **Stanislaus River** – Under existing conditions, simulated flows on the Stanislaus River in March of critical, dry and below normal water years (San Joaquin Valley 60-20-20 Index) would not always meet the flow standard set for migrating Chinook salmon and steelhead (2,000 cfs) for the No-Action Alternative. Similarly, simulated flows on the Stanislaus River in March of critical, dry and below normal water years (San Joaquin Valley 60-20-20 Index) would not always meet the flow standard set for migrating Chinook salmon and steelhead (2,000 cfs) for the action alternatives. Therefore, it is reasonable to anticipate that under the action alternatives, flows would be released from New Melones Dam to benefit or minimize impacts to Stanislaus River salmonids.

For the reasons described above, under all action alternatives, the effects on fall-run Chinook salmon and other native fishes in the Merced, Tuolumne, and Stanislaus rivers would be less than significant.

Sacramento–San Joaquin Delta. Potential project-level impacts of Alternatives A1 through C2 in the Delta are described below.

Impact FSH-31 (Alternatives A1 Through C2): ***Changes in Water Temperatures and Dissolved Oxygen Concentrations in the Delta – Project-Level.*** Delta fishes are affected by both water temperature and DO concentration, both of which have the potential to be affected by San Joaquin River inflow. Minimal changes are anticipated to both water temperature and DO and, therefore, this impact to Delta fishes is expected to be **less than significant**.

The action alternatives would increase inflow from the San Joaquin River to the Delta during adult migration and smolt emigration periods of fall-run Chinook salmon and steelhead. Increased inflow is expected to have no effect on water temperatures in the Delta. Increased inflow is expected to improve DO conditions for migration of adult salmon and steelhead in the San Joaquin River. The improved conditions would likely have a beneficial effect on Central Valley fall-run Chinook salmon and Central Valley steelhead.

The San Joaquin side of the Delta (south Delta) often has poor water temperature conditions for Delta fishes, especially during late summer and early fall (Nobriga et al. 2008, Feyrer 2004, Kimmerer 2004). Water temperatures are especially important for Chinook salmon and steelhead adults that migrate upstream in the San Joaquin River beginning in late summer, and smolts that migrate downstream through the Delta in the spring, because these fish have lower temperature tolerances than other Delta fish species.

Water temperatures would be potentially affected in the south Delta if Alternatives A1 through C2 alter San Joaquin River inflow water temperatures. The degree of any impact would depend on the size of the temperature change and the volume of the inflow. The SJR5Q water temperature model simulated effects of the action alternatives on water temperatures in the San Joaquin River from Friant Dam to immediately downstream from the confluence with the Merced River. Modeling results indicate that Alternatives A1 through C2 would have little effect on water temperatures at the location immediately downstream from the confluence with the Merced River. Because this location is downstream from the Merced River, these results show that effects of the Merced River on water temperature of the San Joaquin River would not be different under Alternatives A1 through C2 relative to the No-Action Alternative. Therefore, it is reasonable to conclude that water temperatures of San Joaquin River inflow would minimally differ among the No-Action Alternative and Alternatives A1 through C2, and Delta fishes would experience a less-than-significant impact.

Alternatives A1 through C2 would potentially affect DO in the San Joaquin River near the Stockton Deep Water Ship Channel (SDWSC). DO levels at the SDWSC are often low during late summer and early fall because of high water temperatures, algal biomass, and low river flow (Giovannini 2005, Lee and Jones-Lee 2003). San Joaquin River inflow is expected to slightly increase during October and November of all year types for Alternatives A1 through C2 (Figures 5-7 and 5-8). Little change in inflow is expected for

July through September. It is assumed that operations of the Head of Old River Barrier, which is installed during fall of most years to increase San Joaquin River flow past Stockton, would not change. Therefore, no effect on Delta fishes, including delta smelt, green sturgeon, Chinook salmon, and steelhead would occur as a result of changes in DO concentrations under Alternatives A1 through C2.

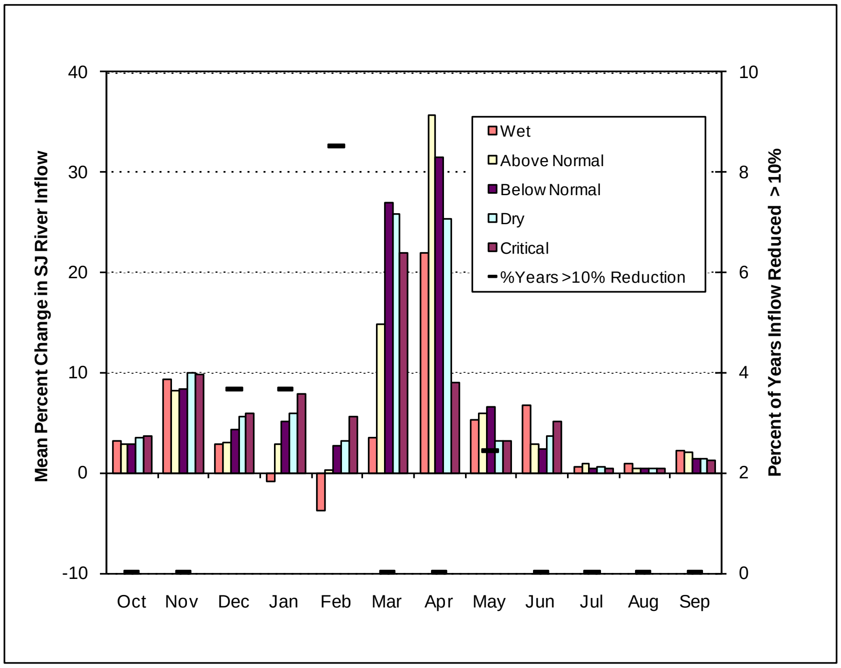


Figure 5-7.
Mean Percent Changes in San Joaquin River Flow at Vernalis and Percent of Years with Flow Reductions Greater Than 10 Percent Between Existing Conditions and Alternatives A1 Through C2, 2005 Level of Development

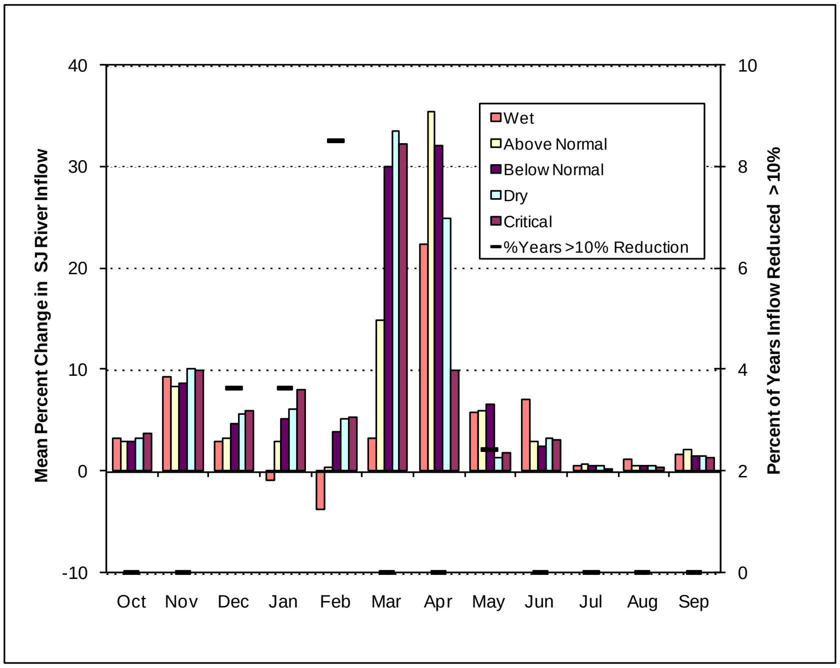


Figure 5-8.
Mean Percent Changes in San Joaquin River Flow at Vernalis and Percent of Years with Flow Reductions Greater Than 10 Percent Between No-Action Alternative and Alternatives A1 Through C2, 2030 Level of Development

Impact FSH-32 (Alternatives A1 Through C2): ***Changes in Pollutant Discharge and Mobilization in the Delta – Project-Level.*** Alternatives A1 through C2 would cause a minor local reduction in pollutants at the confluence of the San Joaquin River with the Delta. This reduction would provide a less than significant and beneficial effect on Delta fishes. This impact would be **less than significant** and **beneficial**.

Alternatives A1 through C2 would increase San Joaquin River flow into the Delta. Water quality modeling results show that the increased flow would dilute salinity of San Joaquin River inflow (see Chapter 14.0, “Hydrology – Surface Water Quality”). Other pollutants in the river would be similarly diluted. This effect does not extend very far into the Delta, perhaps because much of the increased San Joaquin River water volume entering the Delta would be offset by exports at the Jones and Banks Pumping Plants. The dilution of pollutants is expected to have a localized beneficial effect on Delta fishes.

Impact FSH-33 (Alternatives A1 Through C2): ***Changes in Sediment Discharge and Turbidity in the Delta – Project-Level.*** Alternatives A1 through C2 are expected to have no direct effect on turbidity in the Delta, but are expected to have an indirect effect on Delta fishes by moving fish away from the south Delta, where turbidity is generally low compared to other parts of the Delta. This indirect impact is expected to be less than significant to Delta fish species, including delta smelt and longfin smelt. This impact would be **less than significant**.

Alternatives A1 through C2 have the potential to cause short-term increases in turbidity of San Joaquin River inflow resulting from mobilization of sediments during Restoration construction activities. However, the effects of construction activity are anticipated to be localized within the Restoration Area and would be further minimized with appropriate best management practices included in the Conservation Strategy, and in mitigation for construction-related impacts, as described in this Draft PEIS/R.

Alternatives A1 through C2 would likely have a persistent indirect effect on the average turbidity to which Delta fishes would be exposed. The south Delta has turbidities substantially lower than other regions of the Delta (Nobriga et al. 2008). Alternatives A1 through C2 are not expected to affect this turbidity, but Alternatives A1 through C2 are expected to affect flow patterns in the south Delta, and these flow patterns are expected, in turn, to affect the movement of fish into and out of the south Delta. Therefore, Alternatives A1 through C2 potentially affect turbidity for Delta fishes indirectly. Enhanced turbidity affords small-bodied fish species and life stages favorable conditions for reducing predation and enhancing feeding.

Impact FSH-34 (Alternatives A1 Through C2): ***Changes in Fish Habitat Conditions in the Delta – Project-Level.*** Alternatives A1 through C2 are expected to cause no direct effect on habitat connectivity in the Delta, but could potentially reduce the chances of fish entering the south Delta, where barriers may impede their migrations. Large fish such as adult Central Valley fall-run Chinook salmon and green and white sturgeon are especially vulnerable to effects of such barriers. Additional protection would be provided to the fish because the action alternatives would be operated consistent with applicable laws, regulations, BOs, and court orders in place at the time the water was recaptured. This indirect impact on habitat connectivity would be **less than significant** and **beneficial**.

Alternatives A1 through C2 would have no direct effect on habitat connectivity in the Delta. However, Alternatives A1 through C2 potentially reduce the number of fish entering the south Delta. A number of barriers are seasonally installed in the south Delta to control water levels and water quality for agricultural diversions. A barrier is also installed at the head of Old River during fall to increase flow in the San Joaquin River, and during spring to reduce straying of Chinook salmon smolts from the San Joaquin River. Once in the south Delta, fish migrations may be impeded by the barriers (Hallock et al. 1970).

Impact FSH-35 (Alternatives A1 Through C2): ***Changes in Diversions and Entrainment in the Delta– Project-Level.*** Alternatives A1 through C2 would increase Delta exports during most months and water year types. The increased diversions would result in higher entrainment risks for fish located in the south Delta. However, increased San Joaquin River inflows, and ratios of the inflows to reverse flows predicted for Alternatives A1 through C2, are expected to reduce the number of fish at risk of entrainment. The increased risk of fish entrainment in the south Delta is expected to be somewhat offset by the reduction in numbers of fish at risk. Therefore, this impact would be **less than significant**.

The Jones and Banks export facilities are the largest in the south Delta, and entrain millions of fish each year (Reclamation 2008). The facilities have fish screens used to salvage fish greater than a certain size (around 20 mm), but many of the salvaged fish are assumed not to survive their return to the Delta (Kimmerer 2004). The loss of fish at the facilities has been shown to contribute to recent declines of delta smelt (Kimmerer 2008) and Central Valley steelhead (Reclamation 2008). Other species are also affected by direct losses from entrainment or salvage-related mortality. Diversion effects of Alternatives A1 through C2 are related not only to changes in the volume of water diverted but also to changes in flow patterns caused by the diversions that affect how fish are distributed with respect to the south Delta. Hundreds of agricultural diversions in the south Delta are also responsible for entraining small fishes.

The mean level of Jones and Banks pumping plants diversions is expected to increase under Alternative A1 during most months and year types, with especially large increases during April of all except Wet water year types (Figures 5-9 and 5-10). The greatest increases (about 23 percent) are predicted for Dry water year types in February under the 2005 LOD (Figure 5-9) and in April under the 2030 LOD (Figure 5-10). Under both LODs, April is expected to have the highest percent of years (more than 40 percent) with an increase in monthly Jones and Banks pumping plant diversion rate of greater than 10 percent. The largest average reduction in the diversions (about 6 percent) is expected for February of Below-Normal water year types under the 2030 LOD (Figure 5-10).

Alternatives A1 through C2 are predicted to result in generally higher Banks and Jones pumping plant diversions. The higher diversion rates are expected to result in greater entrainment risk for fish in the south Delta. However, Alternatives A1 through C2 would increase San Joaquin River inflows, and the ratio of inflows to reverse flows, in Old and Middle rivers, which would help keep fish away from the south Delta. This effect of the increased inflows and ratios is expected to offset the increased entrainment risk of south Delta fish from increased exports, resulting in no net change in fish entrainment.

Interim and Restoration flows reaching the Delta would be recaptured at existing facilities within the Delta consistent with applicable laws, regulations, BOs, and court orders in place at the time the water was recaptured. Compliance contributes to the determination of a less-than-significant effect of Jones and Banks pumping plant diversions on Delta fishes.

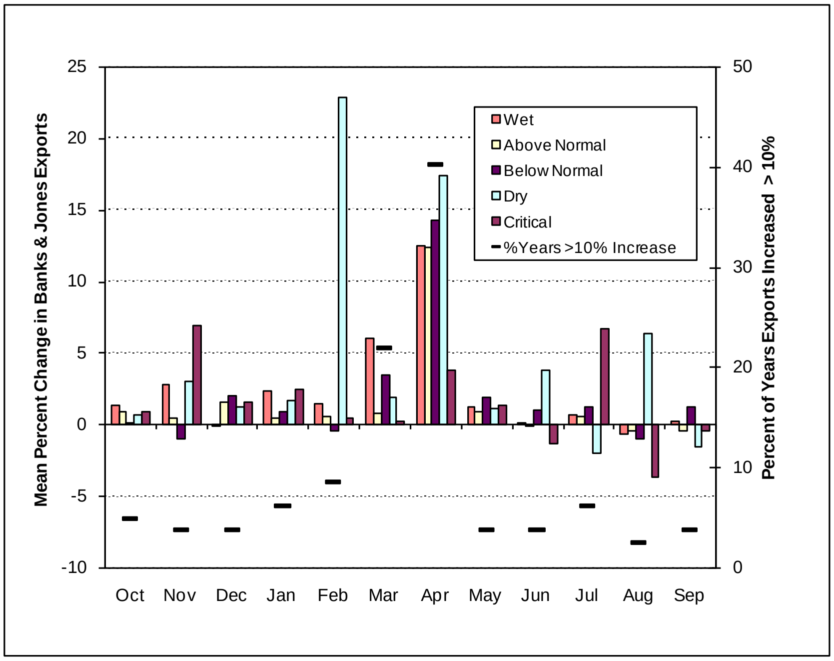


Figure 5-9.

Mean Percent Changes in Diversions at Banks and Jones Facilities and Percent of Years with Diversion Increases Greater Than 10 Percent Between Existing Conditions and Alternatives A1 Through C2, 2005 Level of Development

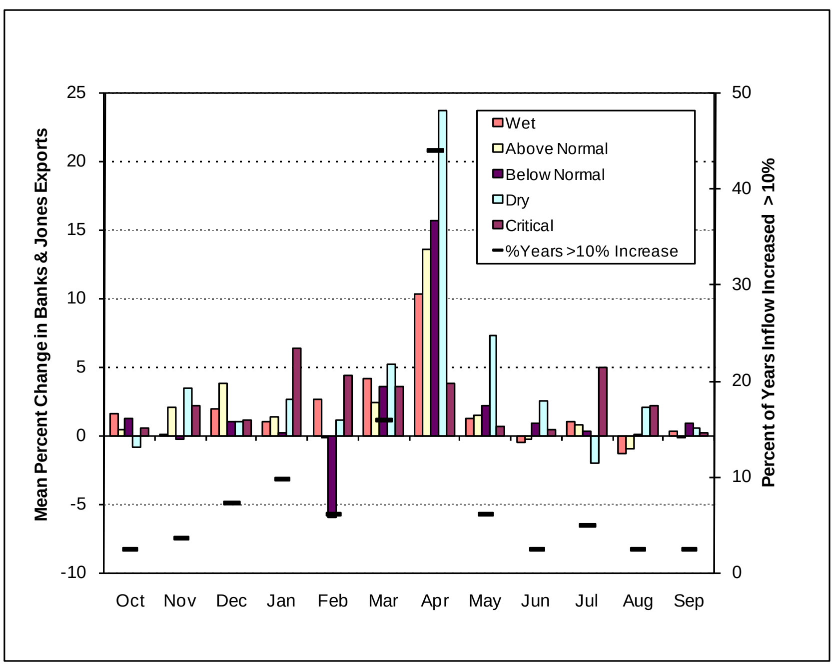


Figure 5-10.

Mean Percent Changes in Diversions at Banks and Jones Facilities and Percent of Years with Diversion Increases Greater Than 10 Percent Between No-Action Alternative and Alternatives A1 Through C2, 2030 Level of Development

Impact FSH-36 (Alternatives A1 Through C2): ***Changes in Predation Levels in the Delta – Project-Level.*** Alternatives A1 through C2 are expected to result in lower average fish predation rates on many Delta fish species because the alternatives would produce flow patterns that would help to keep fish from the south Delta where predation rates are high. The flow effects would be more favorable during March and April, when early life stages of many special-status fish species are present. The reduced predation is beneficial for early life stages and small-bodied fish species, including delta smelt and longfin smelt. This impact would be **less than significant** and **beneficial**.

The potential effects of Alternatives A1 through C2 on predation are expected to be largely determined by the distribution of fish with respect to the south Delta. Predation rates are higher for most fishes in the south Delta than in other parts of the Delta for a variety of reasons: (1) turbidity is generally lower in the south Delta and, therefore, fish are more visible to their predators (Nobriga et al. 2008; Feyrer et al. 2007), (2) many of the structures and facilities in the south Delta provide excellent conditions for predacious fish, particularly Clifton Court Forebay and the fish louver screens at the Jones and Banks pumping facilities (Reclamation 2008), and (3) recent invasions by the submerged plant, *Egeria densa*, provide favorable habitat conditions for black bass species, which prey heavily on young life stages of other fishes (Nobriga and Feyrer 2007, Nobriga et al. 2005). Alternatives A1 through C2 are predicted to increase the ratio of San Joaquin River inflow to reverse flows in Old and Middle rivers, which could lead to fish population distributions that have fewer fish in the south Delta. The increases would be greatest for March and April (Figures 5-11 and 5-12), a period during which early life stages of many fish species, which are particularly vulnerable to predation, are present in the Delta.

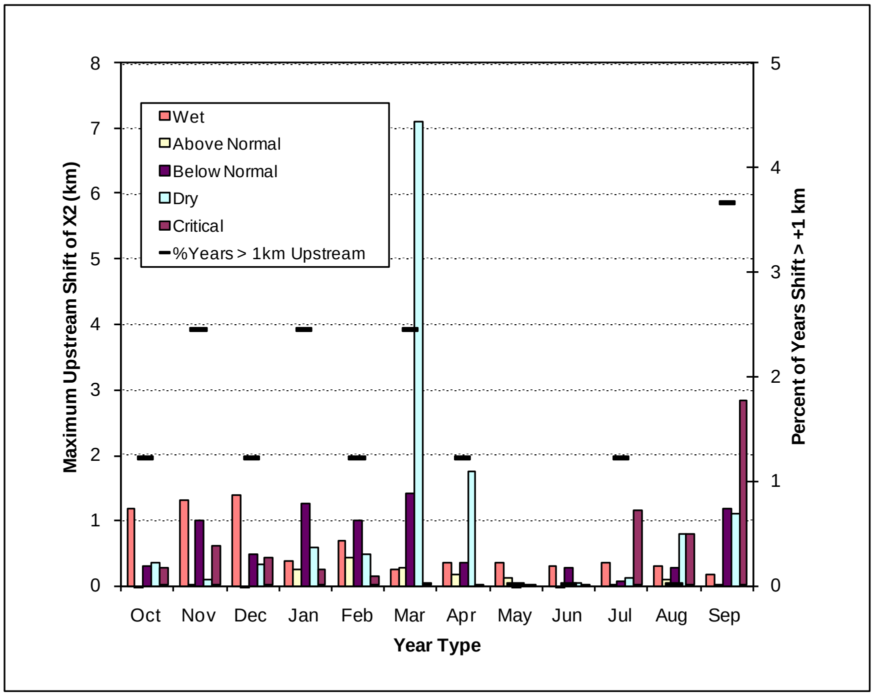


Figure 5-11.
Maximum Mean Monthly Upstream Shifts in X2 and Percent of Years with Greater Than 1 Kilometer Mean Monthly Upstream Shift Under 2005 Level of Development

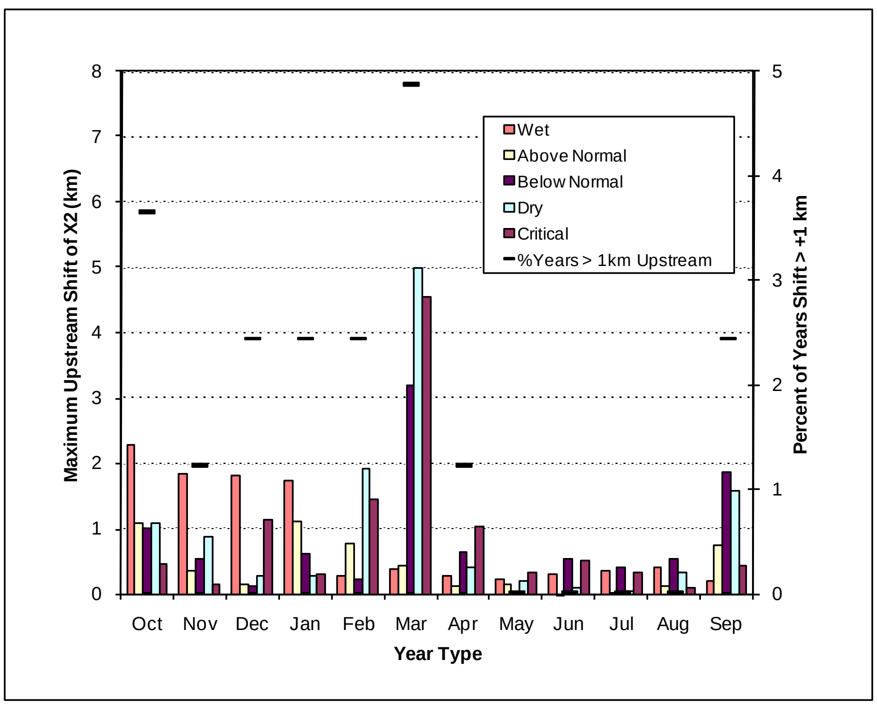


Figure 5-12.
Maximum Mean Monthly Upstream Shifts in X2 and Percent of Years with Greater Than 1 Kilometer Mean Monthly Upstream Shift Under 2030 Level of Development

Impact FSH-37 (Alternatives A1 Through C2): ***Changes in Food Web Support in the Delta – Project-Level.*** Alternatives A1 through C2 are expected to reduce time spent by planktivorous Delta fishes in the poor feeding conditions of the south Delta, thus improving their average food resource and food web support conditions. However, a decrease in small fish in the south Delta would adversely affect piscivorous fish species. Fish species most likely to benefit from this effect include delta smelt and longfin smelt, both of which are at least partially planktivorous in all life stages. Fish species most likely to be adversely affected include striped bass, whose juveniles and adults rely heavily on fish prey. Alternatives A1 through C2 are predicted to have very little effect on X2 and, thus, would have no effect on food resources and other conditions in the LSZ. The net impact on food resources and food web support of Alternatives A1 through C2 would be **less than significant**.

Habitat conditions are considered poor in the south Delta because of factors including high water temperatures, low turbidity, and high diversion rates, which likely reduce the abundance of prey species. Low turbidity reduces feeding rates for delta smelt (Baskerville-Bridges et al. 2004). The reason for this is not entirely understood, but it is believed that turbidity provides visual contrast that helps delta smelt find their prey. Feeding of other planktivorous species such as longfin smelt and the larval and early juvenile life stages of nearly all species probably are similarly adversely affected by low turbidity. Because Alternatives A1 through C2 are predicted to increase the ratio of San Joaquin River inflow to reverse flow in Old and Middle rivers, the number of fish present in the south Delta is expected to decrease. As a result, the feeding conditions for planktivorous fish would, on average, improve. However, because numbers of small fish in the south Delta would be reduced, food resources for piscivorous species such as striped bass, which benefit from the increased water clarity, would decline.

An additional potential effect of Alternatives A1 through C2 on food web support results from changes in Delta outflow and X2. Delta outflow largely determines X2, which is used to reference the location of the LSZ. The LSZ is an area that historically has had high prey densities and other favorable habitat conditions for rearing juvenile delta smelt, striped bass, and other fish species (Kimmerer 2004). The LSZ is believed to provide the best combination of habitat conditions when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers, which is the basis for the "X2 standards" in the SWRCB's *1995 Bay-Delta Plan* (U.S. Department of the Interior 2005). When Delta outflow is low, X2 is located in the relatively narrow channel of these rivers, whereas at higher outflows, X2 moves downstream into more open waters (Kimmerer 2004). (X2 is referenced as the distance from the Golden Gate Bridge; therefore, higher X2 values correspond to greater distances upstream. The confluence of the two rivers is at about 81 km from the Golden Gate Bridge; thus, increases in X2 above 81 km are considered to adversely affect habitat and food web support, while decreases below 81 km are considered to have beneficial effects.

Modeling results show that Alternatives A1 through C2 would rarely appreciably affect X2. The highest expected mean upstream shift in X2 is 0.4 km for March of Dry water year types. Figures 5-11 and 5-12 show the predicted maximum upstream shift in X2 for each month and year type, and the percentage of years for each month with mean monthly upstream shifts of greater than 1 km. The maximum upstream shift was about 7 km for March of a Dry water year type under the 2005 LOD (Figure 5-11). A few additional years had upstream shifts of 2 or more km under the 2030 LOD (Figure 5-12). Less than 5 percent of years for any month were predicted to have upstream shifts of more than 1 km. Predicted downstream shifts of X2 of more than 1 km (not shown on graphs) were similarly infrequent.

Upstream shifts that moved X2 from downstream to upstream from the confluence of the Sacramento and San Joaquin rivers could be especially deleterious for fish habitat. Using 81 km as an estimate of the location of the confluence, Alternatives A1 through C2 were predicted to move X2 from downstream to upstream from the confluence for only 3 simulated months (0.3 percent of all months simulated), and in all three cases, the shift was about 1 km. The relatively minor effect of Alternatives A1 through C2 on X2 is expected because the San Joaquin River has much less effect on Delta outflow than the Sacramento River, and increases in San Joaquin River inflow would be largely offset by increased exports from the south Delta.

Impact FSH-38 (Alternatives A1 Through C2): ***Salinity Changes in the Delta – Project-Level.*** As previously described for Impact FSH-37, modeling results show that Alternatives A1 through C2 were predicted to move X2 from downstream to upstream from the confluence for only 3 simulated months (0.3 percent of all months simulated), and in all three cases, the shift was about 1 km. This impact would be **less than significant**.

Impact FSH-39 (Alternatives A1 Through C2): ***Changes to Delta Inflow and Flow Patterns in the Delta – Project-Level.*** Alternatives A1 through C2 would increase San Joaquin River inflows and reverse Old and Middle river flows, and ratios of the inflows to reverse flows. These outcomes would likely result in lower occurrences of most Delta fish species in the south Delta, which would provide a beneficial effect to many Delta fish species, including Central Valley fall-run Chinook salmon, Central Valley steelhead, Sacramento splittail, longfin smelt, and delta smelt. This effect would be most beneficial under Alternatives A1 and A2, because these alternatives do not include water recapture in the San Joaquin River between the Merced River confluence and the Delta. Alternatives B1 and B2 include water recapture at existing facilities along the San Joaquin River, and would therefore have less beneficial effects to Delta species than Alternatives A1 and A2 (as described under program-level impacts of Alternatives B1 and B2). This effect would be least beneficial under Alternatives C1 and C2 because these alternatives would have the most water recapture in the San Joaquin River upstream from the Delta, and therefore would have the least increase in San Joaquin River inflows and reverse Old and Middle river flows, and ratios of the inflows to reverse flows (as described under program-level impacts of Alternatives C1 and C2). Additional protection would be provided to the fish because the action alternatives would be operated consistent with applicable laws, regulations, BOs, and court orders in place at the time the water was recaptured. This impact would be **less than significant** and **beneficial**.

Delta flow is important to fishes in the Delta, where human-induced changes in Delta channels and patterns of flow circulation have strongly affected fish distribution and migration behaviors, and survival. The largest flows in the Delta are tidal flows, which far exceed other flows in most Delta channels, but the nontidal flows determine the net direction of water movement, and therefore strongly affect fish movements.

The Jones and Banks export facilities affect fish distributions in the south Delta because exporting large volumes often results in water flowing upstream. These reverse flows in the south Delta make the fish more vulnerable to being entrained by the pumps and delay their migrations through or from the south Delta. Reversed flows are believed to affect fish movements by direct transport of weak swimmers such as larval fish (Monson et al. 2007, Kimmerer 2004), and by inappropriate olfactory and other environmental cues for migrating fish, such as adult and juvenile Chinook salmon (Mesick 2001).

Inflow from the San Joaquin River affects the movement of fish into and out of the south Delta, which is generally considered to have poor habitat conditions for most fish species relative to other parts of the Delta (Freyer and Healey 2003, Feyrer 2004, Monson et al. 2007, Nobriga et al. 2008). High inflows may directly transport larval fish and other weak swimmers downstream and away from the south Delta, and may reduce straying of all life stages from the main river channel into channels that lead toward the south Delta pumps. Survival of emigrating San Joaquin River fall-run Chinook smolts is positively correlated with San Joaquin River inflow (SJRGA 2001 through 2009). Higher inflows may provide stronger environmental cues for adult fish migrating upstream and smolts and other juveniles migrating downstream (Mesick 2001). Higher inflow may also improve downstream transport of the semibuoyant eggs of striped bass.

Alternatives A1 through C2 are expected to result in increased mean San Joaquin River inflow for nearly all water year types in every month. Figures 5-13 and 5-14 show the mean percent changes from the existing conditions and No-Action Alternative to Alternatives A1 through C2 under both the 2005 LOD and 2030 LOD in simulated monthly mean flow of the San Joaquin River at Vernalis for each water year type. The greatest mean increases in San Joaquin River flow are predicted for March and April. The only mean decreases in flow were predicted for January and February. No more than 9 percent of years in any month had flow reductions of greater than 10 percent (Figures 5-13 and 5-14).

Alternatives A1 through C2 are expected to result in increased mean reverse flow (i.e., upstream flow) for the Old and Middle rivers combined for nearly all water types in most months. Figures 5-15 and 5-16 display the mean percent changes from the existing conditions and No-Action Alternative to Alternatives A1 through C2 in simulated monthly mean reverse flow for each water year type. The largest increases in mean reverse flow would occur in April. Reverse flows increased an average of about 10 percent in April for all year types, except Critical, and reverse flow during April increased more than 10 percent at least 40 percent of the time. The largest decreases in mean reverse flow relative to existing conditions would occur in March and August, while the largest decreases compared with the No-Action Alternative would occur in February and March.

San Joaquin River inflows and reverse Old and Middle rivers flow have counteracting effects on fish distribution with respect to the south Delta, and the ratio of inflow to reverse flow was used to evaluate the net effect of these flows on fish distributions. The ratio is particularly useful for evaluations when Alternatives A1 through C2 result in high inflow and high reverse flow, as expected for April of most years (Figures 5-13 through 5-16). Figures 5-13 and 5-14 show the mean percent changes from the existing conditions and the No-Action Alternative to Alternatives A1 through C2 in the ratio of simulated monthly mean San Joaquin River flow at Vernalis to simulated monthly mean reverse flow of Old and Middle rivers for each water year type. Increases in the ratio were more prevalent than decreases, indicating that, on average, Alternatives A1 through C2 would increase San Joaquin River inflow more than it would increase reverse flows in the Old and Middle rivers. The greatest mean increases in the ratio are predicted for March and April. The predicted ratios declined more than 10 percent in at most, about 13 percent of years in any month.

Alternatives A1 through C2 are predicted to result in generally higher San Joaquin River inflows, reverse Old and Middle river flows, and ratios of inflows to reverse flows. These outcomes would likely result in lower occurrences of most Delta fish species in the south Delta, where survival is often reduced.

Delta outflow is important to many Delta fishes (Kimmerer 2004). The abundance of many Delta fish species is positively correlated with Delta outflow (Kimmerer 2004, Jassby 1993). Moderate levels of Delta outflow create conditions that transport weak swimmers and encourage movement of stronger swimmers to downstream areas of the Delta, including the LSZ, where habitat conditions are more favorable for rearing larval and juvenile fish. Elevated outflow also helps create more favorable habitat conditions, as determined by the position of X2.

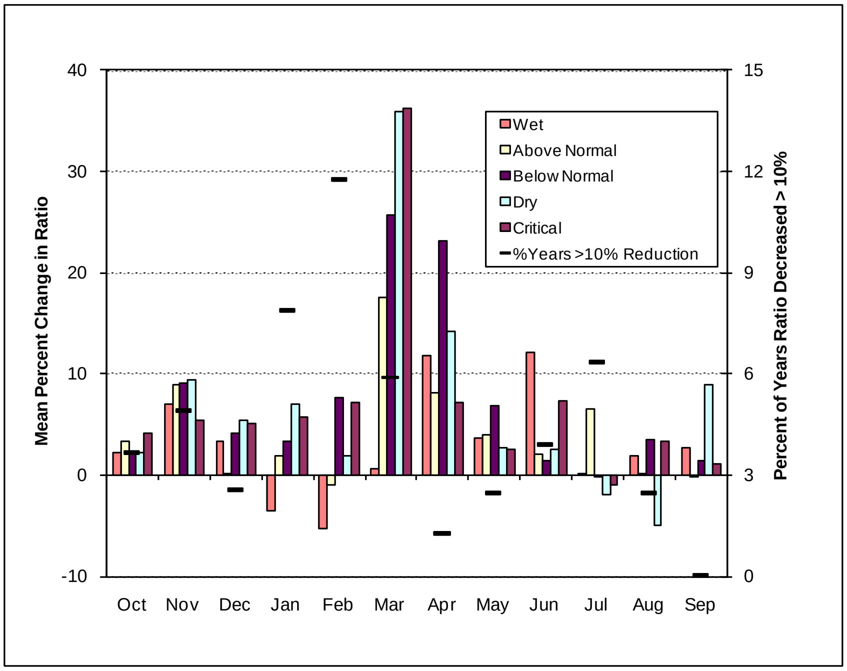


Figure 5-13.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined and Percent of Years with Reverse Flow Increases Greater Than 10 Percent from Existing Conditions and Alternatives A1 Through C2, 2005 Level of Development

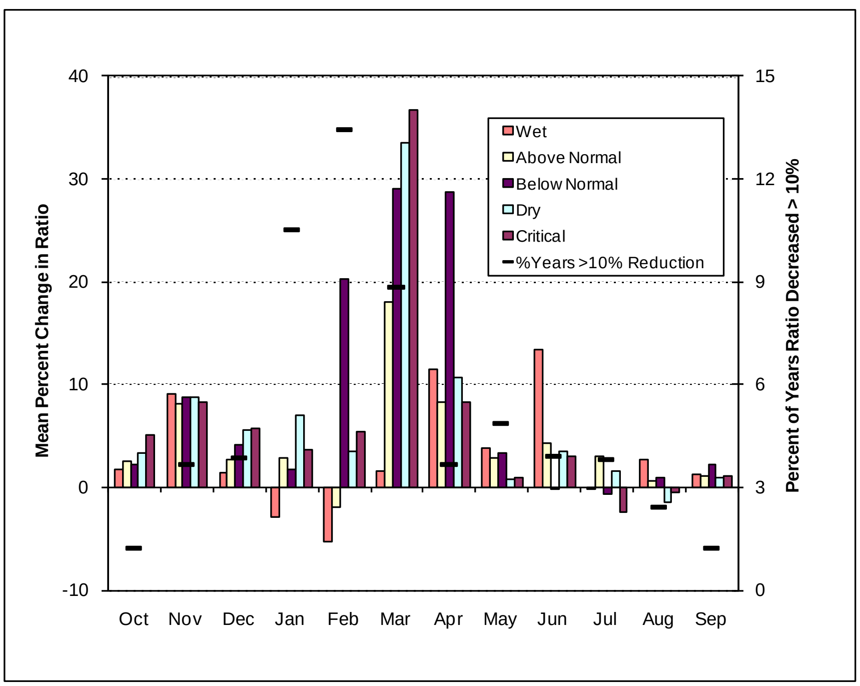


Figure 5-14.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined and Percent of Years with Reverse Flow Increases Greater Than 10 Percent from the No-Action Alternative and Alternatives A1 Through C2, 2030 Level of Development

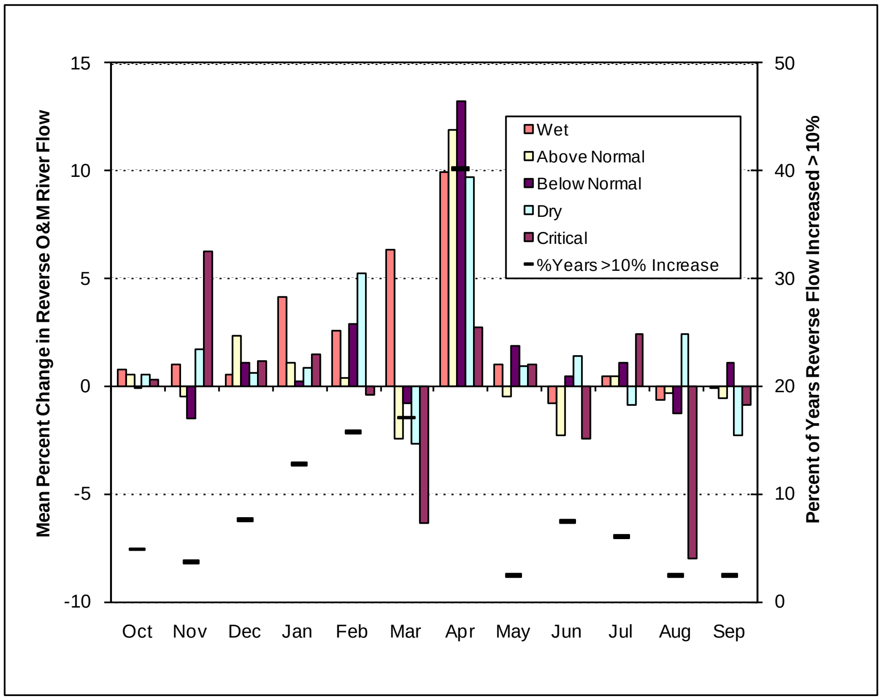


Figure 5-15.
Mean Percent Changes in Reverse Flow of Old and Middle Rivers Combined and Percent of Years with Reverse Flow Increases Greater Than 10 Percent Between Existing Conditions and Alternatives A1 Through C2, 2005 Level of Development

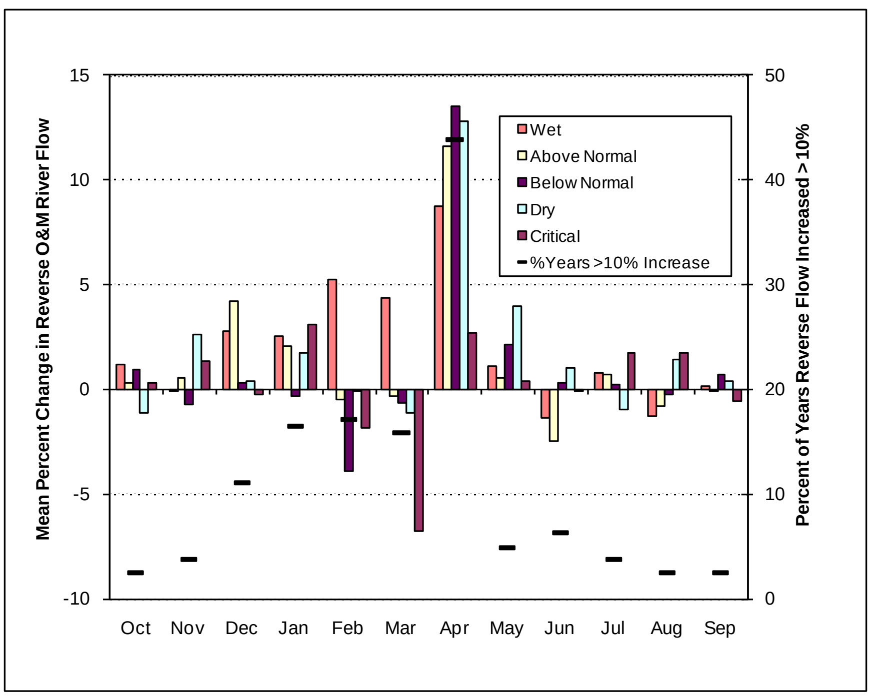


Figure 5-16.
Mean Percent Changes in Reverse Flow of Old and Middle Rivers Combined and Percent of Years with Reverse Flow Increases Greater Than 10 Percent Between the No-Action Alternative and Alternatives A1 Through C2, 2030 Level of Development

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Chapter 6.0 Biological Resources – Vegetation and Wildlife

This chapter describes the environmental and regulatory settings for vegetation and wildlife, as well as environmental consequences and conservation measures, as they pertain to implementation of the program alternatives. Fisheries are described separately in Chapter 5.0, "Biological Resources – Fisheries." Vegetation and wildlife are discussed by the following geographic regions: San Joaquin River Upstream from Friant Dam, San Joaquin River from Friant Dam to the Merced River, San Joaquin River from Merced River to the Delta, the Sacramento-San Joaquin Delta, and the CVP/SWP water service areas. Additional detail is provided in Appendix L, "Biological Resources – Vegetation and Wildlife" and consequences of alternatives on vegetation are quantitatively assessed in Appendix N, "Geomorphology, Sediment, and Vegetation Assessment." The Conservation Strategy (fully described in Chapter 2.0, "Description of Alternatives"), which is included in the action alternatives, reduces each potentially significant impact to vegetation and wildlife to a less-than-significant level, where feasible, and precludes the need for mitigation measures. Throughout this chapter, species are referred to using their common name. At the first usage of a common name, the Latin name is also presented in parentheses.

Throughout this chapter, species are referred to using their common name. At the first usage of a common name, the Latin name is also presented in parentheses.Throughout this chapter, species are referred to using their common name. At the first usage of a common name, the Latin name is also presented in parentheses.Throughout this chapter, species are referred to using their common name. At the first usage of a common name, the Latin name is also presented in parentheses.

6.1 Environmental Setting

Biological resources addressed in this section include terrestrial plant and wildlife communities, special-status species, species recovery areas, designated critical habitat, and sensitive natural communities. This section is based on baseline biological resource conditions at the time the NOI and NOP of this Draft PEIS/R was issued in August 2007. Baseline conditions were determined through a review of scientific literature and existing data sources. Existing documents reviewed for preparation of this section include:

- *Historical Riparian Habitat Conditions of the San Joaquin River — Friant Dam to the Merced River*, prepared by Jones & Stokes Associates, Inc. for, Fresno, California. April 1998. (Reclamation 1998a).

- *Analysis of Physical Processes and Riparian Habitat Potential of the San Joaquin River — Friant Dam to the Merced River*, prepared by Jones & Stokes Associates, Inc. for Reclamation, Fresno, California. October 1998. (Reclamation 1998b).
- *Riparian Vegetation of the San Joaquin River*, prepared by DWR for Reclamation. May 2002. (DWR 2002).
- *San Joaquin River Restoration Study Background Report*, edited by McBain and Trush. December 2002. (McBain and Trush 2002).

6.1.1 Historical and Regional Perspective

The San Joaquin River originates high in the Sierra Nevada. It rapidly descends and exits mountainous terrain in the area now occupied by Friant Dam. The portion of the river downstream from the current location of Friant Dam is a deeply incised channel that discharges to the valley floor near Gravelly Ford. Before the influx of settlers after the Civil War in the 1860s and the subsequent agricultural development, the San Joaquin River and its main tributaries in their natural state meandered across alluvial fans along the main axis of the San Joaquin Valley floor. The river distributed higher flows into a complex network of sloughs that branched off both sides of the river. It flowed through a flat, homogeneous topography and supported a limited riparian forest. The flat valley floor surrounding the riparian forest often took the form of extensive wetlands, dominated by tule marsh. Riparian forest zones were present along the margins of the primary river channel and were not very extensive (The Bay Institute 1998).

Near Mendota, the San Joaquin River merged with Fresno Slough, a wider and deeper waterway than the San Joaquin River. Fresno Slough was part of an intricate slough system that exchanged water between the Tulare Lake Basin and the San Joaquin River. Downstream from Mendota, the San Joaquin River flowed through a network of large slough channels traversing extensive riparian woodland, tule marshes, and backwater ponds until it joined with the Merced River. Downstream from this point, the floodplain was more confined and the river exhibited a highly sinuous pattern of rapid channel meander, which created a rich complex of oxbow lakes, backwater sloughs, ponds, and sand bars. In its lower sections just upstream from the Delta, the river formed low natural levees approximately 6 feet high (The Bay Institute 1998).

The San Joaquin River has changed dramatically since the early part of the twentieth century. The river is now largely confined within constructed levees and bounded by agricultural and urban development, flows are regulated through dams and water diversions, and floodplain habitats have been fragmented and reduced in size and diversity (McBain and Trush 2002). As a result, the riparian communities and associated wildlife have substantially changed from historic conditions (Reclamation 1998a). The presence of Friant Dam reduces the frequency of scouring flows; consequently, the vegetation succession of riparian scrub to forest is no longer balanced by periodic loss of forest to the river because of erosion and appearance of new riparian scrub on sand and gravel bars. In addition, operation of Friant Dam has caused the loss of gradually declining flows in spring which are periodically necessary to disperse seed of willows and cottonwoods, and establish seedlings of these riparian tree and shrub species.

Drought conditions caused by diversions have also caused a loss of riparian vegetation in several reaches of the river (e.g., Reaches 2, 4A), and urban and agricultural development have caused a gradual loss in the area available for riparian habitat (Reclamation 1998a).

Federal and State wildlife preserves have been established to conserve, protect, and enhance migratory waterfowl habitat and native ecological communities of the San Joaquin Valley. The preserves furnish important native habitats, including valley oak and mixed riparian forests and seasonal and permanent wetlands, to support and benefit wildlife species, particularly those of special concern. Land preserves in or adjacent to the Restoration Area are shown in Figure 6-1.

6.1.2 San Joaquin River Area Upstream from Friant Dam

Elevations in the Millerton Lake area range from approximately 310 feet at Friant Dam to more than 2,100 feet at the ridges surrounding the upper end of the lake. Plant communities around Millerton Lake are mostly foothill woodlands and grassland, with riparian vegetation along the shoreline. Adjacent hillsides support foothill pine-blue oak woodland with abundant grass/forb and shrub understory. Open grassland and savanna-type habitat conditions also exist in some areas. Several large basalt tables known to have vernal pools surround the canyon, well above 1,600 feet in elevation.

Upland vegetation above Millerton Lake is dominated by foothill woodland with areas of open grassland and rock outcroppings. The predominant vegetation includes foothill pine (*Pinus sabiniana*), blue oak (*Quercus douglasii*), and interior live oak (*Quercus wislizeni*). Montane coniferous forest constitutes the higher elevations upstream from Mammoth Pool. Habitat types in this area are meadow, riparian deciduous, lodgepole pine (*Pinus contorta* ssp. *murrayana*), mixed conifer, ponderosa pine (*Pinus ponderosa*), rock outcrop, and brush.

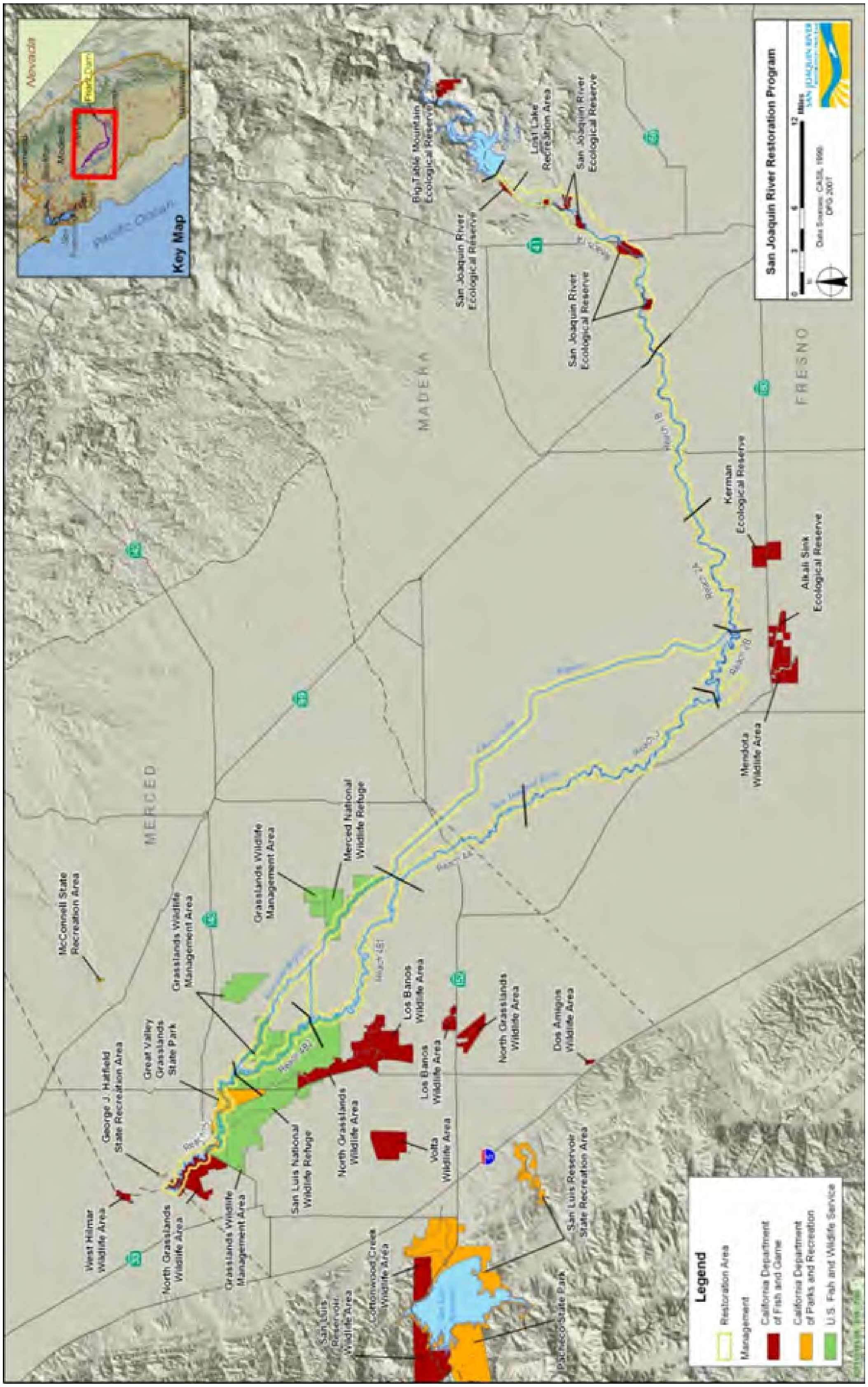

Figure 6-1.
Land Preserves in the Vicinity of the Restoration Area

Millerton Lake hosts a diverse wildlife community, both resident and seasonal. The upper San Joaquin River area is a relatively rich wildlife region of the Sierra Nevada foothills (Reclamation and DWR 2005). Forest canopy, shrub, and understory layers vary considerably by slope, aspect, and various management activities. Wildlife in the higher elevation portions of the watershed is typical of the mid-elevation Sierra Nevada. Important deer winter ranges and bear habitat exist in the Temperance Flat area, in the U.S. Department of the Interior, Bureau of Land Management's (BLM) San Joaquin River Gorge Management Area (SJRGMA).

Six special-status plant species are known to occur in the Millerton Lake region. Although special-status plant surveys were not conducted in the Millerton Lake region for this Draft PEIS/R, these species have been identified during other surveys in the vicinity of Millerton Lake and their occurrences are documented in the CNDDB (DFG 2011a). Hartweg's pseudobahia (*Pseudobahia bahiifolia*), federally listed as endangered and found in grasslands, is reported present. Species federally listed as threatened include San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) and fleshy owl's clover (*Castilleja campestris* ssp. *succulenta*). Tree anemone (*Carpenteria californica*) is an extremely localized species endemic to the region, and is State-listed as threatened. Bogg's Lake hedge-hyssop (*Gratiola heterosepala*), State-listed as an endangered species, along with San Joaquin Valley Orcutt grass and fleshy owl's clover, are found in vernal pools and lake margins. Several populations of Madera leptosiphon (*Leptosiphon serrulatus*), on California Native Plant Society (CNPS) List 1B, are recorded along the shores of Millerton Lake. Suitable conditions for this species probably also exist in other parts of the study area. Blue elderberry (*Sambucus nigra* ssp. *caerulea*), a shrub often associated with riparian habitat, occurs in the watershed. Elderberry shrubs, including blue elderberry, are host plants for the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), federally listed as threatened.

Although protocol-level surveys for special-status wildlife species in the Millerton Lake region have not been conducted specifically for this Draft PEIS/R, several special-status wildlife species have been identified during various surveys and incidental observations and are known to occur in the Millerton Lake region (Reclamation and DWR 2005, DFG 2011a). These species include California red-legged frog (*Rana draytonii*), western pond turtle (*Actinemys marmorata*), California tiger salamander (*Ambystoma californiense*), California spotted owl (*Strix occidentalis occidentalis*), golden eagle (*Aquila chrysaetos*), western spadefoot (*Spea hammondii*), northern harrier (*Circus cyaneus*), bald eagle (*Haliaeetus leucocephalus*), valley elderberry longhorn beetle, and western (California) mastiff bat (*Eumops perotis californicus*) (Reclamation and DWR 2005, DFG 2011a).

6.1.3 San Joaquin River from Friant Dam to Merced River

This section describes the plant communities, wildlife habitats, common wildlife, invasive plants, and sensitive biological resources known to occur in or adjacent to the San Joaquin River Restoration Area. Information on special-status plant and wildlife species was compiled through a review of the following sources:

- *Inventory of Rare and Endangered Plants of California* (CNPS 2001, 2007)
- CNDDB (DFG 2011a)
- Special Vascular Plants, Bryophytes, and Lichens List (DFG 2011b)
- Federally Listed and State-Listed Endangered and Threatened Animals of California (DFG 2010b) and Special Animals List (DFG 2009)
- USFWS's Federal Endangered and Threatened Species List (USFWS 2011)
- Sections describing the biological resources within the specific study reaches are based on the analysis of biological resources in these reaches prepared in McBain and Trush (2002), DWR (2002), and Reclamation (1998a and 1998b). In these analyses, study areas were used that encompassed 1,000 feet from the edge of levees (e.g., the upper portion of Reach 1 and most of Reaches 3 and 4) or extent of riparian vegetation (e.g., portions of Reaches 1 and 2) if those features were present. When no levee, escarpment, or clear, discrete outer boundary of riparian vegetation was present, but riparian vegetation extended more or less continuously from the mainstem to adjacent sloughs or side channels, the boundary was set at 2,000 feet from the centerline of the main channel of the San Joaquin River (e.g., portions of Reach 5) (McBain and Trush 2002, DWR 2002, Reclamation 1998a and 1998b). Because the Restoration Area, as defined by the SJRRP, varies somewhat from this definition, land cover in some portions of the Restoration Area was not mapped in the previous studies. Descriptions of reach-specific physical conditions, plant communities and habitat types, and sensitive resources by reach are based on the above listed studies, and the CNDDB (DFG 2011a).

Plant Communities and Wildlife Habitat

Plant communities and community composition found in the Restoration Area are described in this section. Plant communities were classified by DWR (2002) using a modified Holland system (Holland 1986). Table 6-1 lists, in acres, the Plant Communities and Land Cover in the various reaches of the Restoration Area.

Table 6-1.
Plant Communities and Land Cover in the Restoration Area

Vegetation Type	Reaches and Bypasses (acres)									
	Reach 1A	Reach 1B	Reach 2A	Reach 2B	Reach 3	Reach 4A	Reach 4B1	Reach 4B2	Reach 5	Bypasses
Cottonwood Riparian Forest	166	79	30	48	429	16	18	14	29	0
Cottonwood Riparian Forest LD1	27	114	41	1	23	4	2	2	0	0
Willow Riparian Forest	198	119	43	110	116	68	177	330	506	2
Willow Riparian Forest LD	28	0	4	6	8	14	88	100	249	0
Mixed Riparian Forest	439	260	0	0	0	6	0	0	0	0
Mixed Riparian Forest LD	65	19	2	0	0	0	0	0	1	0
Valley Oak Riparian Forest	265	0	0	0	0	0	16	7	35	0
Willow Scrub	214	113	76	38	188	38	101	18	70	0
Willow Scrub LD	73	32	124	15	41	10	0	13	10	0
Riparian Scrub	53	48	209	67	56	61	55	3	71	20
Elderberry Savanna	2	0	3	63	0	0	0	0	0	0
Emergent Wetlands	204	5	11	64	8	41	164	139	217	0
Nonnative Tree	54	22	9	0	0	0	0	0	12	0
Giant Reed2	3	4	6	0	0	0	0	0	0	0
Grassland/Pasture	1,513	286	470	227	157	201	620	2,131	2,955	1
Agricultural Uses	1,450	2,821	2,569	1,858	4,669	2,775	3,768	111	580	18
Alkali Sink	0	0	0	0	0	0	0	0	2	0
Open Water	1,307	220	327	279	341	113	140	123	440	5
Riverwash[3]	34	47	170	3	22	68	3	0	6	0
Disturbed	1,998	335	181	243	654	401	452	183	110	1
Urban	158	0	0	0	332	0	0	0	0	0
No Data[4]	2,412	642	255	1,622	1011	780	909	157	41	19,576
Total[5]	10,663	5,166	4,530	4,644	8,058	4,595	6,513	3,331	5,333	19,622
Ratio of Natural Habitat[6] Per River Mile	194.2 acres/ mile	48.0 acres/ mile	79 acres/mile		47.5 acres/ mile	14.8 acres/ mile	512.8 acres/mile		508.0 acres/ mile	unknown

Source: DWR 2002
Notes:
1 Canopy cover less than 30 percent.
2 In reaches 1A, 1B, and 2A, by 2008, giant reed acreage had increased to 16.4, 7, and 17.5 acres, respectively (R. Stephani, pers. comm.).
3 Riverwash partially depends on flow at the time of the survey/photograph, and values should not be presumed to be precise.
4 No data exist for areas within the Restoration Area that were not mapped by DWR (2002).
5 Columns do not all sum exactly to total acreage because of round off error.
6 Natural habitat used in this calculation includes all categories except agricultural uses, open water, disturbed, urban, and no data.
Key:
LD = low density

The wildlife species associated with these communities or that these communities could potentially support are also described. It should not be inferred that presence of species listed has been confirmed, except where specifically noted.

Riparian Forest. Riparian forest has been classified into four major types based on the dominant species: cottonwood riparian forest, willow riparian forest, mixed riparian forest, and valley oak riparian forest (Table 6-1). In areas where canopy cover was less than 30 percent, the community was mapped as “low density” (DWR 2002).

Cottonwood riparian forest is a multilayered riparian forest found on the active low floodplain of the San Joaquin River. Older and decadent stands of cottonwood riparian forest also exist in areas that were formerly active floodplains, but are now on functional terraces because of the reduction in high flow regime following completion of Friant

Dam and associated diversion canals. Common dominant trees in the overstory include Fremont cottonwood (*Populus fremontii*) and Goodding's black willow (*Salix gooddingii*). California wild grape (*Vitis californica*) is a conspicuous vine found growing within the canopy of this forest. The midstory is often dominated by shade-tolerant shrubs and trees, such as Oregon ash (*Fraxinus latifolia*) or California box elder (*Acer negundo* ssp. *californica*). Other shrubby species of willow (*Salix* spp.) may also be present within the midstory. The understory typically is dominated by native grasses and forbs, such as creeping wildrye (*Leymus triticoides*), stinging nettle (*Urtica dioica*), and Santa Barbara sedge (*Carex barbarae*).

Willow riparian forest is dominated by willows, frequently almost exclusively by black willow. Red willow (*Salix laevigata*) and arroyo willow (*Salix lasiolepis*) are also common. Occasional scattered cottonwoods, ashes, or white alders (*Alnus rhombifolia*) may be present but are never an important part of the canopy cover. Usually cover is dense. California buttonbush (*Cephalanthus occidentalis*) is often present and may even dominate the riverbank for stretches.

Mixed riparian forest is a multilayered winter-deciduous forest generally found on the intermediate terrace of the floodplain of the San Joaquin River. Species dominance in mixed riparian forest depends on site conditions, such as availability of groundwater and frequency of flooding. Typical dominant trees in the overstory and midstory include Fremont cottonwood, box elder, Goodding's black willow, Oregon ash, and western sycamore (*Platanus racemosa*). Immediately along the water's edge, white alder occurs in the upper portion of the study area. Common shrubs include red willow, arroyo willow, and California buttonbush. The understory of mixed riparian forest is similar to that of cottonwood riparian forest.

Valley oak riparian forest is a tree-dominated habitat with an open-to-closed canopy. This forest type is found on the higher portions of the floodplain and is therefore exposed to less flood-related disturbance than other riparian vegetation types in the study area. Valley oak is the dominant tree in this vegetation type; California sycamore, Oregon ash, and Fremont cottonwood are present in small numbers. Common understory species in this vegetation type include creeping wild rye, California wild rose (*Rosa californica*), Himalayan blackberry (*Rubus armeniacus*), California wild grape (*Vitis californica*), and California blackberry (*Rubus ursinus*).

Large, mature riparian forest stands support the most dense and diverse breeding bird communities in California (Gaines 1974). Tall riparian trees provide high-quality nesting habitat for raptors, such as red-tailed hawk (*Buteo jamaicenesis*), red-shouldered hawk (*Buteo lineatus*), Swainson's hawk (*Buteo swainsoni*), and white-tailed kite (*Elanus leucurus*). These trees also provide nesting habitat for cavity-nesting species, such as downy woodpecker (*Picoides pubescens*), wood duck (*Aix sponsa*), northern flicker (*Colaptes auratus*), ash-throated flycatcher *Myiarchus cinerascens*), oak titmouse (*Baeolophus inornatus*), tree swallow (*Tachycineta bicolor*), and white-breasted nuthatch (*Sitta carolinensis*). Riparian forests and associated wetlands produce populations of insects that feed on foliage and stems during the growing season. These insects, in turn, are prey for migratory and resident birds, including Pacific-slope flycatcher (*Empidonax* *difficilis*), western wood-pewee (*Contopus sordidulus*), olive-sided flycatcher (*Contopus cooperi*), warbling vireo (*Vireo gilvus*), orange-crowned warbler (*Vermivora celata*), yellow warbler (*Dendroica petechia*), Bullock's oriole (*Icterus bullockii*), and spotted towhee (*Pipilo maculatus*). Mammal species using riparian forests include coyote (*Canis latrans*), beaver (*Castor canadensis*), river otter (*Lontra canadensis*), raccoon (*Procyon lotor*), desert cottontail (*Sylvilagus audobonii*), and striped skunk (*Mephitis mephitis*).

Scrub. Three types of scrub habitat – willow scrub, riparian scrub, and elderberry savanna – were mapped previously in the Restoration Area (DWR 2002).

Willow scrub is a dense assemblage of willow shrubs often found within the active floodplain of the river. Sites with willow scrub are subject to more frequent scouring flows than sites supporting riparian forests. Willow scrub often occupies stable sand and gravel point bars immediately above the active channel. Dominant shrubs in willow scrub include sandbar willow (*Salix exigua*), arroyo willow, and red willow. Occasional emergent Fremont cottonwood may also be present in willow scrub.

Areas classified as riparian scrub consist of woody shrubs and herbaceous species and are dominated by different species depending on river reach. Some areas are dominated by mugwort (*Artemisia douglasiana*) together with stinging nettle and various tall weedy herbs; others are dominated either by blackberry (usually the introduced Himalayan blackberry) or wild rose in dense thickets, with or without scattered small emergent willows. Such ruderal associations may be maintained by periodic disturbance (i.e., flood control clearing of woody vegetation).

Elderberry savanna is a shrub-dominated community characterized by widely spaced blue elderberry shrubs with an herbaceous understory typically dominated by nonnative grasses and forbs that are characteristic of annual grassland communities. This community is found on fine-textured, rich alluvium outside active channels but in areas that are subject to periodic flooding (Holland 1986).

Typical bird species found in scrub habitat include western wood-pewee, black phoebe (*Sayornis nigricans*), yellow-billed magpie (*Pica nuttalli*), bushtit (*Psaltriparus minimus*), Bewick's wren (*Thryomanes bewickii*), lazuli bunting (*Passerina amoena*), blue grosbeak (*Passerina caerulea*), and American goldfinch (*Carduelis tristis*). Mammal species using scrub habitats are similar to those described for riparian forest habitats above.

Emergent Wetlands. Emergent wetlands typically occur in the river bottom immediately adjacent to the low-flow channel. Sites like backwaters and sloughs where water is present through much of the year support emergent marsh vegetation such as common tule (*Schoenoplectus acutus* var. *occidentalis*) and cattails (*Typha* spp.). More ephemeral wetlands, especially along the margins of the river and in swales adjacent to the river, support an array of native and nonnative herbaceous species, including western goldenrod (*Euthamia occidentalis*), smartweed (*Polygonum* spp.), Mexican rush (*Juncus mexicanus*), horseweed (*Conyza canadensis*), willow herb (*Epilobium* spp.), saltgrass (*Distichlis spicata*), sunflower (*Helianthus* sp.), and curly dock (*Rumex crispus*). Many wildlife species are known to use emergent wetlands, including song sparrow (*Melospiza melodia*), common yellowthroat (*Geothlypis trichas*), marsh wren (*Cistothorus palustris*), and red-winged blackbird (*Agelaius phoeniceus*). Mammal species that use this habitat include California vole (*Microtus califonicus*), common muskrat (*Ondatra zibethicus*), and Norway rat (*Rattus norvegicus*). Pacific chorus frog (*Pseudacris regilla*) and western terrestrial garter snake (*Thamnophis elegans*) are commonly present in this habitat.

Nonnative Tree. Nonnative trees are discussed in the "Invasive Plants" section below.

Giant Reed. This plant community is characterized by dense stands of the invasive grass species giant reed (*Arundo donax*). These stands are up to 13 feet tall and consist solely of giant reed with no other plant species present. Giant reed stands provide very little habitat value for wildlife.

Grassland and Pasture. Grassland and pasture is a forb- and grass-dominated plant community. Generally, sites with grassland or pasture are well drained and flood only occasionally under existing hydrologic conditions. Most areas of grassland or pasture are above the frequently flooded zone of the San Joaquin River. The grassland and pasture vegetation type is composed of an assemblage of nonnative annual and perennial grasses and occasional nonnative and native forbs. The most abundant species are nonnative grasses (ripgut brome (*Bromus diandrus*), foxtail fescue (*Vulpia myuros*), and foxtail barley (*Hordeum murinum* ssp. *leporinum*)) and forbs (red-stemmed filaree (*Erodium cicutarium*) and horseweed). Typical bird species associated with grasslands include northern harrier, ring-necked pheasant (*Phasianus colchicus*), mourning dove (*Zenaida macroura*), burrowing owl (*Athene cunicularia*), horned lark (*Eremophila alpestris*), loggerhead shrike (*Lanius ludovicianus*), and savannah sparrow (*Passerculus sandwichensis*). Mammal species that use grasslands include deer mouse (*Peromyscus maniculatus*), California vole, California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), American badger (*Taxidea taxus*), and coyote. Common amphibian and reptile species associated with grasslands in the San Joaquin Valley include western toad (*Bufo boreas*), western fence lizard (*Sceloporus occidentalis*), western racer (*Coluber constrictor mormon*), and gopher snake (*Pituophis catenifer*).

Alkali Sink. Alkali sinks are shallow seasonally flooded areas or playas that are dominated by salt-tolerant plants. Soils typically are fine-textured with an impermeable caliche layer or clay pan. Salt encrustations are often deposited on the surface as the playa dries. Alkali sinks support valley sink scrub, which is a low-growing open-to-dense succulent shrubland community dominated by alkali-tolerant members of the goosefoot family, especially iodine bush (*Allenrolfea occidentalis*) and seablites (*Suaeda* spp.). An herbaceous understory usually is lacking, but sparse cover of annual grasses, such as Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*) and red brome (*Bromus madritensis* ssp. *rubens*), may be present. Alkali sinks flood seasonally, but do not flood every year and respond to local thunderstorms. Wildlife species typically associated with alkali sink habitat include species of common and listed kangaroo rats (*Dipodomys* spp.), Nelson's antelope squirrel (*Ammospermophilus nelsoni*), San Joaquin kit fox (*Vulpes* *macrotis mutica*), coyote, side-blotched lizard (*Uta stansiburiana*), and blunt-nosed leopard lizard (*Gambelia sila*).

Agriculture. Agricultural lands in the Restoration Area consist primarily of annual crops, orchards, and vineyards. The annual crops include field crops, such as cotton, sweet corn, and safflower; truck, nursery, and berry crops, such as lettuce, bell peppers, strawberries, melons, and tomatoes; and rice. The orchards consist of citrus and subtropical crops, including lemons, nectarines, olives, and oranges, and deciduous fruit and nut crops, including almonds, apples, peaches, pistachios, plums, and walnuts. The vineyards are composed of raisin, table, and wine grapes.

Cropland agricultural habitats can provide food and cover for wildlife species, but the value of the habitat varies greatly among crop type and agricultural practices. Grain crops provide forage for songbirds, small rodents, and waterfowl at certain times of year. Pastures, alfalfa, and row crops, such as beets and tomatoes, provide foraging opportunities for raptors because of the frequent flooding, mowing, or harvesting of fields, which make prey readily available. Orchards and vineyards have relatively low value for wildlife because understory vegetation growth that would provide food and cover typically are removed. Species that use orchards and vineyards, such as ground squirrel, American crow (*Corvus brachyrhynchos*), Brewer's blackbird (*Euphagus cyanocephalus*), and European starling (*Sturnus vulgaris*), often are considered agricultural pests.

Open Water. Open water is characterized by permanent or semipermanent ponded or flowing water. Open water may be the result of constructed impoundments or naturally occurring water bodies. Open water areas provide habitat for waterfowl, pond turtle, Pacific chorus frog, and bullfrog (*Rana catesbeiana*). Both submerged and floating aquatic vegetation are used as basking or foraging habitat and provide cover for aquatic wildlife species. Deeper open water areas without vegetation provide habitat for species that forage for fish, crayfish, or other aquatic organisms, such as river otter (*Lontra canadensis*) and waterfowl.

Riverwash. Riverwash consists of alluvial sands and gravel associated with the active channel of the San Joaquin River. Generally, riverwash areas exist as sand and gravel point bars within the floodplain of the river. Woody and herbaceous plant cover can be low, although controlled hydrologic releases from the dam that prevent scour can allow denser plant growth on some point bars between high flow releases from storm events. Numerous herbaceous species occur in riverwash areas; however, most are relatively uncommon. Foxtail fescue, Bermuda grass (*Cynodon dactylon*), red-stemmed filaree, panicled willow herb (*Epilobium brachycarpum*), and lupine species (*Lupinus* spp.) are typically the most abundant plant species on riverwashes in the Restoration Area. Riverwash provides nesting habitat for shorebirds, such as killdeer (*Charadrius vociferus*). Other species, such as mallard (*Anas platyrhynchos*) or western pond turtle, may use riverwash habitats for roosting or resting.

Disturbed Areas. Disturbed areas include roads, canals, levees, and aggregate pits. Also included are areas used by off-highway vehicles and sites where rubble or fill has been deposited. Active and former aggregate mines are included if they are dry or unvegetated. As with agricultural habitats, low vegetation cover and species diversity in disturbed habitats limit their value to wildlife. However, these habitats are expected to support some common mammals, such as California ground squirrel, deer mouse, and desert cottontail.

Invasive Plants. Invasive plants are species that are not native to the region, persist without human assistance, and have serious impacts on their nonnative environment (Davis and Thompson 2000). The term “invasive plant” differs from the classification terms “nonnative,” “exotic,” or “introduced plant” because it is (when applied correctly) used only to describe those nonnative plant species that displace native species on a large enough scale to alter habitat functions and values. The California Invasive Plant Council (CalIPC) maintains a list of species that have been designated as invasive in California. The term “noxious weed” is used by government agencies for nonnative plants that have been defined as pests by law or regulation (CDFA 2007). Many invasive noxious trees and shrubs that have the ability to occupy channel and floodplain surfaces are a constant threat to river floodway capacity, and substantial cost and resources are required to remove and control large stands. Unlike the native riparian flora, many invasive riparian species do not attract populations of invertebrate life or produce edible seed and fruit that provide the food web for fish and aquatic and terrestrial wildlife. The distribution and abundance of invasive plant species in the Restoration Area is described below, and for the predominant species, accounts of their ecology are given in Appendix L, “Biological Resources – Vegetation and Wildlife.”

A comprehensive survey of the riparian vegetation on the San Joaquin River identified several invasive species in the Restoration Area (DWR 2002). Additional surveys for invasive plant species were conducted in the Restoration Area for Reclamation in 2008. Prevalent species and their associated CalIPC category and California Department of Food and Agriculture (CDFA) rating are identified in Table 6-2. None of the species identified are listed as noxious weeds by U.S. Department of Agriculture (USDA). The invasive species were mapped separately from the riparian vegetation and land cover, with the exception of large stands of invasive trees (blue gum (*Eucalyptus globulus*), salt cedar (*Tamarix* sp.), tree-of-heaven (*Ailanthus altissima*)) and giant reed (nonwoody) that could be identified on aerial photos. The invasive species included in the “invasives” GIS layer are red sesbania (*Sesbania punicea*), giant reed, blue gum, tree-of-heaven, pampas grass (*Cortaderia* sp.), and edible fig (*Ficus carica*). A number of other invasive nonnative species occur, but their occurrence was not systematically mapped. These species include Himalayan blackberry, white mulberry (*Morus alba*), castor bean (*Ricinus communis*), Lombardy poplar (*Populus nigra*), and salt cedar (DWR 2002).

Table 6-2.
Prevalent Invasive Species in the Restoration Area

Species	California Invasive Plant Council Inventory Category[1]	California Department of Food and Agriculture Rating[2]
Terrestrial Riparian Species		
Red sesbania (*Sesbania punicea*)	High, Red Alert	Q
Salt cedar (*Tamarix* spp.)	High	B
Giant reed (*Arundo donax*)	High	B
Chinese tallow (*Sapium sebiferum)*	Moderate	--
Tree-of-heaven (*Ailanthus altissima*)	Moderate	C
Blue gum (*Eucalyptus globulus*)	High	--
Perennial pepperweed (*Lepidium latifolium*)	High	B
Aquatic Species		
Water hyacinth (*Eichornia crassipes)*	High	C
Water milfoil (*Myriophyllum spicatum)*	High	C
Parrot's feather (*Myriophyllum aquaticum*)	High, Red Alert	--
Curly-leaf pondweed (*Potamogeton crispus)*	Moderate	--
Sponge plant (*Limnobium spongia*)	--	Q

Sources: California Invasive Plant Council 2006, CDFA 2007, USDA 2006
Notes: CalIPC = California Invasive Plant Council.
[1] California Invasive Plant Council Inventory Categories:
- High – Have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.
- Moderate – Have substantial and apparent, but generally not severe, ecological impacts on physical processes, plant and animal communities, and vegetation structure. Reproductive biology and other attributes are conducive to moderate to high rates of dispersal, but establishment generally depends on ecological disturbance. Ecological amplitude and distribution range from limited to widespread.
- Limited – Invasive but ecological impacts are minor on a Statewide level, or not enough information was available to justify higher rating. Reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are limited, but these species may be locally persistent and problematic.
- Red Alert – plants with the potential to spread explosively; infestations currently small and localized.

[2] California Department of Food and Agriculture Rating:
- B – Eradication, containment, control or other holding action at the discretion of the commissioner.
- C – State-endorsed holding action and eradication only when found in a nursery; action to retard spread outside of nurseries at the discretion of the commissioner.
- Q – Temporary rating for eradication, containment, rejection, or other holding action at the State-county level, outside of nurseries pending determination of a permanent rating.

Key:
-- = Not applicable

Additional invasive plants have been identified through meetings with local stakeholders and SJRRP agency personnel, and through survey efforts completed in 2008. These species include nonnative trees (Chinese tallow (*Sapium sebiferum*), Catalpa (*Catalpa bignonioides*), Russian olive (*Elaeagnus angustifolia*), Chinaberry (*Melia azedarach*), tree tobacco (*Nicotiana glauca*)), emergent and submergent aquatic plants (sponge plant (*Limnobium spongia*), water hyacinth (*Eichornia crassipes*), curly leaf pond weed (*Potamogeton crispus*), parrot feather (*Myriophyllum aquaticum*), water milfoil (*Myriophyllum spicatum*), water primrose (*Ludwigia hexapetala*)) and herbaceous weeds (bull thistle (*Cirsium vulgare*), star thistles (*Centaurea* spp.), Bermuda grass, perennial pepperweed (*Lepidium latifolium*), and other common nonnative grasses and forbs that compete with native riparian species for shoreline and low floodplain establishment and growth sites).

At the time of the comprehensive riparian vegetation survey in 2000, blue gum was the most widespread and abundant invasive species in the Restoration Area (DWR 2002). It was mapped in all reaches except Reaches 3 and 4 and the bypasses (see reach descriptions below), and encompassed more than 100 acres (Table 6-3). Giant reed is also widespread, mapped in all reaches except Reach 4 and the bypasses, and encompassing about 40 acres. Himalayan blackberry is also frequently encountered, especially in riparian scrub communities, where it is observed over long channelized portions of the river. Red sesbania is a relatively recent introduction to the San Joaquin River, but it is spreading aggressively and occurs extensively through Reaches 1A and upper Reach 1B, then more sparsely in lower Reach 1B and Reach 2A as of 2008. It has also been observed at three closely distributed locations on the Eastside Bypass. Red sesbania has spread far beyond what was mapped in 2000 by DWR (DWR 2002), and the number of locations and acres present may be much greater than those provided in Table 6-3. Invasive species information collected in 2008 was also included in the baseline description here because invasive species such as red sesbania can rapidly colonize a river corridor and substantially change vegetation composition identified during surveys conducted in 2000. The recent and rapid spread of red sesbania is a particular concern to the SJRRP because it has successfully colonized both disturbed bar soil and substrate (banks of aggregate mining pits, sand and gravel bars, other exposed surfaces), as well as encroached into the occupied understory of existing dense riparian vegetation, and formed monocultures along the low-flow shoreline.

Table 6-3.
Acreage of Invasive Species Mapped in the Restoration Area

Species	Reach 1		Reach 2		Reach 3		Reach 4		Reach 5		Total	
	Number of locations	Acres	Number of locations	Acres	Number of locations	Acres	Number of locations	Acres	Number of locations	Acres	Number of locations	Acres
Blue gum	68	117.75	4	7.05	--	--	--	--	3	12.29	75	137.09
Giant reed	59	23.37	47	17.46	3	0.22	--	--	1	0.26	110	41.31
Red sesbania	32	17.24	--	--	--	--	--	--	--	--	32	17.24
Tree-of-heaven	5	3.44	1	0.49	--	--	--	--	--	--	6	3.93
Edible fig	5	1.04	2	0.14	--	--	--	--	--	--	7	1.18
Lombardy poplar	--	--	--	--	--	--	--	--	1	1.62	1	1.62
Salt cedar	--	--	1	0.16	1	0.07	1	0.05	--	--	3	0.28
White mulberry	--	--	--	--	1	0.09	--	--	--	--	1	0.09
Castor bean	--	--	--	--	--	--	1	0.07	--	--	1	0.07
Pampas grass	1	0.03	--	--	--	--	--	--	--	--	1	0.03
Total invasives	171	162.87	55	25.30	5	0.38	2	0.12	5	14.17	238	202.84
Total Survey Area		15,821		9,174		8,058		11,439		5,333		49,825

Source: DWR 2002

Note: Bypasses not included in area surveyed.

Key:
-- = Not Applicable

Also based on recent information from stakeholders, water hyacinth is present in Reaches 2, 3, and 4, and a small population of Chinese tallow is present in Reach 1. In 2008, Chinese tallow was also observed in Reach 3. Perennial pepperweed, an herbaceous invasive not mapped by DWR in 2000, was documented in two occurrences in the Eastside Bypass, four occurrences in Fresno Slough, and was widely distributed and abundant in patches in Reach 5 and adjoining Salt and Mud sloughs of the Restoration Area in 2008. Low-flow channels choked with a mix of floating and submergent aquatic weeds severely decrease flow capacity, lower DO (higher biochemical oxygen demand), and benefit habitat for nonnative fish species (e.g., centrarchids) that prey on native juvenile fish. Dense surface mats of aquatic weeds also cause greater adult mosquito production and diminish the effectiveness of biological mosquito control measures (e.g., bacterial toxin dispersal, mosquitofish).

Overall, as mapped in 2000 by DWR (2002), Reach 1 contained the greatest acreage of invasive woody species, with more than 162 acres of invasive plants documented, and also the greatest diversity of invasive species, with seven documented invasive woody species. Reach 2 had the second largest acreage of invasive species, with more than 25 acres mapped, while Reaches 3 and 4 contained few invasive plants. Reach 5 had 14 acres of invasive plants, mostly consisting of three large blue gum stands (DWR 2002).

Before 2008, the Chowchilla, Eastside, and Mariposa bypasses were not surveyed or mapped for invasive species, and no other references with comparable data were found for these portions of the Restoration Area. In 2008, observations of red sesbania were recorded in the Eastside Bypass during that year's survey effort.

Invasive species may interfere with the success of restoration actions, particularly when a restoration action (such as increased instream flow releases, gravel infusion, or channel modification) creates an opportunity for the expanded establishment of the invasive species. Under such conditions, dispersal and establishment of invasive, nonnative riparian species may occur at a rate faster than natural establishment of native riparian species, absent deliberate weed suppression and other vegetation management measures. Common characteristics of invasive species that allow them to outcompete native riparian vegetation and establish more quickly on newly exposed substrate sites (aggregate mine spoils, eroding river banks, wildfire scars, and flood-scoured floodplains and bars) include the following:

- More than one seed dispersal mechanism with prodigious quantities of seed production
- Longer season of viable seed release, dispersal, and germination potential
- Dormant seed or rhizome viability over many years
- Greater range of tolerance of inundation, flow scour, or dry season soil moisture deficits
- Ornamental features (e.g., bright red flowers) that encourage dispersal from gardens
- Fast growth rates, stump sprouting and fast recovery from top removal

Nonnative vegetation such as eucalyptus trees provides roosting and nesting habitat for several native avian species (e.g., hawks and waterbirds) and insects (i.e., monarch butterflies); however, studies have found the diversity and abundance of wildlife to be lower in eucalyptus groves than in native scrub and oak woodland habitats (Hanson et al. 1979). Each of the major invasive plant species of the San Joaquin River system is discussed in more detail below.

Red Sesbania: CalIPC Category – High, Red Alert; CDFA Rating – Q. Red sesbania is a woody shrub that grows up to 15 feet in height. It produces clusters of bright red flowers in late spring through fall and forms distinctive winged seed pods. Red sesbania grows on channel banks, bars, and islands, low in the riparian zone and inundated by typical spring floods. Red sesbania infestations are relatively new in California and are rapidly spreading among Central Valley waterways (Hunter and Platenkamp 2003). Red sesbania produces seed pods containing a spongy tissue and float for up to 10 days, even after splitting open. These pods fall from the branches throughout winter and spring and are distributed by river flows. The seeds germinate when abraded.

Early sprouting sesbania plants can mature in one season and begin producing seed pods. Seeds that do not germinate can persist in a seed bank until abraded in subsequent years. The species forms dense thickets. It also has some degree of shade tolerance. Because it has the potential to form dormant seed banks and to regenerate in its own shade, red sesbania may be able to maintain its dominance on a site through recurrent recruitment.

Red sesbania is displacing native plants that provide essential food and shelter for a wide variety of wildlife species. Sesbania also contains saponin, a chemical that is poisonous to both humans and wildlife. Along shallower streams, clusters of sesbania are spreading into the waterways. These tall shrubs can contribute to bank erosion and increase the chance of flooding through obstruction of the waterway. Red sesbania can stabilize banks during less than extreme peak-flow events causing reduced sediment supply, narrowing and deepening of the river channel, encroachment of side channels, and reduced channel diversity. Red sesbania is a major threat to the biodiversity of native plants in riparian habitats (Hunter and Platenkamp 2003).

Salt Cedar: CalIPC Category – High; CDFA Rating – B. Salt cedar is a deciduous, openly branched shrub that commonly reaches a height of 12 to 15 feet. Salt cedar is highly adapted to disturbed, aquatic landscapes, including riparian forests, wetlands, floodplains, lake perimeters, and irrigation ditches. Most of the habitat infested with salt cedar has been disturbed, or altered, by human activities. The species prefers silty soils and shallow water tables. However, this long-lived species is tolerant of an extensive range of ecological settings and once established, can survive without access to water (Carpenter 1988).The majority of salt cedar infestations occur in the intermountain region of the western United States, as well as California, Texas, and the Great Plains states (Carpenter 1988).

Salt cedar is adapted to sexual and vegetative reproduction. The shrubs produce numerous flowers that release tiny, tufted seeds dispersed by either wind or water (Plant Conservation Alliance 2005). The seeds germinate immediately and only remain viable for up to 45 days (Carpenter 1988). Lengthy periods of saturated soil are necessary for the establishment of salt cedar seedlings. The ephemeral nature of the seed viability precludes the species from forming a seed bank. Vegetative reproduction occurs through adventitious roots and submerged stems (Plant Conservation Alliance 2005). Buried and submerged stems as well as stem fragments have the ability to produce roots and shoots. The species is highly adapted to fire and flooding and resprouts vigorously after disturbance by these events. The seedlings are slow growers and may be outcompeted by the rapidly growing native riparian species. Mature specimens are extremely vulnerable to shading (Carpenter 1988).

As with most invasive, nonnative species, salt cedar displaces valuable native riparian plant species such as willow and cottonwood, especially in landscapes altered by human activity. The replacement of riparian vegetation may lead to the reduction of wildlife habitat value. It has been documented that areas infested with salt cedar have lower bird density and diversity than areas with native stands of vegetation (Carpenter 1988). However, some birds have been documented nesting in the salt cedar shrubs, including blue grosbeak and yellow-billed cuckoo (RHJV 2004). Salt cedar also affects the natural flood and fire regime in some areas. Areas dominated by salt cedar have higher frequencies and intensities of fire and floods (Plant Conservation Alliance 2005). Other adverse effects include increased topsoil salinity, lowered water tables, widened flood plains, increased sediment deposition, incised stream channels, and loss of mycorrhizal fungi for native plant species (Carpenter 1988).

Giant Reed: CalIPC Category – High; CDFA Rating – B. Giant reed is an herbaceous perennial plant resembling bamboo. Stands of giant reed can reach up to 30 feet in height and, under optimal conditions, the individual stems, or culms, can grow up to 4 inches per day (Team Arundo del Norte 1995). Giant reed can often be found growing alongside waterways, including lakes, streams, and ditches. Giant reed thrives in all types of soils and under a broad range of ecological conditions. After establishing at the water's edge, giant reed quickly moves up the riparian profile and begins establishing in the drier upland surroundings (Bell 1998).

The root system of giant reed is the main means of reproduction in the United States. Vegetative reproduction occurs through horizontally growing stems lying beneath the soil surface that produce roots and shoots. As the roots spread from the parent plant, new clones sprout up from underground stems and during floods, plant fragments may be carried downstream to new sites where they take root and begin forming a new colony. Throughout spring and into fall, the canes will produce large plumed inflorescences in the upper segment of the stem with densely packed cream to brown colored flowers, but germination of seeds is rare in California (Dudley 2000).

Adaptive abilities to sustain in highly disturbed habitats allow giant reed to aggressively outcompete native species and shift the succession of riparian plant communities (Bell 1998). Giant reed is highly productive, growing at an annual rate of 3 to 10 tons of dry cane (up to 35 tons wet weight) per acre (Perdue 1958, Christou et al. 2003). Roots have been measured to grow 3 feet deep within 3 months from cut stems (Sher et al. 2002) and root mats 3 feet thick form (Hughes 2003), or even several feet deeper in areas where the giant reed causes accretion of sediment layers. If conditions are right, infestations quickly develop into tall, crowded grass forests devoid of any plant species variability. A number of toxic compounds are produced within various plant parts that help to prevent the growth of other plant species (Bell 1998). As giant reed replaces native riparian vegetation, it reduces habitat and the food supply, particularly insects, needed by riparian birds (Dudley 2000). Dense forests of giant reed can create fire hazards and threaten infrastructure during flood events (Team Arundo del Norte 1995). Fire hazards arise because of the weed's highly combustible nature. The rapidly growing colonies produce massive amounts of dry material that increase fire frequency in riparian areas. Without the giant reed and other combustible invasive weeds, native riparian vegetation normally would deter burns (Bell 1998).

When growing around structures such as dams and bridges, high flows are obstructed by the thick stands, which may undermine the structures' integrity. Although often planted for erosion control, giant reed can promote bank erosion because its shallow root system is easily undercut and bank collapse may follow (Dudley 2000). By densely growing in the low-flow channel and throughout streambanks, giant reed can cause excessive roughness in the channel, not only by its own biomass, but also by the accretion of sediment and stabilization of gravel and sediment bars. Channel constriction can reduce flood capacity and contribute to flooding. Water displaced around the giant reed is forced into banks, and may cause substantial lateral erosion.

Chinese Tallow: CalIPC Category – Moderate. Chinese tallow is a tall tree that produces three-lobed fruits that change from green to a brown-black at maturity. It also produces a milky, white sap that can be a skin irritant or diarrhetic in humans. Chinese tallow is adapted to a variety of disturbed sites and a wide range of soil conditions (alkaline, saline, or acid soils). It grows most vigorously in alluvial forests, on low alluvial plains, and on rich leaf-molds, preferring well-drained clay-peat soils (Bogler 2000).

Chinese tallow is characteristic of a woody invader, in that it grows rapidly, begins reproduction when young (after only 3 years), produces abundant viable seed, and can reproduce from cuttings. It produces seeds soon after establishment, leading to a rapid increase in stem and cover density. Additionally, Chinese tallow is able to become widely established following natural disturbances that eliminate or damage the canopy layer (Smith et al. 1997). Seeds are spread by birds and may also float for great distances (Bogler 2000).

Chinese tallow can invade wildland areas and swiftly replace natural communities with nearly monospecific stands. It alters natural soil conditions, creating an inhospitable environment for many native species (Bogler 2000). Chinese tallow is able to alter nutrient cycles. It may enhance productivity (or encourage eutrophication) in ecosystems by the addition of nutrients (mainly nitrogen and phosphorous) from the rapid decay of its leaves (Cameron and Spencer 1989). These leaves produce tannins, but it is unclear if Chinese tallow produces other allelopathic compounds that may interfere with the germination of native North American species (Conway 1997). Further, the presence of Chinese tallow seems to favor nonnative arthropods (Miller and Cameron 1983) that may also negatively affect the native ecosystem.

Tree-of-Heaven: CalIPC Category – Moderate; CDFA Rating – C. Tree-of-heaven is a medium-sized deciduous tree that rapidly reaches heights of around 80 feet. Tree-of-heaven frequently invades open, disturbed sites. The tree is common in urban settings and along roadsides. In rural areas, the tree will establish itself on sites that have been disturbed by natural events or human intrusion. Tree-of-heaven has a high tolerance for poor soils, atmospheric pollution, and drought. Within California, tree-of-heaven can often be found in the foothills and within the Sacramento Valley (Hunter 2000).

Tree-of-heaven reproduces both sexually by seed and asexually by vegetative sprouts. The numerous seeds produced in fall may remain on the tree through the winter. Once released, the wind-dispersed seeds will travel long distances from the parent plant. These seeds have a high germination rate (Hunter 2000). Established trees sprout numerous suckers from the roots and re-sprout vigorously from cut stumps and root fragments.

Tree-of-heaven aggressively outcompetes native species once established. One tree can produce more than a half a million seeds each year. The seedlings grow rapidly and develop a taproot within three months. With their quick growth rate, the trees can rapidly occupy the habitat of native species. Additionally, the tree-of-heaven leaves and bark produce toxins that remain in the soil and impede the establishment of other plant species (Hunter 2000).

Blue Gum: CalIPC Category – High. Blue gum is an evergreen, hardwood tree species that typically grows to heights of 150 to 180 feet. Often found growing in disturbed habitats, blue gum is hardy enough to flourish in landscape plantings along roadways and property lines where it is used as wind screens, shelterbelts, sound barriers, or ornamentals (Esser 1993). Adaptations to disturbance such as aggressive reproduction in areas with bare ground and the release of toxic compounds allow blue gum to invade riparian forests, floodplains, and other areas that are either inherently high disturbance sites or are highly altered by human intervention.

Blue gum is able to reproduce both sexually by seed and asexually by vegetative sprouts. Blue gum produces woody fruits that release small seeds which are dispersed by wind and water (Esser 1993). Seeds germinate within a couple of weeks following dispersal if conditions are favorable (Boyd 2000). Vegetative reproduction includes sprouting from the trunk, stumps, and roots. Roots and shoots can also form branches when in contact with soil (Esser 1993).

The leaves of blue gum have toxic compounds that are released into the soil litter layer, inhibiting the growth of other species. Consequences of the resulting monoculture of eucalyptus include a loss of biological diversity. Eucalyptus trees may create a population sink for many species. For example, the winter flowering period attracts migratory birds and the source of food discourages them from departing for the season. The flower nectar attracts insects. Birds feeding on these insects or the flower nectar may get covered in a tar-like substance secreted from the flower, eventually causing the birds to suffocate (Stallcup 1997). However, mature trees do provide canopy cover and perching and nesting sites for raptors and other birds when native riparian trees are absent. Blue gum stands also pose a great fire risk. This extremely flammable species ignites spot fires when burning litter and strips of bark are transported on the wind (Boyd 2000).

Water Hyacinth: CalIPC Category – High; CDFA Rating – C. Water hyacinth is a free-floating aquatic plant that forms dense, interconnected drifting mats. The thick, waxy green leaves are held upright above the water surface on bulbous, air-filled stalks. Aquatic systems inhabited by water hyacinth include ponds, lakes, wetlands, slow-moving waters such as rivers and streams, ditches, irrigation canals, and wastewater treatment facilities (Batcher 2000, Ramey 2001). It is able to tolerate a number of environmental extremes, including fluctuating water levels and flow velocities, extremes in nutrient concentration, pH, temperatures, and toxic compounds (Batcher 2000). Occasionally it is found growing in water-logged soils adjacent to water bodies (Godfrey 2000a).

Water hyacinth is considered one of the most productive plants on earth. In early spring, the plants begin to vegetatively produce daughter plants by runners. These runners grow horizontally and can produce new plants every 6 to 18 days (Ramey 2001). Research found that one plant is capable of producing enough daughter plants to cover 6,500 square feet in 1 year (Godfrey 2000a). By late summer or early fall, these huge colonies are in full bloom. Reproduction by seed is thought to be less important to the spread of this plant species, and seedlings are seldom seen in natural settings. Each flower can produce from 3 to 450 seeds per fruit with seeds remaining viable for up to 20 years (Batcher 2000). The seeds mainly sink to the bottom of the water and remain dormant until a drought (Ramey 2001). The seeds may also be dispersed by flowing water and migratory waterfowl. Both intentional and unintentional dispersal by humans is also common. Many infestations are the result of deliberate introduction or the disposal of excess plants from someone's water garden (Godfrey 2000a).

Many sources claim that water hyacinth is the most troublesome aquatic weed in the world. By clogging waterways and displacing native aquatic species, the weed disrupts many natural settings and causes serious economic hardships. Waterfowl and other wildlife habitat may be critically altered by these infestations because they displace native aquatic plant communities and obscure water sources. Potential problems include reduced oxygen and light availability, altered invertebrate and vertebrate communities, increased nutrient concentrations, increased temperatures, impeded water flow, clogged intake pumps, decreased power generation, and reduced recreational access (Batcher 2000). The huge mats of hyacinth are also ideal breeding grounds for mosquitoes and other insects that act as vectors for disease (Ramey 2001). Finally, it has been shown that hyacinth infestations significantly increase the loss of water in lakes and rivers because of the high rate of evaporation from their leaves (Godfrey 2000a).

Water Milfoil: CalIPC Category – High; CDFA Rating – C; and Parrot's Feather: CalIPC Category – High, Red Alert. Parrot's feather and water milfoil are both submerged aquatic plants with whorled feathery leaves. Both species form dense mats of vegetation that take root along the water's substrate and then branch profusely once they are near the water's surface. The leaves remaining below quickly die off without access to light (Bossard et al. 2000, Godfrey 2000b). Both of these species can be found growing in slow-moving to still waters of lakes, ponds, marshes, streams, ditches, and canals at lower elevations. They also have the ability to establish on dry ground and then grow into the water source. Milfoils prefer silty, inorganic soils, but can persist on many types of substrates (Washington Water Quality Program 2002). They are often found on disturbed surfaces in areas with high nutrient runoff (Bossard et al. 2000, Godfrey 2000b).

Both parrot's feather and water milfoil rely on vegetative reproduction for spreading and dispersal. While water milfoil does produce viable seed, it is not thought that sexual reproduction is a major factor in the spread of this species (Washington Water Quality Program 2002). Parrot's feather is incapable of producing seed outside its native range (Godfrey 2000b). Sometime during the growing season the colonies go through autofragmentation, when the plant produces roots at the leaf nodes and then becomes brittle and breaks apart (Washington Water Quality Program 2002). Only a tiny piece of stem is required for a new colony to take root. Both species die back during winter, but they can over-winter in warmer climates (Bossard et al. 2000, Godfrey 2000b).

Both aquatic plants are recognized as invasive species threatening natives and causing significant problems in water bodies. Water milfoil is considered more of a pest, but both have similar effects on the habitats they occupy. The species choke out waterways, shade out native aquatic species, reduce wildlife habitat values, interfere with recreational opportunities (i.e., boating, fishing, swimming), create stagnant waters perfect for mosquito reproduction, and increase water temperatures (Washington Water Quality Program 2002, Bossard et al. 2000, Godfrey 2000b). Water milfoil has been reported to increase phosphorus and nitrogen levels in waters when it is decomposing, and it can raise the pH and decrease available oxygen. Other threats include increased flooding problems and obstruction of irrigation pumps and water intakes (Bossard et al. 2000, Godfrey 2000b).

Curly-Leaf Pondweed: CalIPC Category – Moderate. Curly-leaf pondweed is a submersed, perennial aquatic plant. The plant can tolerate a wide range of climatic conditions, including very low water temperatures and low light intensities. Curly-leaf pondweed is restricted to alkaline calcareous waters and is tolerant of slightly brackish and polluted water. The plant is mainly rooted in silt or clay but can also be found in gravel or sand. Curly-leaf pondweed occurs in submersed aquatic plant communities that include rivers, streams, ponds, and freshwater lakes (North Dakota Department of Agriculture 2008).

Curly-leaf pondweed reproduces by seeds and turions, which are thick fleshy shoots. The turions develop in early spring from axillary buds located along the stem and tend to drop off by early summer. Turions begin to germinate in the fall and develop plants in the winter. Dormant turion and seed production are completed from late June to August depending on water temperature. A single dormant plant can produce more than 900 turions in one year. Approximately 960 seeds can be produced during one growing season from a single plant, but seed germination rarely occurs. Therefore, vegetative reproduction through dormant turions is more critical to the plant’s survival than seed production (North Dakota Department of Agriculture 2008).

Curly leaf pondweed can grow in dense stands, thus covering large areas of the water surface. The ability of the plant to quickly develop by spring or early summer can result in a reduction of water flow through irrigation canals, cause a restriction of water-based recreation activities, and a nuisance in fisheries. Curly leaf pondweed displaces native plant communities by rapidly growing above native aquatic species, thus impeding and reducing desirable plant production. Curly-leaf pondweed plants usually die back in late summer, which results in rafts of dying plants piling up on shorelines, and often is followed by an increase in phosphorus, a nutrient, and undesirable algal blooms (Minnesota Natural Resources Department 2005).

Spongeplant: CDFA Rating – Q. Spongeplant is an aquatic perennial plant that grows in dense floating mats or roots in mud on wetland edges. It is found in slow-moving water of streams, sloughs, and lakes, or stranded along shore and in marshes.

Spongeplant reproduces rapidly by both seed and stolons, quickly filling newly colonized sites with both clones and new individuals. The flowers are held above water, and pollination is probably via wind currents. The seeds are shed above water but germinate when submerged, and the seedlings float to the surface where they grow rapidly. Individual seeds are covered with small spines and the seeds, when shed, are contained in a gelatinous mass; both can readily attach to watercraft and if they should become established in navigable waterways are likely to spread rapidly and widely (Hrusa 2008). Waterfowl and other wildlife species may also distribute seeds (Wisconsin Department of Natural Resources 2008).

Spongeplant can negatively affect water quality, fish, and wildlife habitat, and can hinder navigation and recreational use (Wisconsin Department of Natural Resources 2008).

Invasive Wildlife

The introduction of nonnative wildlife species can be detrimental to native species assemblages. Nonnative wildlife species distribution and abundance in the Restoration Area is unknown but likely includes bullfrog, crayfish, and red-eared sliders (*Trachemys scripta elegans*), which are common in most of California's waterways. Several invasive invertebrate species, such as quagga mussels (*Dreissena rostriformis bugensis*) and zebra mussels (*Dreissena polymorpha*), Asian clam (*Corbicula* spp.), New Zealand mud snail (*Potamopyrgus antipodarum*), and Chinese mitten crab (*Eriocheir sinensis*), are known to occur in the study area. Each of these is discussed briefly below.

Quagga and zebra mussels are destructive invasive aquatic species. They reproduce quickly and in large numbers. Once established, eradication is extremely difficult. Quagga and zebra mussels are filter feeders that consume large portions of the microscopic plants and animals that form the base of the food web. Their consumption of significant amounts of phytoplankton from the water decreases zooplankton and can cause a shift in native species and a disruption of the ecological balance of entire bodies of water. In addition, they can displace native species, further upsetting the natural food web. Quagga and zebra mussels can colonize on hulls, engines and steering components of boats, and other recreational equipment and if left unchecked, can damage boat motors and restrict cooling. They also attach to aquatic plants, and submerged sediment and surfaces such as piers, pilings, water intakes, and fish screens, potentially clogging water intake structures and hampering the flow of water. They frequently settle in massive colonies that can block water intake and threaten municipal water supply, agricultural irrigation, and power plant operations. As of October 2007, quagga mussels have been found in many of the waters of the Colorado River drainage. In January 2008, zebra mussels were discovered in San Justo Reservoir, in San Benito County. They are not known to occur in the Restoration Area (DFG 2008a).

The Asian clam is present in rivers and streams throughout California. The species is most abundant in well-oxygenated, clear waters but is found both in stream and lake habitats. Clay and fine-to-coarse grained sand are preferred substrates, although they may be found in lower numbers on most any substrate (USGS 2001). Asian clams have been documented in tributary rivers to the San Joaquin River, including the Merced River. The clam is thought to affect ecosystem processes by limiting suspended algal biomass within tributaries, thereby reducing export of suspended algae into mainstem rivers (Stillwater Sciences 2007).

New Zealand mud snail is an invasive species with a high reproductive potential that inhabits many habitat types including silt, sand, gravel, cobbles, and vegetation. If the snail population become very dense and comprises a large percentage of the macroinvertebrate biomass, impacts on natural ecosystems can be substantial. New Zealand mud snail can reduce food resources and populations of other macroinvertebrates, particularly mayflies, caddisflies, and chironomids. They can also reduce whole-stream algal production. Very little information is available on New Zealand mud snail as a food resource for fish, but it does not appear as though they are the preferred food of trout. There is general consensus that New Zealand mud snail could have a significant impact on trout fisheries, including federally listed species. Populations of the New Zealand mud snail have been documented on several rivers in Northern California, including the Napa and Calaveras rivers; however, the New Zealand mud snail has not been documented in the Restoration Area (DFG 2008b).

The mitten crab is catadromous – adults reproduce in saltwater and the offspring migrate to freshwater to rear. The ecological impact of a large mitten crab population is not well understood. Although juveniles primarily consume vegetation, they do prey upon animals, especially invertebrates, as they grow. A large population of mitten crabs could reduce populations of native invertebrates through predation, and change the structure of fresh and brackish water benthic invertebrate communities (DFG 1998b). Chinese mitten crabs have been found in the Delta and eastern San Joaquin County (Escalon-Bellota Weir on the Calaveras River and Littlejohns Creek near Farmington), and south to the San Luis NWR near Gustine (DFG 1998). In the last decade, there have been several unconfirmed reports of the Chinese mitten crab from the lower Stanislaus and Merced rivers, but no official collections have been documented from this area; in addition, no crabs were reported from these areas during 2007 (Stillwater Sciences 2007).

Distribution of Vegetation and Invasive Plants in the Restoration Area

Vegetation types in the Restoration Area are described here by reach based on a combination of on-the-ground vegetation sampling and interpretation of recent aerial photographs (DWR 2002). The area and distribution of vegetation by type are based on studies by DWR during 2000 (DWR 2002) and GIS data (DWR 2002) (Table 6-1).

Reach 1A. As a result of stabilized active channel conditions below Friant Dam (due to reduced magnitude, frequency, and duration of flood flows), the extent of gravel bars (riverwash) and herbaceous riparian and marsh vegetation has declined from historical conditions. In addition, riparian forest has shifted from cottonwood dominance to mixed riparian forest, with dominance by willows and alders, which are particularly effective colonizers following upstream diversions (Reclamation 1998a). Reach 1A presently supports continuous riparian vegetation, except where the channel has been disrupted by instream aggregate removal or off-channel aggregate pits that have been captured by the river. This reach has the greatest diversity of vegetation types and has the highest overall diversity of plant species. Based on the 2000 vegetation surveys by DWR (DWR 2002), all eight classifications of riparian communities (cottonwood, willow, mixed, and oak riparian forest; willow and riparian scrub and elderberry savanna; and emergent wetlands) are present in this reach. Approximately half of the total number of plant taxa recorded were native. However, the largest areas occupied by invasive tree species (blue gum and tree-of-heaven) were recorded in Reach 1A. Giant reed and red sesbania were also recorded primarily in Reach 1A (DWR 2002). Chinese tallow, catalpa, and salt cedar were recorded in Reach 1A in 2008.

Reach 1B. Reach 1B has one of the lowest ratios of natural vegetation per river mile. In 14 miles of channel, there is a little over 1 square mile of natural habitat present (Table 6-1). Woody riparian vegetation is prevalent and occurs mainly in narrow strips immediately adjacent to the river channel. Willow scrub is more abundant (13 percent) than in Reach 1A (7 percent) (DWR 2002). Mature vegetation on the back side of many point bars and on low floodplains is scarce. Remnant valley oaks are present on some of the higher terraces. Previously cleared terraces and the understory of the cottonwood and oak stands are dominated by nonnative annual grasses (McBain and Trush 2002). Blue gum, giant reed, red sesbania, and tree-of-heaven were prevalent in Reach 1B in 2000. Catalpa was noted in Reach 1B in 2008.

Reach 2A. Riparian vegetation in the upper 10 miles of this reach (Reach 2A) is sparse or absent because the river is usually dry and the shallow groundwater is overdrafted (McBain and Trush 2002). Grassland/pasture is relatively abundant in Reach 2A, contributing almost 50 percent to the total natural land cover (excluding urban and agricultural land cover types). The most abundant riparian communities present are riparian and willow scrub habitats. The only significant stand of elderberry savanna mapped in the Restoration Area occurs on the left bank near the Chowchilla Bypass Bifurcation Structure, at the junction of Reaches 2A and 2B (DWR 2002). Invasive species recorded in Reach 2A in 2000 included large stands of blue gum and tree-of-heaven and giant reed (DWR 2002). Red sesbania was sparsely distributed in Reach 2A as of 2008.

Reach 2B. The lower few miles of Reach 2B support narrow, patchy, but nearly continuous vegetation, because this area is continuously watered by the backwater of the Mendota Pool affecting both surface and groundwater elevation. (The vegetation modeling in Appendix N, Attachment 6 simulates the influence of hydrology on vegetation in this area.) The riparian zone is very narrowly confined to a thin strip 10 to 30 feet wide bordering the channel. The herbaceous understory, however, is very rich in native species and a high portion of the total vegetative cover is native plants. Invasive species were not mapped in Reach 2B by DWR in 2000. In 2008, giant reed was noted in four locations in Reach 2B, and giant reed, perennial pepperweed, and salt cedar were found in Fresno Slough, which flows into the Mendota Pool portion of Reach 2B from the south. The margins of Mendota Pool support some areas of emergent vegetation dominated by cattails and tules; a few cottonwoods and willows grow above the waterline.

Reach 3. Nearly continuous riparian vegetation of various widths and cover types occurs on at least one side of the channel in this reach (McBain and Trush 2002); however, the narrow width of the riparian corridor results in a very low ratio of native vegetation per river mile (DWR 2002). In Reach 3, cottonwood riparian forest is the most abundant native vegetation type, followed by willow scrub, willow riparian forest, and riparian scrub. Small amounts (less than 0.5 acre each) of giant reed and nonnative trees were mapped in Reach 3 (DWR 2002). An occurrence of Chinese tallow was recorded in Reach 3 in 2008. The narrow riparian corridor is likely a result of development of the upper and middle floodplain elevations for agricultural and urban uses. A reduction in the frequency of flood events also likely resulted in less frequent scouring events, decreasing the abundance of early successional riparian vegetation (i.e., scrub) and riverwash (Reclamation 1998b), while allowing the riparian forest to establish.

Reach 4A. Reach 4A is sparsely vegetated, with a very thin band of vegetation along the channel margin (or none at all). Willow scrub and willow riparian forest occur in small to large stands, and ponds rimmed by small areas of marsh vegetation are present in the channel; however, this reach has the fewest habitat types and lowest ratio of natural vegetation per river mile in the Restoration Area.

Reach 4B. Reach 4B1 supports a nearly unbroken, dense, but narrow corridor of willow scrub or young mixed riparian vegetation on most of the reach, with occasional large gaps in the canopy. Reach 4B1 no longer conveys flows because the Sand Slough Control Structure diverts all flows into the bypass system. As a result, the channel in the Reach 4B1 is poorly defined and filled with dense vegetation and, in some cases, is plugged with fill material. Because of the wider floodplain and available groundwater, as well as management of the land as part of the San Luis NWR, Reach 4B2 contains vast areas of natural vegetation, compared to the upstream reaches. Grasslands and pasture are the most common vegetation type, but willow riparian forest and emergent wetlands are also relatively abundant (DWR 2002). No significant stands of nonnative trees or giant reed were found in Reach 4 (DWR 2002).

Reach 5. In Reach 5, the San Joaquin River is surrounded by large expanses of upland grassland with numerous inclusions of woody riparian vegetation in the floodplain. Remnant riparian tree groves are concentrated on the margins of mostly dry secondary channels and depressions, or in old oxbows. Along the mainstem San Joaquin River, a relatively uniform pattern of patchy riparian canopy hugs the channel banks as large individual trees or clumps (primarily valley oaks or black willow) with a mostly grassland or brush understory (McBain and Trush 2002). The most abundant plant community is grassland and pasture, followed by willow riparian forest, emergent wetland, willow and riparian scrub, and willow, oak, and cottonwood riparian forests. Alkali scrub is also present in this reach (DWR 2002). Less than 0.5 acre of giant reed was mapped in Reach 5, but larger stands of nonnative trees were recorded (DWR 2002). Perennial pepperweed was widely distributed and patchily abundant in Reach 5 and adjoining Salt and Mud sloughs in 2008.

Eastside Bypass. Upland vegetation in the Eastside Bypass is grassland and ruderal vegetation (i.e., nonnative herbaceous of disturbed lands). The reach between the Sand Slough Control Structure and Merced NWR (approximately 4.5 miles) supports a number of duck ponds. The next 2.2 miles of the bypass are located in the Merced NWR, which encompasses more than 10,000 acres of wetlands, native grasslands, vernal pools, and riparian habitat, and hosts the largest wintering populations of lesser sandhill cranes (*Grus canadensis canadensis*) and Ross's geese (*Chen rossii*) along the Pacific Flyway. Farther downstream, the Eastside Bypass passes through the Grasslands WMA, an area of private lands with conservation easements held by the USFWS, and through the East Bear Creek Unit of the San Luis NWR Complex. Patchy riparian trees and shrubs occur along the banks of the Eastside Bypass in these areas. Side channels and sloughs (e.g., Duck, Deep, and Bravel sloughs) are present along the lower Eastside Bypass, some of which support remnant patches of riparian vegetation. Two occurrences of perennial pepperweed and three occurrences of red sesbania were noted in the Eastside Bypass in 2008.

Sensitive Biological Resources

Sensitive biological resources including special-status species, recovery areas, designated critical habitat, and sensitive natural communities are discussed below. Appendix L, "Biological Resources – Vegetation and Wildlife," provides lists of special-status plant and wildlife species that are known or have potential to occur in the Restoration Area along with their listing status, habitat requirements, and other data. Appendix L, "Biological Resources – Vegetation and Wildlife," also contains figures that illustrate the distribution of sensitive biological resources in the Restoration Area. Several data sources were reviewed to develop these lists, including records from DFG's CNDDB (DFG 2011a), CNPS's Inventory of Rare and Endangered Plants of California (CNPS 2009), and USFWS's species lists. The following U.S. Geological Survey (USGS) 7.5-minute quadrangles encompass the Restoration Area (within approximately 1,500 feet of the San Joaquin River and bypass systems) and its vicinity, and were searched in the CNDDB and CNPS: Biola, Bliss Ranch, Broadview Farms, Delta Ranch, Firebaugh, Firebaugh Northeast, Fresno North, Friant, Gravelly Ford, Gregg, Gustine, Herndon, Ingomar, Jamesan, Lanes Bridge, Little Table Mountain, Madera, Mendota Dam, Millerton Lake West, Millerton Lake East, Newman, Oxalis, Poso Farm, San Luis Ranch, Sandy Mush, Santa Rita Bridge, Stevinson, Tranquility, and Turner Ranch.

For the purpose of this document, special-status species are plant and wildlife species that are:

- Species listed, species proposed for listing, or candidates for possible future listing as threatened or endangered under the Federal ESA

- Species listed or proposed for listing by the State as threatened or endangered under CESA

- Plant species designated as rare under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.)

- Plant species considered by the CNPS to be "rare, threatened, or endangered in California" (Lists 1B and 2 in CNPS 2007, which correspond to DFG's Rare Plant Ranks 1B and 2 in CNDDB)

- Wildlife species considered species of special concern by DFG

- Wildlife species designated as fully protected by the California Fish and Game Code

- Birds that receive protection under the Bald Eagle Protection Act (e.g., bald eagle, golden eagle) and the Migratory Bird Treaty Act (MBTA) (All birds except European starlings, English house sparrows, rock doves (pigeons), and nonmigratory game birds such as quail, pheasant, and grouse are protected under the MBTA.)

Special-Status Plant Species. Based on the results of the database searches and review of existing environmental documentation, 30 special-status plant species were identified as having potential to occur in the Restoration Area. Appendix L, “Biological Resources – Vegetation and Wildlife,” lists these species and gives information on their listing status, habitat, distribution, flowering period, and potential for occurrence in the Restoration Area. Also, descriptions of known and potentially occurring special-status plants that are federally listed or State-listed as endangered or threatened and CNPS-listed species that have been documented in the Restoration Area are presented in Appendix L, “Biological Resources – Vegetation and Wildlife.” Species descriptions are derived from *The Jepson Manual* (Hickman 1993), and known occurrence and distribution information is from CNDDB and CNPS records, as well as information contained in the *San Joaquin River Restoration Study Background Report* (McBain and Trush 2002).

Special-Status Wildlife Species. A total of 63 special-status wildlife species have been recorded historically in the region, and 61 are known or have potential to occur in the Restoration Area. Although historically known from the region, California red-legged frog and giant kangaroo rat are at present considered extirpated from the Restoration Area. Species could occur in areas where they have not been documented, if suitable habitat is present.

Appendix L, “Biological Resources – Vegetation and Wildlife,” summarizes the legal status, habitat requirements, and potential for occurrence of special-status wildlife species in the Restoration Area. Appendix L, “Biological Resources – Vegetation and Wildlife,” also presents descriptions of species that are federally listed or State-listed, followed by summaries of other special-status wildlife species that may occur in the Restoration Area and that could be affected by the project.

Recovery Areas. Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. These plans often define recovery units and core habitat recovery areas to focus recovery efforts. Several recovery units and core areas overlap or are in close proximity to the Restoration Area. In Appendix L, “Biological Resources – Vegetation and Wildlife,” Exhibits 3a through 3c show locations of USFWS-designated recovery units with core areas in the vicinity of the Restoration Area.

California Red-Legged Frog. The goal of the *Recovery Plan for the California Red-Legged Frog* (USFWS 2002a) is to protect the long-term viability of all existing California red-legged frog populations within each recovery unit. The recovery plan identifies core areas (within each of the recovery units) in which suitable habitats should be protected and/or managed for California red-legged frogs in perpetuity, and where the ecological integrity of these areas would not threatened by adverse anthropogenic habitat modification. The core areas, which are distributed throughout portions of the historic and current range, represent a system of areas that, when protected and managed for California red-legged frogs, will allow long-term viability of existing populations and reestablishment of populations within the historic range.

The Sierra Nevada foothills recovery unit for this species extends throughout the entire Restoration Area. The recovery plan indicates that the Sierra Nevada foothills and Central Valley recovery units have a low recovery value because there are few existing California red-legged frog populations, high levels of threats and, in general, medium habitat suitability. No core areas are identified in the Restoration Area.

San Joaquin Kit Fox. *The Recovery Plan for the Upland Species of the San Joaquin Valley, California* (USFWS 1998) covers 34 species of plants and animals that occur in the San Joaquin Valley of California, addressing five endangered plant species, one threatened plant species, and five endangered animal species, in addition to 23 candidate species or species of concern. The recovery plan considers the San Joaquin kit fox to be an umbrella species, giving many of its needs a higher priority in recovery actions at the regional level (i.e., the ecosystem level) than those of other species because it is one of the species that will be hardest to recover; fulfilling the fox's needs also meets those of many other species. The recovery plan identifies several core areas for the San Joaquin kit fox. One of these core recovery areas extends through Reach 1; another encompasses all of Reaches 2B through 5, as well as the Eastside and Chowchilla bypasses.

Vernal Pool Species. *The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a) features 33 species of plants and animals that occur exclusively or primarily within vernal pool ecosystems in California and southern Oregon. The 20 federally listed species are composed of 10 endangered plants, five threatened plants, three endangered animals, and two threatened animals.

The Vernal Pool Recovery Plan identifies 16 vernal pool regions that are discrete units that assist in targeting areas to be conserved for the recovery, and conservation objectives of each of the species addressed in the recovery plan. The goal of the recovery plan is to protect the long-term viability of existing populations within each vernal pool region through the protection of suitable habitat within core areas. Core areas are the specific sites that are necessary to recover the endangered or threatened species addressed in the recovery plan, or to conserve sites that are necessary to recover these listed species and/or the species of concern addressed in the recovery plan. Core areas are not species-specific and may contain multiple listed species and species of concern.

The southern Sierra foothills vernal pool region encompasses most of Reach 1A. Associated with this vernal pool region are the Madera Core recovery area and the Fresno Core recovery area. However, both of these core areas abut, but are outside of, the Restoration Area.

The San Joaquin Valley vernal pool region extends from Reaches 2 through 5, including the Eastside and Chowchilla bypasses. Associated within this vernal pool region is the Grasslands Ecological Area core area. Portions of this core area are within the Restoration Area around Reaches 4B and 5, and the Eastside Bypass.

Designated Critical Habitat. "Critical habitat" is a term defined and used in the ESA. It is a specific geographic area(s) that is essential for the conservation of a threatened or endangered species, and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species but is determined essential to the conservation of the species. Only areas that contain the primary constituent elements required by the species are considered critical habitat. Primary constituent elements are those physical and biological features of a landscape that a species needs to survive and reproduce. Several areas designated as critical habitat for listed species occur within or adjacent to the Restoration Area. Appendix L, "Biological Resources – Vegetation and Wildlife," shows designated critical habitat for listed plant species and designated critical habitat for listed wildlife species.

Vernal Pool Species. Critical habitat for four vernal pool crustaceans and 11 vernal pool plants was proposed on September 24, 2002 (USFWS 2002b). The final rule to designate critical habitat for these species was published on August 6, 2003 (USFWS 2003). A reevaluation of noneconomic exclusions from the August 2003 final designation was published on March 8, 2005 (USFWS 2005b). An evaluation of economic exclusions from the August 2003 final designation was published on August 11, 2005 (USFWS 2005c). Administrative revisions with species-by-unit designations were published on February 10, 2006 (USFWS 2006a). On May 31, 2007, USFWS published a clarification of the economic and noneconomic exclusions for the 2005 final rule designating critical habitat for these species in California and southern Oregon (USFWS 2007).

In Reach 1A, no critical habitat is designated within the Restoration Area, although critical habitat for vernal pool fairy shrimp, hairy Orcutt grass, San Joaquin Orcutt grass, and succulent owl's clover abuts the Restoration Area on either side. In Reaches 4B and 5 and along the Eastside Bypass, there are several designated critical habitat units for vernal pool species, including Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, Colusa grass, and Hoover's spurge. Designated critical habitat units for all these species except Colusa grass are within portions of the Restoration Area.

California Tiger Salamander. On August 23, 2005, USFWS designated 199,109 acres of critical habitat in 19 counties for the central population of California tiger salamander (USFWS 2005d). No critical habitat for California tiger salamander is designated in the Restoration Area, although critical habitat for California tiger salamander abuts the Restoration Area on either side in Reach 1A.

Fresno Kangaroo Rat. Critical habitat for the Fresno kangaroo rat was designated on January 30, 1985 (USFWS 1985). This critical habitat unit is located nearly 2 miles south of Reach 2B.

Sensitive Natural Communities. Sensitive natural communities include those that are of special concern to resource agencies or are afforded specific consideration through the CEQA, Section 1602 of the California Fish and Game Code, Section 404 of the Federal Clean Water Act (CWA), and the Porter-Cologne Water Quality Control Act, as discussed below in Section 6.2, Regulatory Setting. Sensitive natural communities may be of special concern to these agencies and conservation organizations for a variety of reasons, including their locally or regionally declining status, or because they provide important habitat to common and special-status species. Many of these communities are tracked in the DFG CNDDB, a Statewide inventory of the locations and conditions of the State's rarest plant and animal taxa and vegetation types.

Natural communities within the Restoration Area that would be considered sensitive by regulatory agencies include cottonwood riparian forest, willow riparian forest, mixed riparian forest, valley oak riparian forest, willow scrub, riparian scrub, alkali sink (or valley sink scrub), and emergent wetlands. As previously described, these communities were included in the vegetation mapping data collected by DWR (2002).

Additional sensitive natural communities are known to be present adjacent to the San Joaquin River and could be affected by restoration activities that may occur away from the main channel or bypasses (e.g., setback levees). These communities are cismontane alkali marsh, valley sacaton grassland, and vernal pools. Community descriptions are derived from *Preliminary Terrestrial Natural Communities of California* (Holland 1986). Appendix L, "Biological Resources – Vegetation and Wildlife," shows where sensitive natural communities have been reported to the CNDDB.

Cismontane Alkali Marsh. Cismontane alkali marsh occurs on alkaline soils in lake beds and other floodplain areas of the Sacramento and San Joaquin rivers. It is characterized by dense cover of perennial, emergent herb species. Characteristic species are similar to those found in freshwater marsh communities but also include salt-tolerant species, such as saltgrass, alkali heath, salt marsh fleabane, and Parish's pickleweed. Standing water or saturated soil are present most of the year, and high evaporation with low input of freshwater make this community somewhat salty, especially in summer.

Valley Sacaton Grassland. Valley sacaton grassland is a medium height, tussock-forming grassland dominated by alkali sacaton. Saltgrass, pickleweed, and nonnative annual grasses also often are present. It occurs on fine-textured, poorly drained, usually alkaline soils on sites that have a seasonally high water table or that are seasonally inundated. This community type usually intergrades and co-occurs with alkali meadow and northern claypan vernal pool communities. It was once extensive in the San Joaquin Valley from the Tulare Lake Basin to Stanislaus and Contra Costa counties, but only remnants remain.

Vernal Pools. Vernal pools are seasonal pools that typically occur in grassland and form in depressions where winter rainfall perches on soils with a restrictive layer. They support herbaceous plant communities characterized by low-growing annual grasses and forbs adapted to live both on land and in water. Vernal pools provide potential habitat for federally listed species, including San Joaquin Orcutt grass, hairy Orcutt grass, and vernal pool crustaceans.

Distribution of Sensitive Biological Resources in the Restoration Area

Reach 1A. The riparian vegetation and elderberry savanna along Reach 1A support documented occurrences of the valley elderberry longhorn beetle. Known great egret, great blue heron, and cormorant rookery sites are present in Reach 1A at the following locations: the base of Friant Dam, in the DFG's Rank Island Ecological Reserve, and at the DFG Milburn Ecological Reserve. The rookeries at the base of Friant Dam and Rank Island Ecological Reserve support great blue heron and great egret nests. The rookery at the Milburn Ecological Reserve supports nests of all three species (Dulik, pers. comm., 2008). A spotted bat was collected from the San Joaquin Fish Hatchery in the 1970s, and there is a 1990s observation record of San Joaquin kit fox just west of Friant Dam (DFG 2011a). High above the alluvial plain of the river corridor in Reach 1A, just outside the Restoration Area, are terraces that support vernal pool grasslands and emergent wetlands. Numerous occurrences of special-status plant and animal species are documented in these habitats, including California tiger salamander, vernal pool fairy shrimp (*Branchinecta lynchi*), western spadefoot, hairy Orcutt grass (*Orcuttia pilosa*), Sanford's arrowhead (*Sagittaria sanfordii*), San Joaquin Valley Orcutt grass, spiny-sepaled button-celery (*Eryngium spinosepalum*), and succulent owl's clover. These terraces contain designated critical habitat for succulent owl's clover, hairy orcutt grass, San Joaquin orcutt grass, California tiger salamander, and vernal pool fairy shrimp.

Reach 1B. No special-status plants or animals are identified in Reach 1B (DFG 2011a), largely because of the minimal amount of remnant native habitats along this stretch of the river. Nonetheless, it is likely that raptors and possibly other sensitive species associated with grasslands use the remnant habitats in this reach.

Reach 2A. The only special-status species mapped by DFG (2009) as occurring in Reach 2A is Swainson's hawk. An occurrence of heartscale (*Atriplex cordulata*) is documented in the grasslands on the terraces above the alluvial plain, and outside the identified Restoration Area in this reach. These species are both associated with grassland habitats and, in the case of Swainson's hawk, agricultural areas and riparian forest habitats. It is likely that other grassland- and scrub-affiliated species use the limited remnant habitats in this reach, and valley elderberry longhorn beetle could potentially occur in the elderberry savanna. Elderberry shrubs have been documented along the river within this reach (DWR 2002).

Reach 2B. Occurrences of Swainson's hawk are recorded throughout Reach 2B; the DFG (2008b) indicates that numerous nesting sites are present in the riparian forest and foraging opportunities exist in the agricultural fields and grasslands along this reach. Silvery legless lizard (*Anniella pulchra*) has been documented in the riparian scrub located in Lone Willow Slough at the Chowchilla Bypass Bifurcation Structure. In the marshy backwater area of the Mendota Pool that extends into Reach 2B, several special-status species are documented, including records from the mid-1970s of giant garter snake (*Thamnophis gigas*) and western pond turtle and a 1948 record of Sanford's arrowhead (DFG 2011a). Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) has been documented in the riparian and willow scrub habitats around the Mendota Pool in the 1950s (DFG 2011a). Bank swallows (*Riparia riparia*), which use habitats along banks or bluffs usually adjacent to water, have been documented in the vicinity of the Mendota Pool. Several other special-status species have been documented at MWA, outside the Restoration Area, including Lost Hills crownscale (*Atriplex vallicola*), giant garter snake, blunt-nosed leopard lizard, burrowing owl, western mastiff bat, Nelson's antelope squirrel, and San Joaquin Kit fox (DFG 2011a).

Reach 3. Giant garter snake, western pond turtle, and western yellow-billed cuckoo are documented as occurring in suitable habitats in Reach 3. Occurrences of Swainson's hawk are recorded throughout this reach, where this hawk forages in the grassland and agricultural areas, and nests in the riparian forest along the river. Several occurrences of San Joaquin kit fox from the 1990s have been documented in the grasslands immediately east and west but outside of the Restoration Area along this reach of the river. Lesser saltscale (*Atriplex minuscula*) and Munz' tidy-tips (*Layia munzii*), both associated with alkaline scrub and grassland habitats, are both documented in the higher terraces above the alluvial plain and just outside the Restoration Area along this reach.

Reach 4. Occurrences of Swainson's hawk are recorded throughout Reach 4, where this hawk forages in the grassland and agricultural areas, and nests in the riparian forest along the river. The San Luis NWR and Grasslands WMA in Reach 4B support marsh and emergent wetlands, native grasslands, alkali sink, riparian forests, and vernal pool habitats; the Grasslands WMA supports the largest remaining block of contiguous wetlands in the Central Valley. Numerous documented occurrences of special-status species affiliated with these habitats have been documented throughout this subreach. Species include American badger, California tiger salamander, Conservancy fairy shrimp (*Branchinecta conservatio*), giant garter snake, northern harrier, San Joaquin kit fox, vernal pool fairy shrimp, vernal pool tadpole shrimp (*Lepidurus packardi*), western pond turtle, western spadefoot, and Delta button-celery (*Eryngium racemosum*). Critical habitat for Hoover's spurge (*Chamaesyce hooveri*), Colusa grass (*Neostapfia colusana*), vernal pool tadpole shrimp, vernal pool fairy shrimp, longhorn fairy shrimp (*Branchinecta longiantenna*), and Conservancy fairy shrimp has been designated within and adjacent to Reach 4B2 of the Restoration Area.

Reach 5. Occurrences of Swainson's hawk are recorded throughout Reach 5, where this hawk forages in the grassland and agricultural areas, and nests in the riparian forest along the river. Just north of the San Joaquin River and Bear Creek confluence, the river crosses through the Great Valley Grasslands State Park and then again traverses through the San Luis NWR. The State Park and San Luis NWR support marsh and emergent wetlands, alkali sacaton (*Sporobolus airoides*) grasslands, alkali sink, riparian forest, and vernal pool habitats. Numerous occurrences of special-status species affiliated with these habitats are documented in the State Park and San Luis NWR, including American badger, California tiger salamander, Conservancy fairy shrimp, longhorn fairy shrimp, San Joaquin kit fox, tricolored blackbird (*Agelaius tricolor*), vernal pool tadpole shrimp, western pond turtle, western spadefoot, and Delta button-celery. The State Park and NWR also support occurrences of other rare and endangered species, although these are not documented in the Restoration Area itself; these species include alkali milk-vetch (*Astragalus tener* var. *tener*), brittlescale (*Atriplex depressa*), heartscale, Hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*), lesser saltscale, prostrate navarretia (*Navarretia prostrata*), vernal pool smallscale (*Atriplex persistens*), and Wright's trichocoronis (*Trichocoronis wrightii*). Farther along this reach, the river traverses the North Grasslands Wildlife Area, which contains more than 7,000 acres of wetlands, riparian habitat, and uplands, and provides habitat for Swainson's hawk and greater sandhill cranes (*Grus canadensis tabida*) and lesser sandhill cranes. The West Hilmar Wildlife Area is located to the north and contains 340 acres of oaks, cottonwoods, and grasslands providing habitat for great blue heron (*Ardea Herodias*) and great egret (*Ardea alba*). Critical habitat for vernal pool tadpole shrimp, vernal pool fairy shrimp, longhorn fairy shrimp, and Conservancy fairy shrimp extends from Reach 4B2 into Reach 5.

Eastside Bypass. Where the Eastside Bypass traverses through the Grasslands WMA, San Luis NWR, and the Merced NWR, which support marsh and perched wetlands, sand dunes, riparian forests, native grasslands, and vernal pool habitats, there are several documented occurrences of special-status species affiliated with these habitats. These species include California tiger salamander, Conservancy fairy shrimp, San Joaquin kit fox, Swainson's hawk, tricolored blackbird, vernal pool fairy shrimp, vernal pool tadpole shrimp, Delta button-celery, and Wright's trichocoronis. The Merced NWR also supports habitat for Colusa grass and wintering lesser sandhill crane. Other special-status species, including American badger, brittlescale, heartscale, Sanford's arrowhead, and vernal pool smallscale, are documented in the vicinity but outside the Restoration Area. Critical habitat for Hoover's spurge, Colusa grass, vernal pool tadpole shrimp, vernal pool fairy shrimp, and Conservancy fairy shrimp has been designated within and adjacent to the Restoration Area along the Eastside Bypass.

Mariposa Bypass. The Mariposa Bypass supports several occurrences of Delta button-celery. Critical habitat for Hoover's spurge, Colusa grass, vernal pool tadpole shrimp, vernal pool fairy shrimp, and Conservancy fairy shrimp has been designated within and adjacent to the Restoration Area along the Mariposa Bypass.

6.1.4 San Joaquin River from Merced River to the Delta

The San Joaquin River downstream from the Merced River confluence is similar to the river upstream from the confluence. The upstream portion of the reach below the Merced River is more incised than the downstream area, with generally drier conditions in the riparian zone and a less developed understory.

Agricultural land use has encroached on the riparian habitat along most of the river. Along much of the river, only a narrow ribbon of riparian habitat is supported. However, riparian habitat is more extensive locally, especially near the confluence with tributary rivers, within cutoff oxbows, and in the 6,500-acre San Joaquin River NWR between the confluences with the Tuolumne and Stanislaus rivers. Remnant common tule- and cattail-dominated marshes may occur in these areas.

Special-status species in this reach include plant species that occur in the river floodplain, such as Delta button-celery, and marsh plants, such as Sanford's arrowhead, a CNPS List 1B species. Special-status animals include valley elderberry longhorn beetle, Swainson's hawk, and a number of riparian-dependent songbirds, such as least Bell's vireo (*Vireo bellii pusillus*) and yellow warbler. The riparian brush rabbit (*Sylvilagus bachmani riparius*), federally listed and State-listed as endangered, and riparian woodrat (*Neotoma fuscipes riparia*), federally listed as endangered, are found along the lower San Joaquin River (DFG 2011a).

6.1.5 Sacramento–San Joaquin River Delta

The Delta is divided into numerous islands by hundreds of miles of waterways. Historically, the Delta had extensive areas of wetlands. Nearly all of the Delta's wetlands have been reclaimed by agriculture and other land uses. However, some small islands remain in a quasi-natural state. (These quasi-natural islands include "flooded islands" that were once reclaimed land, but were abandoned after levee failures.) Some other areas also support aquatic and wetland communities.

Delta wetlands are considered to be among the most productive wildlife habitats in California. These wetlands include permanent saline, brackish, and freshwater marshes; seasonal freshwater wetlands; open water; tidal and nontidal marshes, and emergent wetlands; and agricultural cropland (DFG 2007).

Many special-status species are known or are likely to occur in the Delta because of the presence of unique wetland habitats. Tidal marshes and emergent wetlands support several special-status wildlife species, including the California black rail (*Laterallus jamaicensis coturniculus*), California clapper rail (*Rallus longirostris obsoletus*), greater sandhill crane (*Grus canadensis tabida*), salt marsh common yellowthroat (*Geothlypis trichas sinuosa*), salt marsh harvest mouse (*Reithrodontomys raviventris*), Suisun ornate shrew (*Sorex ornatus sinuosus*), Suisun song sparrow (*Melospiza melodia maxillaris*), and tricolored blackbird (*Agelaius tricolor*). The giant garter snake is known to inhabit sloughs, canals, and low-gradient streams and freshwater marshes in the Delta. Vernal pools and other freshwater seasonal wetlands support several special-status crustaceans, including vernal pool tadpole shrimp (*Lepidurus packardi*) and vernal pool fairy shrimp (*Branchinecta lynchi*). Although it is severely declining because of a dramatic shrinkage of suitable habitat, the valley elderberry longhorn beetle has been found in the Delta region on McCormack-Williamson and New Hope Tracts.

6.1.6 CVP/SWP Water Service Areas

The CVP/SWP water service areas contain a large diversity of both lowland and upland habitats and species, although agricultural and urban growth has reduced the area and connectivity of important habitats that are critical to sustaining a wide variety of unique plants and animals (DFG 2007). The agricultural land and urban development that dominate the CVP/SWP water service areas, respectively, can support many wildlife species, most of which are highly adapted to these disturbed environments.

The CVP/SWP water service areas are dominated by agricultural land and urban development, which can support many wildlife species, most of which are highly adapted to these disturbed environments. The conflict between urban growth and conservation of native habitat has resulted in the listing of a number of wildlife species that were threatened with extinction. The region also supports a variety of exotic species, some of which are detrimental to survival of native species.

The California condor (*Gymnogyps californianus*), lightfooted clapper rail (*Rallus longirostris levipes*), California least tern (*Sternula antillarum brownie*), least Bell's vireo (*Vireo bellii pusillus*), Belding's Savannah sparrow (*Passerculus sandwichensis beldingi*), southwestern willow flycatcher (*Empidonax traillii extimus*), California gnatcatcher (*Polioptila californica*), Mohave ground squirrel (*Spermophilus mohavensis*), and Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) are examples of species that have been listed as threatened or endangered under the ESA and that could occur within the CVP/SWP water service areas.

6.2 Regulatory Setting

This section presents the applicable Federal, State, and local laws and regulations associated with biological resources (vegetation and wildlife) in the study area.

6.2.1 Federal

Federal laws and regulations pertaining to biological resources are discussed below.

Clean Water Act Sections 401 and 404

See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of the Clean Water Act sections 401 and 404.

Endangered Species Act

See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of ESA.

Migratory Bird Treaty Act

The MBTA, first enacted in 1918, provides for protection of international migratory birds and authorizes the Secretary to regulate the taking of migratory birds. Under the MBTA, it is unlawful, except as permitted by regulations, to pursue, hunt, take, capture or kill any migratory bird (Title 16, Section 703 of the USC). This prohibition includes direct and indirect acts, although harassment and habitat modifications are not included unless they result in direct loss of birds, nests, or eggs. The current list of species protected by the MBTA, which can be found in 50 CFR Section 10.13, includes several hundred species, essentially all native birds. Loss of nonnative species, such as house sparrows, European starlings, and rock pigeons, is not covered by this statute.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (Eagle Act), first enacted in 1940 and amended several times since then, prohibits the taking or possession of and commerce in bald and golden eagles, including their parts, nests, or eggs, with limited exceptions. The

Eagle Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" (16 USC 668–668d). USFWS has defined "disturb" under the Eagle Act, as follows (72 Federal Register (FR) 31132–31140, June 5, 2007):

> *Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle; (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.*

In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, on the eagle's return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment. USFWS has proposed new permit regulations to authorize the take of bald and golden eagles under the Eagle Act, generally when the take to be authorized is associated with otherwise lawful activities (72 FR 31141–31155, June 5, 2007). With the delisting of the bald eagle in 2007, the Eagle Act is the primary Federal law protecting bald eagles, as well as golden eagles.

Fish and Wildlife Coordination Act

See chapter 5.0, "Biological Resources – Fisheries," for a discussion of the fish and Wildlife Coordination Act.

Executive Orders

Several EOs address ecosystem protection:

- EO 11312: Invasive Species. See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of this Executive Order.

- EO 11990: Protection of Wetlands. See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of this EO.

- EO 13186 (January 10, 2001) directs Federal agencies that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement a MOU with USFWS promoting the conservation of migratory bird populations. Implementation actions and reporting procedures identified in the MOU should be included in each agency's formal planning process, such as resource management plans and fisheries management plans.

- EO 13443 (August 16, 2007) directs Federal agencies that have programs and activities that have a measurable effect on public land management, outdoor recreation, and wildlife management to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat.

CALFED

The CALFED Bay-Delta Program (CALFED) is a cooperative effort of more than 24 Federal and State agencies with regulatory and management responsibilities in the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The Federal agencies involved in CALFED are Reclamation, USFWS, NMFS, USACE, and the EPA. The State agencies involved in CALFED are DFG, DWR, and the SWRCB.

CALFED will develop long-term measures to address problems affecting the Bay-Delta. The program focuses on four objectives:

- To provide optimal water quality (water quality objective)
- To improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta estuary to support sustainable populations of diverse plant and animal species (ecosystem restoration objective)
- To reduce shortages between water supplies and current and projected demands on the system (water supply reliability objective)
- To reduce the risk of failure of levees that protect land use and associated economic activities, water supply, and other infrastructure and ecosystems (Delta levee system reliability objective)

On the upper portion of the San Joaquin River, from Friant Dam to the Merced River, CALFED sponsors the San Joaquin River Riparian Habitat Restoration Program Pilot Project. The purpose of the project is to establish and maintain riparian habitat along the river where little or none existed before, using releases from Friant Dam to disperse and germinate native tree seed in the spring.

Central Valley Project Improvement Act

See Chapter 13.0, “Hydrology – Surface Water Supplies and Facilities,” for a discussion of the Central Valley Project Improvement Act (CVPIA).

Comprehensive Conservation Plans for National Wildlife Refuges

USFWS is directed to develop CCPs to guide the management and resource use for each refuge of the NWR System under requirements of the NWR Improvement Act of 1997. Refuge planning policy also directs the process and development of CCPs. A CCP describes the desired future conditions and long-range guidance necessary for meeting refuge purposes. It also guides management decisions and sets forth strategies for achieving refuge goals and objectives within a 15-year time frame. Several important NWRs are present along the San Joaquin River and elsewhere in the San Joaquin Valley.

San Luis National Wildlife Refuge. San Luis NWR does not have an approved CCP; however, planning was initiated in 2002 (USFWS 2001). The primary goals of the refuge are to accomplish the following:

- Provide feeding and resting habitat for migrating and wintering waterfowl and other waterbirds.
- Provide habitat and management for endangered species, threatened species, and/or species of special concern.
- Preserve the natural diversity of the flora and fauna representative of the lower San Joaquin Valley and the natural processes that maintain that diversity.
- Provide high-quality wildlife-dependent recreation and environmental education programs.

Merced National Wildlife Refuge. Merced NWR does not have an approved CCP; however, planning was initiated in 2002 (USFWS 2001). The primary goals of the refuge are the same four goals described for the San Luis NWR, and an additional goal to alleviate crop depredation.

San Joaquin River National Wildlife Refuge. San Joaquin River NWR has prepared a final CCP (USFWS 2006b). The primary goals of the refuge are to accomplish the following:

- Conserve and protect the natural diversity of migratory birds, resident wildlife, fish, and plants through restoration and management of riparian, upland, and wetland habitats on refuge lands.
- Contribute to the recovery of threatened/endangered species, as well as the protection of populations of special-status wildlife and plant species and their habitats.
- Provide optimum wintering habitat for Aleutian Canada geese to ensure the continued recovery from threatened and endangered species status.
- Coordinate the natural resource management of the San Joaquin River NWR in the context of the larger Central Valley/San Francisco Ecoregion.
- Provide the public with opportunities for compatible, wildlife-dependent visitor services to enhance understanding, appreciation, and enjoyment of natural resources at the San Joaquin River NWR.

6.2.2 State of California

State laws and regulations pertaining to biological resources are discussed below.

Porter-Cologne Water Quality Control Act

See Chapter 14.0, “Hydrology – Surface Water Quality,” for a discussion of the Porter-Cologne Water Quality Control Act.

California Endangered Species Act

See Chapter 5.0, “Biological Resources – Fisheries,” for a discussion of CESA.

California Fish and Game Code

Several sections of the California Fish and Game Code provide environmental protections applicable to the Restoration Area:

- **Section 1602 –** Streambed Alteration. See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of Section 1602 of the California Fish and Game Code.

- **Sections 1900–1913 –** Sections 1900–1913 of the California Fish and Game Code codify the Native Plant Protection Act, which is intended to preserve, protect, and enhance endangered or rare native plants in the State. The act directs DFG to establish criteria for determining which native plants are rare or endangered. Under Section 1901, a species is endangered when its prospects for survival and reproduction are in immediate jeopardy from one or more causes. A species is rare when, although not threatened with immediate extinction, it is in such small numbers throughout its range that it may become endangered if its present environment worsens. Under the act, the Fish and Game Commission may adopt regulations governing the taking, possessing, propagation, or sale of any endangered or rare native plant.

- CNPS has developed and maintains lists of plants of special concern in California, as described above under "Special-Status Species." CNPS-listed species have no formal legal protection, but the values and importance of these lists are widely recognized. Plants listed on CNPS Lists 1A, 1B, and 2 meet the definitions of Section 1901 of the California Fish and Game Code and may qualify for State listing. Therefore, for purposes of this analysis, they are considered rare plants pursuant to Section 15380 of CEQA.

- **Sections 3503 and 3513–Protection of Birds –** Section 3503 of the California Fish and Game Code states that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird. Section 3503.5 specifically states that it is unlawful to take, possess, or destroy any raptors (i.e., eagles, hawks, owls, and falcons), including their nests or eggs. Section 3513 provides for adoption of the MBTA's provisions. It states that it is unlawful to take or possess any migratory nongame bird, as designated in the MBTA, or any part of such migratory nongame bird. These State codes offer no statutory or regulatory mechanism for obtaining an incidental take permit for the loss of nongame, migratory birds. Typical violations include destruction of active raptor nests resulting from removal of vegetation in which the nests are located. Violation of Sections 3503.5 and 3513 could also include disturbance of nesting pairs that results in failure of an active raptor nest.

- **Fully Protected Species Under California Fish and Game Code –** See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of the California Fish and Game Code.

California Department of Fish and Game Species Designations

See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of Section 1602 of the California Fish and Game species designations.

6.2.3 Regional and Local

Regional and local plans and policies pertaining to biological resources are discussed below.

San Joaquin River Management Program

The San Joaquin River Management Program (SJRMP) was authorized by AB 3603 and signed by the governor on September 18, 1990. Specific issues addressed by SJRMP include flood protection, water supply, water quality, recreation, fisheries, and wildlife. SJRMP produced a report in 1995, outlining recommendations in the form of projects, studies, and acquisitions.

Recovery Plan for Upland Species of the San Joaquin Valley, California

The Recovery Plan for Upland Species of California was released by USFWS on September 30, 1998. This plan focuses on 34 species of plants and animals that occur in the San Joaquin Valley and that are either federally listed as threatened or endangered or are candidates for Federal listing or species of concern. The ultimate goal of the recovery plan is to delist the 11 endangered and threatened species addressed in the plan and ensure the long-term conservation of the other 23 species (USFWS 1998). The plan provides for both an ecosystem approach and a community level strategy. While not regulatory in nature, the Recovery Plan needs to be taken into consideration when analyzing potential impacts on upland natural community habitats in the San Joaquin Valley to ensure that projects do not prevent or impair the plan's future long-term implementation success. It is also used by the USFWS to determine recommendations and requirements during endangered species consultation for these species.

Central Valley Joint Venture

The Central Valley Joint Venture (CVJV) is a self-directed coalition consisting of 20 Federal and State agencies and private conservation organizations. This partnership directs its efforts toward the common goal of providing for the habitat needs of migrating and resident birds in the Central Valley of California. The CVJV was established in 1988 as a regional partnership focused on the conservation of waterfowl and wetlands under the North American Waterfowl Management Plan. It has since broadened its focus to the conservation of habitats for other birds, consistent with major national and international bird conservation plans and the North American Bird Conservation Initiative. The CVJV Implementation Plan (2006) has identified specific goals and objectives for conservation activities for waterfowl, shorebirds, waterbirds, and riparian songbirds.

Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture (RHJV) was initiated in 1994 and includes signatories from 18 Federal, State, and private agencies. The RHJV promotes conservation and the restoration of riparian habitat to support native bird populations through three goals:

- Promote an understanding of the issues affecting riparian habitat through data collection and analysis.
- Double riparian habitat in California by funding and promoting on-the-ground conservation projects.
- Guide land managers and organizations to prioritize conservation actions.

RHJV conservation and action plans are documented in the Riparian Bird Conservation Plan (RHJV 2004). The conservation plan targets 14 “indicator” species of riparian-associated birds and provides recommendations for habitat protection, restoration, management, monitoring, and policy. The report notes habitat loss and degradation as one of the most important factors causing the decline of riparian birds in California.

San Joaquin River Parkway Master Plan

See Chapter 5.0, “Biological Resources – Fisheries,” for a discussion of the San Joaquin River Parkway Management Plan.

County Plans

Pertinent county plans include the Fresno, Madera, and Merced county general plans, as well as the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan.

Fresno County General Plan. The Fresno County General Plan was updated in October 2000. In the study area, Fresno County’s land use jurisdiction lies south and west of the San Joaquin River centerline, through Reaches 1, 2, and 3, and into Reach 4A. The general plan identifies 27 primary land use designations (defined in terms of allowable uses and intensity standards) and three overlay designations (an overlay land use designation modifies the policies, standards, or procedures established for the underlying primary land use designation). One of the three overlay designations is for the San Joaquin River corridor.

Agriculture is essential to the visions and goals of the Fresno County General Plan; that focus is reflected in its land use policies, which guide decisions to minimize the conversion of productive agriculture land, protect agricultural activities from incompatible land uses, and control expansion of nonagricultural development onto productive agricultural lands. The general plan also identifies as a priority the protection and enhancement of water quality and quantity in Fresno County’s streams, creeks, and groundwater basins through the protection of floodplain lands.

Policies in the general plan seek to protect natural areas, particularly riparian and wetland habitats, in the county, and to preserve habitat diversity in Fresno County through restoring and enhancing habitats that support fish and wildlife species so that populations are maintained at viable levels. Notably, the general plan seeks to preserve and enhance the San Joaquin River corridor principally in those areas adjoining the county’s river corridor by avoiding adverse impacts from development and encouraging environmentally friendly recreational and agricultural activities. One policy in the general plan directs the county to require riparian protection zones around natural watercourses, recognizing that these areas provide highly valuable wildlife habitat. Another policy recommends the acquisition (through fee acquisition or protective easements, often in cooperation with other local, State, and Federal agencies and private entities) of creek corridors, wetlands, and areas rich in wildlife, or of a fragile ecological nature as public open space where such areas cannot be effectively preserved through the regulatory process. The general plan prioritizes the protection of wetlands, riparian habitat, and meadows because they are recognized as essential habitats for birds and wildlife, and it requires a minimum 200-foot-wide wildlife corridor along particular stretches of the San Joaquin River and Kings River, whenever possible.

Madera County General Plan Policy Document. The Madera County General Plan Policy Document, adopted in October 1995, is a stand-alone document that is part of the Madera County General Plan. In the study area, Madera County's land use jurisdiction lies northeast of the San Joaquin River centerline and continues downstream from Friant Dam through Reaches 1, 2, 3, and 4A.

The general plan prioritizes the maintenance of agriculturally designated areas for continued agricultural uses and directs urban uses to designated new growth areas, existing communities, and existing cities. It discourages the conversion of prime agricultural land to nonagricultural land uses unless an immediate and clear need can be demonstrated.

One of the goals in the general plan is to protect and enhance the natural qualities of Madera County's streams, creeks, and groundwater, minimizing sedimentation and erosion of creeks and damage to riparian habitat. The general plan also prioritizes the protection of wetland communities and related riparian areas throughout Madera County as valuable resources, the protection of riparian zones around natural watercourses, and the conservation of remaining upland habitat areas adjacent to wetlands and riparian areas that are critical to the feeding or nesting of wildlife species associated with these wetland and riparian areas. One policy in the general plan directs the county to support the goals and policies of the Parkway Plan (see Section 3.3.4, "San Joaquin River Parkway Plan," above) to preserve existing habitat and maintain, enhance, or restore native vegetation to provide essentially continuous riparian and upland habitat for wildlife along the river between Friant Dam and the SR 145 crossing.

The general plan also identifies a goal to protect, restore, and enhance habitats that support fish and wildlife species so as to maintain populations at viable levels, by protecting critical nesting and foraging areas, important spawning grounds, migratory routes, waterfowl resting areas, oak woodlands, wildlife movement corridors, and other unique wildlife habitats critical to protecting and sustaining wildlife populations, and by ensuring the conservation of sufficiently large, continuous expanses of native vegetation to provide suitable habitat for maintaining abundant and diverse wildlife if this preservation does not threaten the economic well-being of the county. Another goal of the general plan is to preserve and enhance open space lands to maintain the natural resources of the county by supporting preservation and enhancement of natural land forms, natural vegetation, and natural resources (including wetland preserves, riparian corridors, woodlands, and floodplains) as open space. These open space and natural areas should be interconnected and of sufficient size to protect biodiversity, accommodate wildlife movement, and sustain ecosystems.

Merced County General Plan. The Merced County Year 2000 General Plan was adopted in December 1990. In the Restoration Area, Merced County's land use jurisdiction includes half of Reach 4A and all of Reach 5.

The general plan includes a plan for the comprehensive and long-range management, preservation, and conservation of "open-space lands" and contains provisions for managing and conserving Merced County's natural resources and for protecting life, health, and property from natural hazards. Policies associated with implementing this goal are designed to ensure that the development of Merced County will not significantly interfere with or destroy valuable natural resources, and that development will occur with recognition of sensitive resources and hazardous conditions. The purpose of the general plan is to maintain the natural topography, vegetation, wildlife, and scenic beauty of Merced County to the greatest extent possible, while recognizing that Merced County must balance needs for affordable housing and economic opportunities. One of the goals of the general plan is to ensure that habitats that support rare, endangered, or threatened species are not substantially degraded, and that rare and endangered species are protected from urban development and are recognized in rural areas.

San Joaquin County Multi-Species Habitat Conservation and Open Space Plan

See Chapter 5.0, "Biological Resources – Fisheries," for a discussion of the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan.

6.3 Environmental Consequences and Mitigation Measures

This section describes the direct and indirect effects that the program alternatives will have on vegetation and wildlife resources in the study area, with the focus of the analysis on the Restoration Area, where most impacts will occur. The program alternatives evaluated in this chapter are described in detail in Chapter 2.0, "Description of Alternatives," and summarized in Table 6-4. The potential impacts are summarized in Table 6-5.

Table 6-4.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
Project-Level	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
Project-Level	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
Program-Level	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
Program-Level	Actions in Reach 4B1 to provide at least:	4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
Program-Level	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
Program-Level	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	New pumping infrastructure on the San Joaquin River					✓	✓
Program-Level	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:
[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.
[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.
Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 6-5.
Summary of Environmental Consequences and Mitigation Measures – Vegetation and Wildlife

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources – Vegetation and Wildlife: Program Level				
VEG-1: Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
VEG-2: Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-3: Facilitate Increase in Distribution and Abundance of Invasive Plants in the Restoration Area	No-Action	SU	--	SU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-4: Substantially Affect Special-Status Plant Species in the Restoration Area	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-5: Substantially Reduce Habitat or Populations of Special-Status Animals in the Restoration Area	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-6: Substantially Alter Designated Critical Habitat in the Restoration Area	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-7: Conflict with Adopted Conservation Plans in the Restoration Area	No-Action	LTS	--	LTS
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial

Table 6-5.
Summary of Environmental Consequences and Mitigation Measures – Vegetation and Wildlife (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources – Vegetation and Wildlife: Program Level (continued)				
VEG-8: Substantially Alter Riparian Habitat and Other Sensitive Communities Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-9: Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-10: Facilitate Increase in Distribution and Abundance of Invasive Plants Between the Merced River and the Delta	No-Action	SU	--	SU
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-11: Substantially Alter Special-Status Plant Species Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-12: Substantially Reduce Habitat or Populations of Special-Status Animals Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-13: Substantially Alter Designated Critical Habitat Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-14: Conflict with Adopted Conservation Plans Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	No Impact	--	No Impact
	A2	No Impact	--	No Impact
	B1	No Impact	--	No Impact
	B2	No Impact	--	No Impact
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Table 6-5.
Summary of Environmental Consequences and Mitigation Measures – Vegetation and Wildlife (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources – Vegetation and Wildlife: Project Level				
VEG-15: Effects of Surface Water Fluctuation on Biological Resources Upstream from Friant Dam	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-16: Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
VEG-17: Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-18: Facilitate Increase in Distribution and Abundance of Invasive Plants in Sensitive Natural Communities in the Restoration Area	No-Action	SU	--	SU
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-19: Substantially Affect Delta Button-Celery and Other Special-Status Plant Species in the Restoration Area	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-20: Substantially Reduce Habitat or Populations of Special-Status Animal Species in the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-21: Substantially Alter Designated Critical Habitat in the Restoration Area	No-Action	No Impact	--	No Impact
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

**Table 6-5.
Summary of Environmental Consequences and Mitigation Measures –
Vegetation and Wildlife (contd.)**

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Biological Resources – Vegetation and Wildlife: Project Level (continued)				
VEG-22: Conflict with Provisions of Adopted Habitat Conservation Plans, Natural Community Conservation Plans, and Other Approved Local, Regional, or State Conservation Plans in the Restoration Area	No-Action	LTS	--	LTS
	A1	LTS and Beneficial	--	LTS and Beneficial
	A2	LTS and Beneficial	--	LTS and Beneficial
	B1	LTS and Beneficial	--	LTS and Beneficial
	B2	LTS and Beneficial	--	LTS and Beneficial
	C1	LTS and Beneficial	--	LTS and Beneficial
	C2	LTS and Beneficial	--	LTS and Beneficial
VEG-23: Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans Between the Merced River and the Delta	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-24: Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans in the Delta	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
VEG-25: Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans in the CVP/SWP Water Service Areas	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS

Key:
LTS = less than significant
SU = significant and unavoidable

6.3.1 Impact Assessment Methodology

This analysis of impacts on vegetation and wildlife resulting from implementing the program alternatives is based on review of existing biological resources documented in or near the Restoration Area, information obtained from the CNDDB and CNPS databases, review of aerial photos, and quantitative modeling of riparian vegetation for existing and future conditions (Appendix N, “Geomorphology, Sediment, and Vegetation Assessment”). The effects of Interim and Restoration flows and water recapture on vegetation and wildlife are evaluated at a project level; all other impacts on vegetation and wildlife are analyzed at a program level of detail.

Significance Criteria

The thresholds of significance for impacts for this analysis are based on Appendix G of the State CEQA Guidelines, as amended, and Federal Executive Order 11312 regarding invasive species. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. Impacts on vegetation and wildlife are significant if implementing an alternative would do any of the following:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by USFWS or DFG.
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by USFWS or DFG.
- Have a substantial adverse effect on federally protected wetlands, as defined by Section 404 of the CWA (including but not limited to marsh, vernal pool, coastal), through direct removal, filling, hydrological interruption, or other means.
- Introduce or substantially spread a nonnative invasive plant species.
- Interfere substantially with the movement of any native resident or migratory wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
- Substantially reduce the habitat of a wildlife species, cause a wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or substantially reduce the number or restrict the range of an endangered, rare, or threatened species.
- Conflict with local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
- Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan.

6.3.2 Program-Level Impacts and Mitigation Measures

This section provides a program-level evaluation of the direct and indirect effects of the program alternatives on biological resources. The action alternatives could affect biological resources during the modification or construction of facilities or during other program-level actions (e.g., spawning gravel enhancements). Potential for significant effects on biological resources would not extend upstream from Friant Dam or downstream into the Delta or CVP/SWP water service areas because there would be no construction or related program-level actions in these areas. Therefore, these geographic areas are not discussed further in this section. Project-level impacts, discussed in a separate section, include discussions of potential operations-related effects upstream from Friant Dam and in the Delta and CVP/SWP water service areas.

No-Action Alternative

For vegetation and wildlife, the No-Action Alternative includes reasonably foreseeable future actions related to water resource management, to be implemented in the Delta and San Joaquin Valley regions, as described in Chapter 2.0, “Description of Alternatives.” However, implementing USACE policy regarding levee vegetation was considered too speculative for meaningful consideration with regard to effects on vegetation and wildlife because of uncertainty regarding how the policy would be implemented in the study area. Discussions are continuing between USACE, other Federal agencies, and State and local agencies in California with responsibilities for levee maintenance, and may result in local variances to the national policy allowing less vegetation removal (CVFPB 2009). The effects of other projects associated with the projected regional population increase and buildout of existing General Plans by 2030 are described, and their contributions to 2030 conditions are evaluated for significance in Chapter 26.0, “Cumulative Impacts.”

San Joaquin River from Friant Dam to Merced River. Potential program-level impacts of the No-Action Alternative within the Restoration Area are described below.

Impact VEG-1 (No-Action Alternative): ***Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area – Program-Level.*** Under the No-Action Alternative, actions that could fragment or remove native vegetation from riparian habitat and other sensitive natural communities would not be carried out. There would be **no impact**.

Implementing the No-Action Alternative would not convert sensitive natural communities in the Restoration Area to other vegetation types or to agricultural or developed land uses. Further, implementing this alternative would not fragment or remove native vegetation from riparian habitats or other sensitive natural communities. There would be no impact.

Impact VEG-2 (No-Action Alternative): ***Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified in the Restoration Area. Actions that could fill, fragment, isolate, divert, or substantially alter wetlands or other waters of the United States would not be implemented. There would be **no impact**.

Impact VEG-3 (No-Action Alternative): ***Facilitate Increase in Distribution and Abundance of Invasive Plants in the Restoration Area – Program-Level.*** Under the No-Action Alternative, current water and land management practices that facilitate the dispersal and establishment of invasive species would continue. In addition, other projects could introduce and spread invasive species. This impact would be **significant and unavoidable**.

Under the No-Action Alternative, existing populations of invasive plant species would continue to be introduced and spread in the Restoration Area. Invasive species would be dispersed to suitable sites by flood flows; natural and agricultural drainage; and other water releases from Friant Dam, the Mendota Pool, and other facilities. Specifically, four priority species (red sesbania, salt cedar, giant reed, and Chinese tallow) have been identified as having the potential to adversely affect habitats and increase substantially as a result of continued water management operations in the Restoration Area. This impact would be significant.

Other projects could facilitate the dispersal and establishment of invasive plants in several ways: through transporting propagules into the Restoration Area; creating bare ground for them to establish; by altering hydrology in a manner that is advantageous to invasive species; and eliminating competing native vegetation. Future projects would be subject to environmental review; however, only projects that have a Federal nexus are required to address impacts of invasive species (required under Federal Executive Order 11312), and CEQA-only projects would not necessarily be required to mitigate such impacts. Therefore, this impact would be significant. No mitigation is required for the No-Action Alternative; therefore, this impact is significant and unavoidable.

Impact VEG-4 (No-Action Alternative): ***Substantially Affect Special-Status Plant Species in the Restoration Area – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified in the Restoration Area, and actions that could substantially eliminate or fragment special-status plant species or their habitats would not be carried out. This impact would be **less than significant**.

Under the No-Action Alternative, existing habitats of special-status plants in the Restoration Area would remain comparable to existing conditions. Implementing the No-Action Alternative would not substantially eliminate or fragment special-status plant habitat along the San Joaquin River or in the bypass system. This alternative also would not substantially alter ecologically important interactions with other organisms or alter habitat functions that affect special-status plant species. This impact would be less than significant.

Impact VEG-5 (No-Action Alternative): ***Substantially Reduce Habitat or Populations of Special-Status Animals in the Restoration Area – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified in the Restoration Area, and potential actions that could affect special-status animal species or their habitats would not be carried out. This impact would be **less than significant**.

Under the No-Action Alternative, existing habitats of special-status animals in the Restoration Area would remain comparable to habitats under existing conditions. No habitat or special-status animals would be removed or taken as a result of activities under the No-Action Alternative. Implementing the No-Action Alternative would not substantially reduce habitat for special-status animals in the Restoration Area or cause a wildlife population to drop below self-sustaining levels along the San Joaquin River or in the bypass system. Therefore, this impact would be less than significant.

Impact VEG-6 (No-Action Alternative): ***Substantially Alter Designated Critical Habitat in the Restoration Area – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified in the Restoration Area, and actions that could affect designated critical habitat would not be carried out. This impact would be **less than significant**.

The Restoration Area includes federally designated critical habitat for the following federally listed plant and animal species: succulent owl's-clover, hairy orcutt grass, Hoover's spurge, Colusa grass, California tiger salamander, vernal pool tadpole shrimp, vernal pool fairy shrimp, longhorn fairy shrimp, and Conservancy fairy shrimp. In addition, critical habitats for San Joaquin orcutt grass and Fresno kangaroo rat (*Dipodomys nitratoides exilis*) have been designated within five miles of the Restoration Area (see Appendix L, "Biological Resources – Vegetation and Wildlife"). Implementing the No-Action Alternative would not modify any of the primary constituent elements of designated critical habitat for these species. Therefore, this impact would be less than significant.

Impact VEG-7 (No-Action Alternative): ***Conflict with Adopted Conservation Plans in the Restoration Area – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified in the Restoration Area, and actions that could affect adopted conservation plans would not be carried out. This impact would be **less than significant**.

Implementing the No-Action Alternative would not conflict with adopted conservation plans because no reasonably foreseeable projects would implement actions within the Restoration Area that could reduce the effectiveness of conservation strategies, or otherwise prevent attainment of conservation plan goals and objectives, would be implemented. This alternative also would not beneficially affect plans, because it would not support their attainment of goals or objectives related to enhancing or restoring biological resources along the San Joaquin River. (All of the potentially affected Federal, State, regional, and local plans have such goals or objectives.) This impact would be less than significant.

San Joaquin River from Merced River to the Delta. Program-level impacts of the No-Action Alternative along the San Joaquin River downstream from the Merced River confluence to the Delta are described below.

Impact VEG-8 (No-Action Alternative): ***Substantially Alter Riparian Habitat and Other Sensitive Communities Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, actions that could remove, disturb, or otherwise alter riparian habitat or other sensitive natural communities along the San Joaquin River between the Merced River and the Delta would not be carried out. This impact would be **less than significant**.

Implementing the No-Action Alternative would not substantially eliminate or fragment sensitive natural communities along the San Joaquin River between the Merced River and the Delta. This alternative also would not substantially alter ecologically important interactions with other organisms or alter habitat functions that affect sensitive natural communities. Riparian habitat and other conditions of sensitive natural communities would remain comparable to existing habitat and conditions; vegetation removal or habitat alterations associated with the Settlement would not occur.

Impact VEG-9 (No-Action Alternative): ***Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States Between the Merced River and the Delta – Program-Level.*** Implementing the No-Action Alternative would not substantially fill, eliminate, or fragment waters of the United States along the San Joaquin River between the Merced River and the Delta. This alternative also would not substantially alter wetland functions or hydrologic conditions. Wetland habitat and other waters of the United States would remain comparable to wetland habitat and other waters under existing conditions, and discharge of fill or dredged material would not occur. This impact would be **less than significant**.

Impact VEG-10 (No-Action Alternative): ***Facilitate Increase in Distribution and Abundance of Invasive Plants Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, current water and land management practices that facilitate the dispersal and establishment of invasive species would continue. In addition, other projects under the No-Action Alternative could result in the introduction and spread of invasive species. This impact would be **significant and unavoidable**.

Under the No-Action Alternative, introduction and spread of invasive plant species would continue at rates consistent with current conditions along the San Joaquin River from the Merced River to the Delta. Reasonably foreseeable actions under the No-Action Alternative such as the City of Stockton Delta Water Supply Project and Arvin-Edison Canal Expansion could facilitate the dispersal and establishment of invasive plants along the San Joaquin River between the Merced River and the Delta in several ways: through transporting propagules into the area, creating bare ground for them to establish, altering hydrology in a manner that is advantageous to invasive species, and eliminating competing native vegetation. Future projects would be subject to environmental review; however, only projects that have a Federal nexus are required to address impacts of invasive species, and CEQA-only projects would not necessarily be required to mitigate such impacts. Therefore, this impact would be significant. No mitigation is required for the No-Action Alternative; therefore, this impact is significant and unavoidable.

Impact VEG-11 (No-Action Alternative): ***Substantially Alter Special-Status Plant Species Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, reasonably foreseeable actions could harm special-status plant species along the San Joaquin River between the Merced River and the Delta. This impact would be **less than significant**.

Under the No-Action Alternative, reasonably foreseeable actions such as the City of Stockton Delta Water Supply Project and Arvin-Edison Canal Expansion could cause ground disturbance, vegetation removal, or other habitat modifications that could affect special-status plants along the San Joaquin River between the Merced River and the Delta. This impact would be less than significant.

Impact VEG-12 (No-Action Alternative): ***Substantially Reduce Habitat or Populations of Special-Status Animals Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, reasonably foreseeable actions could harm special-status animal species along the San Joaquin River between the Merced River and the Delta. This impact would be **less than significant**.

Under the No-Action Alternative, reasonably foreseeable actions such as the City of Stockton Delta Water Supply Project and Arvin-Edison Canal Expansion could cause ground disturbance or other habitat modifications that could affect special-status animals, or remove, take, or otherwise harm special-status animal species along the San Joaquin River between the Merced River and the Delta. This impact would be less than significant.

Impact VEG-13 (No-Action Alternative): ***Substantially Alter Designated Critical Habitat Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified along the San Joaquin River between the Merced River and the Delta, and Settlement actions that could affect designated critical habitats would not be carried out. The San Joaquin River between the Merced River and the Delta does not include federally designated critical habitat of any federally listed plant or animal species. Critical habitat for Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) and soft bird's-beak (*Cordylanthus mollis* ssp. *mollis*) has been designated north of Suisun Bay. There may be areas in uplands near the river that are designated as critical habitat for other species. Implementing the No-Action Alternative would not modify designated critical habitat for any species along the San Joaquin River between the Merced River and the Delta because Settlement actions would not be carried out. This impact would be **less than significant**.

Impact VEG-14 (No-Action Alternative): ***Conflict with Adopted Conservation Plans Between the Merced River and the Delta – Program-Level.*** Under the No-Action Alternative, facilities and channels would not be constructed or modified along the San Joaquin River between the Merced River and the Delta, and actions that could conflict with adopted conservation plans would not be carried out. This impact would be **less than significant**.

Implementing the No-Action Alternative would not conflict with adopted conservation plans for locations along the San Joaquin River between the Merced River and the Delta because no actions that could reduce the effectiveness of conservation strategies, or otherwise prevent attainment of conservation plan goals and objectives, would be implemented. This alternative also would not beneficially affect plans, because it would not support their attainment of goals or objectives related to enhancing or restoring biological resources along the San Joaquin River. (All of the potentially affected Federal, State, regional, and local plans have such goals or objectives). This impact would be less than significant.

Alternatives A1 and B1

Program-level impacts under Alternatives A1 and B1 would be identical. These impacts would be associated with construction actions in the Restoration Area, as described below. No haul roads, staging areas, control structures, or other facilities would be constructed outside the Restoration Area under Alternatives A1 and B1, and no facilities would be modified outside this area. Therefore, no program-level impacts are described outside the Restoration Area.

Impact VEG-1 (Alternatives A1 and B1): ***Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area – Program-Level.*** Some program-level actions under Alternatives A1 and B1 within the Restoration Area would adversely affect riparian habitat. Other actions, such as creation of new floodplain habitat, would result in potentially beneficial effects. Implementing the action alternatives' riparian habitat and sensitive natural communities' conservation measures would offset adverse effects on riparian habitat and other sensitive natural communities. This impact would be **less than significant** and **beneficial**.

Settlement actions could directly or indirectly cause both adverse and beneficial effects on riparian vegetation. The action alternatives also includes conservation measures to avoid, minimize, or compensate for potentially adverse effects on riparian habitat and other sensitive natural communities (Conservation Measures RHSNC-1 and RHSNC-2), and these measures would be implemented as part of the program-level actions, where applicable. The potential effects of program-level actions and related conservation measures are described in the following paragraphs.

Program-level actions included in Alternatives A1 and B1 could result in vegetation removal in riparian or other sensitive plant communities. Riparian forest and scrub communities, and emergent wetlands, are considered sensitive natural communities by DFG and potentially subject to DFG jurisdiction under Section 1602 of the California Fish and Game Code. Aquatic habitats may qualify as waters of the United States under Section 404 of the CWA and waters of the State under the Porter-Cologne Water Quality Control Act. Such habitats are potentially subject to USACE jurisdiction or jurisdiction of the Central Valley RWQCB. (Impacts on waters of the United States are addressed separately under Impact VEG-2).

Under Alternatives A1 and B1, in-channel vegetation within Reach 4B1 may be removed to improve flow conveyance (to convey at least 475 cfs) and a low-flow channel, or system of channels, would be constructed in the Mariposa and Eastside bypasses. This alternative also involves modifying Reach 2B to convey at least 4,500 cfs. Modifications in these or in other reaches could include removing vegetation, establishing a new low-flow channel or channels for fish passage, dredging, grading, and recontouring activities.

A bypass channel would be constructed around the Mendota Pool in Reach 2B to convey at least 4,500 cfs from Reach 2B to Reach 3. The bypass would be constructed through agricultural lands; therefore, sensitive natural-community vegetation would not be removed except where the bypass connects to the existing river channel. The bypass would not affect water supplies and operations in Mendota Pool.

Also under Alternatives A1 and B1, gravel pits within Reach 1 could be filled or isolated from river flows as part of restoration activities. Many of these gravel pits support riparian forest and scrub communities and emergent wetlands that would be directly removed if the gravel pits were filled, or that would eventually die if the gravel pits were isolated and no longer receive enough water to support emergent wetland and riparian plant species.

Constructing haul roads, staging areas, new levees, and other potential ancillary facilities, and improving existing levees, could also result in removal of vegetation from riparian habitat and other sensitive natural communities (alkali sink, elderberry savanna, valley sacaton grassland, and vernal pool communities). Supplementing gravel in the river channel to augment spawning habitat could bury vegetation in sensitive natural communities and inhibit plant regeneration. Constructing and installing fish passages, fish barriers, and new control structures, as well as modifying existing control structures, road crossings, or DFG's San Joaquin Hatchery, could result in removal of small, localized patches of riparian or emergent wetland vegetation.

In Reach 4B1, modifications to increase conveyance to at least 475 cfs would include a reduction in the extent of in-channel riparian vegetation. The nature and extent of this removal has not yet been determined. However, because in-channel riparian vegetation is a major factor limiting conveyance in Reach 4B1, a small to substantial portion of existing riparian vegetation along this reach (457 acres) may be removed or regularly disturbed by maintenance activities.

The conservation measures would avoid, minimize, and mitigate the effects of facility construction and modification, and other restoration projects. Conservation Measure RHSNC-1 requires that riparian habitat and other sensitive natural communities be identified and mapped before commencing construction activities, that these communities be avoided by construction to the extent feasible, and that the State lead agency will comply with Section 1602 of the California Fish and Game Code. Conservation Measure RHSNC-2 requires that a Riparian Habitat Mitigation and Monitoring Plan (RHMMP) be developed and implemented to compensate for impacts to riparian, wetland, and other sensitive communities. This measure would ensure that loss of riparian habitat is compensated on a no-net-loss basis.

In addition to direct removal of riparian and emergent wetland vegetation, program-level actions could result in indirect effects on sensitive natural communities. Indirect effects could include the introduction and spread of invasive plant species, habitat fragmentation, hydrologic modifications, and alteration of geomorphic processes that scour and deposit sediment. Conservation Measure RHSNC-2 requires developing and implementating an RHMMP that would address these effects in conjunction with attaining no-net-loss of habitat acreage or function. Also, Conservation Measure INV-1 requires monitoring and controlling the spread of invasive plant species that could interfere with successful establishment and survival of native riparian plant species. This measure would enhance riparian and emergent wetland communities by controlling invasive species, such as red sesbania and giant reed, that can displace native riparian and wetland species.

Although many program-level actions under Alternatives A1 and B1 could result in removal of riparian and wetland vegetation, other actions under Alternatives A1 and B1 would result in beneficial effects on riparian and wetland communities. Actions under Alternatives A1 and B1 would include creating new floodplain habitat in Reach 2B. During periods of maximum inundation during flood flows and spring nonflood releases, this new floodplain would be inundated, and during the growing season, surface or groundwater would be accessible to plants over a greater area than at present. These changes would support the establishment and persistence of riparian and wetland vegetation over a greater area than at present. As a result, riparian and wetland habitat would be expanded from current conditions, particularly in Reach 2B, which is currently dry in most years and supports only a very narrow strip of riparian scrub habitat. Riparian vegetation also would establish within the Mendota Pool Bypass, creating a riparian corridor along a new channel segment.

Alternatives A1 and B1 also include potential actions to create and/or enhance floodplain habitat (in addition to that along Reach 2B), and to create and/or enhance side-channel habitat. New side-channel habitat may be created by excavating channels in uplands adjacent to the existing river channel, or by removing sediment from abandoned channels to reconnect them to the river channel. Enhancement activities could include dredging or widening side channels. In some instances, actions to isolate side channels, such as constructing berms or filling channels, could be implemented. Although these actions could involve channel grading and contouring activities that could remove some existing emergent wetland and riparian vegetation, the overall effect of these actions would be creation and enhancement of riparian and wetland vegetation.

To summarize, some actions under Alternatives A1 and B1, such as creation and enhancement of floodplain habitat, would result in potentially beneficial effects and overall direct and indirect impacts on riparian habitat, emergent wetland, and other sensitive natural communities in the Restoration Area would be less than significant with implementation of the riparian habitat and sensitive natural communities conservation measures (as described in Chapter 2.0, “Description of Alternatives”).

Impact VEG-2 (Alternatives A1 and B1): ***Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area – Program-Level.*** Some permanent or temporary fill of jurisdictional waters of the United States would occur at some project sites. Implementing the wetland conservation measures would offset adverse effects on waters of the United States and waters of the State, including wetlands. This impact would be **less than significant**.

As described in the following paragraphs, the program-level actions have the potential to result, indirectly or directly, in both adverse and beneficial effects on jurisdictional waters of the United States and waters of the State, including wetlands. The SJRRP includes conservation measures to avoid, minimize, or compensate for adverse effects on waters of the United States and waters of the State, including wetlands, and these measures would be implemented by as part of the program-level actions, where applicable.

Implementing Alternatives A1 and B1 would result in channel modifications in the Eastside and Mariposa bypasses, Reach 2B, Reach 4B1, and possibly other river reaches to create new low-flow channels for fish passage. These and other program-level actions may involve dredging, grading, and recontouring within the ordinary high-water mark of waters of the United States. As a result, dredged or fill materials would be discharged into waters of the United States, and permanent fill of USACE jurisdictional wetlands could occur.

Vernal pool habitat is present along Reaches 1A, 4B, and 5 and the Eastside and Mariposa bypasses. Vernal pools along Reach 1A are outside the Restoration Area; however, creating haul roads, staging areas, or other ancillary features adjacent to Reach 1A could result in loss or degradation of vernal pools. Restoration actions would not affect vernal pools in Reach 5 because no ground-disturbing activities or actions that could result in fill of vernal pools would occur in this reach. Program-level actions in Reach 4B1 and the Eastside and Mariposa bypasses, particularly channel modifications along the Eastside and Mariposa bypasses, could result in fill of vernal pools. Conservation Measures VP-1, VP-2, and WUS-1 require that vernal pools and other seasonal wetland habitats be identified and mapped before commencing construction activities and that these habitats, plus a 250-foot buffer, be avoided by construction activities to the greatest extent feasible. Conservation Measures VP-3 and WUS-2 require the lead agencies of subsequent site-specific to develop and implement compensatory mitigation resulting in no net loss of acreage, functions, or values of aquatic habitats that cannot be avoided, consistent with Section 404 of the CWA. This measure would ensure that loss of vernal pool habitat is compensated on a no-net-loss basis.

Program-level actions to manage side-channel habitat may also result in temporary or permanent fill of waters of the United States, including wetlands. Side-channel enhancement could involve dredging, grading, and recontouring to widen existing channels, which would result in discharge of fill material. In addition, some side channels could be permanently filled or isolated by constructing berms within the channel. These actions could result in loss of not only the filled side channels, but any associated wetland habitat that they support.

Construction of haul roads, staging areas, new levees, and other potential ancillary facilities could result in temporary or permanent fill of waters of the United States, including wetlands. Dumping gravel into the river channel to augment spawning habitat constitutes placement of fill into waters of the United States. Constructing and installing fish passages, fish barriers, and new control structures, as well as modifying existing control structures and road crossings, and other program-level actions, could also result in placement of fill into waters of the United States.

In addition to direct fill, indirect impacts on water quality could result from the transport of pollutants and sediment in runoff from adjacent construction sites or from construction or modification of road crossings, control structures, fish barriers, structures for fish passage, and other program-level actions. Conservation Measure WUS-2c requires Reclamation to obtain Section 401 water quality certification or to meet waste discharge requirements (WDR) (in the case of waters of the State disclaimed by USACE). This certification would occur before any groundbreaking activity within 250 feet of waters of the United States or waters of the State. Implementing these conservation measures would ensure indirect effects on water quality are avoided or minimized.

Many of the Restoration actions could result in discharge of dredged or fill material into waters of the United States, including wetlands. Most of these activities would not result in permanent loss of acreage, functions, or values of wetland habitats. New low-flow channel, side-channel, bypass channel, and floodplain habitat would be created and these and other modified areas of river reaches and bypasses would continue to convey water and support aquatic habitat. After project completion, in most instances, affected waters of the United States would be expected to have greater functional capacity than under existing conditions for several reasons: (1) fish habitat would be enhanced, (2) channels would be modified to better convey and attenuate flood flows, (3) measures to reduce sediment transport would be implemented (e.g., settling basins, bed and bank stabilization, sand traps), (4) floodplain habitat would be expanded and enhanced, (5) river reaches that are typically dry would convey seasonal flows, and (6) riparian habitat would be enhanced.

Implementing Conservation Measures VP-1, VP-2, and WUS3 would ensure that loss and degradation of waters of the United States, including vernal pools and other wetland habitats, would be avoided and minimized during construction activities, to the extent feasible. Implementing Conservation Measures VP-3 and WUS-2 would ensure that any wetland habitat or other waters of the United States that could not feasibly be avoided would be replaced, restored, or enhanced so that the project would result in no net loss of aquatic acreage, functions, and values. Therefore, this impact would be less than significant.

Impact VEG-3 (Alternatives A1 and B1): ***Facilitate Increase in Distribution and Abundance of Invasive Plants in the Restoration Area – Program-Level.*** Erosion-control materials, seed mixes, and unwashed construction equipment often transport propagules of invasive plants to construction sites where disturbed areas can provide ideal conditions for their establishment, and aid their spread into adjacent sensitive plant communities. Implementing the invasive plant conservation measure of the Conservation Strategy would offset potential adverse effects from the introduction and spread of invasive plant species. This impact would be **less than significant**.

Construction and modification of facilities and other program-level actions have the potential to introduce and spread invasive plant species in the Restoration Area. Red sesbania and giant reed are currently widespread in Reaches 1A, 1B, and 2A. Red sesbania is displacing willow scrub from sand and gravel bars in these reaches and is spreading rapidly. Many other invasive tree and shrub species are also present and interfere with establishment and survival of native riparian trees and shrubs. Ground-disturbing construction activities can create gaps in native vegetation that provide optimal sites for establishment of invasive plants. Construction equipment can transport propagules of invasive plants from one site to another. Any of the program-level actions under Alternatives A1 and B1 that incorporate vegetation removal, dredging, grading, contouring, or other ground disturbance have high potentials to spread existing invasive plant species throughout the Restoration Area. Conservation Measure INV-1 requires implementing weed management practices at all construction sites to reduce the risk of spreading or introducing invasive plants.

Invasive riparian plant species have the potential to substantially reduce the effectiveness of Alternatives A1 and B1. The native riparian vegetation in portions of the Restoration Area, especially in Reach 1, has already been substantially replaced by invasive species, including red sesbania, giant reed, tamarisk, Chinese tallow, and others. Red sesbania, giant reed, tamarisk, and Chinese tallow have been identified as high priority for control in the Restoration Area because they have the greatest potential to interfere with the success of the SJRRP. These invasive species cause general habitat degradation by displacing native riparian species such as willows and Fremont cottonwood, which provide habitat for native fish and wildlife species.

Invasive plant species also have the ability to rapidly colonize bare areas, which would be created by construction and modifications associated with some program-level actions under Alternatives A1 and B1. After colonizing bare gaps created by construction, rapidly growing invasive plants could potentially choke the channel, increasing hydraulic roughness and potentially causing an increased flood hazard. Red sesbania is of particular concern because it has the potential to substantially affect restoration success for the following reasons:

- It is a particularly aggressive invader.
- It is known to be toxic to invertebrates and fish (at least an indirect effect on salmon food sources is expected).
- It colonizes gravel bars and is expected to tie up gravel resources that are required for spawning by Chinook salmon.
- It can cause an increase in hydraulic roughness, because it colonizes many of the areas where native species typically do not grow and forms dense thickets. It likely alters the river hydraulics and adversely affects flow required to move juvenile salmonids through the system.

Program-level actions under Alternatives A1 and B1 have the potential to spread existing invasive plant species and possibly introduce additional invasive plant species. Implementing Conservation Measure INV-1 (Table 2-7) would ensure that invasive plant infestations are monitored and controlled and that the spread and introduction of invasive plants are minimized during construction. Therefore, this impact would be less than significant.

Impact VEG-4 (Alternatives A1 and B1): *Substantially Affect Special-Status Plant Species in the Restoration Area – Program-Level.* Construction activities along haul routes, in staging areas, and in project footprints could take, or temporarily or permanently eliminate habitat for a variety of special-status plants, depending on their locations within the Restoration Area. Program-level actions such as augmenting spawning gravels also could cause such effects. Implementing the special-status plant conservation measures of the Conservation Strategy would offset potential adverse effects on special-status plant species. This impact would be **less than significant**.

Thirty-five special-status plant species are known or have potential to occur in the Restoration Area (see Appendix L, “Biological Resources – Vegetation and Wildlife”). Actions under Alternatives A1 and B1 that involve removing vegetation and disturbing the ground surface could result in direct removal or mortality of special-status plants, if they are present, or in removal or degradation of suitable habitat as a result of site alteration. Several indirect impacts on special-status plants have the potential to occur: changes in vegetation as a result of changes in management practices; altered hydrology from construction of new levees, haul roads, new or modified channels, or other program-level actions; habitat fragmentation; and the introduction or spread of invasive species during construction activities.

Implementing Conservation Measures DBC-2, PALM-1, PLANTS-1, and VP1 would minimize potential impacts on special-status plants by requiring surveys to identify and map special-status plants before commencing any construction activities. Conservation Measure VP-1 and VP-2 require that potential habitat for listed vernal pool plant species be mapped and that this habitat, plus a 250-foot buffer, be avoided during siting of facilities and ground-disturbing activities, to the extent feasible. Conservation Measures DBC-3 and PALM-2 require the development of compensatory mitigation in consultation with DFG (for Delta button-celery and palmate-bracted bird’s beak) and USFWS (for palmate-bracted bird’s beak). Implementing Conservation Measures VP-3, DBC-3, PALM-2, and PLANTS-2 would ensure that any loss of occupied habitat that could not feasibly be avoided would be compensated through a combination of seeding/transplantation, restoration, preservation and enhancement, and/or creation, as appropriate. Therefore, this impact would be less than significant.

Impact VEG-5 (Alternatives A1 and B1): *Substantially Reduce Habitat or Populations of Special-Status Animals in the Restoration Area – Program-Level.* Construction activities along haul routes, in staging areas, and in project footprints could disturb take, or temporarily or permanently eliminate habitat for a variety of special-status animals, depending on their locations within the Restoration Area. Program-level actions such as augmentation of spawning gravels, also could cause adverse effects. Implementing special-status animal conservation measures of the Conservation Strategy would offset potential adverse effects on special-status animal species. This impact would be **less than significant**.

As described in the following paragraphs, program-level actions have the potential to result, indirectly or directly, in both adverse and beneficial effects on special-status animals. The Conservation Strategy includes conservation measures to avoid, minimize, or compensate for potential adverse effects on special-status animals, and these measures would be implemented by as part of the program-level actions, where applicable.

Forty-six special-status animal species are known or have potential to occur in the Restoration Area. Table 6-6 summarizes the potential for significant impacts on each special-status animal species.

Program-level actions under Alternatives A1 and B1 that involve removing vegetation and disturbing the ground surface could result in mortality of special-status animals, if they are present. In addition, a number of program-level actions may remove or degrade potential habitat for special-status species, including the following: creating, enhancing, or isolating side channels; creating setback levees; constructing bypasses or modifying existing structures; filling or isolating gravel pits; increasing channel capacity or establishing low-flow channels; and supplementing spawning gravels. The following indirect impacts on special-status animals have the potential to occur: changes in habitat as a result of changes in management practices; altered hydrology from construction of new levees, haul roads, and new or modified channels; habitat fragmentation; and introduction or spread of invasive species during construction activities.

The Conservation Strategy includes conservation measures to identify and map potential special-status wildlife habitat and to avoid and minimize loss and degradation of suitable habitat, loss of individuals, and take of listed species during construction activities. If suitable habitat for special-status animals cannot be avoided, focused surveys and/or other methods to measure the potential magnitude of the project impacts (e.g., quantification of potential habitat) would be performed at a level of detail necessary to satisfy applicable environmental compliance and permitting requirements. Any unavoidable loss of habitat for valley elderberry longhorn beetle, giant garter snake, and Swainson’s hawk, or loss of special-status bat roosts, would be compensated through implementation of the conservation measures (as described in Chapter 2.0, “Description of Alternatives”). Conservation Measure INV-1 requires control practices be applied at construction sites to minimize the introduction and spread of invasive species. Incorporation of the special-status animal conservation measures of the Conservation Strategy into restoration projects would ensure that potential adverse effects on special-status animals and their habitat are less than significant.

Table 6-6.
Programmatic Evaluation of Potential Effects from Construction and Modification of Facilities and Other Restoration Projects on Special-Status Wildlife Species in the Restoration Area

Species and Status[1]	Potential for Effects[2 3]
Vernal Pool Invertebrates conservancy fairy shrimp (FE, CH) longhorn fairy shrimp (FE, CH) vernal pool fairy shrimp (FT, CH) vernal pool tadpole shrimp (FE, CH)	High. Special-status vernal pool invertebrates are known to occur in uplands adjacent to the San Joaquin River and bypasses. Vernal pool habitat is present adjacent to Reaches 1A, 4B2, and 5, and the Eastside and Mariposa bypasses. Potentially suitable seasonal wetland habitat could be present within the Eastside and Mariposa bypasses. Potential for disturbance or loss of habitat would occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities. Ground disturbance could result in direct fill of vernal pools or indirectly affect hydrology and ecosystem function during work in upland habitats.
valley elderberry longhorn beetle (FT)	High. Valley elderberry longhorn beetle is known to occur in Reaches 1A and 2, and elderberry shrubs (potential habitat) are widespread along the San Joaquin River, especially in Reaches 1 and 2. Elderberry shrubs grow rapidly and may occur in additional areas that have not been surveyed or have grown in areas since the surveys were conducted. In addition, valley elderberry longhorn beetle could occur in more shrubs, as the exit hole surveys were not comprehensive and results may be outdated. Potential for disturbance or loss of habitat would occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities, particularly where such activities are conducted near riparian habitats.
California tiger salamander (FT, CH, ST) western spadefoot (SSC)	Moderate. California tiger salamander and western spadefoot are not expected to occur within the San Joaquin River corridor, but may occur in uplands adjacent to the river or bypasses. Potential for disturbance or loss of aquatic breeding, upland forage, refuge, and dispersal habitat could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities. Ground disturbance could result in direct loss of habitats or indirectly result in elimination of areas essential for seasonal movement.
giant garter snake (FT, ST) western pond turtle (SSC)	High. Giant garter snake is known to occur in Mendota Pool. Western pond turtle is likely to be widespread in slow-moving aquatic habitat where there are basking areas. Aquatic habitat could be affected during instream work to increase channel capacity, supplement spawning gravel, fill of gravel pits, modification of side channels, and installation of fish screens or other modification to diversion structures. Potential for disturbance or loss of upland nesting and aestivation habitat could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities.

Table 6-6.
Programmatic Evaluation of Potential Effects from Construction and Modification of Facilities and Other Restoration Projects on Special-Status Wildlife Species in the Restoration Area (contd.)

Species and Status[1]	Potential for Effects[2][3]
blunt-nosed leopard lizard (FE, SE, FP)	High. Blunt-nosed leopard lizard is known to occur in uplands adjacent to the San Joaquin River and bypasses. Potentially suitable habitat may be present within the Eastside Bypass. Potential for disturbance or loss of habitat could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities.
California horned lizard (*Phrynosoma coronatum frontale*) (SSC) San Joaquin whipsnake (*Masticophis flagellum ruddocki*) (SSC)	Low. California horned lizard and San Joaquin whipsnake distribution in or adjacent to the Restoration Area is not known; however, suitable habitat is present. Disturbance or loss of habitat could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities. Because restoration projects would affect only a very small fraction of the grassland habitat that could support these species, potential impacts are not expected to result in a substantial adverse effect on the species, result in a substantial reduction in habitat, or cause the population to drop below self-sustaining levels.
silvery legless lizard (SSC)	Low. Silvery legless lizard is known to occur near the confluence with the Chowchilla Bypass Bifurcation Structure in Reach 2B and in Reach 5. This species has a narrow range and limited dispersal capability. It occurs in upland habitats characterized by sandy soils, and vegetation that produces leaf litter. Disturbance or loss of habitat could occur during construction of Mendota Pool Bypass and modification of the channel capacity of Reach 2B. Disturbance to upland habitats for the species is not expected to result in a substantial adverse effect on the species, result in a substantial reduction in habitat, or cause the population to drop below self-sustaining levels.
Birds Breeding in Emergent Marsh redhead (*Aythya americana*) (SSC) least bittern (*Ixobrychus exilis*) (SSC) tricolored blackbird (SSC) yellow-headed blackbird (*Xanthocephalus xanthocephalus*) (SSC)	Moderate. In-channel wetland and riparian vegetation within Reaches 2B and 4B1 would be removed to improve flow conveyance and to construct a low-flow channel. This vegetation and associated wetlands may provide nesting habitat for redhead, least bittern, tricolored blackbird, and yellow-headed blackbird. Establishment of new low-flow channels within other river reaches for fish passage could involve vegetation removal, dredging, grading, and recontouring activities. Isolation or fill of the gravel pits may also remove marsh vegetation. These activities could result in loss or disturbance to birds nesting in marsh habitat if construction occurs during the breeding season. Temporary loss of habitat may occur during construction. Settlement actions may result in long-term beneficial effects to riparian and marsh habitats through creating more flood plain and managing invasive plant species.

Table 6-6.
Programmatic Evaluation of Potential Effects from Construction and Modification of Facilities and Other Restoration Projects on Special-Status Wildlife Species in the Restoration Area (contd.)

Species and Status[1]	Potential for Effects[2 3]
Birds Nesting in Trees and Shrubs Swainson's hawk (ST) white-tailed kite (FP) western yellow-billed cuckoo (FC, SE) loggerhead shrike (SSC)	High. Swainson's hawk are known to nest in almost every reach of the river. White-tailed kite and loggerhead shrike could nest throughout the river corridor where there is suitable nesting habitat. Western yellow-billed cuckoo are rare throughout the river corridor. Disturbance from construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities could result in loss of trees and shrubs occupied by nesting birds if construction occurs during the breeding season.
Birds Nesting Low and on Ground northern harrier (SSC) short-eared owl (*Asio flammeus*) (SSC) burrowing owl (SSC) least Bell's vireo (FE, SE) yellow warbler (SSC) yellow-breasted chat (SSC) grasshopper sparrow (*Ammodramus savannarum*) (SSC)	Moderate. Northern harrier, grasshopper sparrow, and short-eared owl nest in tall grasslands, crops, or wetland vegetation; burrowing owl nests in sparsely vegetated open grasslands; least Bell's vireo, yellow warbler, and yellow-breasted chat nest in riparian scrub and woodlands. Northern harrier, burrowing owl, short-eared owl, and grasshopper sparrow are expected to nest in suitable habitats in the Restoration Area. Least Bell's vireo was rediscovered nesting at the San Joaquin River NWR in 2006, but is not expected to nest in the Restoration Area. Yellow warbler and yellow-breasted chat currently are not known to nest within the San Joaquin Valley. Although these species are not known to currently nest in the Restoration Area, potentially suitable habitat may be present. Disturbance during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities could result in loss of low- and ground-nesting birds if construction occurs during the breeding season.
bald eagle (FD, SE, FP)	Low. Bald eagle are reported to nest along the Chowchilla Bypass (Dulik, pers. Comm. 2008), and historically may have nested elsewhere within the Restoration Area. Suitable foraging habitat may be present in areas of slow moving open water where prey species such as waterfowl, shorebirds, or fish are present. Construction activities are unlikely to substantially reduce the amount of foraging habitat in the area.
American peregrine falcon (*Falco peregrinus anatum*) (FD, SE, FP)	Low. American peregrine falcon is unlikely to nest near the San Joaquin River. Suitable foraging habitat may be present in areas of slow moving open water where prey species such as waterfowl, shorebirds, or fish are present. Construction activities are unlikely to substantially reduce the amount of foraging habitat in the area.

**Table 6-6.
Programmatic Evaluation of Potential Effects from Construction and Modification of Facilities and Other Restoration Projects on Special-Status Wildlife Species in the Restoration Area (contd.)**

Species and Status[1]	Potential for Effects[2 3]
Birds Wintering in Grasslands and Agricultural Fields greater sandhill crane (ST, FP) lesser sandhill crane (SSC) mountain plover (*Charadrius montanus*) (SSC)	Low. These special-status birds may use grasslands or agricultural fields adjacent to San Joaquin River and bypass system to forage in winter. Potential for disturbance or loss of habitat could occur during construction of setback levees, bypass structures, haul and access roads, staging area, modifications to channels in the bypass system, or other ground-disturbing activities. Because grassland and agricultural fields are relatively common in the Restoration Area, potential impacts are not expected to result in loss of individuals, a substantial adverse effect on the species, or a substantial reduction in habitat, or cause the population to drop below self-sustaining levels.
Bank swallow (ST)	Low. There is a historical nesting location for bank swallow at Mendota Pool. However, this nesting colony was last reported in 1980 (DFG 2011a). The current population of bank swallows is restricted to portions of the upper Sacramento River, with a few colonies located on the central and north coast, in northeastern California, and in Mono and Inyo counties (DFG 2005).
Special-Status Bats pallid bat (*Antrozous pallidus*) (SSC) Townsend's big-eared bat (*Corynorhynus townsendii*) (SSC) spotted bat (SSC) western red bat (*Lasiurus blossevillii*) (SSC) western mastiff bat (SSC)	Moderate. Bat roosts are not known to occur in the Restoration Area; however, buildings, bridges, tree hollows, or other structures could provide suitable habitat. Disturbance during modifications to bridges or road crossings, construction of setback levees and bypass structures, modifications to channels in the bypass system, or other ground-disturbing activities could result in loss of roosting colonies.
riparian brush rabbit (FE, SE)	Low. Riparian brush rabbit is unlikely to occur in the Restoration Area. Only known to occur in limited areas near San Joaquin River NWR, downstream from proposed construction activities.
Nelson's antelope squirrel (ST)	Moderate. Nelson's antelope squirrel is known to occur near the Mendota Pool. Construction of the Mendota Bypass or channel modifications in Reach 2B could affect this species.
Fresno kangaroo rat (FE, CH)	Moderate. Recent trapping surveys have not detected this species along the San Joaquin River (ESRP 2004). Populations may still occur at Alkali Sink Ecological Reserve and Mendota Wildlife Areas or other private lands where suitable habitat could exist. Construction activities and facility modifications are unlikely to affect known populations, but could affect habitat on private land adjacent to Reach 2B that has not been surveyed.
Riparian (San Joaquin Valley) woodrat (FE, SCC) ringtail (*Bassariscus astutus*) (FP)	Low. The distribution of these two special-status mammals is not well known. Although species are not known to occur in the Restoration Area, potentially suitable habitat is present. Ringtail is unlikely to occur on the valley floor in the San Joaquin Valley. Riparian woodrat populations are greatly reduced, with the only known population at Caswell Memorial State Park with a possible second population near Vernalis, downstream from the Restoration Area.

Table 6-6.
Programmatic Evaluation of Potential Effects from Construction and Modification of Facilities and Other Restoration Projects on Special-Status Wildlife Species in the Restoration Area (contd.)

Species and Status[1]	Potential for Effects[2 3]
American badger (SSC)	Low. American badger presence in the Restoration Area is unknown; however, suitable habitat is present. Because grassland and agricultural fields are relatively common in the Restoration Area, potential impacts are not expected to result in a substantial adverse effect on the species, result in a substantial reduction in habitat, or cause the population to drop below self-sustaining levels.
San Joaquin kit fox (FE, ST)	Moderate. San Joaquin kit fox has been observed in the Restoration Area. Construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities could result in loss or disturbance to dens.

Notes:
[1] Legal Status Definitions:
U.S. Fish and Wildlife Service Federal Listing Categories:
CH = Designated Critical Habitat
FC = Candidate
FD = Delisted
FE = Endangered
FT = Threatened
California Department of Fish and Game State Listing Categories:
FP = Fully Protected
SC = Candidate
SE = Endangered
SSC = Species of Special Concern (no formal protection):
ST = Threatened
[2] Describes potential effects that would be avoided and minimized by conservation measures of the Conservation Strategy. (These measures are described in Chapter 2.0, “Description of Alternatives.”)
[3] Potential for Effects Definitions:
High: The species is expected or known to occur in multiple areas or large geographic areas that could be affected by major construction or ground disturbance. The potential for adverse effects is considered high given the rarity of the species and the potential magnitude of the effects.
Moderate: Habitat conditions, behavior of the species, known occurrences in the project vicinity, or other factors indicate a relatively high likelihood that the species would occur at the project site. The potential for adverse effects is considered moderate given the rarity of the species and the potential magnitude of the effects.
Low: Suitable habitat is available at the project site; however, there are little to no other indicators that the species might be present and/or potential habitat is not likely to be adversely affected by the proposed activities or the activities would be beneficial. The potential for adverse effects is considered low given the rarity of the species and the potential magnitude of the effects.

Key:
NWR = National Wildlife Refuge
SJRRP = San Joaquin River Restoration Program

Alternatives A1 and B1 would also have beneficial effects on some special-status species. Program-level actions that promote establishment of riparian or emergent wetland vegetation over the long term, such as increasing floodplain habitat in Reaches 2B and 4B1, may have a potential benefit for riparian and wetland-associated species. (Potential beneficial effects on riparian and wetland habitats are described in Impact VEG-1).

Overall, with implementation of the Conservation Strategy, impacts on special-status animals would be less than significant.

Impact VEG-6 (Alternatives A1 and B1): *Substantially Alter Designated Critical Habitat in the Restoration Area – Program-Level.* Critical habitat for federally listed species is designated in and adjacent to the Restoration Area. Project footprints, haul routes, and staging areas could thus affect primary constituent elements in these designated areas. Program-level actions such as augmenting spawning gravels could also cause adverse effects. Implementing critical habitat and Fresno kangaroo rat conservation measures of the Conservation Strategy would offset potential adverse effects on critical habitat. This impact would be **less than significant**.

The Restoration Area includes federally designated critical habitat for the following federally listed plant and animal species: succulent owl's-clover, hairy orcutt grass, Hoover's spurge, Colusa grass, California tiger salamander, vernal pool tadpole shrimp, vernal pool fairy shrimp, longhorn fairy shrimp, and Conservancy fairy shrimp. In addition, critical habitats for San Joaquin orcutt grass and Fresno kangaroo rat have been designated within 5 miles of the Restoration Area (see Appendix L, "Biological Resources – Vegetation and Wildlife").

Program-level actions occurring in Reach 1A under Alternatives A1 and B1, such as construction and use of haul routes and staging areas for spawning-gravel augmentation or activities to fill or isolate gravel pits, could affect critical habitats for several species designated in and adjacent to the Restoration Area, including succulent owl's-clover, hairy orcutt grass, San Joaquin orcutt grass, vernal pool fairy shrimp, and California tiger salamander.

In addition, designated critical habitat for Hoover's spurge, vernal pool tadpole shrimp, vernal pool fairy shrimp, longhorn fairy shrimp, and Conservancy fairy shrimp could be affected by program-level actions proposed in Reaches 4B2 and 5 under Alternatives A1 and B1. Similar activities could occur in the Eastside and Mariposa bypasses and could affect designated critical habitats for these species and for Colusa grass. Also in the Eastside and Mariposa bypasses, structures may be modified to allow fish passage; a fish ladder may be constructed to allow upstream and downstream fish passage; and channel modifications may occur to allow fish passage under low flows. Project footprints, haul routes, and staging areas could modify primary constituent elements for critical habitat in these areas.

Program-level actions proposed in Reach 2B include constructing the Mendota Pool Bypass and an associated bifurcation structure. Constructing the bypass and bifurcation structure could affect the primary constituent elements of designated critical habitat for Fresno kangaroo rat, depending on where the project footprint and the staging and access areas are located.

Conservation Measure CH-1 requires the lead agencies of subsequent site-specific projects to identify the potential for program-level actions to adversely modify federally designated critical habitat and, to the extent feasible and practicable, design project elements to avoid direct and indirect adverse modifications on these areas. Furthermore, Conservation Measures VP-1 and VP-2 ensure that adverse effects on vernal pool habitat would be minimized and avoided, to the extent feasible, by requiring potentially suitable habitat for special-status vernal pool species to be identified, mapped, and protected by a 250-foot avoidance buffer area before construction activities. Conservation Measure CH-2 requires the lead agencies of subsequent site-specific projects to develop compensatory mitigation, in consultation with USFWS, for any unavoidable impacts on federally designated critical habitat.

With implementation of the conservation measures described above, impacts on critical habitat would be less than significant.

Impact VEG-7 (Alternatives A1 and B1): ***Conflict With Adopted Conservation Plans in the Restoration Area – Program-Level.*** Some program-level actions could have small adverse effects on adopted conservation plans, but implementing Alternatives A1 and B1 would not adversely affect habitat or species overall and would beneficially affect attainment of goals set forth in adopted conservation plans. This impact would be **less than significant** and **beneficial**.

Although some program-level actions, including construction and modification of facilities, and spawning gravel augmentation, could have small adverse effects on these plans, overall, implementing Alternatives A1 and B1 would not adversely affect adopted conservation plans. Implementing Alternatives A1 and B1 would not adversely affect adopted conservation plans because this would not substantially reduce the viability of target species, reduce habitat value or interfere with the management of conserved lands, or eliminate opportunities for conservation actions. Implementing Alternatives A1 and B1 would support the enhancement and restoration of biological resources along the San Joaquin River. In the Restoration Area, all potentially affected Federal, State, regional, and local plans have such goals or objectives, and implementing Alternatives A1 and B1 would beneficially affect their attainment. Therefore, this impact would be less than significant and beneficial.

Alternatives A2 and B2

Program-level impacts under Alternatives A2 and B2 would be identical. These impacts would be associated with construction actions within the Restoration Area, as described below. No haul roads, staging areas, control structures, or other facilities would be constructed outside the Restoration Area under Alternatives A2 and B2, and no facilities would be modified outside this area. Therefore, no program-level impacts are described outside the Restoration Area.

Impact VEG-1 (Alternatives A2 and B2): ***Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area – Program-Level.*** Some project footprints, haul routes, or staging areas would likely contain and, thus, directly affect riparian habitat; program-level actions such as spawning gravel augmentation could also cause such effects. Implementing riparian habitat and sensitive natural communities' conservation measures of the Conservation Strategy would offset adverse effects on riparian habitat and other sensitive natural communities. This impact would be **less than significant**.

Program-level actions under Alternatives A2 and B2 could directly or indirectly cause both adverse and beneficial effects on riparian vegetation. The action alternatives also include conservation measures to avoid, minimize, or compensate for adverse effects on riparian habitat and other sensitive natural communities (Conservation Measures RHSNC-1 and RHSNC-2), and these measures would be implemented as part of the program-level actions, where applicable. The potential effects of the program-level actions and related conservation measures are described in the following paragraphs.

This impact would be similar to Impact VEG-1 (Alternatives A1 and B1). The impact under Alternatives A2 and B2 would differ from the Alternatives A1 and B1 impact in the potential magnitude of impacts on riparian and emergent wetland habitats and other sensitive natural communities within Reach 4B1.

Because Alternatives A2 and B2 involve modifying Reach 4B1 to convey at least 4,500 cfs, and Alternatives A1 and B1 involve modifying the channel to convey at least 475 cfs, there is greater potential to remove and disturb vegetation in sensitive natural communities under Alternatives A2 and B2.

Construction of the new levees and associated floodplain expansion create increased opportunities to affect sensitive natural communities because of the expanded area of disturbance. However, general areas where the levees would be constructed and the new floodplain developed are currently characterized primarily by agricultural lands; therefore, the acreage of sensitive natural communities potentially present is expected to be very low. The riparian forest and scrub and emergent wetland vegetation that currently occupy a narrow band along Reach 4B1 have greater potential to be affected because a wider channel would have to be constructed, requiring a greater level of dredging and grading. The higher flows would have potential to submerge more of the existing vegetation frequently enough and long enough to result in the death of some native riparian and wetland plants.

These potential adverse effects would be offset somewhat by potential beneficial effects of these alternatives, including creation of new floodplain habitat and near-continuous flow conveyance in Reach 4B1, which is typically nearly dry under current conditions. The new levee setback and floodplain, coupled with near-continuous flows, would be expected to ultimately result in a net increase in acreage of riparian and emergent wetland vegetation.

Alternatives A2 and B2 also include conservation measures that would avoid, minimize, and compensate for adverse effects. Conservation Measure RHSNC-1 requires State lead agency compliance with Section 1602 of the California Fish and Game Code, and Conservation Measure RHSNC-2 requires developing and implementing an RHMMP to compensate for loss of acreage and function of riparian habitat. Conservation Measure RHSNC-2 also requires unavoidable losses of other sensitive natural communities (e.g., recognized as sensitive in the CNDDB but not protected under other regulations or policies) be compensated through creating, restoring, or preserving in perpetuity in-kind communities at a sufficient ratio for no net loss of habitat function or acreage. These measures would ensure that loss of riparian habitat and other sensitive natural communities is compensated on a no-net-loss basis. Also, Conservation Measure INV-1 requires monitoring and controlling the spread of invasive plant species that could interfere with successful establishment and survival of native riparian plant species. This measure would enhance riparian and emergent wetland communities by controlling invasive species, such as red sesbania and giant reed, that can displace native riparian and wetland species.

Therefore, this would be a less-than-significant effect.

Impact VEG-2 (Alternatives A2 and B2): ***Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area – Program-Level.*** Some permanent or temporary fill of jurisdictional waters of the United States would occur at some project sites. Implementing wetland conservation measures of the Conservation Strategy would offset adverse effects on waters of the United States and waters of the State, including wetlands. This impact would be **less than significant**.

This impact would be similar to Impact VEG-2 (Alternatives A1 and B1). Alternatives A2 and B2 would potentially affect more acreage of waters of the United States within Reach 4B1 than Alternatives A1 and B1.

Alternatives A2 and B2 would involve modifying Reach 4B1 to convey at least 4,500 cfs, and Alternatives A1 and B1 involve modifying the channel to convey at least 475 cfs. Therefore, greater potential exists under Alternatives A2 and B2 to discharge dredged or fill material into water of the United States in this reach, or to fill greater amounts of waters of the United States, because a wider channel would have to be constructed, requiring more dredging and grading.

Construction of new levees and associated floodplain expansion would create increased opportunities to affect wetlands and other waters of the United States because of the expanded area of disturbance. However, the general areas where the levees would be constructed and the new floodplain developed are currently characterized primarily by agricultural lands; therefore, the acreage of waters of the United States potentially present is expected to be very low. Potential adverse effects on waters of the United States are offset somewhat by potential beneficial effects of these alternatives, including creation of new floodplain habitat and near-continuous flow conveyance Reach 4B1, which is typically nearly dry under current conditions. The new levee setback and floodplain, coupled with near-continuous flows, would be expected to ultimately result in increased acreage of waters of the United States, including wetlands, which would likely develop on the floodplain adjacent to the modified channel.

As discussed under Impact VEG-2, Conservation Measures VP-1, VP-2, VP-3, WUS-1, and WUS-2 would avoid or minimize adverse effects on waters of the United States and waters of the State, including wetlands, to the extent feasible and require compensating unavoidable effects on a no-net-loss basis. Therefore, this impact would be less than significant.

Impact VEG-3 (Alternatives A2 and B2): ***Facilitate Increase in Distribution and Abundance of Invasive Plants in the Restoration Area – Program-Level.*** Erosion-control materials, seed mixes, and unwashed construction equipment often transport propagules of invasive plants to construction sites where disturbed areas can provide ideal conditions for their establishment, and aid their spread into adjacent sensitive plant communities. Implementing the invasive plant conservation measure of the Conservation Strategy would offset potential adverse effects from the introduction and spread of invasive plant species. This impact would be **less than significant**.

This impact would be similar to Impact VEG-3 (Alternatives A1 and B1). Alternatives A2 and B2 would disturb more acreage within Reach 4B1 than Alternatives A1 and B1. New setback levees would be constructed, causing ground disturbance and creating bare ground where invasive plants could establish. In addition, the expanded floodplain area within the new levees would take land out of agricultural production, leaving it open to invasive plant infestations.

As discussed under Impact VEG-3, implementing Conservation Measure INV-1 (Table 2-7) would ensure that invasive plant infestations are monitored and controlled and that the spread and introduction of invasive plants is minimized during construction. Therefore, this impact would be less than significant.

Impact VEG-4 (Alternatives A2 and B2): ***Substantially Affect Special-Status Plant Species in the Restoration Area – Program-Level.*** Construction activities along haul routes, in staging areas, and in project footprints could take or temporarily or permanently eliminate habitat for a variety of special-status plants, depending on their locations within the Restoration Area. Program-level actions such as augmenting spawning gravels also could cause such effects. Implementing special-status plant conservation measures of the Conservation Strategy would offset potential adverse effects on special-status plant species. This impact would be **less than significant**.

This impact would be similar to Impact VEG-4 (Alternatives A1 and B1). Alternatives A2 and B2 would disturb more acreage within Reach 4B1 than Alternatives A1 and B1. This larger disturbance area increases opportunities to take special-status plants or to eliminate or degrade special-status plant habitat. However, implementing Conservation Measures VP-1, VP-2, VP-3, PALM-1, PALM-2, PLANTS-1, and PLANTS-2 would ensure that adverse effects to special-status plants are avoided and minimized to the extent feasible and that any unavoidable loss of occupied habitat would be compensated through dedication of conservation easements, purchase of mitigation credits, transplantation or seed collection and establishment of new plant occurrences, preservation and enhancement of existing populations, or restoration or creation of suitable habitat in sufficient quantities to compensate for the impact.

In addition to Plants-1 and Plants-2, these alternatives include additional conservation measures for Delta button-celery in the bypasses. Numerous occurrences of Delta button-celery, a species that is State-listed as endangered, have been documented in Reach 4B1 and the Eastside Bypass. A substantial portion of all known occurrences of this species are found here. Dredging and grading activities to create new low-flow channels or widen existing channels, as well as levee construction and road crossing modifications in Reach 4B1, have the potential to remove or otherwise take Delta button-celery and remove or degrade its habitat. Conservation Measure DBC-1, however, requires occurrences of Delta button-celery to be mapped and requires development of a conservation plan, including a preservation strategy. If direct impacts to Delta button-celery could occur, DBC-3 requires that compensatory mitigation be developed in consultation with DFG. Delta button-celery should be avoided during construction activities, to the greatest extent feasible. Creating an expanded floodplain and terraced channels has the potential to beneficially affect Delta button-celery by creating additional floodplain habitat. Additionally, Conservation Measure DBC-3 requires compensation for loss of habitat, which could include development of detailed habitat creation and enhancement designs to incorporate habitat features for Delta button-celery (e.g., depressions within seasonally inundated areas) into floodplains with potentially suitable habitat conditions and establishment of new occurrences to replace any adversely affected occurrences.

With implementation of the Conservation Strategy (as described in Chapter 2.0, “Description of Alternatives”), this impact would be **less than significant**.

Impact VEG-5 (Alternatives A2 and B2): ***Substantially Reduce Habitat or Populations of Special-Status Animals in the Restoration Area – Program-Level.*** Construction activities along haul routes, in staging areas, and in project footprints could take or temporarily or permanently eliminate habitat for a variety of special-status animals, depending on their locations within the Restoration Area. Implementing special-status animal conservation measures of the Conservation Strategy would offset potential adverse effects on special-status animal species. This impact would be **less than significant**.

This impact would be similar to Impact VEG-5 (Alternatives A1 and B1). However, the potential magnitude of impact of Alternatives A2 and B2 on special-status animals within Reach 4B1 is greater. Because Alternatives A2 and B2 would involve modifying Reach 4B to convey at least 4,500 cfs, and Alternatives A1 and B1 involve modifying the channel to convey at least 475 cfs, the potential to remove and disturb habitat that could support special-status wildlife species is greater under Alternatives A2 and B2.

Construction of the new levees and associated floodplain expansion increase the potential to affect special-status animal species because of the expanded area of disturbance. However, the general areas where levees would be constructed and new floodplain developed are currently characterized primarily by agricultural lands; therefore, the acreage of habitat that potentially supports special-status animals is expected to be very low. Additionally, as discussed under Impact VEG-5, conservation measures have been incorporated into the action alternatives to avoid and minimize adverse effects on special-status animals and their habitats, and to compensate for any unavoidable losses.

The riparian forest and scrub and emergent wetland habitats, which could support several special-status animals, currently occupy a narrow band along Reach 4B1. These habitats have greater potential to be affected because a wider channel would have to be constructed, requiring a greater level of dredging and grading. The higher flows would have potential to submerge more of the existing vegetation frequently enough and long enough to result in the death of some native riparian and wetland plants. However, conservation measures, including implementation of an RHMMP (RHSNC-2), have been incorporated into the action alternatives to avoid and minimize losses of riparian habitat acreage and function.

These potential adverse impacts would be offset somewhat by potential beneficial effects of this alternative, including creation of new floodplain habitat and near-continuous flow in Reach 4B1, which is typically dry under current conditions. The new levee setback and floodplain, coupled with near-continuous flows, would be expected to ultimately result in a net increase in acreage of riparian and emergent wetland vegetation, which would provide more potential habitat for several special-status animals.

In conclusion, with implementation of the applicable conservation measures of the Conservation Strategy (described above and provided in Chapter 2.0, "Description of Alternatives"), this impact would be less than significant.

Impact VEG-6 (Alternatives A2 and B2): *Substantially Alter Designated Critical Habitat in the Restoration Area – Program-Level.* Critical habitat (e.g., for vernal pool species) is designated in the Restoration Area and, thus, project footprints, haul routes, and staging areas could affect primary constituent elements in these designated areas. Program-level actions such as augmenting spawning gravels could also cause such effects. Implementing the critical habitat conservation measures of the Conservation Strategy would offset potential adverse effects on critical habitat. This impact would be **less than significant**.

This impact would be similar to Impact VEG-6 (Alternatives A1 and B1). However, the potential magnitude of impact of Alternatives A2 and B2 on designated critical habitat within Reach 4B is greater. Because Alternatives A2 and B2 would involve modifying Reach 4B to convey at least 4,500 cfs, and Alternatives A1 and B1 involve modifying the channel to convey at least 475 cfs, the potential to remove and disturb designated critical habitat for federally listed plants and animal species is greater under Alternatives A2 and B2.

Construction of the new levees and associated floodplain expansion increase the potential to affect designated critical habitat because of the expanded area of disturbance. However, the general areas where levees would be constructed and new floodplain developed are currently characterized primarily by agricultural lands; therefore, the acreage of habitat that contains the primary constituent elements of designated critical habitat is expected to be very low.

Implementing the critical habitat conservation measures of the Conservation Strategy (CH-1 and CH-2), as discussed under Impact VEG-6, would ensure that adverse effects on critical habitat are avoided and minimized to the extent feasible and that compensation for unavoidable adverse effects is developed and implemented through the Section 7 consultation process. This impact would be less than significant.

Impact VEG-7 (Alternatives A2 and B2): ***Conflict With Adopted Conservation Plans in the Restoration Area – Program-Level.*** Construction or modification of facilities would directly have little or no adverse effects on these plans; some actions would have a direct beneficial effect; and many would have indirect beneficial effects by enabling restoration of additional riparian habitat. This impact would be **less than significant** and **beneficial**.

This impact would be similar to Impact VEG-7 (Alternatives A1 and B1), except differences in the location and magnitude of program-level actions along Reach 4B1. For the same reasons given previously, this impact would be less than significant and beneficial.

Alternative C1

Program-level impacts in the Restoration Area under Alternative C1 would be identical to those impacts described for Alternatives A1 and B1.

Additionally, Alternative C1 would result in program-level impacts to vegetation and wildlife along the San Joaquin River downstream from the Merced River, associated with the construction of new pumping infrastructure, as described below.

Impact VEG-8 (Alternative C1): ***Substantially Alter Riparian Habitat and Other Sensitive Communities Between the Merced River and the Delta – Program-Level.*** Some project footprints, haul routes, or staging areas would likely contain, and thus directly affect, riparian habitat or other sensitive natural communities. Implementing riparian habitat and sensitive natural communities' conservation measures of the Conservation Strategy would offset adverse effects on riparian habitat and other sensitive natural communities. This impact would be **less than significant**.

Under Alternative C1, vegetation within sensitive natural communities could be removed or degraded by construction of new pumping infrastructure along the San Joaquin River between the Merced River and the Delta. Additional sensitive natural community vegetation could be removed or degraded by the construction of haul roads, staging areas, and other facilities ancillary to construction and operation of the pumping infrastructure. However, conservation measure RHSNC-1 requires that riparian habitat and other sensitive natural communities be mapped before starting SJRRP actions and that all facilities be designed and sited to avoid adverse effects on these habitats. Implementing Conservation Measures RHSNC-1 and RHSNC-2 would ensure in-kind replacement of sensitive habitats that could not be avoided during construction at ratios resulting in no net loss of habitat acreage and function. Therefore, this impact would be less than significant.

Impact VEG-9 (Alternative C1): ***Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States Between the Merced River and the Delta –***

Program-Level. Discharge of dredged or fill material into jurisdictional waters of the United States would occur at some project sites. Implementing wetland conservation measures of the Conservation Strategy would offset adverse effects on waters of the United States and waters of the State, including wetlands. This impact would be **less than significant**.

Constructing new pumping infrastructure along the San Joaquin River between the Merced River and the Delta under Alternative C1 would result in placement of fill material (i.e., the materials making up the pumping infrastructure) into the San Joaquin River, a water of the United States. Construction of haul roads, staging areas, and other facilities ancillary to construction and operation of the pumping infrastructure could also result in discharge of dredged or fill material into waters of the United States, including wetlands.

However, Conservation Measure WUS-1 requires that potential waters of the United States, including wetlands, be mapped before starting program-level actions and that all facilities be designed and sited to avoid adverse effects on these habitats. Implementing Conservation Measure WUS-2 would ensure in-kind replacement of all waters of the United States and waters of the State that could not be avoided during construction at ratios resulting in no net loss of habitat acreage, functions, and values. Therefore, this impact would be less than significant.

Impact VEG-10 (Alternative C1): ***Facilitate Increase in Distribution and Abundance of Invasive Plants Between the Merced River and the Delta – Program-Level.*** Erosion-control materials, seed mixes, and unwashed construction equipment often transport propagules of invasive plants to construction sites where disturbed areas can provide ideal conditions for their establishment, and aid their spread into adjacent sensitive plant communities. Implementing invasive plant conservation measure of the Conservation Strategy would offset potential adverse effects from the spread and introduction of invasive plants. This impact would be **less than significant**.

Ground-disturbing construction activities can create gaps in native vegetation that provide optimal sites for establishment of invasive plants, and construction equipment can transport propagules of invasive plants from one site to another. Construction of new pumping infrastructure under Alternative C1 could facilitate the spread of invasive plant species along the San Joaquin River between the Merced River and the Delta by introducing propagules and creating such gaps in the native vegetation, thus allowing these species to establish.

As discussed under Impact VEG-3, implementing Conservation Measure INV-1 (Table 2-7) would ensure that invasive plant infestations are monitored and controlled and that the spread and introduction of invasive plants are minimized during construction. Therefore, this impact would be less than significant.

Impact VEG-11 (Alternative C1): ***Substantially Alter Special-Status Plant Species Between the Merced River and the Delta – Program-Level.*** Construction activities along haul routes, in staging areas, and in project footprints could take or temporarily or permanently eliminate habitat for a variety of special-status plants, depending on their locations. Implementing special-status plant conservation measures of the Conservation Strategy would offset potential adverse effects on special-status plants. This impact would be **less than significant**.

Suitable habitat for and documented occurrences of numerous special-status plant species, including federally listed and State-listed species, are present along the San Joaquin River between the Merced River and the Delta. Constructing new pumping infrastructure, and haul roads, staging areas, and other facilities ancillary to construction and operation of the pumping infrastructure could result in the removal of special-status plants and the loss or degradation of their habitat along the San Joaquin River.

However, Conservation Measures PALM-1, PLANTS-1, VP-1, and VP-2 require surveys to identify and map special-status plants be conducted before starting project construction and that any special-status plants found be avoided to the extent feasible. Conservations Measures PLANTS-2, PALM-2, and VP-3 require that DFG or USFWS be consulted, depending on species status, if adverse effects on special-status plants cannot be avoided and that compensatory mitigation be developed and implemented to offset unavoidable losses of occupied habitat. Therefore, this impact would be less than significant.

Impact VEG-12 (Alternative C1): ***Substantially Reduce Habitat or Populations of Special-Status Animals Between the Merced River and the Delta – Program-Level.*** Construction activities along haul routes, in staging areas, and in project footprints could take, or temporarily or permanently eliminate habitat for a variety of special-status animals, depending on their locations. Implementing special-status animal conservation measures of the Conservation Strategy would offset potential adverse effects on special-status animal species. This impact would be **less than significant**.

Suitable habitat for and documented occurrences of numerous special-status animal species, including federally listed and State-listed species, are present along the San Joaquin River between the Merced River and the Delta. Constructing new pumping infrastructure, and haul roads, staging areas, and other facilities ancillary to construction and operation of the pumping infrastructure could result in the removal of special-status animals and the loss or degradation of their habitat along the San Joaquin River.

However, the Conservation Strategy includes conservation measures to identify and map potential special-status wildlife habitat and to avoid and minimize loss and degradation of suitable habitat, loss of individuals, and take of listed species during construction activities (as described in Chapter 2.0, “Description of Alternatives”). If suitable habitat for special-status animals cannot be avoided, focused surveys and/or other methods to measure the potential magnitude of the project impacts (e.g., quantification of potential habitat) would be performed at a level of detail necessary to satisfy applicable environmental compliance and permitting requirements. Any unavoidable loss of habitat for valley elderberry longhorn beetle, giant garter snake, and Swainson’s hawk, or loss of special-status bat roosts would be compensated for through implementation of the conservation measures. Incorporation of the special-status animal conservation measures into program-level actions would ensure that potential adverse effects on special-status animals and their habitat are reduced to a less-than-significant level. This impact would be less than significant.

Impact VEG-13 (Alternative C1): ***Substantially Alter Designated Critical Habitat Between the Merced River and the Delta – Program-Level.*** Critical habitat (e.g., for vernal pool species) is designated along the San Joaquin River between the Merced River and the Delta. Project footprints, haul routes, and staging areas could affect primary constituent elements in these designated areas. Implementing critical habitat conservation measures of the Conservation Strategy would offset potential adverse effects on critical habitat. This impact would be **less than significant**.

Constructing new pumping infrastructure along the San Joaquin River between the Merced River and the Delta could affect designated critical habitat for federally listed plant or animal species. The primary constituent elements of critical habitats could be modified or degraded by the construction of haul roads, staging areas, and other facilities ancillary to construction and operation of the pumping infrastructure.

Conservation Measure CH-1 requires the lead agencies of subsequent site-specific projects to identify the potential for actions to adversely modify federally designated critical habitat and, to the extent feasible and practicable, design project elements to avoid direct and indirect adverse modifications on these areas. Conservation Measure CH-2 requires lead agencies of subsequent site-specific projects to develop compensatory mitigation, in consultation with USFWS, for any unavoidable impacts on federally designated critical habitat. Therefore, this impact would be less than significant.

Impact VEG-14 (Alternative C1): ***Conflict With Adopted Conservation Plans Between the Merced River and the Delta – Program-Level.*** Construction or modification of facilities along the Merced River and the Delta could conflict with the goals and provisions of adopted conservation plans. Implementing conservation plan-related conservation measures of the Conservation Strategy would minimize the potential to conflict with adopted conservation plans. This impact would be **less than significant**.

In contrast to program-level actions in the Restoration Area, construction of new pumping infrastructure along the San Joaquin River and the Delta would not contribute to the attainment of the goals of an adopted conservation plan. Depending on the site chosen, construction of new pumping infrastructure along the San Joaquin River between the Merced River and the Delta could interfere with the goals of an adopted conservation plan or reduce the effectiveness of conservation strategies if it were to result in the loss of covered species or removal or degradation of their habitat.

Conservation Measure CP-1 requires the lead agencies to site facilities and conduct construction activities in a manner consistent with the goals and strategies of adopted Habitat Conservation Plans, Natural Community Conservation Plans, or other approved local, regional, or State habitat conservation plans, to the extent feasible and practicable. If not feasible, Conservation Measure CP-2 requires the lead agencies of subsequent site-specific actions to implement any measures required by that plan to offset any potential affects that the construction of new pumping infrastructure would cause. Therefore, this impact would be less than significant.

Alternative C2

Program-level impacts in the Restoration Area under Alternative C2 would be identical to those impacts described for Alternatives A2 and B2. These impacts would be associated with physical actions in the Restoration Area, including actions to increase conveyance capacity in Reach 4B1 to 4,500 cfs.

Additionally, program-level impacts in the San Joaquin River downstream from the Merced River under Alternative C2 would be identical to impacts described for Alternative C1. These impacts would be associated with the construction of new pumping infrastructure.

These impacts would be less than significant with implementation of the Conservation Strategy (as described in Chapter 2.0, "Description of Alternatives").

6.3.3 Project-Level Impacts and Mitigation Measures

This section provides a project-level evaluation of the direct and indirect effects on biological resources resulting from project-level actions contained in each action alternative. The action alternatives could affect biological resources by altering habitat conditions or resource availability as a consequence of altering releases of water from Friant Dam and recapturing a portion of that water at existing facilities at various locations downstream. All action alternatives have the same project-level effects as water releases from Friant Dam and potential water recapture relocations do not vary between action alternatives at the project level. The project-level effects of the No-Action Alternative are also described.

No-Action Alternative

Impacts within the San Joaquin River upstream from Friant Dam, in the Restoration Area, downstream from the Merced River, in the Delta, and in the CVP/SWP water service areas under the No-Action Alternative are described below.

San Joaquin River Upstream from Friant Dam. There would be no project-level impacts under the No-Action Alternative in the vicinity of Millerton Lake, as described below.

Impact VEG-15 (No-Action Alternative): ***Effects of Surface Water Fluctuation on Biological Resources Upstream from Friant Dam – Project-Level.*** Under the No-Action Alternative, surface water conditions in the San Joaquin River and associated reservoirs above Friant Dam would not be substantially altered. Surface water elevations would continue to fluctuate within the existing gross pool elevation in response to annual variations in temperature and precipitation and current water management policies. As a result, biological resources in this area would be subjected to hydrologic conditions similar to those that have occurred since construction of Friant Dam. Biological resources above the dam are adapted to the current hydrologic regime and variations in the surface water level; therefore, they would not be adversely affected by implementation of the No-Action Alternative. There would be **no impact**.

San Joaquin River from Friant Dam to Merced River. Project-level impacts of the No-Action Alternative along the San Joaquin River from Friant Dam to the Merced River are described below.

Impact VEG-16 (No-Action Alternative): *Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area – Project-Level.* Implementing the No-Action Alternative would not substantially alter habitat conditions in the Restoration Area, including existing hydrologic conditions and associated scour and sediment deposition, which could affect riparian habitat or other sensitive natural communities. Sensitive natural communities or wetlands would not be converted to other vegetation types or to agricultural or developed land uses, nor would native vegetation be fragmented or removed from riparian habitats or other sensitive natural communities. There would be **no impact**.

Impact VEG-17 (No-Action Alternative): *Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area – Project-Level.* Implementing the No-Action Alternative would not result in reoperation of Friant Dam. As a result, hydrologic conditions would remain comparable to existing conditions. No activities that could fill or otherwise affect waters of the United States would be implemented. There would be **no impact**.

Impact VEG-18 (No-Action Alternative): *Facilitate Increase in Distribution and Abundance of Invasive Plants in Sensitive Natural Communities in the Restoration Area – Project-Level.* Under the No-Action Alternative, existing populations of invasive plant species would continue to be introduced and spread along the San Joaquin River as a result of dispersal to suitable sites by flood flows; natural and agricultural drainage; and other water releases from Friant Dam, the Mendota Pool, and other facilities. In particular, four species (i.e., red sesbania, salt cedar, giant reed, and Chinese tallow) have been identified as primary invasive species with the potential to affect habitats along the San Joaquin River. These species could potentially spread substantially as a result of continued water management operations along the San Joaquin River. This impact would be **significant and unavoidable**.

Impact VEG-19 (No-Action Alternative): *Substantially Affect Delta Button-Celery and Other Special-Status Plant Species in the Restoration Area – Project-Level.* Implementing the No-Action Alternative would not result in changes to existing hydrologic conditions, which could affect Delta button-celery. No Settlement-associated ground disturbance, vegetation removal, or other habitat modifications that could take or otherwise harm special-status plants in the Restoration Area would occur. This impact would be **less than significant**.

Impact VEG-20 (No-Action Alternative): *Substantially Reduce Habitat or Populations of Special-Status Animal Species in the Restoration Area – Project-Level.* Implementing the No-Action Alternative would not result in reoperation of Friant Dam and would not alter habitat conditions for special-status animals. This alternative would not substantially eliminate or fragment habitat along the San Joaquin River or in the bypass system. The No-Action Alternative also would not substantially alter ecologically important interactions with other organisms. Implementing the No-Action Alternative would not substantially alter habitat conditions, including existing hydrologic conditions and the associated scour and sediment deposition. There would be **no impact**.

Impact VEG-21 (No-Action Alternative): ***Substantially Alter Designated Critical Habitat in the Restoration Area – Project-Level.*** Implementing the No-Action Alternative would not result in reoperation of Friant Dam. As a result, no changes would occur in existing hydrologic conditions and the associated scour and sediment deposition that could affect any primary constituent elements of designated critical habitat for federally listed species. Existing primary constituent elements of designated critical habitats in the Restoration Area would remain comparable to existing conditions. There would be **no impact**.

Impact VEG-22 (No-Action Alternative): ***Conflict with Provisions of Adopted Habitat Conservation Plans, Natural Community Conservation Plans, and Other Approved Local, Regional, or State Conservation Plans in the Restoration Area – Project-Level.*** Implementing the No-Action Alternative would not result in reoperation of Friant Dam. Because no changes in flow regimes would be implemented, this alternative would not conflict with adopted conservation plans. The effectiveness of conservation strategies would not be reduced, and attainment of conservation plan goals and objectives would not be otherwise prevented. The No-Action Alternative also would not result in beneficial effects on plans, because it would not support attainment of goals or objectives related to enhancing or restoring biological resources along the San Joaquin River. (All potentially affected Federal, State, regional, and local plans have such goals or objectives.) There would be **no impact**.

San Joaquin River from Merced River to the Delta. Project-level impacts of the No-Action Alternative from Merced River to the Delta are described below.

Impact VEG-23 (No-Action Alternative): ***Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans Between the Merced River and the Delta – Project-Level.*** Implementing the No-Action Alternative would not result in reoperation of Friant Dam and would not result in any substantial changes to the hydrology of the San Joaquin River between the Merced River and the Delta. This impact would be **less than significant**.

Under the No-Action Alternative, existing habitats and use of the portion of the study area along the San Joaquin River between the Merced River and the Delta by special-status species would remain comparable to existing conditions. Implementing this alternative would not substantially eliminate or fragment habitat along the San Joaquin River or in the bypass system, nor would it substantially alter ecologically important interactions with other organisms.

Implementing the No-Action Alternative would not convert sensitive natural communities or wetlands to other vegetation types or to agricultural or developed land uses. Native vegetation would not be fragmented, filled, or removed from riparian habitats or sensitive natural communities.

The No-Action Alternative would not substantially affect conservation plans or other regional and local plans and policies regarding biological resources. Implementing this alternative would not adversely affect plans and policies for areas along the San Joaquin River between the Merced River and the Delta because it would not substantially reduce the viability of target species, reduce the habitat value or interfere with the management of conserved lands, eliminate opportunities for conservation actions, or otherwise conflict with adopted conservation plans or local policies. Implementing the No-Action Alternative also would not beneficially affect plans because it would not support attainment of goals or objectives related to enhancing or restoring biological resources along the San Joaquin River. (All potentially affected Federal, State, regional, and local plans have such goals or objectives).

This impact would be less than significant.

Sacramento–San Joaquin Delta. Project-level impacts of the No-Action Alternative in the Delta are described below.

Impact VEG-24 (No-Action Alternative): *Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans in the Delta – Project-Level.* Implementation of the No-Action alternative would not result in reoperation of Friant Dam and would not result in any changes to the hydrology, habitat conditions, existing habitats, or use of the Delta by special-status species. No actions or activities that could alter or fill waters of the United States or remove, fragment, or otherwise degrade sensitive natural communities in the Delta would be implemented. Implementing the No-Action Alternative would not substantially reduce the viability of target species, reduce the habitat value or interfere with the management of conserved lands in the Delta, eliminate opportunities for conservation actions, or otherwise conflict with adopted conservation plans. This impact would be **less than significant**.

CVP/SWP Water Service Areas. Project-level impacts of the No-Action Alternative within the CVP/SWP Water Service Areas are described below.

Impact VEG-25 (No-Action Alternative): ***Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans in the CVP/SWP Water Service Areas – Project-Level.*** Implementation of the No-Action Alternative would not result in reoperation of Friant Dam and would not result in any changes to the hydrology, habitat conditions, existing habitats, or use of the CVP/SWP water service area by special-status species. No actions or activities that could alter or fill waters of the United States or remove, fragment, or otherwise degrade sensitive natural communities in the CVP/SWP water service areas would be implemented. Implementing the No-Action Alternative would not substantially reduce the viability of target species, reduce the habitat value or interfere with the management of conserved lands in the CVP/SWP water service areas, eliminate opportunities for conservation actions, or otherwise conflict with adopted conservation plans. This impact would be **less than significant**.

Alternatives A1 through C2

Project-level impacts of the action alternatives would be associated with Interim and Restoration flows, and would affect all five geographic areas, as described below.

San Joaquin River Upstream from Friant Dam. Project-level impacts of Alternatives A1 through C2 at Millerton Lake and on the San Joaquin River upstream from Friant Dam are described below.

Impact VEG-15 (Alternatives A1 through C2): ***Effects of Surface Water Fluctuations from Friant Dam Reoperation on Biological Resources Upstream from the Friant Dam – Project-Level.*** Under the action alternatives, surface water fluctuations above Friant Dam could change minimally from existing conditions at specific times of year, but would remain within historical fluctuation levels. Biological resources present upstream from Friant Dam are adapted to fluctuating water levels, and water levels would not vary enough from existing conditions to have a substantial adverse effect on biological resources. This impact would be **less than significant**.

Reoperating Friant Dam would change surface water levels for Millerton Lake because of revised facilities operations. Millerton Lake is operated as a single-year reservoir, with no annual carryover, and is fully exercised (i.e., full to minimum storage) in virtually all years; this operational scenario would not change under the action alternatives. During spring flood operations, the reservoir is operated to specific storage targets; by late summer, the reservoir is typically drawn down as far as possible based on the physical diversion elevation. Because these limits would not be affected by reoperation, fluctuations in reservoir levels would remain within historical operational scenarios, and biological resources in this area would be subjected to hydrologic conditions similar to those that have occurred since construction of Friant Dam. Biological resources within the fluctuation zone above Friant Dam, including sensitive natural communities, waters of the United States, and sensitive species, are adapted to variations in surface water levels and would not be substantially affected by reoperation of Friant Dam.

Surface water elevations would remain within the historical range, but the annual reduction in surface water elevation could occur earlier in the year than under the No-Action Alternative. Two special-status plant species could be present at the shoreline of Millerton Lake: Bogg's Lake hedge-hyssop and Madera leptosiphon. Blue elderberry (host to the federally listed valley elderberry longhorn beetle) could also be present along the shoreline.

Reoperation of Friant Dam would not cause a substantial impact on these species. Bogg's Lake hedge-hyssop may be growing at or in the zone that is seasonally inundated. However, water levels within this zone already vary drastically from year to year, and reoperation of Friant Dam is unlikely to cause a substantial impact on Bogg's Lake hedge-hyssop because this species is adapted to substantial interannual variation in inundation and hydrology. Madera leptosiphon grows in blue oak woodland or grassland habitats present only above the shoreline and would not be affected. Blue elderberry shrubs grow in woodland and riparian vegetation above the immediate shoreline and thus would not be substantially affected.

For the reasons described above, this impact would be less than significant.

San Joaquin River from Friant Dam to Merced River. Project-level impacts for Alternatives A1 through C2 along the San Joaquin River from Friant Dam to the Merced River are described below.

Impact VEG-16 (Alternatives A1 through C2): ***Substantially Alter Riparian Habitat and Other Sensitive Communities in the Restoration Area – Project-Level.*** Reoperation of Friant Dam would permanently inundate and thus eliminate some patches of riparian vegetation. Reoperation would also expand or create additional areas of riparian vegetation. In addition, as necessary, applicable conservation measures of the Conservation Strategy would be implemented to offset potential adverse effects of Friant Dam reoperation on riparian habitat and other sensitive natural communities. Therefore, on balance, the reoperation is expected to substantially increase the extent of riparian habitat. This impact would be **less than significant** and **beneficial**.

Reoperating Friant Dam could directly or indirectly cause both adverse and beneficial effects on riparian vegetation. The action alternatives also include a Conservation Strategy with conservation measures to avoid and minimize the loss of riparian habitat and other sensitive natural communities during implementation of Interim and Restoration flows, and to promote the establishment of riparian vegetation (see Chapter 2.0, "Description of Alternatives"). The potential effects of project-level actions on riparian habitat and other sensitive natural communities, and related conservation measures are described in the following paragraphs.

In some locations within the Restoration Area, Interim and Restoration flows would submerge the shoots and leaves of existing riparian and wetland plants for weeks or months during each growing season. The growth of submerged plants would be reduced and some plant parts would be damaged (Coops et al. 1996, Keddy 2000). Successive years of prolonged submergence would result in mortality of some trees, shrubs, and perennial forbs that are dominant in these areas. However, riparian and wetland plants possess numerous adaptations that reduce physiological stress and damage when partially or completely submerged (Braendle and Crawford 1999, Karrenberg et al. 2002, Keddy 2000, Kozlowski et al. 1991). Also, the riparian and willow scrub and wetland vegetation that could be submerged are resistant to damage from prolonged inundation (Karrenberg et al. 2002, Keddy 2000, Vaghti and Greco 2007). Furthermore, this vegetation exists in locations that already experience scour and deposition of sediment during periodic flood flows. Thus, mortality would be expected only in riparian and wetland vegetation subjected to complete and continual submergence for several weeks or months every year, and would not occur on a large enough scale to substantially reduce the extent of existing riparian or wetland vegetation.

The scour and deposition of sediment can damage riparian and wetland vegetation by abrasion or burial (Friedman and Auble 1999). Along Reach 2 (upstream from the backwater of Mendota Pool), scour and sediment deposition may occur, as described in Chapter 10.0, "Geology and Soils." Most riparian vegetation along this reach is riparian or willow scrub, however, and the dominant species of these communities (e.g., sandbar willow) are particularly resistant to damage by scour or burial. The dominant species of emergent wetlands (e.g., cattail and tule species) also are resistant to such damage (Grace and Harrison 1986, Keddy 2000). Furthermore, scour and deposition of sediment sustains floodplain habitats (such as the depressions with which Delta button-celery is associated) and creates opportunities for plant establishment, thus sustaining the diversity of riparian and wetland vegetation. Therefore, although scour and deposition of sediment from Interim and Restoration flows would damage and bury some riparian and wetland plants, it would ultimately enhance floodplain habitat and increase establishment opportunities. As a result, a substantial adverse effect on riparian or wetland vegetation is not expected.

In the long term, Interim and Restoration flows are expected to result in a net increase in riparian and emergent wetland vegetation throughout the Restoration Area. Specifically, dam reoperation would increase the extent and duration of inundation, raise groundwater levels, and restore flows to reaches (e.g., Reaches 2B and 4B1) that currently are not inundated by most seasonal flows and are inundated by flood flows only periodically (every 2 to 5 years) that occur during winter, spring, or early summer (McBain and Trush 2002).

Reclamation conducted a study of vegetation response to flow regimes and mechanical actions of the alternatives using a one-dimensional flow, sediment transport, vegetation growth model called SRH-1DV (Appendix N, "Geomorphology, Sediment, and Vegetation Assessment"). This vegetation model predicts that riparian vegetation would increase in Reaches 1A, 1B, 2A, 2B, 3, 4A, and 4B1 with increased flows from reoperation of Friant Dam. The model predicts minimal or no change in vegetation in Reaches 4B2, 5, and the Eastside and Mariposa bypasses. In Reach 2B, the width of riparian vegetation is predicted to double by the modeling study. The SRH-1DV vegetation modeling results also predict that increased productivity of native riparian species would outpace increases in invasive riparian species, such as red sesbania, thereby reducing the competitive advantage these species have under existing conditions. While invasive plant productivity area is predicted to increase by approximately

16 percent as a result of implementing restoration flows without invasive species management, native riparian plant productivity area is predicted to increase by 33 percent.

Expected changes in riparian vegetation were also evaluated in a one-dimensional steady-state HEC-RAS model used to evaluate the expected impact on flow conveyance capacity of the San Joaquin River and bypasses from changes in riparian vegetation in response to flow regime changes. This evaluation predicted that the future extent of riparian vegetation along Reaches 1A, 3, 4B2 (downstream from Mariposa Bypass), and 5 is not likely to change substantially in response to Restoration Flows, and that changes in riparian vegetation in the bypasses would be minimal. This evaluation also predicted that riparian vegetation would increase in at least portions of Reach 1B, 2A, 2B, and 4A.

Although there are some differences in the predicted changes in vegetation by reach between the SRH-1DV vegetation modeling results and the more qualitative potential future vegetation evaluation, both predict an overall expansion of riparian vegetation in the Restoration Area in response to reoperation of Friant Dam. Similarly, pilot flow studies conducted in 2000 and 2001 suggest that restoring perennial and seasonally variable flows would increase riparian plant establishment and encourage greater plant species diversity (McBain and Trush 2002).

In many locations and times of year throughout the Restoration Area, Interim and Restoration flows would increase groundwater elevations in the root zones of riparian and wetland plants and possibly submerge some, but not all, of their aboveground parts. Where this hydration or partial submergence occurs during late spring to fall, plant growth would increase because the growth of riparian and wetland plants is sensitive to water availability at these times of year (Grace and Harrison 1986, Mitsch and Gosselink 2007, USACE 2000).

In some locations, Interim and Restoration flows would seasonally inundate areas that are currently dry during summer. This could result in adverse impacts to vernal pools and other seasonal wetlands that are adapted to wet conditions in winter and dry conditions in summer. These seasonal wetland habitats would qualify as waters of the United States under Section 404 of the CWA and waters of the State under the Porter-Cologne Water Quality Control Act. Impacts on waters of the United States are addressed separately under Impact VEG-17, below.

Increasing inundation could also result in beneficial effects. Inundation would create conditions suitable for dispersal and establishment of riparian or wetland plants. These conditions could be created by scour and sediment deposition, water transport of plant seeds and fragments to new locations, increased water availability, and reduced competition from upland plant species (such as some nonnative grasses) that are intolerant of prolonged submergence.

Conservation Measure RHSNC-2 requires implementing an RHMMP as part of the action alternatives. In addition, Conservation Measure INV-1 includes monitoring and controlling the spread of invasive plant species that could interfere with successful establishment and survival of native riparian plant species. This measure would enhance riparian and emergent wetland communities by controlling invasive species, such as red sesbania and giant reed, which can displace native riparian and wetland species.

For the reasons discussed above, Interim and Restoration flows are expected to result in a less-than-significant and beneficial effect from the action alternatives.

Impact VEG-17 (Alternatives A1 through C2): ***Fill, Fragment, Isolate, Divert, or Substantially Alter Jurisdictional Waters of the United States in the Restoration Area – Project-Level.*** Reoperating Friant Dam would permanently inundate and thus eliminate some patches of wetland vegetation, but would also expand or create additional areas of wetland vegetation. On balance, the reoperation should increase the extent of wetlands and conservation measures of the Conservation Strategy would be implemented to offset any potential adverse effects on waters of the United States, including wetlands. Therefore, this impact on waters of the United States would be **less than significant**.

As described in the following paragraphs, the project-level actions have the potential to result, indirectly or directly, in both adverse and beneficial effects on jurisdictional waters of the United States and waters of the State, including wetlands. The action alternatives include conservation measures to avoid, minimize, or compensate for adverse effects on waters of the United States and waters of the State, including wetlands (as described in Chapter 2.0, “Description of Alternatives”), and these measures would be implemented as part of the action alternatives.

Reoperating Friant Dam would not result in discharge of dredged or fill material into waters of the United States. Hydrologic modifications resulting from reoperation would not result in the loss or degradation of waters of the United States. River reaches and bypasses that currently convey water would continue to do so, and reaches that are typically dry for most of the year would convey water and support aquatic habitat for longer periods than under existing conditions.

However, some wetlands would potentially be eliminated because they would become permanently inundated. In some locations, Interim and Restoration flows would seasonally inundate areas that are currently dry during early summer. This could result in adverse impacts to vernal pools and other seasonal wetlands that are adapted to wet conditions in winter and dry conditions in summer, if they are present within existing levees. Depending on the duration, timing, and magnitude of summer flooding, these impacts could be significant. Interim and Restoration flows would generally be confined to the low-flow channel and these channels are below grade; therefore, flows would be unlikely to extend to adjacent lands outside existing levees even in the case of seepage or levee failure. Also, the project includes seepage management and monitoring that would prevent long-term impacts from seepage. However, there is some potential for vernal pools or other seasonal wetlands to be present within the existing levees along the Eastside and Mariposa bypasses, and there is limited potential for these wetlands, if they are present, to be adversely affected by extended frequency or duration of inundation resulting from reoperation of Friant Dam. It is very unlikely that vernal pools and other seasonal wetlands would be substantially affected by the project because (1) Interim and

Restoration flows would be restricted to low-flow channels where these types of wetlands do not occur, (2) habitats within existing levees are already subject to periodic flooding, and (3) the acreage of vernal pool or other seasonal wetland habitat present within the bypass levees is expected to be very low, if any. However, because the bypass channels have not been surveyed and habitat has not been mapped, the possibility for seasonal wetlands to be present and adversely affected by the project cannot be ruled out.

Overall, the acreage and functional capacity of wetlands is expected to increase compared to existing conditions because Interim and Restoration flows would seasonally inundate areas that do not currently support wetlands. As discussed under Impact VEG-16, this inundation would create conditions suitable for dispersal and establishment of wetland plants. These conditions could be created by several factors: scour and sediment deposition, water transport of plant seeds and fragments to new locations, increased water availability, and reduced competition from upland plant species (such as some nonnative grasses) that are intolerant of prolonged submergence. The primary and most ecologically important difference from existing flood flows would be the duration and seasonality of inundation. Interim and Restoration flows would inundate some areas for much longer periods than would seasonal flows or flood flows, and these flows would occur in seasons when current flood flows do not occur (i.e., summer and fall). As a result, both perennial and seasonal wetland habitats would be established, depending on landscape position relative to the low-flow channel.

Conservation Measure WUS-1 requires the distribution of potential waters of the United States, including wetlands, be mapped in the Restoration Area before implementing Settlement actions in the Eastside and Mariposa bypasses that may affect waters of the United States or waters of the State. Based on the mapped distribution, field observation, and hydraulic modeling, the lead agencies will determine the acreage of impacts, if any, on waters of the United States and waters of the State that would result from project-level actions. Conservation Measure WUS-2 requires the lead agencies to replace, restore, or enhance on a “no net loss” basis the acreage, functions, and values of wetlands and other waters of the United States and waters of the State that would be removed and/or degraded with reoperation of Friant Dam. Therefore, this impact would be less than significant.

Impact VEG-18 (Alternatives A1 through C2): *Facilitate Increase in Distribution and Abundance of Invasive Plants in Sensitive Natural Communities in the Restoration Area – Project-Level.* Interim and Restoration flows could both enhance dispersal of red sesbania and other invasive plant species downstream, and substantially increase opportunities for establishment, growth, and reproduction downstream. These species, especially red sesbania, are capable of substantially affecting riparian and wetland vegetation. Conservation measures of the Conservation Strategy would be implemented to offset the potential adverse effects from changes to the distribution and abundance of invasive plants. This impact would be **less than significant**.

Red sesbania is currently abundant and widespread throughout Reaches 1 and 2 of the Restoration Area. Interim and Restoration flows could substantially increase the quantity of water flowing through some reaches of the San Joaquin River. In these reaches and portions of the bypass system, more water would flow continuously during summer and fall. These hydrologic alterations could introduce and spread the five species identified as the primary invasive species that have potential to substantially alter habitats and increase as a result of project-level actions: red sesbania, salt cedar, giant reed, sponge plant, and Chinese tallow. These hydrologic alterations also could potentially cause a substantial increase in the distribution of sponge plant, which is an aquatic invasive species that is present in Reach 1 but that currently has a very restricted distribution in California.

Interim and Restoration flows would disperse propagules of these species, particularly giant reed and red sesbania. Giant reed is dispersed by high flows (and machinery) that fragment plants and carry fragments downstream to new sites, where they take root and begin forming a new colony (Bossard et al. 2000). Red sesbania produces seed pods that float for several days (Hunter and Platenkamp 2003). Sponge plant is an aquatic species distributed by water. Therefore, these species could be dispersed to additional locations by Interim and Restoration flows.

In the San Joaquin Valley, these five invasive species are largely confined to sites with moderate or high levels of water availability. Therefore, by increasing water availability throughout the growing season, particularly in locations that would otherwise lack surface water (such as Reach 2A), Interim and Restoration flows could aid their establishment at any locations along the San Joaquin River that receive Interim and Restoration flows. Established plants are less sensitive than seedlings to water availability and have deeper and more extensive root systems; therefore, these plants, once established, would likely persist at additional sites. In particular, Interim and Restoration flows may aid the establishment of red sesbania at additional locations. Because red sesbania is abundant in Reach 1 and produces floating seed that can remain dormant for at least several years, the increased availability of water during the growing season would likely allow the establishment of numerous individuals in locations where they otherwise would not have been able to germinate, grow, and survive.

Conservation Measure INV-1 requires the lead agencies to implement the Invasive Vegetation Monitoring and Management Plan (Appendix L, “Biology – Vegetation and Wildlife”) before the release of Interim and Restoration flows to control the spread and introduction of invasive plants in the Restoration Area. Conservation Measure INV-1 mandates comprehensive surveys to identify, map, and quantify invasive plant infestations on the mainstem of the San Joaquin River in the Restoration Area before reoperation of Friant Dam commences. As specified under Conservation Measure INV-1, the vegetation management plan also includes measures to monitor, control, and eradicate, where possible, invasive plant infestations. The vegetation management plan includes monitoring procedures, success criteria, and adaptive management measures for controlling invasive plant species. For these reasons, this impact would be less than significant.

Impact VEG-19 (Alternatives A1 through C2): ***Substantially Affect Delta Button-Celery and Other Special-Status Plant Species in the Restoration Area – Project-Level.*** A substantial portion of the known populations and occupied habitat of Delta button-celery in the Restoration Area is located in areas that would be affected by project-level actions. In addition, vernal pools and other seasonal wetlands that have potential to support special-status plant species could be adversely affected by project-level actions and this, in turn, could adversely affect special-status plants if they are present. Conservation measures of the Conservation Strategy would be implemented to offset potential adverse effects on special-status plants. This impact would be **less than significant**.

Delta button-celery, a species that is State-listed as endangered, has been documented at 36 locations in the Restoration Area within Reaches 4B and 5 and the Eastside and Mariposa bypasses. These occurrences represent approximately three-quarters of all known occurrences of Delta button-celery. Because this species inhabits seasonally inundated floodplain depressions in riparian scrub habitat and the release of Interim and Restoration flows would substantially alter the hydrologic regime within Reach 4B, the action alternatives have potential to result in both beneficial and adverse effects on Delta button-celery populations in this reach. The action alternatives also include conservation measures to avoid and minimize the loss of Delta button-celery during implementation of Interim and Restoration flows, and to promote the expansion of suitable habitat for this species (see Chapter 2.0, “Description of Alternatives”). The potential effects of project-level actions on Delta button-celery and other special-status plants, and related conservation measures are described in the following paragraphs.

Adverse effects on Delta button-celery could result if occupied habitat becomes inundated for too long during the growing season for plants to successfully complete any portion of their life cycle. Although periodic flood flows are necessary to sustain Delta button-celery habitat, and the species is adapted to seasonal inundation, prolonged inundation during spring and summer can adversely affect this species (DFG 2005).

Beneficial effects on Delta button-celery could result from the creation of additional suitable habitat for this species and a hydrologic regime that enhances conditions for growth and reproduction of existing populations. Increasing the frequency, extent, and duration of inundation within Reach 4B1 under all action alternatives, in addition to the channel and floodplain modifications to enable conveyance of at least 4,500 cfs under Alternatives A2, B2, and C2, is expected to restore and enhance floodplain habitat for Delta button-celery. This floodplain habitat was adversely affected by the reduced flood frequency and intensity that resulted from construction and operation of Friant Dam and the associated levee, canal, and bypass systems.

Conservation Measures DBC-1, DBC-3, and DBC-4 specify that Reclamation would develop and implement a Delta button-celery conservation plan that includes a preservation and adaptive management strategy for existing occurrences of Delta button-celery. The Delta button-celery conservation plan would be developed in consultation with DFG and would identify and implement all measures necessary to avoid and minimize impacts to Delta button-celery and include compensatory mitigation for impacts. The conservation plan would include conducting comprehensive surveys to identify, quantify, and map occurrences of Delta button-celery in the Restoration Area before release of Interim and Restoration flows that would result in inundation beyond the existing low-flow channel. These occurrences would be monitored for changes in distribution and abundance during implementation of the Settlement. The Delta button-celery conservation plan would include performance criteria and corrective management, determined in coordination with DFG, to apply if performance criteria are not met. If monitoring efforts indicate a decrease in Delta button-celery during at least 2 consecutive or nonconsecutive years following initiation of Interim and Restoration flows, or other time period as determined in coordination with DFG, Reclamation would provide compensatory mitigation through habitat creation for loss of habitat and, if necessary, would attempt to establish new occurrences. Additional compensatory mitigation may include preserving and enhancing other existing populations of Delta button-celery within the Restoration Area or off site. Additional conservation and mitigation measures may be developed as necessary in consultation with DFG during implementation of the conservation plan. With implementation of the Conservation Strategy, impacts on Delta button-celery would be less than significant.

Six other federally listed or State-listed plant species are known from or could occur in the Restoration Area. Five of these are vernal pool species that could occur on terraces above Reach 1A: succulent owl's-clover, Bogg's Lake hedge-hyssop, Colusa grass, San Joaquin Valley Orcutt grass, and hairy Orcutt grass. Because of their landscape position on high terraces outside the Restoration Area, Interim and Restoration flows would not substantially alter the hydrologic regime in vernal pool systems above Reach 1A, and vernal pool plant species would not be affected. The sixth species, Hoover's spurge, could occur in vernal pool habitat in Reaches 4B and 5 and the Mariposa and Eastside bypasses. Potential impacts to vernal pool species in this area are discussed below.

An additional 23 special-status plant species that are not federally listed or State-listed are known from or could occur in the Restoration Area. Six of these species occur primarily in vernal pool landscapes: alkali milk-vetch, vernal pool smallscale, dwarf downingia, spiny-sepaled button-celery, little mousetail, and prostrate navarretia.

Vernal pool and seasonal wetlands suitable for these vernal pool plant species are not likely to be present within the San Joaquin River corridor (e.g., between the existing banks or levees); therefore, Interim and Restoration flows are not likely to affect these species in these areas.

Vernal pool habitat is present within the Restoration Area in Reaches 4B and 5 and the Mariposa and Eastside bypasses. It is unlikely that vernal pools occur within existing channels and levees; however, the potential cannot be ruled out because habitat mapping has not been completed in these areas and vernal pools are known to occur, or have occurred historically, outside the bypass levees in adjacent lands. Hoover's spurge, Colusa grass, and Bogg's Lake hedge hyssop are federally listed or State-listed plant species that could occur in vernal pools in Reaches 4B and 5 and the Mariposa and Eastside bypasses. As discussed previously under Impact VEG-17, vernal pools and other seasonal wetlands outside the levees would not be affected by reoperation of Friant Dam. If vernal pools or other seasonal wetland habitats are present within existing levees, Interim and Restoration flows could increase the extent, duration, or frequency of inundation in these habitats. Special-status vernal pool plants could be adversely affected if these habitats become inundated too long during the growing season for them to complete their life cycles.

The action alternatives include Conservation Measures VP-1 and PLANTS-1 to avoid and minimize loss of vernal pool habitat and risk of take of special-status vernal pool plants. Conservation Measure VP-3 provides that Reclamation would compensate for temporary or permanent loss of vernal pool habitat or take of listed species. Compensatory mitigation would include creating or restoring vernal pool habitat at adequate ratios to offset the habitat acreage, functions, and values that would be lost, account for the temporal loss of habitat, and contain an adequate margin of safety to reflect anticipated success. Therefore, impacts on special-status vernal pool plants, including federally listed and State-listed species, would be less than significant.

Five of the special-status species that are not federally listed or State-listed are species of upland, annual grassland landscapes: subtle orache, recurved larkspur (*Delphinium recurvatum*), round-leaved filaree (*Erodium macrophyllum*), Munz's tidy-tips, and caper-fruited tropidocarpum (*Tropidocarpum capparideum*). Potential habitat for these species may be inundated by Interim and Restoration flows, particularly along Reaches 1 and 2 during spring and early summer flows. However, at any one location along the river, only a small portion of the upland grassland has the potential to be inundated. These would also be areas that already experience periodic inundation by flood flows; thus, species in these areas have some ability to tolerate or recover from flood flows or reestablish from adjacent uplands. For these reasons, these species would not be substantially affected. These impacts would be less than significant.

Five of the special-status species that are not federally listed or State-listed are species of riverine or marsh habitats or that could occur in riparian vegetation: four-angled spikerush (*Eleocharis quadrangulata*), California satintail (*Imperata brevifolia*), slender-leaved pondweed (*Potamogeton filiformis*), Sanford's arrowhead, and Wright's trichocoronis. Sanford's arrowhead is known from the Mendota Pool, but inundation of marsh and riparian habitat at the Mendota Pool and its backwater along Reach 2B would not change substantially as a result of Interim and Restoration flows because the water surface elevation of the Mendota Pool and, consequently, of the backwater along Reach 2B, are managed for the operation of connected canals conveying water supply deliveries. This would not change with the project-level actions.

Elsewhere, Interim and Restoration flows would alter inundation of marsh and riparian habitats and thus could affect these five special-status species. As described throughout this chapter, marsh and riparian plants could experience temporary adverse and beneficial impacts, but these impacts would not be substantial. Therefore, these species would not be substantially affected by Interim and Restoration flows. These impacts would be less than significant.

Palmate-bracted bird's beak, a species that is federally listed and State-listed as endangered, is known to occur in the vicinity of the Restoration Area near Reach 3 and the Chowchilla Bypass. This species grows in saline-alkaline soils in valley sink scrub and alkali meadow communities (USFWS 1998). This species primarily occurs along drainage channels (USFWS 1998). Suitable habitat for this species may be present in the Restoration Area, and Interim and Restoration flows could adversely affect this species if it is present. Conservation Measure PALM-1 requires surveys to identify and map occurrences of palmate-bracted bird's beak within suitable habitat in the Restoration Area, and measures to avoid adverse effects on occupied habitat to the extent feasible. Conservation Measure PALM-2 ensures a compensatory mitigation plan for loss of individuals and occupied habitat would be developed in consultation with USFWS and DFG. Therefore, impacts on palmate-bracted bird's beak would be less than significant.

In summary, impacts on special-status plant species other than Delta button-celery, palmate-bracted bird's beak, and vernal pool-associated species would be unlikely to occur, would be avoided, would not be substantial, or could be beneficial. These impacts would be less than significant. Impacts on Delta button-celery, palmate-bracted bird's beak, and special-status plant species associated with vernal pool habitats, if they are present, would be less than significant with implementation of Conservation Measures VP-1, VP-3, DBC-1, DBC-3, PALM-1, and PALM-2.

Impact VEG-20 (Alternatives A1 through C2): ***Substantially Reduce Habitat or Populations of Special-Status Animal Species in the Restoration Area – Project-Level.*** A variety of special-status animals could be affected by initial inundation of occupied habitat and/or loss of upland habitat converted to open water, wetland, or riparian vegetation types. Implementing special-status animal conservation measures would offset potential adverse effects on special-status animals. This impact would be **less than significant**.

Forty-six special-status animal species are known or have the potential to occur in the Restoration Area. Interim and Restoration flows could inundate areas that are seasonally inundated during winter, spring, or early summer (March 16 through June 30) in most years, and areas that are not inundated by most seasonal flows but are periodically inundated by flood flows (every 2 to 5 years) that occur during winter, spring, or early summer (McBain and Trush 2002).

Most potential effects of Interim and Restoration flows would be comparable to effects of the periodic flood flows that have occurred historically and would continue under both the No-Action Alternative and the action alternatives. Many of these effects are beneficial, such as greater availability of water to support growth of riparian or wetland vegetation. The primary and most ecologically important difference from existing flows would be the duration and seasonality of inundation; Interim and Restoration flows could inundate some areas for much longer periods than would existing seasonal flows or flood flows, and Interim and Restoration flows also would occur in seasons when some reaches are typically dry (i.e., summer and fall).

Special-Status Invertebrates. Five federally listed invertebrate species are known to occur in the Restoration Area. Valley elderberry longhorn beetle is associated with riparian habitat and the following four species are associated with vernal pools:

isolated pools that remained contained only a few invertebrates, such as Dytiscid larvae. The cladocerans and ostracods that dominated the pools during the previous survey were no longer evident.

Although listed vernal pool invertebrates are unlikely to occur within the low-flow channels in the Eastside and Mariposa bypasses, some seasonal wetland habitat may be present on bank terraces within existing levees. These habitats could become unsuitable for vernal pool invertebrates if they would be regularly inundated by Interim and Restoration flows. If listed vernal pool invertebrates are present in these habitats, implementing Interim and Restoration flows that would extend beyond the existing low-flow channel would be a potentially significant impact. However, if it is determined that areas within 250 feet of suitable vernal pool invertebrate habitat would be regularly inundated by Interim and Restoration flows, Conservation Measure VP-3 requires that a compensatory mitigation plan be developed, in consultation with USFWS, to replace, restore, and enhance vernal pool habitat at an adequate mitigation ratio to offset the habitat acreage, functions, and values that would be lost, account for the temporal loss of habitat, and contain an adequate margin of safety to reflect anticipated success. Therefore, this impact would be less than significant.

Valley elderberry longhorn beetle, federally listed as threatened, is solely dependent on its host plant, blue elderberry (*Sambucus mexicanus*) to complete its life cycle. Elderberry shrubs are associated with riparian habitats and typically are located on the higher portions of levees and streambanks, which are not subject to inundation or scouring (Fremier and Talley 2009).

During 2004 and 2005, surveys for elderberry shrubs and evidence of valley elderberry longhorn beetle were conducted over 77 percent of the San Joaquin River between Friant Dam and the Merced River confluence (ESRP 2006). Evidence of valley elderberry longhorn beetle was found to occur in 14 shrubs in Reach 1A and two shrubs in Reach 2, out of more than 400 shrubs examined (ESRP 2006). Thus, fewer than 4 percent of examined elderberry shrubs in Reaches 1 and 2 contained evidence of past valley elderberry longhorn beetle occupancy (ESRP 2006).

Valley elderberry longhorn beetle may occur in other locations in the Restoration Area where their host plant is present. During vegetation surveys of the Restoration Area, elderberry shrubs have been documented in Reach 1A in riparian forest along the lower portions of bluffs above the river, and in several patches of elderberry savanna that are at higher elevations along Reaches 1 and 2 (Reclamation 1998a). Most elderberry shrubs in the Restoration Area are not anticipated to be inundated by Interim and Restoration flows because of their locations higher on the stream banks; however, some elderberry shrubs were noted to be growing along the channel in Reach 2A (ESRP 2004, 2006), likely a result of altered channel formation and limited flows. Except during times of floods, water passing Gravelly Ford (head of Reach 2A) typically infiltrates the sandy bed before reaching the end of Reach 2A.

- Conservancy fairy shrimp, federally listed as endangered
- Longhorn fairy shrimp, federally listed as endangered
- Vernal pool fairy shrimp, federally listed as threatened
- Vernal pool tadpole shrimp, federally listed as endangered

Vernal pools and seasonal wetlands suitable for these vernal pool invertebrates are not likely to be present within the San Joaquin River corridor (e.g., between the existing banks or levees); therefore, Interim and Restoration flows are not likely to affect these species in these areas.

The presence of suitable vernal pool or seasonal wetland habitat in the Eastside and Mariposa bypasses is unknown. These bypasses were created in uplands that historically contained northern claypan vernal pools. Land conversion for agricultural development, and the subsequent hydrologic modification from creating the bypasses and agricultural diversions and discharge, has eliminated natural vernal pools from many areas. However, because of the high clay content of soils in the area, depressions caused by previous construction activities in upland habitats still tend to hold rainwater for an extended period; therefore, soil and hydrologic conditions may be suitable to support vernal pool invertebrates in some areas. Conservation Measure VP-1 requires surveys to identify and map vernal pools and other seasonal wetland habitats that could support special-status species in the Eastside and Mariposa bypasses before releasing Interim and Restoration flows of magnitudes that could result in inundation beyond the existing low-flow channel.

As described under Impact VEG-17, vernal pools are not expected to be substantially affected by the project. The project is designed so that Interim and Restoration flows would be restricted to the low-flow channel, and these channels are below grade; therefore, flows would be unlikely to extend to adjacent lands outside existing levees even in the case of seepage or levee failure. Also, the project includes seepage management and monitoring that would prevent long-term impacts to vernal pools and associated listed invertebrates outside the bypass levees from seepage.

Existing conditions within the existing low-flow channel bypasses are unlikely to be suitable for listed vernal pool invertebrates because of the regular inundation of the channel during seasonal flood flows. A reconnaissance-level survey of the Eastside Bypass from West Washington Road and Sandy Mush Road was conducted in February and March 2000 (DFG 2000). In February, no evidence of any characteristic vernal pool species was observed in rainwater-filled depressions in the Eastside Bypass, with the exception of early successional invertebrates such as ostracods (seed shrimp) and ceriodaphnid cladocerans (water fleas). Dytiscid larvae and adults (predaceous diving beetles), and crayfish exoskeletons were also commonly encountered. No vernal pool plant species surrounded the pools; cocklebur (*Xanthium strumarium*) was the dominant plant species in these areas. In March, most of the pools observed during the previous survey were completely submerged under a continuous sheet of flowing water, likely the result of flood releases down the San Joaquin River. Large fish such as carp were observed in some of the deeper wetted areas, as well as some adult western toad. The few

As described above in Impact VEG-16, Interim and Restoration flows are expected to submerge the shoots and leaves of existing riparian and wetland plants for weeks or months during each growing season, which may damage some plant parts or reduce growth. However, riparian plants can adapt to deal with, and in some cases require, conditions of periodic inundation. As described above, most elderberry shrubs are not expected to be growing in the low-flow channels or in areas currently subject to scouring flows. Elderberry shrubs are relatively inefficient at adjusting to flood inundation compared with other riparian plants, such as willow (Fremier and Talley 2009).

It is uncertain how valley elderberry longhorn beetles would respond to inundation of elderberry host plants for a maximum period of up to 14 weeks, from mid-March to the end of June. Valley elderberry longhorn beetle larvae use the pith of elderberry stems, a very low-nutrient (and probably a low oxygen) environment, as a growth chamber from mid-March to June, when adults emerge to feed and reproduce on leaves and flowers of the elderberry shrub. Therefore, inundating the lower portions of the elderberry plant, if the plant is not damaged or taken, is not likely to adversely affect beetle larvae, if they are present.

In a study on the Cosumnes River, the density of valley elderberry longhorn beetle exit holes was negatively correlated with higher relative bank position (Fremier and Talley 2009). That is, valley elderberry longhorn beetles are more likely to occur in shrubs closer to the river. Although many environmental variables may affect the distribution of valley elderberry longhorn beetle (Fremier and Talley 2009), the proximity to river flows and association with riparian communities are important factors that contribute to the presence of the species.

In the long term, reoperation of Friant Dam is expected to result in a net increase in riparian and emergent wetland vegetation throughout the Restoration Area. Reoperating the dam would increase the extent and duration of inundation, raise groundwater levels, and restore flows to reaches (e.g., Reaches 2B and 4B) that currently are not inundated by most seasonal flows, and are inundated by flood flows only periodically (every 2 to 5 years) during winter, spring, or early summer (McBain and Trush 2002). Ultimately, this would have a beneficial effect on valley elderberry longhorn beetle. In the short term, however, scour and sediment deposition along Reach 2 resulting from Interim and Restoration flows could uproot or bury elderberry shrubs.

Implementing Interim and Restoration flows would not likely result in loss of or damage to most elderberry shrubs growing high on the banks or levees, and therefore would not likely have a significant impact on valley elderberry longhorn beetle if the species were present. However, in Reach 2A, where elderberry shrubs may be growing low within portions of the channel that do not receive regular flows, implementing Interim and Restoration flows could result in damage or physiological stress to elderberry shrubs that may contain valley elderberry longhorn beetle.

Conservation Measure VELB-1 requires surveys be conducted to identify elderberry shrubs in Reach 2A that may be affected by implementing the Interim and Restoration flows, through scouring or deposition of sediment, or prolonged inundation due to their position within the channel. The conservation measure also requires that elderberry shrubs that could be adversely affected be examined for valley elderberry longhorn beetle exit holes in stems greater than 1 inch in diameter. Conservation Measure VELB-2 requires compensation by USFWS for impacts to elderberry shrubs that cannot be avoided.

With implementation of the VELB conservation measures of the Conservation Strategy, this impact on valley elderberry longhorn beetle would be less than significant.

Special-Status Amphibians. California tiger salamander and western spadefoot use vernal pools and seasonal wetlands for breeding and upland grassland habitats for dispersal, foraging, and refuge. California tiger salamander is federally and State-listed as threatened. Western spadefoot is a California species of special concern. These species are not expected to occur within the San Joaquin River corridor; however, suitable-season wetland habitat may exist within the Eastside and Mariposa bypasses, outside the low-flow channels, as described above. Regularly inundating these habitats may make seasonal pools unsuitable by altering their hydrology or by increasing predation from nonnative fish or bullfrogs, which require more permanent water. If California tiger salamander or western spadefoot were present in seasonal wetland habitats in the bypasses, implementing Interim and Restoration flows at magnitudes that would exceed the existing low-flow channel capacity could result in loss of habitat or individuals.

However, vernal pool conservation measures have been incorporated into the Conservation Strategy to avoid, minimize, and compensate adverse effects on vernal pool habitat. These measures include identifying and mapping vernal pool and seasonal wetland habitat potentially suitable for western spadefoot and California tiger salamander within the Mariposa and Eastside bypasses and avoiding and minimizing project effects to the extent feasible (VP-1). Conservation Measure VP-3 requires a compensatory mitigation plan that would result in no net loss of habitat acreage, functions, and values be developed and implemented through the ESA Section 7 consultation process. If suitable habitat for California tiger salamander is identified in areas not currently subject to regular flooding and it is determined that this habitat would be regularly inundated by Interim or Restoration flows, focused surveys for California tiger salamander will be conducted. If California tiger salamander is detected in areas that could be affected by implementing flows, Conservation Measure VP-3 requires Reclamation to consult with DFG and apply for a State incidental take permit. Reclamation would comply with all terms and conditions set forth in the permit as determined in coordination with DFG. Measures to fully mitigate the impact of take of California tiger salamander would be developed during the incidental take permit process. Therefore, this impact would be less than significant.

Special-Status Reptiles. Blunt-nosed leopard lizard is federally listed and State-listed as endangered and is fully protected under the California State Fish and Game Code. The species uses alkali scrub and other open habitats with scattered low bushes. Blunt-nosed leopard lizards are known to occur in the Chowchilla Bypass and could occur if suitable habitat is present in the Eastside and Mariposa bypasses. They are not expected to occur within the San Joaquin River corridor or the existing low-flow channel of the bypasses because these areas are regularly inundated during seasonal flood flows. Implementing Interim and Restoration flows could inundate suitable habitat for the blunt-nosed leopard lizard. However, Conservation Measure BNLL-1 requires potentially suitable habitat for the blunt-nosed leopard lizard be mapped within the Mariposa and Eastside bypasses before Interim and Restoration flow releases that would exceed existing low-flow channel capacity. If it is determined that suitable habitat that is not currently subject to regular flooding would be regularly inundated by Interim or Restoration flows, the conservation measures require that focused surveys be conducted in accordance with a protocol developed by USFWS and DFG for this project. If the blunt-nosed leopard lizard is detected in areas that could be affected by implementing the flows, Reclamation would consult with USFWS and DFG to develop and implement the appropriate additional avoidance measures. Therefore this impact would be less than significant.

Aquatic reptiles (giant garter snake, which is federally listed and State-listed as threatened and western pond turtle, which is a California species of special concern) are known to occur in suitable habitat in the San Luis NWR Complex, in the MWA, and at the Mendota Pool. These reptiles are expected to occur in suitable habitat in other locations in the Restoration Area and may occur in the portions of the river channel that would be inundated by the release of Interim and Restoration flows. These species require aquatic habitat for breeding and foraging during spring and summer. Therefore, the presence of additional flows during these seasons, as well as in winter, would have a beneficial effect on these species. Although water velocities would increase in Mendota Pool between the San Joaquin River and Mendota Dam during Interim Flows, velocity would not be substantially altered because, although hydraulically connected, most of the pool lies outside of the Interim Flow route. Velocities within the pool’s backwater on the San Joaquin River would not increase substantially because of the pool’s width.

Effects on upland habitats that these species use for refuge (giant garter snake) and nesting (western pond turtle) are not expected from Friant Dam reoperation. Flows generally would be restricted to the river channel and immediately adjacent, lower floodplain surfaces, and would not inundate a substantial amount of available upland habitat. These impacts would be less than significant.

The coast horned lizard and San Joaquin whipsnake, both of which are California species of special concern, occur in a variety of open vegetation types, including grassland, oak savanna, scrub, and woodlands. They use small-mammal burrows for refuge and for hibernating during winter. No occurrences of either species in the Restoration Area have been documented, although they do have the potential to be present based on the presence of suitable grassland and scrub habitats. Water from the flow releases generally would be restricted to the river channel and immediately adjacent, lower floodplain surfaces, and would not inundate a substantial amount of available upland habitat. These areas are seasonally inundated or periodically inundated by flood flows (every 2 to 5 years) in winter or spring and early summer (McBain and Trush 2002, EDAW 2008) and are characterized by woody riparian vegetation, emergent marsh, riverwash, and open water. Therefore, these species are not expected to be hibernating in areas that would be inundated during winter flow releases. This impact would be less than significant.

Silvery legless lizard, a California species of special concern, is known to occur in suitable habitat in the San Luis NWR and near the confluence with the Chowchilla Bypass. This species has a narrow range and limited dispersal capability. It occurs in upland habitats characterized by sandy soils and vegetation that produces leaf litter. Silvery legless lizard is not expected to occur in habitats that experience seasonal or periodic inundations. At present, all reaches that would receive Interim and Restoration flows are seasonally inundated except Reaches 2A and 2B and portions of the Eastside Bypass. However, these reaches have been inundated periodically (every 2 to 5 years) by flood flows. Silvery legless lizards are not likely to occur in areas that would be inundated by Interim or Restoration flows. They also are not expected to disperse into areas that could be inundated during Interim or Restoration flows because their movements typically occur within a narrow home range and primarily consist of burrowing into sandy soils, infrequently emerging above the surface. This impact would be less than significant.

Special-Status Birds. Several special-status bird species have the potential or are known to occur in the Restoration Area.

Special-status birds, such as Swainson’s hawk (State-listed as threatened), white-tailed kite (fully protected), western yellow-billed cuckoo (Federal candidate and State-listed as endangered), and loggerhead shrike (California species of special concern) build nests in large trees or shrubs that would be well above the waterline under the action alternatives during the breeding season (approximately February through August). Bald eagles (federally delisted, State-listed as endangered and fully protected) are known to nest along the Chowchilla Bypass (Dulik, pers. comm. 2008) and historically may have nested in other portions of the Restoration Area. Therefore, bald eagles may currently nest in the Restoration Area and may use open-water areas for foraging during winter. Lesser sandhill crane (California species of special concern), greater sandhill crane (State-listed as threatened and fully protected), and mountain plover (California species of special concern) are not expected to nest in the Restoration Area, but may use grasslands and agricultural fields for foraging in winter. Interim and Restoration flows would not substantially inundate upland foraging areas for any special-status bird species. Impacts on these species from implementing the Interim and Restoration flows would be less than significant.

Some special-status species, such as the least bittern, redhead, yellow-headed blackbird, and tricolored blackbird (all California species of special concern) nest closer to the ground in emergent marsh vegetation, such as that present in portions of the San Joaquin River channel. Other special-status songbirds (least Bell’s vireo (federally listed and State-listed as endangered), yellow warbler (California species of special concern), and yellow-breasted chat (California species of special concern) nest in riparian vegetation and may build nests as low as 1 foot from the ground. Other California bird species of special concern in the Restoration Area nest directly on the ground in open areas (burrowing owl) or in areas surrounded by tall grasslands, crops, or wetland vegetation (grasshopper sparrow, short-eared owl, and northern harrier).

The action alternatives could progressively increase nonflood flows in February, March, April, and May throughout the Restoration Area. The potential exists for increased flows to inundate nest sites of ground and low-vegetation nesters if they are established before releases. This would result in nest abandonment and the loss of any viable eggs or chicks that have not yet fledged.

Existing habitat types in these channel reaches have some potential to support these species; however, these areas already experience periodic flood flows during spring, and Interim and Restoration flows would generally be at nearly their highest levels by March 16, before the nesting season of most birds, such as migratory passerines like the least Bell's vireo. Least Bell's vireos would migrate into the Restoration Area or downstream along the San Joaquin River in mid- to late April and would naturally construct their nests above the levels of Interim and Restoration flows. Furthermore, the incidence of nests established below the levels of Interim and Restoration flows during the breeding season is expected to be low, given the prevalence of surrounding suitable habitat. These impacts would be less than significant.

Special-Status Mammals. Several special-status bat species have the potential or are known to occur in the Restoration Area: pallid bat, Townsend's big-eared bat, western red bat, and western mastiff bat (all California species of special concern). Implementing Interim and Restoration flows would not inundate portions of any structures that provide roosting opportunities for bats, such as bridges or maintenance facilities. Bat species occurring in the Restoration Area may roost in large trees or shrubs that would be well above the waterline under the action alternatives. Thus, the release of Interim and Restoration flows would have no impact on individual bats or their roost sites. However, seasonally available foraging habitat would increase for species that feed on insects that congregate over open water. This impact would be beneficial.

San Joaquin kit fox, federally listed as endangered and State-listed as threatened, and American badger, a California species of special concern, are large mammals that occupy grassland and scrub habitats in the Restoration Area. The San Joaquin kit fox recovery area overlaps with portions of the Restoration Area. These mammals create burrows for denning and refuge. Although occupied dens may be located near the river corridor, they would not be affected along any reach by the release of Interim and Restoration flows. Water from the flow releases would be restricted to the channel and adjacent lower floodplain surfaces, which are characterized by open water, riverwash, emergent wetland, and riparian scrub and forest. These habitats are not suitable for denning, although San Joaquin kit fox and American badger may forage and disperse through the river corridor or the Eastside Bypass. Implementing the action alternatives would not affect the ability of these species to carry out these activities; these species are mobile and wide ranging and often use road crossings and culverts to traverse aquatic features. They prey on a wide variety of terrestrial animals, and foraging habitat would remain plentiful along the river corridor, Eastside Bypass, and adjacent habitats. This impact would be less than significant.

The riparian brush rabbit, federally listed and State-listed as endangered, has very limited distribution. Recent captive breeding and recovery efforts have included establishing one population in 2002 in restored habitat on the San Joaquin River Refuge and releasing another small population in 2005 on private lands adjacent to the San Joaquin River NWR, west of Modesto. Other populations are known from Caswell Memorial State Park near Ripon, and in Paradise Cut and the San Joaquin River west of Manteca. Riparian brush rabbit is not expected to occur upstream from the confluence with the Merced River. Because Interim and Restoration flows would have a very minimal effect on riparian habitats downstream from the Merced River (see Impact VEG-23), no impact on riparian brush rabbit would occur.

The riparian woodrat, federally listed as endangered and a California species of special concern, and ringtail, a fully protected species under the California Fish and Game Code, have not been documented in the Restoration Area or its vicinity. Riparian woodrat builds stick houses in dense riparian vegetation at the base of trees or in tree cavities and canopies. Ringtails are found in brushy and wooded areas in foothill areas, especially along water courses, and typically make dens in hollow trees. Although the range of ringtail in California excludes most of the San Joaquin Valley, the distribution of the species is not well documented and could include portions of the Restoration Area, especially the foothill portion of Reach 1. Potentially suitable habitat is present in riparian vegetation that would be inundated by Interim and Restoration flows. However, the only verified extant population of this species is located on the Stanislaus River at Caswell Memorial State Park. The effect of implementing Interim and Restoration flows on riparian communities is greatly diminished below the confluence of the Merced River (see Impact VEG-23). Therefore, no impact on the riparian woodrat would occur. Although some habitat in Reach 1 for ringtail may be affected by Interim and Restoration flows, ringtail dens are not expected to be inundated if they were present in the Restoration Area because they are unlikely to den in the low-flow channel, which is subject to periodic inundation due to seasonal flood flows; therefore, impacts on ringtail are expected to be less than significant.

Fresno kangaroo rat (federally listed and State-listed as endangered) and Nelson’s antelope squirrel (State-listed as threatened) are both small burrowing mammals that have been reported in the vicinity of the Restoration Area. These species inhabit grassland and scrub habitats. They generally do not occupy riparian areas, although they may disperse through dry river washes. These species tend to have small home ranges and are not expected to regularly disperse across the river channel. Suitable upland habitats and occupied burrows may be located adjacent to the project site in the Restoration Area; however, these species would not be affected along any reach or bypass because Interim and Restoration flows would be restricted to the river channel and lower floodplain surfaces. This impact would be less than significant.

Impact VEG-21 (Alternatives A1 through C2): *Substantially Alter Designated Critical Habitat in the Restoration Area – Project-Level.* Critical habitat is designated within the Restoration Area in the river corridor and bypass system. Areas inundated by reoperation of Friant Dam do not include the primary constituent elements of designated critical habitat for vernal pool species. Implementing critical habitat and Fresno kangaroo rat conservation measures would offset potential adverse effects on critical habitat. This impact would be **less than significant**.

The Restoration Area includes federally designated critical habitat for the following federally listed plant and animal species: succulent owl's-clover, hairy orcutt grass, Hoover's spurge, Colusa grass, California tiger salamander, vernal pool tadpole shrimp, vernal pool fairy shrimp, longhorn fairy shrimp, and Conservancy fairy shrimp.

In Reach 1A, critical habitat has been designated on the north side of the river for succulent owl's-clover (Unit 4, USFWS 2006b), hairy orcutt grass (Unit 6, USFWS 2006b), and California tiger salamander (Unit 1B, USFWS 2005a) (see Appendix L, "Biological Resources – Vegetation and Wildlife"). The southern boundaries of these designations extend into the Restoration Area. These species are associated with vernal pool habitats that are located outside the river corridor. In this reach, the uplands and vernal pool complexes are separated from the river corridor by natural bluffs. The river corridor does not contain the primary constituent elements on which these species depend, such as upland foraging and dispersal habitat for California tiger salamander or vernal pools or swales for succulent owl's-clover or hairy orcutt grass, but they may be found in the uplands adjacent to the river corridor. Reoperation of Friant Dam would not affect any of the primary constituent elements of designated critical habitat for succulent owl's-clover, hairy orcutt grass, and California tiger salamander in Reach 1A.

In Reach 4B2 and in the Eastside and Mariposa bypasses, the Restoration Area includes critical habitat for Hoover's spurge (Units 6A-6D, USFWS 2006b), vernal pool tadpole shrimp (Units 16a-16D, USFWS 2006b), vernal pool fairy shrimp (Units 23A-23D, USFWS 2006b), and Conservancy fairy shrimp (Units 7A-7D, USFWS 2006b). The Restoration Area in Reach 5 also includes designated critical habitat for vernal pool tadpole shrimp, vernal pool fairy shrimp, and Conservancy fairy shrimp. Critical habitat for longhorn fairy shrimp (Unit 2, USFWS 2006b) has been designated in the Restoration Area only in Reaches 4B2 and 5. Critical habitat for Colusa grass (Unit 7D, USFWS 2006b) occurs in the Restoration Area only in the Eastside Bypass (see Appendix L, "Biological Resources – Vegetation and Wildlife").

As described in Impacts VEG-17 and VEG-20, vernal pools habitats are not expected to be substantially affected by the project. The project is designed so that Interim and Restoration flows would be restricted to the low-flow channel, and these channels are below grade so that flows would be unlikely to extend to adjacent lands outside existing levees even in the case of seepage or levee failure. Also, the project includes conservation measures that would reduce long-term impacts to vernal pools and associated listed invertebrates outside the bypass levees from seepage (Conservation Measures VP-1 and VP-2).

Although the Eastside and Mariposa bypass system is unlikely to contain vernal pool habitats because of altered hydrologic conditions within the low-flow channel where the Interim and Restoration flows would occur, there is some potential for vernal pools to exist higher in the floodplain given the soil types and presence of vernal pools in the adjacent areas. If the primary constituent elements of designated critical habitats for

Hoover's spurge, Colusa grass, vernal pool tadpole shrimp, vernal pool fairy shrimp, Conservancy fairy shrimp, or longhorn fairy shrimp are present in areas that would be subject to changes in hydrologic conditions due to the Interim and Restoration flows, effects to designated critical habitat could occur.

However, Conservation Measure CH-1 requires Reclamation to determine whether the primary constituent elements of designated critical habitats would be affected by Interim or Restoration flows in the Eastside or Mariposa bypasses or Reach 4B before the flows are released. Conservation Measure CH-2 requires Reclamation to develop compensatory mitigation, in consultation with USFWS, for any unavoidable impacts on federally designated critical habitat. Compensatory mitigation, in combination with avoidance and minimization measures, would meet or exceed a no-net-loss threshold of functions and values for the primary constituent elements of designated critical habitats. Therefore, this impact would be less than significant.

Impact VEG-22 (Alternatives A1 through C2): ***Conflict with Provisions of Adopted Habitat Conservation Plans, Natural Community Conservation Plans, and Other Approved Local, Regional, or State Conservation Plans in the Restoration Area–Project-Level.*** Reoperation of Friant Dam would not conflict with the provisions of an adopted conservation plan. Interim and Restoration flows would enhance opportunities to implement conservation strategies and attain conservation goals by providing hydrologic conditions necessary to restore riparian and aquatic habitats and other sensitive natural communities. This impact would be **less than significant** and **beneficial**.

Reoperating Friant Dam would not result in substantial effects on regional plans and policies regarding biological resources. Implementing the action alternatives would not adversely affect adopted conservation plans. The alternatives would not substantially reduce the viability of target species, reduce habitat value or interfere with the management of conserved lands, or eliminate opportunities for conservation actions. Reoperating Friant Dam would support the future enhancement and restoration of biological resources along the San Joaquin River. In the Restoration Area, all the potentially affected Federal, State, regional, and local plans have such goals or objectives, and implementing any of the action alternatives would beneficially affect their attainment.

As discussed under Impacts VEG-16 and VEG-17, Interim and Restoration flows are expected to result in a long-term increase in wetland and riparian habitats and other sensitive natural communities that support special-status species. These consequences of implementing Interim and Restoration flows would benefit conservation plans that strive to conserve, restore, and enhance these habitats and maintain the species they support. This impact would be less than significant and beneficial.

San Joaquin River from Merced River to the Delta. Project-level impacts for Alternatives A1 through C2 along the San Joaquin River from the Merced River to the Delta would be less than significant, as described below.

Impact VEG-23 (Alternatives A1 through C2): ***Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the United States, and Adopted Conservation Plans Along the San Joaquin River from the Merced River to the Delta – Project-Level.*** Reoperating Friant Dam would increase mean monthly flows in the San Joaquin River between the Merced River and the Delta during some months of most years. However, these changes in flows would be generally seasonal with timing similar to historical flows, much smaller than existing flood flows, not adding to future flood flows, and confined to existing channels. For these reasons, these increased flows would not be sufficient to affect special-status species, sensitive natural communities, waters of the United States, or implementation of adopted conservation plans. This impact would be **less than significant**.

During some months of most years, reoperating Friant Dam would increase mean monthly flows in the San Joaquin River upstream from the Merced River. The largest increases would be in spring and fall. Downstream from the Merced River these changes in flow would progressively become a smaller portion of the total flow in the river as additional flow enters the San Joaquin River from major tributaries (e.g., the Merced, Tuolumne, and Stanislaus rivers).

Between the Merced River and the Delta, the increase in San Joaquin River flow, although considerable, would be small relative to the seasonal and interannual variation in flow along this segment of the river. The increased flows would also be much smaller than flood flows that occur frequently (every 2 to 5 years) along this segment of river. Also, Interim and Restoration flows would not increase flood flows because Interim and Restoration flows would not be released during flood flows.

Because these increased flows would largely be confined within existing channel capacities, they would not increase flood flows, would be within the range of historical flows, and have a similar timing to historical flows, they would not result in substantial adverse changes in conditions affecting vegetation and wildlife. This impact would be less than significant.

Sacramento–San Joaquin Delta Delta. Project-level impacts for Alternatives A1 through C2 within the Delta would be less than significant, as described below.

Impact VEG-24 (Alternatives A1 through C2): ***Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the U.S., and Adopted Conservation Plans in the Delta – Project-Level.*** Reoperating Friant Dam would not result in substantial changes in water levels, flood frequency or magnitude, or other conditions or events that could affect vegetation or wildlife in the Delta. Thus, any changes in the Delta would not be sufficient to affect special-status species, sensitive natural communities, waters of the United States, or implementation of adopted conservation plans. This impact would be **less than significant**.

Reoperating Friant Dam would not result in a decrease in flows reaching the Delta; rather, water flow from the San Joaquin River into the Delta would be increased. However, additional inflows would not substantially change water surface elevations, water quality, or other conditions that could substantially affect vegetation or wildlife. In addition, flood frequency and duration would remain well within the historic range of seasonal and annual fluctuations and would be insufficient to alter habitats and vegetation or to affect special-status species, either directly or indirectly. This impact would be less than significant.

CVP/SWP Water Service Areas. Project-level impacts for Alternatives A1 through C2 within the CVP/SWP water service areas would be less than significant, as described below.

Impact VEG-25 (Alternatives A1 through C2): *Substantially Affect Special-Status Species, Sensitive Communities, Jurisdictional Waters of the U.S., and Adopted Conservation Plans in the CVP/SWP Water Service Areas – Project-Level.* Reoperating Friant Dam would not result in increased water availability in the CVP/SWP water service areas that would remove an impediment to growth, and thus indirectly affect vegetation and wildlife. Although implementing the SJRRP would redistribute some surface water, the effects of this redistribution would be small and dispersed, and other factors could also limit growth. Therefore, effects on special-status species, sensitive natural communities, waters of the United States, and implementation of adopted conservation plans would not be substantial. This impact would be **less than significant**.

Overall, the project-level actions would not increase the supply of surface water; rather, the action alternatives may lead to a net decrease in deliveries of surface water. Interim and Restoration flows could, however, redistribute some surface water: the supply of surface water to the Friant Division of the CVP would be reduced, and there would be a small increase in surface water deliveries from the Delta to other water users south of the Delta. This small increase in surface water deliveries would not induce growth because the CVP is unable to fulfill existing contractual obligations; the small increase in surface water deliveries would be distributed over a large area; and in part, these deliveries would substitute for groundwater pumping. Furthermore, a variety of other factors also influence population, residential, and business growth, and agricultural expansion (e.g., city and county and general plans, and availability of utility and transportation services). Therefore, reoperating Friant Dam would not result in growth that could cause substantial effects on special-status species, sensitive natural communities, or waters of the United States, or interfere with the implementation of an adopted conservation plan. This impact would be less than significant.