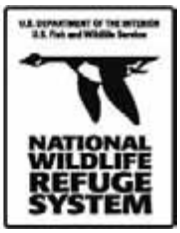

U.S. Fish & Wildlife Service

Proposed Expansion

San Joaquin River

National Wildlife Refuge

Environmental Assessment,
Land Protection Plan,
and Conceptual Management Plan

San Luis National Wildlife Refuge Complex
Merced, Stanislaus, and San Joaquin
Counties, California

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1. Purpose and Need for Action

1.1 Introduction

This draft Environmental Assessment (EA) has been prepared to assist the U.S. Fish and Wildlife Service (Service, USFWS) in evaluating the alternatives and environmental effects of expanding the San Joaquin River National Wildlife Refuge (NWR or Refuge). This assessment is being used by the Service to solicit public involvement in the refuge planning process and to determine whether expanding the Refuge would have a significant effect on the quality of the human environment. This EA is part of the Service's decision-making process in accordance with the National Environmental Policy Act (NEPA).

1.2 Proposed Action

The Service proposes to expand the approved acquisition boundary of the San Joaquin River National Wildlife Refuge and acquire up to 22,156 additional acres (ac) from willing sellers within the proposed expansion area.

1.3 Need to Expand the Refuge

There is a need for protection and enhancement of the riparian corridor of the San Joaquin River. The loss of 95 percent of the riparian habitat has taken its toll on the wildlife that existed along the San Joaquin River corridor. The endangered riparian brush rabbit and the endangered riparian woodrat are two of the species dependent upon riparian habitat along the lower San Joaquin and Stanislaus River corridors. The remaining riparian forests are small, isolated, and vulnerable to major flood events (Williams and Basey 1986); whether they can support viable populations of these and other riparian-dependent species of the area over the long-term is questionable.

Several other listed and sensitive species would benefit from riparian restoration along the San Joaquin River. Migratory bird populations are predicted to increase in the Central Valley if there were sufficient riparian habitat (CVJV 2006). Riparian habitats have been identified as the most important habitats to neotropical migratory bird species in California (Manley and Davidson 1993, Davidson 1995). Due to their biological wealth and severe degradation, riparian areas are the most critical habitat for conservation of neotropical migrants and resident birds in the West (Miller 1951, Gaines 1974, Manley and Davidson 1993, Rich 1998, Donovan et al. 2002).

The Service is the principal Federal agency charged with protecting and enhancing the populations and habitats of endangered and threatened plants and animals, as well as more than 800 species of migratory birds that spend all or part of their lives in the United States. Expanding the San Joaquin River NWR would benefit many species of fish, wildlife and plants.

1.4 Purpose of Expanding the Refuge

The purposes of expanding the Refuge are to 1) protect and restore a diversity of rare and native habitats and their associated populations of fish, wildlife, invertebrate, and plant species of the San Joaquin River; 2) protect, restore, and develop a diversity of habitats for migratory birds such as neotropical songbirds, wading birds, and shorebirds; 3) protect and restore floodplain values and benefits associated with the San Joaquin River, including improved water quality, flood storage, and increased water recharge; 4) protect, restore, and develop habitats for and otherwise support recovery of federally and State listed endangered and threatened species and help

prevent the listing of candidate species and species of management concern; and 5) provide high-quality opportunities for wildlife-dependent recreation.

1.5 Project Area

The Refuge is nine miles west of the city of Modesto and straddles western Stanislaus and San Joaquin Counties, California. The 12,887 acres within the existing approved acquisition boundary are within the historic floodplain of the confluences of the San Joaquin, Stanislaus, and Tuolumne Rivers and are situated between the confluences of the San Joaquin River with the Tuolumne and Stanislaus Rivers (Figure 1). The Refuge boundary includes wetland, upland, and riparian habitats. The proposed expansion area that the Service is considering includes two sections: a northern and a southern expansion area.

The proposed northern expansion area extends approximately 19 river miles (RM) (4.6 miles as the crow flies) downstream of the Refuge. This section of the river is almost entirely in San Joaquin County. From the confluence of the Stanislaus River (RM 75), downstream to the Interstate 5 (I-5; RM 60) overpass, the river is actively meandering, with recent and older oxbow cutoffs. Three sloughs are present: Tom Paine, Red Bridge, and Walthall, which could act as overflow channels but are currently disconnected from the river by project levees that were designed and built by the U.S. Army Corps of Engineers (Corps). This northern portion of the proposed Refuge expansion area is experiencing urban growth, though the majority of this reach is bounded by agriculture, with narrow patches of riparian habitat along the banks. Along the east bank, project levees extend along the entire length; on the left bank, the levees are along the lower 16 miles (RM 54-70). Beyond I-5, the proposed northern expansion includes Paradise Cut, an overflow channel of the San Joaquin that flows to the Delta. There are 10-foot-high levees on the land side of both banks of this (likely) straightened channel. Flows into Paradise Cut are controlled by a weir that has a 15,000 cfs capacity. There is a band of riparian vegetation that supports a small population of endangered riparian brush rabbits along Paradise Cut.

The proposed southern expansion area lies between the Refuge and the Grasslands Ecological Area and includes approximately 34 river miles (20.9 miles as the crow flies) to the south, in Stanislaus County, with a small portion into Merced County. This area includes 12 river miles of the Stanislaus River, of which some parcels are adjacent to Caswell Memorial State Park (Caswell MSP). As with the proposed northern expansion area, agriculture is prevalent on both sides of the Stanislaus and San Joaquin Rivers. From the confluence of the Tuolumne River at RM 83, to RM 94, the San Joaquin River is actively meandering with old and recent cutoffs. There is a mix of project levees and local levees, and between 22 and 31 percent of the banks are eroding, with some use of broken concrete as armoring. In this section, the river has abandoned a portion of its channel and occupies Laird Slough for 4.5 miles. In 1997, severe flooding of farmlands occurred on up to 400 acres, which experienced levee breaches and sand splays (Jones and Stokes 2001).

From RM 99 to the Merced River (RM 118) is the least leveed section of the San Joaquin River. This section includes the City of Modesto's sewage treatment plant, and Del Puerto and Orestimba Creeks, which contribute gravel to the river. There is a section (RM 112 to RM118) with high floodplains and dry oak savannahs, with the lower floodplain and bars showing active riparian regeneration and mature black willow and ash. The Merced River almost doubles the flow of the San Joaquin River at its confluence at RM 118 (Mussetter Engineering, and Jones and Stokes 2000).

1.6 Decisions to be Made

Based on the analysis documented in this EA, the following decisions will be made by the Service's Regional Director of the Pacific Southwest Region (Region 8):

1. Determine whether the Service should expand the approved acquisition boundary of the San Joaquin River National Wildlife Refuge. If so,
2. Select an approved expansion alternative which best fulfills the Refuge purposes based on the analysis in this Environmental Assessment. And,
3. Determine whether the selected alternative would have a significant impact on the quality of the human environment.

The authorities for this protection effort are the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715d, 715e, 715f-715r) and the Fish and Wildlife Act of 1956, as amended (16 U.S.C. 742(a)-754). The Migratory Bird Conservation Act established the Migratory Bird Conservation Commission to approve areas recommended by the Secretary of the Interior for acquisition with migratory Bird Conservation Funds. The Fish and Wildlife Act authorizes the Service to use funds made available under the Land and Water Conservation fund Act of 1965 (16 U.S.C. 4601-4611) to acquire lands, waters, or interests therein for fish, wildlife, and plant conservation purposes.

Intact riparian habitat, San Joaquin River NWR. Photo by Lee Eastman

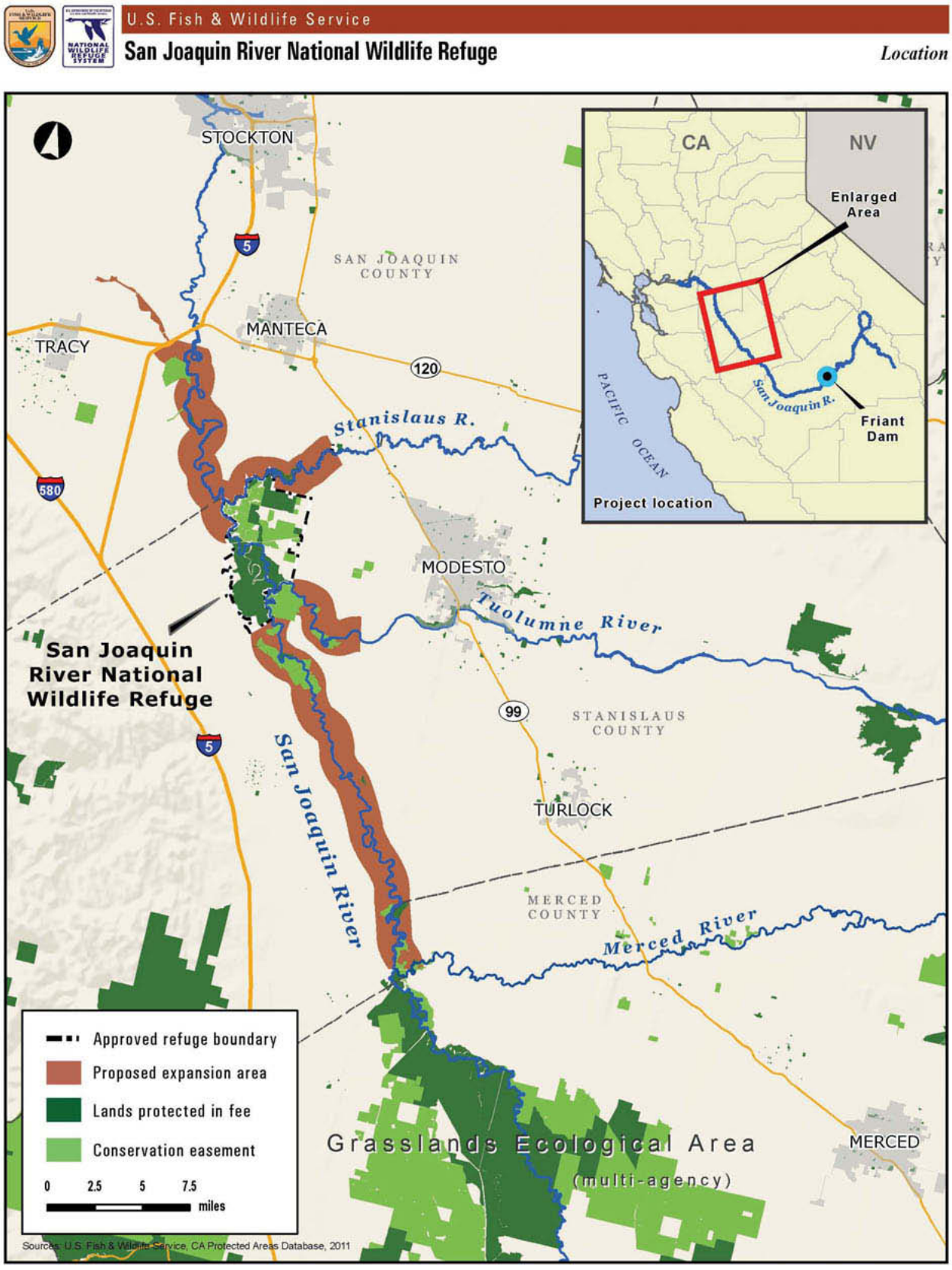

Figure 1. Location of San Joaquin River National Wildlife Refuge

1.7 Public Involvement and Issue Identification

Issues, concerns, and opportunities were identified through early planning discussions and through the public scoping process, which began with mailings of the first planning update. The first planning update for the proposed project was sent to a mailing list of more than 550 individuals, groups, and agencies on May 16, 2011. This update summarized the proposal to protect additional habitat upstream and downstream of the San Joaquin River NWR, and described the steps in the Environmental Assessment process. Public meetings were held in Los Banos and in Modesto, California, on June 1 and 2, 2011, respectively. The purpose of these meetings was to gather the issues and concerns that the public had with the Refuge's proposed expansion and to solicit comments from the public, Tribes, other governmental agencies, and non-governmental organizations. During the two scoping meetings, a presentation was given on the proposed project, and verbal comments were recorded on flipcharts. Additional comments were received via letters, emails, and comment cards. The scoping comment period ended July 15, 2011, and was extended until August 15, 2011, by public request. Notices announcing this extended comment period were sent out to known interested parties and the media. The issues, concerns, and opportunities are a compilation of information received by the Service throughout the planning process. Public scoping and involvement helped direct and provided important elements in the development of the alternatives.

Public input received in response to these updates, workshops, and briefings is incorporated into this EA. Below is a brief summary of the issues identified in the scoping comments we received. A more detailed summary of the comments is included in Appendix E.

- What, if any, lands should be included in the proposed expansion?
- How would the proposed expansion affect agriculture?
- What type of public access would be allowed and how would it be controlled?
- How would the proposed expansion affect flood control activities?
- How would the proposed expansion affect the regional economy?
- What are the proposed project goals and can they be accomplished with existing programs?
- Would this proposal increase water use affect water quality or riparian rights?
- How would the Service manage the proposed expansion area?
- How would the proposed expansion address climate change?
- How would the proposed expansion affect fish and wildlife?
- How would mosquito control be addressed?

1.8 Relationship to Other Conservation Plans and Programs

The conservation goals and objectives of existing plans and programs for the landscapes in which refuges are located are important. They help determine the manner in which a refuge can best contribute to overall conservation efforts and to the functioning of the ecosystems in that area. The Service must coordinate refuge planning with other units of the agency, other government agencies, Tribes, and non-governmental organizations, and, to the extent practical, make refuge plans consistent with the fish and wildlife conservation plans of the State. The Service also endeavors to make refuge planning consistent with the conservation programs of the tribal, public,

and private partners within the ecosystem. The following plans and programs were considered during the development of this document. Relevant sections are listed under each program.

1.8.1 Landscape Level Plans

The California Riparian Habitat Conservation Program (1991) (California Wildlife Conservation Board)

- The CRHCP was created within the Wildlife Conservation Board (WCB) by legislation in 1991.
- The program has a basic mission to develop coordinated conservation efforts aimed at protecting and restoring the State's riparian ecosystems. This is now codified in Fish and Game Code, Section 1385-1391.
- The purpose and goal of the program is to protect, preserve, and restore riparian habitats throughout California by the acquisition of interests and rights in real property and waters to the extent deemed necessary to carry out the purposes of the program.

Draft Least Bell's Vireo Recovery Plan (1998): (USFWS)

- Section 4(f) of the Endangered Species Act (ESA) directs the Fish and Wildlife Service to develop and implement recovery plans for threatened and endangered species. Recovery plans are documents that outline activities needed to stop or reverse the decline of threatened or endangered species and facilitate their long-term survival.
- Protect and manage riparian and adjacent upland habitats within the least Bell's vireo's historical range (which includes the San Joaquin River riparian habitat).
- Develop and evaluate least Bell's vireo habitat restoration techniques.

Recovery Plan for Upland Species of the San Joaquin Valley (1998) (USFWS)

Riparian woodrat:

- Survey and map "all riparian areas along the San Joaquin River and its major tributaries."
- Develop, in collaboration with owners of riparian land and local levee-maintenance districts, an incentive program for preserving cover and riparian vegetation.
- Develop a plan for the restoration of riparian habitat, the establishment of riparian corridors, and the reintroduction, if necessary, of riparian woodrats to suitable habitat.
- Establish conservation agreements with willing landowners that do not already have conservation easements, as appropriate and necessary, to accomplish habitat restoration, linkage, and reintroduction goals.
- Begin efforts to restore and link riparian habitat...

Riparian brush rabbit:

- Develop and implement a cooperative riparian brush rabbit conservation program that will include, at a minimum:
    - Establishment of at least three additional wild populations in the San Joaquin Valley, in restored and expanded suitable habitat within the rabbit's historical range.

Missing Linkages: Restoring Connectivity to the California Landscape (2000) (California Wilderness Coalition)

- This is a report from state, federal, and non-governmental organizations by experts on wildlife movement, outlining possible wildlife movement corridors throughout the state.
- The primary features identified as facilitating animal movement in the Central Valley region included waterways, riparian corridors, flood control channels, contiguous habitat, and upland habitat on levees.
- The Missing Linkages conference report states that 44 percent of the linkages identified in the Central Valley are associated with rivers and streams. The primary threats identified are gaps of 20 miles or more in riparian habitat due to stream channelization.
- Maintaining connectivity between the remaining natural areas and minimizing further fragmentation is crucial to the long-term viability of California's natural heritage.
- Extensive riparian restoration and management was identified as a need to provide refuge from major flood events.

Sacramento and San Joaquin River Basins Comprehensive Study, California (2000) (U.S. Army Corps of Engineers)

- The purpose of the Comprehensive Study is to identify means by which to reduce flood damages along waterways and basins in the Central Valley while restoring environmental resources in these areas.
- The significant width of the floodway is important to maintain the meanders and riparian habitat on the San Joaquin River, though some agricultural fields may have expanded towards the river, requiring construction of local levees or berms to reduce nuisance flooding and sand splays.
- Conservation of the natural river migration process that drives most natural succession on the river is important because setbacks of fields and local levees within bendways eliminates the incentive to harden river banks with revetment.
- Another potential environmental measure related to enhanced floodway capacity is the reconnection of historic sloughs and oxbows to the river in areas that would allow these former channels to convey a portion of high flows similar to natural flow bifurcations through basin and slough complexes.

North American Landbird Conservation Plan (*Pacific Avifaunal Biome*) (2004) (Partners in Flight)

- The Partners in Flight North American Landbird Conservation Plan (Plan) provides a continental synthesis of priorities and objectives that will guide landbird conservation actions at national and international scales. The scope for this Plan is the 448 species of native landbirds that regularly breed in the U.S. and Canada.
- Conduct restoration and management of riparian, pine, oak, chaparral, and coastal scrub habitats to support native conditions, processes, and species.
- Secure conservation status for highest-priority wetland, riparian, oak, chaparral, and coastal scrub habitats.

The Riparian Bird Conservation Plan (2004) (Objectives) (Riparian Habitat Joint Venture)

- This Riparian Bird Conservation Plan is a collaborative effort of the Riparian

- Habitat Joint Venture (RHJV) and California Partners in Flight (CalPIF) and has been developed to guide conservation policy and action on behalf of California's riparian habitats and wildlife. The Conservation Plan focuses on data concerning bird species associated with riparian habitat, but conservation recommendations, if implemented, should benefit many riparian associated species. The following objectives are found in the Plan:
- Prioritize riparian sites for protection and restoration.
- Promote riparian ecosystem health (i.e., a self-sustaining functioning system).
- Increase the value of ongoing restoration projects for bird species.
- Ensure that large landscape scale management and flood control projects maximize benefits to wildlife while benefitting agriculture and urban populations. Achieving multiple goals simultaneously enhances the overall value of such projects to the people of California.
- Design and implement cultivated restoration projects that mimic the diversity and structure of a natural riparian plant community.
- Implement and time land management activities to increase avian reproductive success and enhance populations.
- Protect, enhance, or recreate natural riparian processes, particularly hydrology and associated high water events, to promote the natural cycle of channel movement, sediment deposition, and scouring that create a diverse mosaic of riparian vegetation types.

Central Valley Joint Venture Implementation Plan (2006) (Central Valley Joint Venture)

- The mission of the Central Valley Joint Venture is to work collaboratively through diverse partnerships to protect, restore, and enhance wetlands and associated habitats for waterfowl, shorebirds, waterbirds, and riparian songbirds in accordance with conservation actions identified in the Joint Venture's Implementation Plan.
- The five-year restoration objective for riparian habitat for songbirds in the San Joaquin River Basin is 2,500 acres, with 188,000 acres of restorable habitat in the basin, and approximately 12,249 acres of existing riparian habitat in the basin. There are other riparian habitat restoration objectives for other focal groups, such as waterbirds (e.g., snowy egret), which has a riparian restoration goal of 1,000 acres in the San Joaquin River Basin.

California's State Parks' Central Valley Vision: (2007) (California Department of Parks and Recreation)

- This 27-page document is an overview of the Central Valley Vision process and an explanation of the findings and research conducted over the past three and a half years. The Central Valley Vision will continue to serve as a roadmap for future State Park programs as funding becomes available.
- Recreation facilities: expand recreation facilities (camping, day-use, fishing, boating, trails, and large group facilities), particularly along river corridors, Valley reservoirs, and at the Delta.
- River corridors: expand landholdings and State Parks' presence at existing units and acquire new parklands along river corridors, particularly where opportunities exist to link State Park units and other publicly owned lands.
- Preserve and protect natural lands: acquire lands that preserve and protect threatened natural resources, such as blue oak and sycamore woodlands and native grasslands.

California Wildlife Action Plan (2007) (California Department of Fish and Game)

- In 2000, Congress enacted the State Wildlife Grants Program to support state programs that broadly benefit wildlife and habitats, particularly those addressing "species of greatest conservation need." As a requirement for receiving federal funds under this program, state wildlife agencies were to have submitted a state wildlife action plan to the U.S. Fish and Wildlife Service by October 2005.
- Public agencies and private organizations need to collaboratively protect and restore habitat connectivity along major rivers in the Central Valley.
- Public agencies and private organizations should protect, restore, and improve water-dependent habitats (including wetland, riparian, and estuarine) throughout the region. Design of these actions should factor in the likely effects of accelerated climate change.
- Water management agencies, State and Federal wildlife agencies, and other public agencies and private organizations need to collaboratively improve fish passage by removing or modifying barriers to upstream habitat.
- To support healthy aquatic ecosystems, public agencies and private organizations, in collaboration with the California-Bay Delta Authority, need to improve and maintain water quality in the major rivers of this region.

2012 Draft Central Valley Flood Protection Plan (California Department of Water Resources)

- The Plan is an overview of the Central Valley Vision process and an explanation of the findings and research conducted over the past three and a half years. The Central Valley Vision will continue to serve as a roadmap for future State Park programs as funding becomes available. The plan has the following findings:
- The State supports corridor management planning approaches to develop integrated, multi-benefit projects.
- The State supports implementing integrated projects to achieve multiple benefits, including environmental conservation and restoration, agricultural conservation, water supply and quality, and related benefits.
- Recognizing the benefits to both public safety and the ecosystem, the State has a great interest in integrated environmental stewardship and flood management to leverage investments and associated benefits.
- All levels of project planning and development need to consider opportunities to integrate ecosystem enhancements with flood damage reduction projects.
- The State should encourage programs that provide incentives for including ecosystem improvements and other multi-benefits to projects, as outlined in California Water Code section 12585.7.
- The State supports investing in “no-regrets” programs and actions that clearly enhance system resiliency, integrate programs and resources, and preserve flexibility for future generations. Actions that fall into this category may include the following:
    - Acquisition of agricultural conservation easements where compatible with local land use plans (especially in deep floodplains adjacent to existing flood conveyance channels).

- Expansion of existing river and bypass channels through levee set-backs, creation of new flood bypass channels, and development of wildlife and fisheries habitats in the bypass system, creating open space and integrating with recreation activities.

Lower San Joaquin River Feasibility Study (Ongoing) (U.S. Army Corps of Engineers)

- The purpose of this feasibility study is to determine if there is a Federal interest in providing flood risk management and ecosystem restoration improvements along the Lower (northern) San Joaquin River.

The Bay Delta Conservation Plan (Ongoing) (California Department of Water Resources, U.S. Bureau of Reclamation, National Oceanographic and Atmospheric Administration)

- Designed to achieve the co-equal goals of providing for the conservation and management of aquatic and terrestrial species, including the restoration and enhancement of ecological functions in the Sacramento-San Joaquin River Delta, and improving current water supplies and the reliability of water supply delivery conveyed through the State Water Project (SWP) and the Central Valley Project (CVP). There is a draft plan for restoring the lower San Joaquin River floodplain downstream of the Stanislaus River confluence and restoring more natural flows to stimulate food webs that support native species. The plan also supports integration of habitat restoration with flood management actions, when feasible.

1.8.2 County Plans

The following county plans have some type of riparian conservation recommendations, and although these sections were selected because they promoted the restoration or protection of natural resources, there are many sections within these plans that promote and protect farmlands as well.

San Joaquin County General Plan (1992)

The San Joaquin County General Plan is currently being updated. The 1992 General Plan for the County has two objectives for Vegetation, Fish, and Wildlife Habitat:

1. To protect and improve the County's vegetation, fish, and wildlife resources; and;
2. To provide undeveloped open space for nature study, protection of endangered species, and preservation of wildlife habitat.

In addition, the General Plan under part VI (Resources) has several items that seem to support protection and restoration of riparian habitat:

Policy #3. "Connection of habitat areas shall be encouraged."

Policy #12. "The County shall support restoration plans for anadromous fishes and shall work with the California Department of Fish and Game and other agencies or organizations in developing such plans."

Policy #14. "The County shall support the establishment and maintenance of ecological preserves and accessibility to areas for nature study."

Implementation #4(b). "The County shall support habitat conservation and restoration plans for special-status taxa and shall work with the California Department of Fish and Game and other agencies or organizations in developing such plans."

Implementation #5. "Wetlands and Riparian Habitat. The County shall protect and restore wetlands habitat and riparian habitat by:

(e) Supporting independent ongoing projects by the Department of Fish and Game and other agencies to create or restore wetlands and riparian habitat and establish jurisdictional control for project monitoring."

Implementation #6. "Natural Area Acquisition. The County shall support the protection of valuable ecological lands by:

(c) Supporting acquisition and development of lands for wildlife and habitat protection and enhancement."

Stanislaus County General Plan (1994)

Stanislaus County recognizes the need for natural resources to be maintained for their ecological values as well as for their direct benefit to people. The current Stanislaus County General Plan states that the County had proposed a future park along the San Joaquin River, north of the junction of the San Joaquin and Tuolumne Rivers to the San Joaquin County line.

Merced General Plan, Natural Resources Element (update in process)

- Goal NR-1: Preserve and protect, through coordination with the public and private sectors, the biological resources of the County.
- Policy NR-1.1: Habitat Protection - Identify areas that have significant long-term habitat and wetland values including riparian corridors, wetlands, grasslands, rivers and waterways, oak woodlands, and vernal pools, and provide information to landowners.
- Policy NR-1.2: Protected Natural Lands - Identify and support methods to increase the acreage of protected natural lands and special habitats, including but not limited to, wetlands, grasslands, and vernal pools, potentially through the use of conservation easements.
- Policy NR-1.5: Wetland and Riparian Habitat Buffer - Identify wetlands and riparian habitat areas and designate a buffer zone around each area sufficient to protect them from degradation, encroachment, or loss.
- Policy NR-1.6: Terrestrial Wildlife Mobility - Encourage property owners within or adjacent to designated habitat connectivity corridors that have been mapped or otherwise identified by the California Department of Fish and Game or U.S. Fish and Wildlife Service to manage their lands in accordance with such mapping programs.
- Policy NR-1.17: Agency Coordination - Coordinate with private, local, State, and Federal agencies to assist in the protection of biological resources and prevention of degradation, encroachment, or loss of resources managed by these agencies.

1.8.3 Habitat Conservation Plans

- The **San Joaquin County Multi-Species Habitat Conservation and Open Space Plan** (SJMSCP or Plan), is a 50-year plan to provide a strategy for balancing the need to conserve open space and the need to convert open space to non-open space uses while protecting the region's agricultural economy. The plan allows SJMSCP permittees to receive incidental take permits to mitigate for impacts to SJMSCP covered species resulting from open space land conversion because of covered projects. Once an incidental take permit is issued, it allows the project applicant to unintentionally "take" a threatened or endangered species listed under the Federal ESA or the California Endangered Species Act (CESA). The permit covers 97 species and is 50 years in duration (2051).

- **Pacific Gas & Electric (PG&E) Multi-Species Habitat Conservation Plan** (HCP) for routine operation and maintenance (O&M) activities to comply with the Federal and State Endangered Species Acts. This HCP is unique in that it primarily addresses small-scale temporary effects that are dispersed over a large geographic area. The purpose of the HCP is to enable PG&E to continue to conduct current and future O&M activities in the San Joaquin Valley while minimizing, avoiding, and compensating for possible direct, indirect, and cumulative adverse effects on threatened and endangered species that could result from such management activities. The HCP duration is for 30 years (2036), and the plan area includes portions of nine counties: San Joaquin, Stanislaus, Merced, Fresno, Kings, Kern, Mariposa, Madera, and Tulare.

1.8.4 Related Actions

Several activities involve restoration or development of habitats along of the San Joaquin River:

- **The San Joaquin River Restoration Program** (SJRRP) was formed in response to a 2006 settlement of an 18 year-old lawsuit between the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council (NRDC), and the Friant Water Users Authority (FWUA). The goal of the settlement is to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of Chinook salmon. The settlement also includes a goal to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the settlement.
- **The San Joaquin River Partnership** is a collaboration of 13 private, non-profit organizations committed to seeing the river restored—from its headwaters to the Delta—for future generations. The partnership's mission is to restore a working river to the Central Valley to benefit its human and natural communities.
- **River Islands** is a 5,000-acre master planned project located on the Stewart Tract within the City of Lathrop and at the northern boundary of the proposed northern expansion. The project is approved for 11,000 homes and five million square feet of commercial space. The project will be protected by a 200-year level of flood protection. A portion of the large levees, which are 300 feet wide at the crown, have already been built. Mitigation and enhancement is being considered along Paradise Cut, as a known population of riparian brush rabbit exists there.
- **Lower San Joaquin River Flood By-Pass Proposal**. The South Delta Levee Protection and Channel Maintenance Authority, working with American Rivers, the Natural Resource Defense Council, the Natural Heritage Institute, and the River Islands Group, have applied to the Department of Water Resources for a $5 million grant to create a new flood bypass on the Lower San Joaquin River. The proposed bypass is located between Stewart Tract and Paradise Cut, which is the northern end of the proposed northern expansion. The grant would fund the first phase of planning and property acquisition, which includes riparian habitat to be restored and protected.

1.8.5 Other Protected Areas Near the Proposed Expansion Area

- The proposed expansion would connect the Refuge to the Grasslands Ecological Area (GEA), which is a 160,000-acre mosaic of Central Valley floor habitats located primarily within Merced County between I-5 and I-99 in the northern San Joaquin Valley, west of a

line between Modesto and Fresno. It lies in the historic floodplain of the San Joaquin River in an area historically prone to floods and poor farming soils. This vast network of freshwater marshes (permanent and seasonal), alkali grassland, and riparian thickets is the result of decades of collaborative conservation agreements between private duck clubs, California State Parks (Great Valley Grasslands, Hatfield State Recreation Area), California Department of Fish and Game (Volta, Los Banos, and North Grasslands Wildlife Areas), and the U.S. Fish and Wildlife Service (San Luis and Merced National Wildlife Refuges and Grasslands Wildlife Management Area). The GEA is an Audubon designated Important Bird Area and is considered one of the most important shorebird habitats in the western United States. See the land cover maps, which show protected lands on pages 62-63 in this EA.

California's Central Valley hosts one of the largest wintering shorebird populations of any inland site in western North America. The Ramsar Convention on Wetlands has designated the GEA as a wetland of international importance, and the Manomet Center's Western Hemisphere Shorebird Reserve Network (WHSRN) has designated the GEA of the San Joaquin Basin as a site of international importance to shorebirds (WHSRN 2009). It is among the largest remaining areas of unplowed land on the floor of the Central Valley, and The Nature Conservancy (1998) has identified its Valley Sacaton Grassland (Holland 1986) as the finest example of such habitat in the State.

- The North Grasslands Wildlife Area (China Island Unit) is at the extreme southern end of the expansion study area between the towns of Newman and Gustine. The 7,069-acre wildlife area has a boat ramp and allows fishing, waterfowl and pheasant hunting, wildlife viewing, and camping at the hunter check station. It is at the northernmost part of the larger GEA of Federal, State, and private lands—all managed for wildlife values. The GEA represents the largest remaining contiguous block of wetlands in California.
- The West Hilmar Wildlife Area, on the west bank of the San Joaquin River a few miles downstream of the Merced River confluence, is a 340-acre State wildlife area accessible only by boat, with no facilities. Also near the confluence of the Merced and San Joaquin Rivers is the George J. Hatfield State Recreation Area, a small developed park unit consisting of 47 acres, with a 40-person group camp site.
- Caswell Memorial State Park is adjacent to the Refuge, on the banks of the Stanislaus River, near the town of Ripon. The park protects a fine example of the threatened and still declining riparian oak woodland, which once flourished throughout California's Central Valley. Caswell is home to several endangered animal species, including the endangered riparian brush rabbit and riparian woodrat.
- The San Joaquin River Oxbow Preserve was established to protect the federally endangered riparian brush rabbit. This 30-acre riparian forest preserve is located adjacent to the San Joaquin River within the city of Lathrop in San Joaquin County. The preserve was created in 2004 by Union Pacific Homes as mitigation for their development in the city of Lathrop. The Center for Natural Lands Management became the owner/manager of the preserve in September 2004.

1.9 Conserving Wildlife and Serving People: The U.S. Fish and Wildlife Service

National Wildlife Refuges are administered by the U.S. Fish and Wildlife Service. The Service is the primary Federal agency responsible for conserving, protecting, and enhancing the nation's

fish and wildlife populations and their habitats. It oversees the enforcement of Federal wildlife laws, management and protection of migratory bird populations, restoration of nationally significant fisheries, administration of the ESA, and the restoration of wildlife habitat.

1.10 The National Wildlife Refuge System

Refuge lands are part of the National Wildlife Refuge System, which was founded in 1903 when President Theodore Roosevelt designated Pelican Island in Florida as a sanctuary for Brown Pelicans. Today, the system is a network of 555 refuges and wetland management districts covering over 150 million acres of public lands and waters. Over half of these lands and waters (51 percent) are in Alaska, with approximately 16 million acres located in the lower 48 states and several island territories; the balance in submerged areas of the Pacific Ocean.

The Refuge System is the world's largest collection of lands specifically managed for fish and wildlife. Overall, it provides habitat for more than 5,000 species of birds, mammals, fish, amphibians, reptiles, and insects. As a result of international treaties for migratory bird conservation and other legislation, such as the Migratory Bird Conservation Act of 1929, many refuges have been established to protect migratory waterfowl and their migratory flyways.

Refuges also play a crucial role in preserving endangered and threatened species. The San Joaquin River NWR was instrumental in the delisting of the threatened Aleutian cackling goose (formerly known as the Aleutian Canada goose) and has been involved with the captive breeding and reintroduction of the riparian brush rabbit in an effort to increase their population.

Refuges also provide unique recreational and educational opportunities for people. When human activities are compatible with wildlife and habitat conservation, they are places where people can enjoy wildlife-dependent recreation such as hunting, fishing, wildlife observation, photography, environmental education, and environmental interpretation. Many refuges have visitor centers, wildlife trails, automobile tours, and environmental education programs. Nationwide, approximately 46 million people visit national wildlife refuges each year.

The National Wildlife Refuge System Improvement Act of 1997 established several important mandates aimed at making the management of refuges more cohesive. The preparation of Comprehensive Conservation Plans (CCPs) is one of those mandates. The legislation directs the Secretary of the Interior to ensure that the mission of the Refuge System and purposes of the individual refuges are carried out. It also requires the Secretary to maintain the biological integrity, diversity, and environmental health of the Refuge System.

The goals of the Refuge System are to:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that are strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.

- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (e.g., hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

1.11 San Joaquin River National Wildlife Refuge

The Refuge was established in 1987 to provide winter forage and roosting habitat for the threatened Aleutian cackling goose (formerly known as the Aleutian Canada goose; since delisted), protect other federally listed species, improve and manage habitat for migratory birds, and conserve native fauna and flora. The Refuge lands encompass a mosaic of valley oak riparian forest, riverine and slough habitats, seasonal and permanent wetlands, vernal pools, natural uplands, and agricultural fields. The Refuge has restored over 2,220 acres of riparian habitat, and great potential for riparian and wetland restoration exists in the proposed expansion area. Endangered least Bell's vireos, which had not been seen in the Central Valley for 50 years, migrated to the restoration site and nested for three years. It is thought that future restoration of sufficient connected riparian acreage could bring this species back to the Central Valley permanently.

The Refuge was established under the authority of the Endangered Species Act. Other Refuge lands were also acquired under the Migratory Bird Conservation Act and the North American Wetlands Conservation Act.

The Refuge is the primary wintering site of Aleutian cackling geese, and protection/management of the area has been identified as a critical element in the Aleutian cackling goose recovery plan. In addition, it is a major wintering and migration area for lesser and greater sandhill cranes, snow and Ross' geese, and white-fronted geese. The riparian forest contains a large heron/egret rookery and provides important migration and breeding habitat for neotropical migratory land birds. Federally listed vernal pool invertebrates such as the vernal pool fairy shrimp, vernal pool tadpole shrimp, and the California linderiella have been documented within the Refuge, and valley elderberry longhorn beetles may be present (USFWS 1991).

The endangered riparian brush rabbit was nearly wiped out in 1997 when a severe flood threatened the largest existing population. There were two small known populations, at Caswell Memorial State Park, and the San Joaquin River Delta, though 95 percent of their natural habitat has been destroyed by development and agriculture. As a result, a captive propagation and reintroduction program was initiated. To date, 1,100 captive bred riparian brush rabbits have been released at the San Joaquin River Refuge's West Unit, the San Joaquin River Refuge's East Unit (Buffington Tract), and the Faith Ranch, which has a Service easement. The Refuge now supports the largest and most robust population of riparian brush rabbits in the world, and they are beginning to populate the restored riparian woodlands listed above.

The Refuge purposes are:

- "To conserve fish or wildlife which are listed as endangered species or threatened species or plants..." 16 U.S.C. 1534 (Endangered Species Act of 1973).
- "...For use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. 715d (Migratory Bird Conservation Act).
- "...For the development, advancement, management, conservation, and protection of fish and wildlife resources." 16 U.S.C. 742f(a)(4)

- "...for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition and servitude." 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956).

1.11.1 Goals of the Refuge

The Refuge has five broad goals that were developed for the Comprehensive Conservation Plan (2006). They are consistent with the Refuge purpose and vision, ecoregion goals, Refuge System goals, the National Wildlife Refuge System Improvement Act of 1997, Service policy, and international treaties.

Goal 1 (Biological Diversity) *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.*

Goal 2 (Threatened and Endangered Species) *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.*

Goal 3 (Aleutian Cackling Goose) *Provide optimum wintering habitat for Aleutian cackling geese to ensure the continued recovery from threatened and endangered species status.*

Goal 4 (Ecosystem Management) *Coordinate the natural resource management of the San Joaquin River National Wildlife Refuge within the context of the larger Central Valley/San Francisco Ecoregion.*

Goal 5 (Public Use of the Refuge) *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.*

1.12 Habitat Protection and Land Acquisition Process

If a new refuge acquisition boundary is approved, various means could be used for habitat protection through the purchase of fee title, conservation easement, no-cost transfer, memorandum of understanding (MOU), donation, or exchange. It is the established policy of the Service to acquire land or interests in land only from landowners that are willing sellers. The authorities for the acquisition of the proposed expansion area are the Endangered Species Act of 1973 (16 U.S.C. 1531-1543), as amended; the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715d-715r), as amended; and the Refuge Recreation Act of 1969 (16 U.S.C. 460k-460k-4), as amended. Acquisition funding could be made through the Land and Water Conservation Fund Act of 1965, the Migratory Bird Conservation Fund, or other sources to acquire lands and/or waters, or interests therein, for fish and wildlife conservation purposes.

The approved acquisition boundary is defined as the line(s) enclosing those lands that we have authority to acquire, in whole or in part. This boundary often encompasses both public and private land, but does not imply that all private parcels within the boundary are targeted for our acquisition.

1.12.1 Fee Title Acquisition and Refuge Revenue Sharing

Fee Title Acquisition. Service policy is to acquire lands or interest in lands only from willing participants. Landowners within the project boundary who do not wish to sell their property or any other interest in their property are under no obligation to enter into negotiations or to sell to the Service.

Due to the size of the proposed refuge expansion and value of the agricultural land, it is expected that acquisition may take up to 45 years to acquire 50 percent of the lands proposed. It is also anticipated that some lands may never be acquired by the Service.

The basic considerations in acquiring lands are: (1) biological significance of the land; (2) existing and anticipated threats to fish and wildlife resources; and (3) landowner willingness to sell or otherwise make property available for inclusion into the project. The purchase of refuge lands is dependent upon the availability of funds.

Fee title acquisition normally conveys all ownership rights, including water rights, to the Federal government. Fee title interest is normally acquired when (1) the land's fish and wildlife resources require permanent protection, (2) the land is needed for visitor use development, (3) a pending land use could adversely impact the area's resources, or (4) it is the most practical and economical way to assemble small tracts into a manageable unit.

Revenue Sharing. Under provisions of the Revenue Sharing Act (Public law 95-469), the Service would annually reimburse San Joaquin, Stanislaus, and Merced Counties to help offset tax revenue lost as a result of fee title acquisitions of private property. This law states that the Secretary of the Interior shall pay to each county in which the area acquired in fee title is situated, the greater of the following amounts:

1. An amount equal to the product of 75 cents multiplied by the total acreage of that portion of the fee area that is located within such county.
2. An amount equal to three-fourths of one percent of the fair market value, as determined by the Secretary, for that portion of the fee area that is located within such county.
3. An amount equal to 25 percent of the net receipts collected by the Secretary in connection with the operation and management of such fee area during such fiscal year. However, if a fee area is located in two or more counties, the amount for each county shall be proportionate to the acreage in that county.

Given market values for national wildlife refuge lands in California, the second formula (i.e., 0.75 per cent of the fair market value of acquired lands) is usually used to determine Federal revenue sharing payments. Federal regulations specify that the fair market value of fee title refuge lands is to be reappraised every five years. However, payments to counties have been less than the full amount authorized by the Revenue Sharing Act because Congressional appropriations typically fall short of the maximum authorized amount. For the years 2001-2009, revenue sharing payments averaged 46.5 per cent of the full 0.75 per cent of fair market value.

Congress may appropriate, through the budget process, supplemental funds to compensate local governments for any shortfall in revenue sharing payments. Payments under this act would be made only on lands that the Service acquires in fee. On lands where the Service acquires only partial interest through easement, all taxes would remain the responsibility of the individual landowner.

1.12.2 Easement Acquisition

The option to place conservation easements on private land is an important private property right that comes with land ownership in the United States. Private property owners have a number of private rights that go along with the ownership of property. With a conservation easement, the landowner sells some of those rights. In a conservation easement, the owner of the property, also known as the Grantor of the easement, retains all rights of ownership not specifically prohibited or limited by the easement. These include the rights to exclude public access and to sell the property. The easement holder, or Grantee, only has rights specifically included in the easement. The

objectives and conditions of our conservation easements will recognize lands for their importance to wildlife habitat, and any other qualities that recommend them for wildlife conservation. Activities that are normally restricted under the terms of a conservation easement include:

- Destruction of native habitats,
- Subdividing for the purposes of development,
- Alteration of the area's natural topography (unless for restoration),
- Erecting, constructing, or placing structures or buildings.

In the acquisition of a conservation easement, the Service would acquire the minimum rights needed to preserve and protect habitat. The easement interests acquired would be considered components of the Refuge System and would be subject to those laws and regulations that are applicable to the easement interest acquired. We anticipate easements would total approximately five percent of the total land base of the 22,156-acre acquisition goal within the proposed expansion area. The Service would seek to acquire easements in areas where the acquisition would meet Refuge objectives and be acceptable to the landowner. The landowner would remain responsible for all property taxes.

1.12.3 Memorandum of Understanding and Cooperative Agreements

Several public agencies and organizations currently own lands within the proposed San Joaquin River NWR expansion area. If not acquired by the Service, and dependent on the interests of those organizations, these lands could potentially be managed through cooperative agreements or MOUs between the Service and the public landowners.

1.13 Possible Delayed Restoration

Some parcels may not be of adequate size and/or configuration to be an effective restoration project. The Service may work to acquire large blocks of land to obtain the maximum benefits from restoration, which may include nonstructural flood control, or setback levees. If the Service acquires a parcel(s) that is a portion of a desired block of lands, lands may be leased through a cooperative agreement or MOU so the lands would continue to be farmed until the larger block is acquired by the Service.

1.14 Lands Subject to the Public Trust Doctrine

When California became a state in 1850, it acquired land ownership up to "ordinary high water" of all lands under its tidal or navigable waters. The San Joaquin River was navigable, as was proven in 1857, when a steam ship went upriver within three miles of Millerton (Rose 1992). As a result, as far as Millerton, lands that were formerly inundated by the San Joaquin River at ordinary high water under natural channel conditions are lands that are subject to the Public Trust Doctrine. The State gave up its fee title rights to land above "ordinary low water" to adjacent upland property owners on navigable waterways with an 1872 California Civil Code. However, land title released through this 1872 Civil Code is permanently encumbered by the public's property rights as an easement.

2. Alternatives

Chapter 2 describes three alternatives: the No Action alternative, and two action alternatives that would expand the San Joaquin River NWR boundary and allow the Service to acquire an interest in additional lands as part of the Refuge. Under the No Action alternative, the Refuge boundary would not be expanded and the Service would not pursue acquiring additional interest in lands.

This EA, the Land Protection Plan (Appendix A), and the Conceptual Management Plan (Appendix B) describes the Service's proposed boundary expansion.

2.1 Alternatives Development

The planning team considered the following elements when they developed the alternatives for this project: (1) verbal comments provided during informal public scoping between 2011 and the preparation of this document; (2) issues raised during meetings with various agencies, organizations, elected officials, and individuals during the informal scoping process; (3) goals of ongoing programs to benefit federally listed species, including the Recovery Plan for Upland Species of the San Joaquin Valley (USFWS 1998); (4) breeding riparian songbird goals and objectives of the Central Valley Joint Venture Implementation Plan (2006); (5) Refuge goals, and (6) the mission of the Service to conserve, protect, and where necessary recover the Nation's fish, wildlife, and plant resources for the enjoyment of present and future generations.

Modesto Scoping Meeting. USFWS photo

2.2 Alternatives Considered but Determined to be Impractical

The Service considered acquiring only parcels with existing native habitat along the river corridor. This alternative was eliminated because existing native habitat is only five percent of its original size, is fragmented, and is narrow in most places. These characteristics do not allow for a fully functioning riparian habitat and are clearly not sufficient for the re-establishment of neotropical migratory birds, such at the least Bell's vireo, or riparian-dependent mammals, such as the riparian brush rabbit and riparian woodrat; thus, this alternative does not fully support the goals established for the Refuge.

2.3 Description of Alternatives

The three alternatives developed in detail are presented in this section. Each alternative was analyzed for its effectiveness in meeting the San Joaquin River National Wildlife Refuge purposes, the missions of the Service and the Refuge System, and the needs of the public.

For each of the action alternatives, it is important to note that land acquisition is a slow process that is expected to take at least 45 years to acquire 50 per cent of the proposed expansion area. Since acquisition is governed by the willingness of landowners to sell to the Service and availability of funds, management and public use may be limited until such time as a manageable unit of land is acquired. The uncertainty of land acquisition under the willing seller policy, coupled with the unpredictability of the future economic and social climate, prevents the impact analysis from being an exact science.

If an action alternative is selected, lands acquired by the U.S. Fish and Wildlife Service would be administered in accordance with the National Wildlife Refuge System Administration Act, Refuge Recreation Act, Executive Order 12996 (Management and General Public Use of the National Wildlife Refuge System), National Wildlife Refuge System Improvement Act, and other relevant legislation, Executive orders, regulations, and policies. Management activities would include monitoring the status and recovery of endangered, threatened, and sensitive species; controlling non-native species; restoring native habitats; developing and providing wildlife-dependent recreational, interpretive, and educational opportunities; and coordinating with State and Federal agencies.

A Conceptual Management Plan (Appendix B) for the proposed expansion area of the San Joaquin River NWR contains a general description of the proposed management program. The Refuge's CCP also describes management of the Refuge in more detail. Subject to annual appropriations by Congress, Refuge Revenue Sharing Act payments would be made to counties where lands are acquired in fee title. Public use would be authorized only when it is compatible with the mission of the National Wildlife Refuge System and Refuge purposes.

2.3.1 Alternative 1: No Action

Under this alternative, the Service would not expand the boundary of the San Joaquin River NWR. The Service would only pursue acquisition of the remaining 3,280 acres within the existing 13,914-acre boundary. Management of the Refuge would continue be guided by the Comprehensive Conservation Plan (CCP) (USFWS 2006).

2.3.2 Alternative 2: Southern Expansion

Under Alternative 2, the Service would expand the Refuge southward to connect to California Department of Fish and Game's China Island Unit of the North Grasslands Wildlife Area, approximately 21 miles south along the river corridor (Figure 1). Under Alternative 2, the Service

would work with willing participants to protect and eventually restore native riparian habitat on up to 10,441 acres (existing riparian and open water removed from calculations) within the 14,306-acre proposed southern expansion area. Habitat protection measures would include fee title acquisition, conservation easement acquisition, or cooperative agreements.

This alternative would also connect the San Joaquin River NWR to the project area of the San Joaquin River Restoration Program, which is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts from restoration flows. The entire reach of the San Joaquin River encompassed by this proposed expansion alternative is designated critical habitat for the Central Valley steelhead.

This alternative would support the San Joaquin River Partnership's San Joaquin River Blueway Vision, which was selected as a key project of the Secretary of Interior's America's Great Outdoors (AGO) Initiative. The Partnership's mission is to restore a working river to the Valley to benefit its human and natural communities from the headwaters to the Delta.

2.3.3 Alternative 3: Northern and Southern Expansion (Preferred Alternative)

In addition to the southern expansion described in Alternative 2, Alternative 3 would expand the Refuge boundary approximately 10 miles along the San Joaquin River corridor to the north (Figure 2). Under Alternative 3, the Service would work with willing participants to protect and eventually restore native riparian habitat on up to 16,561 acres (existing riparian and open water removed from calculations) within the 22,156-acre northern and southern expansion areas. Habitat protection measures would include fee title acquisition, conservation easement acquisition, or cooperative agreements. The northern expansion area is considered to be part of the Sacramento/San Joaquin Delta and includes a portion of the delta smelt critical habitat. This alternative includes a greater portion (over Alternative 2) of the San Joaquin River Partnership's San Joaquin River Blueway Vision. The entire reach of the San Joaquin River encompassed by this proposed expansion alternative is designated critical habitat for the Central Valley steelhead.

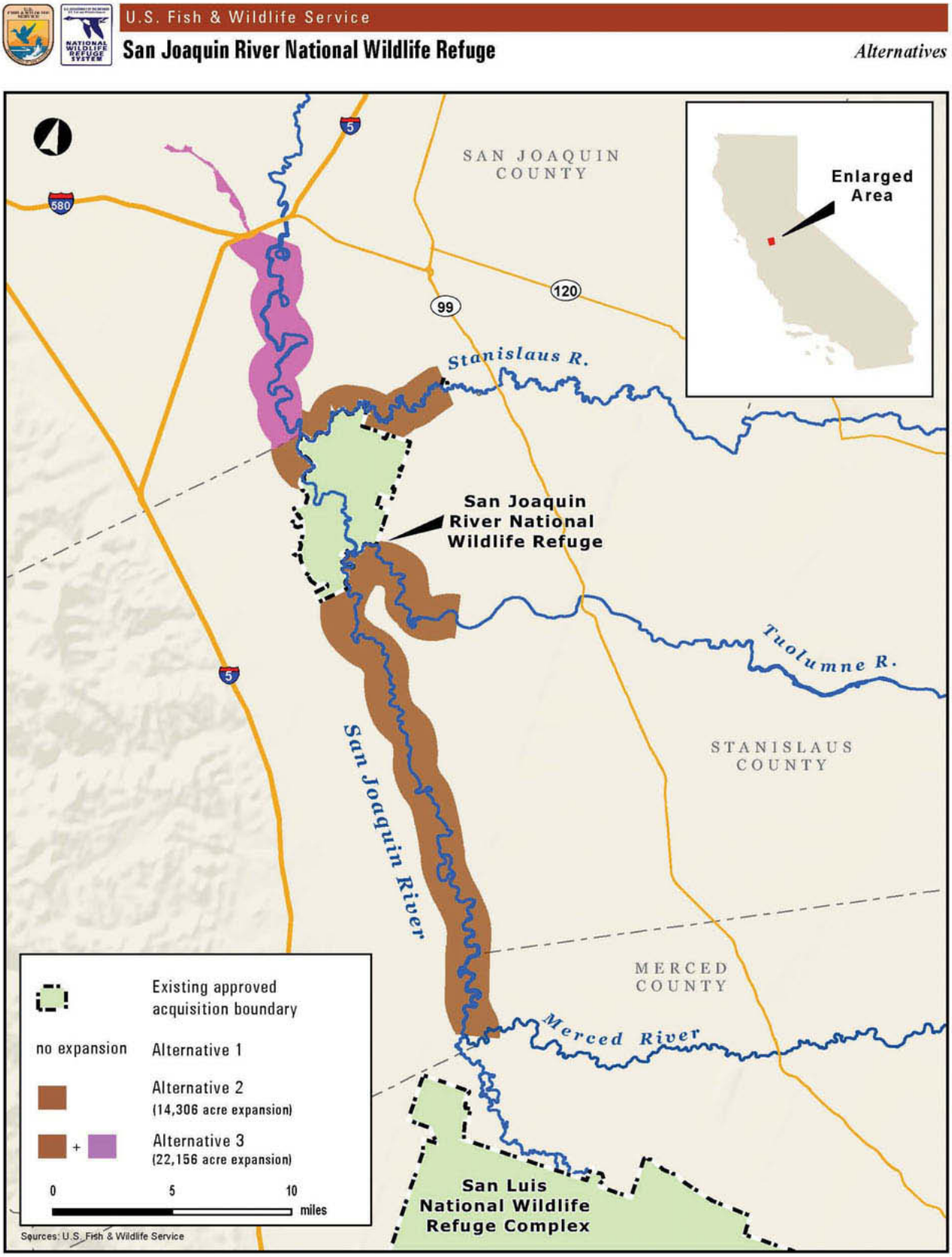

Figure 2. Alternatives Map

2.4 Habitat Restoration

Habitat restoration is a term that refers to return of former agricultural or other developed lands into native plant communities that provide habitat for endangered species, migratory birds, anadromous fish, and/or other native plants and animals. After the Service acquires lands with marginal value to wildlife, it is often necessary to pursue some type of restoration activity to help meet the goals of the Refuge.

The number of acres restored each year will vary and will be dependent on available funding and the rate and extent of acquisitions. The Refuge is currently spending about $1 million per year in grant money on restoration. For Alternatives 2 and 3, it is expected that future grant funding will continue to average about $1 million per year. At this funding rate, an average of 150 acres of acquired lands and one mile of levee will be restored with the appropriate native plants per year.

A general goal of restoration is to reestablish an ecosystem's ability to maintain its function and organization without continued human intervention. Horticultural restoration requires knowledge of local site conditions for a planting to successfully establish. It is common for restoration projects to include a three-year maintenance regime, during which the plants are irrigated, and re-planted as needed and weeds are controlled. Beyond this period of maintenance, species will only survive if they were well-matched to the site conditions. Species of plants must be matched to soil types and hydrologic conditions under which they will grow and prosper. Consequently, the first step in developing a plan and a list of species for any riparian restoration project is a detailed site evaluation that describes soils and local hydrology (RHJV 2009).

Bench on the San Joaquin River NWR, along the Pelican Trail. Photo by Rick Kimball

3. Affected Environment

3.1 Introduction

The proposed expansion area includes terrestrial and aquatic habitats for fish and other wildlife, including rivers, permanent wetlands, oxbows, and sloughs. Three major rivers (San Joaquin, Tuolumne, and Stanislaus) join on the existing Refuge and provide an important nexus for anadromous fish, as all are critical habitat for the Central Valley steelhead and habitat for the fall and late-fall run of Central Valley Chinook salmon, a species of concern. The Merced River, whose confluence with the San Joaquin River is included in the proposed southern expansion area, also provides habitat for these listed and sensitive fish. Nearly all lands within the study area are subject to 100-year flood water though there are human-made levees (FEMA 1996) along the river.

Historically, the northern San Joaquin River and its structurally diverse floodplain provided habitat for a large assemblage of wildlife populations, including millions of migratory birds and the Central Valley's largest spring-run populations of Chinook salmon. Since the gold rush, the San Joaquin has been dammed, sections have been dewatered, bypasses and levees have been built, Chinook salmon are no longer spawning within the main stem of the river, 95 percent of the riparian habitat has been eliminated, and the floodplain has been developed into one of the top agricultural producers for the country. Riparian habitat loss may be the most important cause of population declines among songbird species in western North America (DeSante and George 1994). In addition, along the San Joaquin River, agricultural crop conversion from wildlife compatible crops such as small grains and pasture lands to vineyards, orchards, and dairies is occurring at a relatively rapid rate (USDA 2007).

Presently the San Joaquin River water quality is below what is considered optimum for aquatic life. Groundwater overdraft is evident in the Central Valley, and groundwater quality needs improvement. Levees confine the river and do not allow it to flood adjacent land, which attenuates flood flows, making floods more devastating when they do occur. The river bank continues to be armored, and climate change is likely to affect the landscape negatively, particularly if precipitation in the form of snow shifts to rain as predicted, as this would aggravate flooding and likely lead to increased levee work, such as upgrades and new construction.

Many of the non-native invasive species currently established along and in the San Joaquin River and wetlands (e.g., scarlet wisteria, tree-of-heaven, giant reed, pampas grass, tamarisk, edible fig, parrot's feather, and water hyacinth) have potential to increase in abundance and impact native species to a greater degree. Twenty-three high impact invasive plant species are already present in the area. In addition, there is a potential for quagga and zebra mussels to colonize the area and do great harm.

Immediately upstream (south) of the proposed expansion area, Congress has mandated the Bureau of Reclamation (USBR) to restore a naturally-reproducing and self-sustaining population of Chinook salmon in the San Joaquin River, and to restore flows from Friant Dam to the confluence of the Merced River, approximately 150 miles. Riparian ecosystems require hydrologic and fluvial processes that are associated with this mandate.

3.2 Physical Environment

3.2.1 Climate

The San Joaquin Valley lies between the Coastal Range and the Sierra Nevada Range. Well-protected from the Pacific Ocean, the area displays continental climate characteristics of hot, dry summers with mild winters. Its location on the western edge of the continent protects the region from the weather extremes found farther inland. Precipitation occurs during winter and spring months but is reduced because of the rain shadow effect of the Coast Range. Patterson, a town near the Refuge, has an average annual rainfall of approximately 10 inches. The San Joaquin Valley has a frost-free growing season of 270 to 300 days. The average temperature ranges from a low of 38 degrees Fahrenheit (°F) to a high of just over 100 degrees F; however, extreme temperatures, as low as 20 degrees and as high 115 degrees, have been recorded. Cold-air drainage from the surrounding mountains becomes trapped, forming a persistent inversion layer in the valley. During winter, this is manifested in a dense, ground-hugging fog known as tule fog. Summer days are hot and hazy. Air quality of the Central Valley is poor.

3.2.2 Climate Change

Climate change has been acknowledged as already happening by the majority of prominent scientists in the field (Oreskes 2004). By the end of this century, air temperatures are projected to increase by 2.7 to 8.1 degrees Fahrenheit (°F) in the California region (Cloern et al. 2011). Precipitation in the form of snowfall is expected to decrease and rainfall increase, surface water temperatures are predicted to increase; and the sea level is rising, shifts in reproductive timing and distribution of plants and animals are occurring now and are expected to increase as the effects of climate change increase (Meyer et al. 1999, Barnett et al. 2005, Parmesan 2007, Palmer et al. 2008, Rosenzweig et al. 2008). Native plants and animals will not be protected from the effects of climate change unless we make a concerted effort to physically link isolated reserves and to keep suitable migration corridors open (Field et al. 1999).

Sea level

It is expected that in the next 50-100 years, sea levels are expected to rise 2.29–6 feet above the present-day level. A one-foot rise in sea level resulting from climate change would transform the current high tide peak on the lower San Joaquin from an event that occurs every 100 years on average to one that occurs every 10 years—making the now rare event in the Delta a common one (Field et al. 1999).

Water

California will experience further declines in snow accumulation, and increased winter precipitation will fall mostly as rain rather than snow. Thus, less water will be stored in the snow pack while more water will run off immediately, adding to winter flooding and landslide problems. In addition, the warmer atmosphere can hold more water vapor and result in more intense warm winter-time precipitation events that result in flooding. During anticipated high flow, reservoirs need to release water to maintain their structural integrity. California is at risk of water shortages, floods, and related ecosystem stresses. Changes in the water cycle will probably lead to water shortages during the late spring and summer, worsening drought conditions, irrigation needs, and water use conflicts. Crops that require large amounts of irrigated water, such as grapes, cotton, and alfalfa, will be among the hardest hit (Field et al. 1999).

Temperature

With an increase of 2.7 to 8.1 (°F) in air temperature expected by the end of this century, native terrestrial plant communities that require cooler temperatures and more moisture may move higher, move north, or seek northern exposures. Plant species that are not able to make the shift may exhibit vastly reduced ranges or eventually die off (Sykes 2009). More than half of the mammal species scientists previously projected could expand their ranges in the face of climate change will instead see their ranges contract because the animals won't be able to expand into new areas fast enough, according to some scientists (Schloss et al. 2012).

Most North American turtles and several other reptile species could exhibit vulnerability to climatic change because the temperature experienced as they develop inside the egg determines their sex. Such temperature-dependent sex determination makes these animals uniquely sensitive to temperature change, meaning that climatic change could potentially cause severely skewed sex ratios, which could result in dramatic range contractions (Root and Schneider 2002).

The San Joaquin River is already listed as impaired for water temperature, and climate change will continue to increase the temperatures of open waters. All native anadromous fishes were rated as highly or critically vulnerable to climate change. Such fishes are already stressed by other man-made changes to their streams (Katz et al. 2012).

Phenology

Climate changes that affect the timing of plant or animal life history events such as leaf emergence, flowering, and egg hatching could also threaten biodiversity by disrupting vital interactions between species, from predation to pollination (Menzel et al. 2006, Schwartz et al. 2006, van Asch and Visser 2007). In California, 70 percent of 23 butterfly species advanced the date of first spring flights by an average 24 days over the period from 1972 to 2002 (Forister and Shapiro 2003). Climate warming during spring is the only factor that was able to explain this shift in the date of the butterfly's first flight.

There is some evidence, for example, that climate change could disrupt plant/pollinator relationships and dispersal of seeds by animals in Mediterranean-climate ecosystems, such as the San Joaquin Valley. Pollination by bats, bees, beetles, birds, butterflies, and other animals is required for the successful reproduction of most flowering plants, including both wild and crop species. In California agriculture, pollinators are critical to production of many orchard, field, and forage crops, as well as the production of seed for many root or fiber crops. The continued availability of pollinators depends on the existence of a wide variety of habitat types needed for their feeding, successful breeding, and completion of their life cycles (Buchmann and Nabhan 1996).

Weeds and Invertebrates

Although increased atmospheric concentrations of carbon dioxide—the most prevalent greenhouse gas—may stimulate plant growth, weed and pest populations are also predicted to increase (Trumble and Butler 2009). Crops grown under elevated carbon dioxide levels can have up to twice as many insects and higher levels of insect damage compared to control groups. Warmer temperatures will likely lead to the northern migration of invasive species and weeds (Dermody et al. 2008).

Many of the non-native invasive species currently established along and in the San Joaquin River and wetlands (e.g., scarlet wisteria, tree-of-heaven, giant reed, pampas grass, tamarisk, edible fig, parrot's feather, and water hyacinth) have potential to increase in abundance and impact native species to a greater degree. Twenty-three high impact invasive plant species are already present

in the area (Cal IPCC 2006). In addition, there is a potential for quagga and zebra mussels to colonize the area and do great harm.

The extent to which climate change will impact the proliferation of non-native invasive species in the San Joaquin River and wetlands is unknown. It is expected that with the restoration of riparian habitat, native species will face decreased competition relative to the present circumstances.

3.2.3 Soils and Geology

Schoenherr (1992) provides a broad overview of the soils and geology of California's Central Valley:

> "The Central Valley is a huge basin filled with sediments. The deepest parts of the gravels and sands are marine sediments that have accumulated since the late Jurassic—145 million years ago. The sea retreated from the Central Valley at about the same time that the southern Coast Ranges were uplifted, and during the long history of accumulation of marine sediments in the valley, the basement rock continued to subside. During most of the Pleistocene the area was occupied by shallow brackish and freshwater lakes. During the last 5 million years, sediments accumulated as alluvial deposits washed out of the mountains. These deposits are only a few thousand feet deep over most of the valley floor."

Land on both sides of the river consists primarily of recent alluvial floodplains and basin lands. Soil types are often mixed alluvium mapped as soil associations. Basin soils can be affected by high water tables from river water seepage, as well as saturation of the land by deep penetration of rain and irrigation water. If the land is irrigated, it provides prime farmland, although it floods every few years. Soils further away from the San Joaquin River differ on the east and west sides because of geological influences of the Sierra Nevada and Coast Ranges respectively (Gronberg et al. 1998, Panshin et al. 1998). Sediments on the eastern side are generally highly permeable, medium- to coarse-grained sands with low total organic carbon. Soils on the western side tend to be fine-textured with higher clay content and low permeability than soils on the eastern side of the Valley.

Functioning natural systems replenish themselves. Leaf litter and standing biomass are necessary for soil regeneration. Without the cycle of litter and biodegrading, flooding, and plant growth, the soil would not be replenished. Root systems create an interwoven structure that holds soils together, stabilizing stream banks. They catch and hold pollutants, use phosphates adhering to the soil and sediment particles deposited by runoff or floodwater, and hold harmful or toxic substances in place by minimizing soil movement. Floods can spread onto floodplains, where their energies are dissipated and silt from floodwaters increases soil productivity (NRCS 2007).

The decay of plant detritus produces soil organic matter that has great influence on chemical transport and transformations in soils. Decomposition of vegetation by heterotrophic microbes produces an array of humic substances that are resistant to further degradation, accumulate in soils, and are chemically active (McFee and Kelly 1995). The assemblage of heterotrophic bacteria, fungi, and actinomycetes that perform decomposition also take part in chemical transformations in soil (Alexander 1977). Many synthetic organic chemicals, such as agricultural pesticides and endocrine disruptors, bind strongly to and are immobilized by soil organic matter (Yamamoto et al. 2003) and are subject to degradation by heterotrophic microbes that decompose plant litter (Smith et al. 2008). This prevents some pesticides from moving into water supplies and improves the decomposition of the compounds, but it also can make pesticides less effective by preventing their contact with the target organism.

3.2.4 Topography and River Geomorphology

Elevations on the expansion area vary from approximately 63 feet above sea level at the Merced River confluence to 8 feet at Paradise Cut. The proposed expansion is bisected by the San Joaquin River, which has flood control levees on one or both banks in many reaches. Most of the lands along the river have been leveled and intensively farmed in the past for row crops and irrigated pasture. Small parcels along the river that retain the natural topography are present throughout the study area. The riparian corridors inside the levees are thought to retain their natural topography. Along the river, the sizes of the riparian areas range from narrow corridors to the large floodplain of 2,220 acres of restored land on the Refuge (RM 77-84).

Three major tributaries of the San Joaquin River occur in the proposed expansion area. All three are dammed and join the San Joaquin from the east, with watersheds that originate on the western slope of the Sierra Nevada. The Stanislaus River is located along the Refuge's existing north boundary at the confluence with the San Joaquin River. The Tuolumne River forms the southern boundary of the existing Refuge. The Merced River joins the San Joaquin at the north end of the GEA, which forms the southern boundary of the proposed expansion area. All three rivers contribute significant flows to the San Joaquin River system and have been modified by levees, gravel mining, and water diversions, but to a lesser extent than the San Joaquin River.

Five smaller tributaries cross western Stanislaus County, draining from the eastern slopes of the Diablo Range to the San Joaquin River. From north to south they are: Hospital, Ingram, Salado, Del Puerto, and Orestimba Creeks. Though rainfall is infrequent in these creek watersheds, it is often heavy, making them prone to erosion. None of the creeks flow continuously, and most have been heavily channelized on farmland located upslope from the study area, and essentially act as agricultural drains. Merced County has no small tributaries in the proposed expansion area, and San Joaquin County has no small direct tributaries, though there are three sloughs that are often connected to the river during flood events (Tom Paine, Red Bridge, and Walthall Sloughs).

Much of the land within the proposed expansion area has been separated from river flood water by human-made levees. The course of the San Joaquin River has been modified and channelized to enhance water delivery and flood control. Modification, levee construction, and water diversions to enhance water deliveries and flood control throughout the San Joaquin River system have greatly altered the hydrology and fluvial processes, such as river meandering (Katibah 1984). Except for extreme flood events that result in levee failure, water in the river remains within the levee corridor and does not spread across the floodplain. These fluvial processes are reduced most years, even in the riparian areas inside the levee corridor, because the river flows are reduced from historic levels.

Outflow into the San Joaquin River, surrounded by riprap. Photo by Chris Acree

3.2.5 Surface Water Quality

The San Joaquin River has water quality issues and several agencies are working to reduce pollutant loads. From 1992 until 1995, some 49 pesticides were detected in the San Joaquin River and three subbasins, 22 of which were detected in more than 20 percent of the samples. Available drinking water standards were not exceeded, but the concentrations of seven pesticides exceeded the criteria for the protection of aquatic life. Pesticides in the river have been correlated to agricultural application rates and times (Brown et al. 1999). Selenium, boron, and other trace elements are found naturally in the soils, and nitrates have been found in groundwater in the area.

Upstream of the North Grasslands Wildlife Area, the 370,000-acre Grasslands Watershed contains the largest freshwater wetland ecosystem in California. The watershed also includes approximately 97,000 acres of irrigated farmland. Irrigating the area's selenium- and salt-rich soils allowed selenium and salts to leach into shallow groundwater. To protect their crops from this salty groundwater, farmers installed tile drain systems to lower the water table below the root zone. Subsurface drainage from this agricultural area increased selenium concentrations in wetland supply channels and other downstream water bodies. As a result, the Grasslands Watershed marshes and a portion of the river were placed on California's Clean Water Act (CWA) section 303(d) list of impaired waters for selenium in 1988. The listing of two local tributaries, Mud Slough and Salt Slough, followed in 1990. The Grasslands Bypass Project implemented

agricultural best management practices (BMPs) and area wide measures to re-route drainage and reduce the total selenium loading. These efforts led to significant selenium load reductions, which in turn resulted in the de-listing of Salt Slough (10 miles) in 2008 and three segments of the San Joaquin River (totaling 40.4 miles) in 2010. (EPA 2011a)

The proposed expansion area of San Joaquin River NWR is listed as impaired on the Clean Water Act Section 303(d) list for the following pollutants; (EPA 2011b).

Pollutant	Toxicity-Birds	Toxicity - Fish	Toxicity - Invertebrates	Toxicity - other
Diazinon (a)	High	Moderate to High	High – bees & aquatic Invertebrates	High- Amphibians
Chlorpyrifos (b)	High	High	High - bees & aquatic Invertebrates	
DDT (c)	Moderate, egg shell thinning	High	High – aquatic invertebrates	Moderate for adult frogs
DDE (d)	Moderate, egg shell thinning	High	High – aquatic invertebrates	Moderate for adult frogs
Diuron (e)	Moderate	Moderate to high	High– aquatic invertebrates	
Toxaphene (f)	High	High	High	
Malathion (g)	Moderate to high	Moderate	High - bees	Low for mammals
Pyrethroids (h)	Low	High	Moderate for bees and aquatic invertebrates	High for tadpoles
Dieldrin (i)	Moderate to high	High	High for aquatic invertebrates	
Dimethoate (j)	Very high	Moderate	High – bees & aquatic invertebrates	
Azinphos-methyl (guthion) (k)	Moderate	Very high	High - bees	High for mammals
Trifluralin (l)	Very low	Very high	High – aquatic invertebrates	Low for mammals
Mercury (m)	High, lowered reproduction	Low		High for methyl mercury in amphibians

Pollutant	Toxicity-Birds	Toxicity - Fish	Toxicity - Invertebrates	Toxicity - other
Boron (n)	High, lowered reproduction	High		
Alpha-BHC (o)	Moderate, egg shell thinning	High	High – bees & aquatic invertebrates	Effects the liver of mammals
E. coli				
Sediment toxicity	–	–	–	–
Unknown toxicity	–	–	–	–
Water temperature	–	Species dependent		–
Electrical conductivity				

Source: a – Eisler 1986, b- Odenkirken and Eisler 1988, c- National Pesticide Information Center (NPIC) 1999, d- NPIC 2000, e- Journal of Pesticide Reform 2003, f- EPA 1971, g- Gervais et al 2009, h- NPIC 1998, i- Jorgenson 2001, j- Pesticides News 2002, k- EXTOXNET 1996, l- EXTOXNET 1996, m- Wolfe et al 1998, n- Eisler 1990, o- EXTOXNET 1993

In addition to the above listed pollutants, the California State Water Control Board used a 1972 National Academy of Sciences document to group a select list of organochlorine pesticides and a level of concentration in the water and in fish residue to protect non-human fish consumers (EPA 1972). This grouping was named "Group A" pesticides, which include at least one of the following: aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane, endosulfan, and hexachlorocyclohexane (total including lindane). The San Joaquin River is listed as impaired in the 303(d) list for "Group A" pesticides as well.

The occurrence of pesticides and their effect on the water quality of the San Joaquin River have been studied by several scientists (Foe and Connor 1991, Foe 1995, Kuivila and Foe 1995, MacCoy et al. 1995, Ross et al. 1996, Domagalski 1997). All of these studies detected the presence of pesticides in water samples from the San Joaquin River and its tributaries. Three studies (Foe and Conner 1991, Foe 1995, Kuivila and Foe 1995) demonstrated that water in the San Joaquin River is sometimes toxic to *Ceriodaphnia dubia*, a water flea. Foe (1995) examined the seasonality of pesticide concentrations, *Ceriodaphnia* mortality, and pesticide applications to different crops. He was able to identify the pesticides most likely responsible for the toxicity of the water at different times of the year and to associate these pesticides with the crops to which they were applied. The most significant sources of chlorpyrifos and diazinon appear to be winter storm runoff from orchard and summer irrigation return flows.

The California Environmental Protection Agency, Regional Water Quality Control Board (2002) provides an assessment of pesticides in the San Joaquin River;

> *"Organophosphorous (OP) pesticides used on alfalfa have been identified as the cause of toxicity to aquatic species in watersheds throughout the state. The transport mechanism of the OP pesticides from alfalfa fields to surface water is believed to be primarily due to storm and irrigation water runoff. Major uses of chlorpyrifos in March in the Central Valley are on alfalfa and sugarbeets for weevil and worm control. In addition to Ceriodaphnia toxicity from chlorpyrifos, algal toxicity has been observed in surface waters. The herbicide diuron has been identified as one of the causes. Potential sources are alfalfa runoff, urban storm runoff and applications to rights of way. Approximately 222,000 lbs of diuron was applied to alfalfa in the state in 1998, according to DPR's Annual Pesticide Use Reports. Additional causes of algal toxicity are unknown at this time.*
>
> ***Fish Tissue Problems:*** *The State Board Toxic Substances Monitoring Program has found elevated levels of Group A Pesticides in fish from the Tuolumne, Merced, and Stanislaus Rivers and the mainstream San Joaquin River. Group A Pesticides include chlordane, toxaphene, endosulfan, and a few other pesticides. The chemicals are thought to result primarily from past agricultural use. Agricultural use of chlordane, DDT, and toxaphene is now banned and endosulfan use is closely regulated and much reduced. However, the materials appear to be tightly bound to sediment and move into the river systems as the sediment moves offsite. National Academy of Sciences (NAS) and US Food and Drug Administration (FDA) criteria are used to evaluate tissue levels of contaminants." (California Environmental Protection Agency 2002).*

A thorough understanding of the relationship between agricultural pesticide use and pesticide occurrence in surface water also will be necessary to achieve the objective of the elimination of toxicity in the San Joaquin River above baseline conditions established by the State Water Resources Control Board and the Central Valley Regional Water Quality Control Board in 2002 (State Water Resources Control Board 2002).

Within the proposed expansion area, which lies between river miles 58 and 118, there are 74 diversion points and 83 discharge/inflow sites, according to a report published by the California Regional Water Control Board (CRWCB 1989). The report further states that a "majority of the river in many months of the year is made up entirely of agricultural return flows, both surface and subsurface."

There are four major routes through which pesticides reach the water: (1) it may drift outside of the intended area when it is sprayed, (2) it may percolate, or leach, through the soil, (3) it may be carried to the water as runoff, or (4) it may be spilled accidentally or through neglect. Pesticides may also be carried to water by eroding soil. Factors that affect a pesticide's ability to contaminate water include its water solubility, the distance from an application site to a body of water, weather, soil type, presence of a growing crop, and the method used to apply the chemical.

Pesticides have been linked to declines in amphibian populations. For example, chlorpyrifos is the most widely used organophosphorus pesticide in California. Chlorpyrifos blocks acetylcholinesterase (AChE) at neural synapses, which leads to repeated firing of neurons. This

can cause death through respiratory failure. In addition, chlorpyrifos can be degraded into chlorpyrifos oxon that is at least 100 times more toxic. Endosulfan is the second most commonly used pesticide in California. Endosulfan also impairs neurological function. The U.S. Geological Survey funded experiments that have shown endosulfan is the most toxic of the commonly used pesticides in California. Whereas all three forms of endosulfan are toxic, a mixture of alpha and beta endosulfan resulted in an LC50 of 0.3 µg/kg body weight in *Rana boylii* (foothill yellow-legged frog) and ca. 3 µg/kg body weight in *Pseudacris regilla* (Pacific chorus frog) and *Bufo boreas* (western toad). Approximately 86 percent of adult *P. regilla* collected from an area that had experienced amphibian population declines had trace amounts of one or more of the endosulfans. Although endosulfan use is less than that of chlorpyrifos in California, its longer half-life and high toxicity may make it more dangerous (USGS 2012). Endosulfan has been detected in the San Joaquin River, and according to the Environmental Protection Agency, it will be phased out by 2016 in the United States (Ross et al 2000, USEPA 2010).

The most obvious pollution prevention function of riparian areas kept in a naturally vegetated condition is that such land is not in and of itself a pollution generator. In other words, the more that riparian lands along a particular watercourse are maintained in a naturally vegetated state as opposed to being converted to other pollution-generating land uses, the less pollution will get into that waterway from the riparian lands themselves. As an increasingly larger share of pollution in our rivers and streams is attributable to nonpoint source pollution originating from development of riparian areas along rivers and streams, merely keeping the remaining undeveloped riparian areas in a naturally vegetated condition is a highly effective means of pollution prevention (Cohen 1997).

3.2.6 Flood Management

Although the flood management system on the San Joaquin River has prevented billions of dollars in damages over time and has contributed greatly to the economic development of the State and Nation, flood-related problems still exist. The San Joaquin River flood levee and channel system lacks the capacity to convey design flood flows (USACE 1998). In January 1997, Californians experienced the largest and most extensive flood disaster in the State's history. Major storms caused record flows on many rivers throughout California. In the Central Valley, the flood management systems for the Sacramento and San Joaquin Rivers were pushed to capacity and beyond. Flood storage behind dams reduced flood flows by half or more, saving lives and significantly reducing property damage. However, in some areas, levees were overwhelmed. Where levees performed as designed, damage from erosion was significant. On the San Joaquin River, levees failed in 34 places. Damage to urban and agricultural lands and the cost to replace, restore, and rehabilitate flood damage reached $223 million for the San Joaquin River Basin of California, as shown in table 1(USACE 1998).

Table 1. San Joaquin River Basin Damages Sustained in Recent Floods

Flood Event (Year)	Cost, in Millions of Dollars (in year of event)
1983	$324
1986	$15
1995	$193
1997	$223

Source: USACE, 1998.

After the flooding of 1997, the Corps of Engineers proposed that nonstructural flood control was feasible on the San Joaquin River. Using this model, the Service, the Natural Resource Conservation Service (NRCS), the U.S. Army Corps of Engineers, the California Department of Water Resources, and the California Reclamation Board worked together to create a nonstructural flood control solution at the Refuge. This project involved acquiring lands protected by Corps levees and breeching the levees in seven locations to allow future floods to inundate the new Refuge lands which, in turn, would provide flood protection to areas downstream by offering temporary storage of peak flood flows. This project was part of the restoration of nearly 2,220 acres of riparian forest on former farmlands on the Refuge. The modeling results indicate that the stage reduction is relatively minor at 0.3 feet, which will slightly reduce flood impacts locally. Additional setback levees would provide supplementary stage reduction elsewhere (PWA 2004).

Flooding is an important feature of natural systems, and a dynamic river would commonly contain various seral stages of the riparian habitat at one time due to disturbance events such as floods. This is important, as different bird species are attracted to various vegetation and habitat features within a riparian community (Cohen 1997).

Naturally vegetated riparian areas (uplands as well as floodplains) serve a number of beneficial functions for flood control. An undeveloped, vegetated floodplain reduces the force, height, and volume of floodwaters by allowing them to spread out horizontally and relatively harmlessly across the floodplain. Water that floods into vegetated floodplains reenters the main channel slowly, enabling it to be soaked up by the "sponge" of floodplain wetland soils and streamside forest leaf litter. Living, decaying, and dead vegetation on riparian lands that falls or extends into the water provides numerous barriers against moving water, which slows it down so water is not delivered downstream as quickly. Such vegetation also intercepts and detains runoff from adjacent upland areas that would otherwise flow directly into rivers and exacerbate flooding conditions downstream. The root systems of streamside forest and emergent aquatic vegetation keep pores of the soil open so that two to three times more water can infiltrate the soil compared to lands used for cultivation or grazing (Cohen 1997).

Removing streamside forests from riparian areas impairs their ability to provide flood control in several ways. Floodwater detention is substantially reduced by removing the natural barriers of live, decaying, and dead vegetation from the forest floor. Removing streamside forests will also result in an increase in soil compaction and reduction in soil porosity. All of these impacts combine to cause a significant decrease in infiltration and a subsequent increase in the speed and amount of flood runoff. Excessive sedimentation resulting from the removal of vegetative cover from riparian areas

reduces flood storage, as eroded sediments settle out of the current and fill channels and deeper spots on the river so they can no longer convey or hold as much water. This reduction of storage capacity increases peak discharges and the likelihood of flood damage (Cohen 1997).

Structural attempts at flood control, such as confining watercourses into narrow channels and levees without riparian floodplains, have the effect of raising both the velocity and the height of any subsequent flood flow and make it all the more frightening and destructive when a river breaks through defenses (Cohen 1997).

If the Refuge were to plan any additional nonstructural alternatives to flood control in the future, the analysis would be subject to NEPA compliance, along with the associated public scoping.

3.2.7 Groundwater Quantity

California is the only western state in which groundwater use is almost completely unregulated. California well owners are not required to report pumping or consumption patterns. Increased pumping of groundwater contributes to increased stream flow capture, whereas a gradient leading away from the river causes water to flow from the river into the groundwater. Groundwater near the San Joaquin River is fairly shallow, either due to this gradient, or irrigation, or a combination of the two. Groundwater pumping reduces base flow, reduces groundwater outflows to the Delta, lowers the water table, and increases the likelihood of land subsidence (Hanson et al. 2012).

Although groundwater overdraft does not seem to be a problem in the proposed expansion area, it is a problem within the basin. Measurements over the past 40 years show a fairly continuous decline in groundwater levels in eastern San Joaquin County (USACE 2001). Groundwater levels have declined at an average rate of 1.7 feet per year and have dropped as much as 100 feet in some areas. It is estimated that groundwater overdraft during the past 40 years has reduced storage in the basin by as much as two million acre-feet (af). The USBR (1996) estimated the 1990 annual groundwater extraction in San Joaquin County to be about 731,000 af/year, which exceeds the estimated safe yield of 618,000 af/year. This results in an estimated overdraft of 113,000 af/year. It is estimated that 70,000 af/year of overdraft occurs in northeastern San Joaquin County, and about 35,000 af/year of overdraft occurs in the Stockton East Water District area. Although a comprehensive assessment of overdraft in California's subbasins has not been completed since 1980, the California Water Plan Update reports that three of the subbasins in the San Joaquin River Hydrologic Region (Chowchilla, Eastern San Joaquin, and Madera) are in a critical condition of overdraft (DWR 2009).

3.2.8 Groundwater Quality

As a result of declining groundwater levels, poor quality water has been moving east along a 16-mile front on the east side of the Delta (DWR 1967). As of 2003, groundwater accounted for 30 percent of overall water supply in the San Joaquin Basin (DWR 2003).

Salinity

The degradation was particularly evident in the Stockton area, where the saline front was moving eastward at a rate of 140 to 150 feet per year. Data from 1980 and 1996 indicate that the saline front continues to migrate eastward up to about one mile beyond its 1963 extent (USACE 2001).

Nitrates

Because the occurrence of nitrates is anthropogenic, most areas of higher concentrations are extremely localized and usually are attributed to localized position sources such as septic tanks, dairies, or feed lots (Bertoldi et al. 1991). Nitrates that are generated from the disposal of human

and animal waste products or from the inefficient application of fertilizer and irrigation water have contaminated 200 square miles of groundwater in the region and threaten some domestic water supplies. Higher nitrate concentration, ranging from 5 to 30 mg/L, may adversely affect select crops. Large areas of elevated nitrate in groundwater exist within the subbasin located southeast of Lodi and south of Stockton and east of Manteca extending towards the San Joaquin–Stanislaus County line. Municipal use of groundwater as a drinking water supply is impaired due to elevated nitrate concentrations in the Tracy, Modesto-Turlock, Merced, and Madera areas (SWRCB 1991).

Boron

Agricultural use of groundwater is impaired due to elevated boron concentrations in western Stanislaus and Merced counties (SWRCB 1991) due to boron's excessive phytotoxicity. High boron concentrations occur in the groundwater in the northwestern part of the San Joaquin River Region from the northernmost edge of the region to the southernmost edge of the region (Bertoldi et al. 1991).

Dibromochloropropane (DBCP)

A notable agricultural groundwater contaminant in the hydrologic region is DBCP. DBCP is a soil fumigant and known carcinogen that is now banned, but was extensively used on grapes and cotton (DWR 2003). The presence of this pesticide coincides with land use patterns and is prevalent in groundwater at levels above 0.0005 mg/L north of Merced and Stockton. DBCP is typically observed in shallow, younger groundwater recharged after 1980 in areas occupied by orchards and vineyards, where DBCP was commonly used (Bertoldi et al. 1991). DBCP has been reported above the maximum contaminant level of 0.2 μg/L in the Merced, Turlock, Cosumnes, and Eastern San Joaquin subbasins (Bennett et al. 2006, Landon and Belitz 2008). DWR reported that elevated concentrations of DBCP have also been found in localized areas in the Modesto and Madera subbasins (DWR 2003).

3.3 Biological Environment

3.3.1 Plant Communities

Plant communities within the proposed expansion area include great valley oak riparian, black willow riparian forest, permanent wetland, semipermanent wetland, seasonal wetland, tilled cropland, irrigated pasture, and native grasslands. The value of the remnant riparian habitat is minimal due to the extreme narrowness of the bands of habitat, providing minimal corridor width for migratory birds and very limited habitat for resident species such as the endangered riparian brush rabbit and riparian woodrat.

Riparian Habitats

The riparian habitat along the San Joaquin River is fragmented. Habitat fragmentation is a dynamic process that has three main components: an overall loss of habitat in the landscape, reduction in the size of remaining areas, and increased isolation by new types of land use. Changes to the pattern of habitats in the landscape result in changes to ecological processes that in turn affect the status of the flora and fauna. Effects of habitat fragmentation on wildlife include: loss of species in fragments, changes to the composition of faunal assemblages, and changes to ecological processes that involve animals. Fragmentation isolates habitats, and evidence shows that isolation and the amount of spatial isolation have negative impacts on many populations and communities.

The negative effects of isolation are attributed to the decreased opportunity for animals to move to and from other habitats (Bennett 1998, 2003).

With increased riparian habitat, streamside vegetation would increase, and with time, the resulting fallen trees and branches, root systems, and overhanging vegetation will contribute to the diversity of structural habitats of both terrestrial and aquatic habitats. In turn, this structural diversity provides a wider range of microhabitats that support a greater diversity of aquatic and terrestrial organisms. Streamside vegetation is also an important source of energy for aquatic ecosystems. Herbaceous vegetation and insects are consumed after falling into streams, and branches and logs are a long term source of cover and nutrients for aquatic food webs (Forman 1995).

Great Valley Oak Riparian

Oak woodland once covered much of the landscape surrounding the San Joaquin River NWR; however, only a remnant of this habitat remains. Virtually all of the great valley oak riparian community on the Refuge occurs within the flood control levees. The overstory is dominated by mature valley oaks, with varying amounts of Fremont cottonwood (*Populus fremontii*), box-elder (*Acer negundo*), and willow (*Salix* spp.) present. The understory is dominated by creeping wild rye (*Leymus triticoides*), basket sedge (*Carex barbarae*), California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and in more open areas, mugwort (*Artemisia douglasiana*) and western goldenrod (*Euthamia occidentalis*). Although individual and scattered groves of valley oaks are present on the floodplain and adjacent uplands, most were previously cleared for agricultural development.

Black Willow Riparian Forest

The woody overstory of this vegetative community, which typically grows along water courses, is dominated by black willow (*Salix gooddingii*) with varying amounts of sandbar willow (*Salix hindsiana*), box-elder, buttonbush (*Cephalanthus occidentalis*), and Oregon ash (*Fraxinus latifolia*) (Ornduff 1974). Widely-spaced individual or small groups of Fremont cottonwood (*Populus fremontii*) are present, and black walnut (*Juglans hindii*) occurs in a few locations.

The black willow riparian forest community at the San Joaquin River Refuge occupies much of the river corridor inside the levees along the San Joaquin, Tuolumne, and Stanislaus Rivers, as well as Hospital and Ingram Creeks, which drain into the San Joaquin River.

Wetlands

Permanent Wetlands

Permanent wetlands are those that remain flooded all year and support hydrophytes (water-loving plants)—either herbaceous or woody species (Tiner 1999). These wetlands at the Refuge are ringed by a perimeter of emergent vegetation, such as hardstem bulrush (*Scirpus acutus*) and/or cattail (*Typha latifolia*); oxbows are bordered by riparian forest.

Semipermanent Wetlands

Semipermanent wetlands are flooded most of the year but are dry during late summer to early winter (Smith et al. 1995). There are semipermanent wetlands on oxbow sloughs along the San Joaquin River. Bulrush and cattails can often thickly vegetate these areas; the oxbows are ringed by riparian vegetation.

Seasonal Wetlands

Seasonal wetlands are flooded during autumn and maintained throughout the winter until drawdown occurs in spring (Smith et al. 1995).

Grasslands (Uplands)

Native Grasslands

Native grasslands on the Refuge consist of lands with native undulating topography modified by small channels and berms, but not land-leveled. Central Valley grassland habitats have been severely altered over the past 150 years. Exotic annual grass species, principally of Mediterranean origin, replaced the native perennial grasses that likely once dominated these grasslands. Many annual exotics, including ripgut brome, soft chess, wild oats, and others, now prevail on the grasslands; however, native grassland species, such as alkali sacaton, saltgrass, and spikeweed, are still common in some areas. Restoration of native habitats, including these grasslands, is a critical element for Refuge management. Noxious weedy species, such as yellow starthistle and pepperweed, are also beginning to invade some of these habitats. Aggressive control of exotic species is critical to maintain native habitat.

Tilled Cropland

Tilled croplands consist of lands that have been converted from a more natural condition by land-leveling and installation of pipelines for irrigation and are under active management for agricultural crop production. Privately owned tilled croplands within the Refuge acquisition boundary are planted to these and other cereal grains, alfalfa, tomatoes, beans, and melons for commercial production. In recent decades, agricultural production in the San Joaquin Valley has shifted away from wildlife-friendly crops such as grain, hay, and alfalfa in favor of higher valued crops. This trend is most apparent in the increased production of almonds and wine grapes in the Valley.

Irrigated Pasture

Irrigated pasture consists of lands that have been converted from a more natural condition by land-leveling, installing pipelines to facilitate flood irrigation, and planting a mixture of domestic grasses and legumes. They are maintained by frequent irrigation and are typically grazed by cattle year-round, following a rotational cycle that averages about eight months of grazing per year. Irrigation has been continued on irrigated pasture lands on the Refuge to provide short grass foraging habitat for Aleutian cackling geese, sandhill cranes, and other migratory birds.

Wintering geese on farmed field at the San Joaquin River NWR. Photo by Lee Eastman

3.3.2 Wildlife

California's diverse terrain and vegetative communities provide conditions for a high degree of wildlife diversity. This same diversity is reflected in the proposed expansion area which has the potential to provide habitat for over 325 species of wildlife. A complete species list is found in Table 4.

The role of riparian areas in maintaining biodiversity is well known; their relative contributions greatly exceed the proportion of the landscape they occupy (Naiman et al. 1993, Naiman et al. 2000, Crow et al. 2000). In the Pacific Coast ecoregion, 60 percent of amphibian species, 16 percent of reptiles, 34 percent of birds, and 12 percent of mammals can be classified as riparian obligates (Kelsey and West 1998).

Some animals use riparian areas as part of their home ranges or territories, moving through them on a short-term basis and over periods of hours and days. In fact, the short-term movements of small mammals and birds within riparian areas have been shown to aid in the cycling of nutrients between the aquatic environment and adjacent uplands (Dobrowolski et al. 1993).

Riparian habitat loss may be the most important cause of population declines among songbird species in western North America (DeSante and George, 1994). From a landscape perspective, habitats are species-specific "patches" in spatially varied landscapes. The occurrence and abundance of organisms is associated with the amount of usable habitat in a landscape, as well as with habitat patch sizes, shapes, and arrangements (Hannon and Schmiegelow 2002). Habitats that are too small, fragmented, or isolated may not support specific organisms over the long term

because they are no longer fully functioning habitats for these organisms. Many habitats can be defined as species specific, and habitat size, shape, and arrangement requirements in a landscape differ among species. However, more, larger, and better-connected patches of a specific habitat are generally more likely to provide the conditions for the persistence or recovery of species associated with that habitat (Lindenmayer et al. 2008).

3.3.3 Invertebrates

The study area provides habitat for both aquatic and terrestrial invertebrate species. It is believed that the aquatic and terrestrial invertebrate fauna is representative for the Central Valley. Non-systematic field observations have detected the presence of representatives from 9 of the 13 insect orders with aquatic species (Merritt and Cummins 1996), as well as two types of native bees.

3.3.4 Reptiles and Amphibians

A preliminary survey of reptiles and amphibians was conducted at the San Joaquin River NWR in 1998; the survey was not meant to be all-encompassing but to focus on reptile/amphibian use of major habitats. The survey indicated low overall capture rates, but documented 13 of the 27 species of reptiles and amphibians with the potential to occur on the Refuge. The survey detected reptile and amphibians in woodlands and native grasslands, but none in fallow agricultural fields. Similar results are anticipated for the proposed expansion area.

3.3.5 Fish

Historically, California supported over 90 freshwater species of native fishes; the Sacramento-San Joaquin Valley sustained approximately 60 native species (Schoenherr 1992). Although there is still a diversity of aquatic habitats in the Central Valley, the natural assemblages of Central Valley fish communities have been degraded by altered flow regimes, levee construction/maintenance and associated loss of floodplain, reduction in riparian habitats, the introduction of exotic fish species, and other factors.

In the San Joaquin River, many native fish species have been extirpated or are severely reduced in number, but several still occur, including Pacific lamprey (*Lampetra tridentata)*, hitch (*Lavinia exilicauda)*, Sacramento blackfish (*Orthodon microlepidotus)* , Sacramento sucker (*Catostomus occidedntalis)*, tule perch (*Hysterocarpus traski)* , prickly sculpin (*Cottus asper)* , Sacramento splittail (*Pogonichthys macrolepidotus)*, and white sturgeon (*Acipenser transmontanus*). Some of these species are dependent on large river systems, while others use sloughs and other backwater habitats. Sensitive fish species found in the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers include fall and late fall Chinook salmon, a species of concern, and the threatened Central Valley steelhead. All of the proposed expansion area is critical habitat for the Central Valley Steelhead Distinct Population Segment. Rivers in the San Joaquin Basin do not meet (cool) temperature water quality criteria to protect anadromous fish beneficial uses. The California Department of Fish and Game believes that one critical factor limiting anadromous salmon and steelhead population abundance is high water temperatures, which exist during critical life stages in the tributaries and the mainstem. This results largely from water diversions, hydroelectric power operations, water operations and other factors (CDFG 2010).

The endangered delta smelt has been found near Mossdale at the northern border of the proposed northern expansion area, and critical habitat has been designated as far upstream as the confluence of the Stanislaus River on the San Joaquin River.

Introduced species now dominate many of the aquatic habitats of the Central Valley, including those in the San Joaquin River. Thirty-six introduced fish species are present in the Central

Valley (Schoenherr 1992). Refuge aquatic habitats are now dominated by the following non-native species: black bass, carp, bluegill, threadfin shad, red shiner, and striped bass.

Floodplain Use

Floodplains are important habitats for fish, particularly for spawning and rearing (Welcomme 1985, Coop 1989, Bayley 1995, Sparks 1995). The main reasons for this is the abundance of food in the form of invertebrates, and the physical conditions such as increased cover and lower velocity of the floodplain when compared to the main channel during high flow events (Jeffres et al 2008). The floodplain appears to be valuable for the Sacramento splittail and juvenile Chinook salmon (Sommer 2001).

Stream Temperature

California Chinook salmon, coho salmon, steelhead trout, and coastal cutthroat trout are all Pacific salmon species (genus Oncorhynchus), and all require cold water. Water temperature tolerance varies somewhat between species and between life stages. Warm temperatures can reduce fecundity, decrease egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, and decrease the ability of young salmon and trout to compete with other species for food and to avoid predation (Spence et al. 1996, McCullough 1999).

Sunset on the San Joaquin. Photo by Chris Acree

Steelhead/Rainbow Trout

All of the proposed expansion area has been designated critical habitat for Central Valley steelhead (*Oncorhynchus mykiss*). Steelhead/rainbow trout have a broad range of life history strategies that include strains that always emigrate to the ocean and other strains that generally do not. Strains that emigrate to the sea are called steelhead, and strains that remain resident in freshwater are termed rainbow trout. Both adult steelhead and rainbow trout typically survive after spawning, though it is rare that adult steelhead will spawn more than twice. Studies have

shown there to be little or no genetic differences between steelhead and rainbow trout inhabiting the same stream system (NMFS 1996). Juvenile steelhead in streams are similar in appearance to juvenile rainbow trout. Adult steelhead are generally larger than adult rainbow trout and display a more uniform and silvery color upon entering fresh water.

Steelhead have a life history similar to salmon, and much of their habitat requirements are similar. The primary difference is that juveniles will remain in the tributaries for at least one year before smolting. The majority of spawning for winter-run steelhead occurs between December and April. Steelhead spawning can occur in water depths from 0.5 to 4 feet, water velocities from 0.75 to 4.5 feet per second, and utilizing gravels from 0.25 to 5 inches in diameter. Water temperatures between 40 to 58 °F are generally required for spawning and egg development (Reiser and Bjornn 1979). Steelhead eggs are deposited in gravels and hatch in 30 to 90 days. Fry generally emerge during April and May, and juvenile steelhead will spend 1-3 years in freshwater before emigrating to the ocean, where they will spend 2-4 years before returning to spawn. Adults that survive spawning return to the ocean from April through June. Juveniles will usually emigrate from November through May.

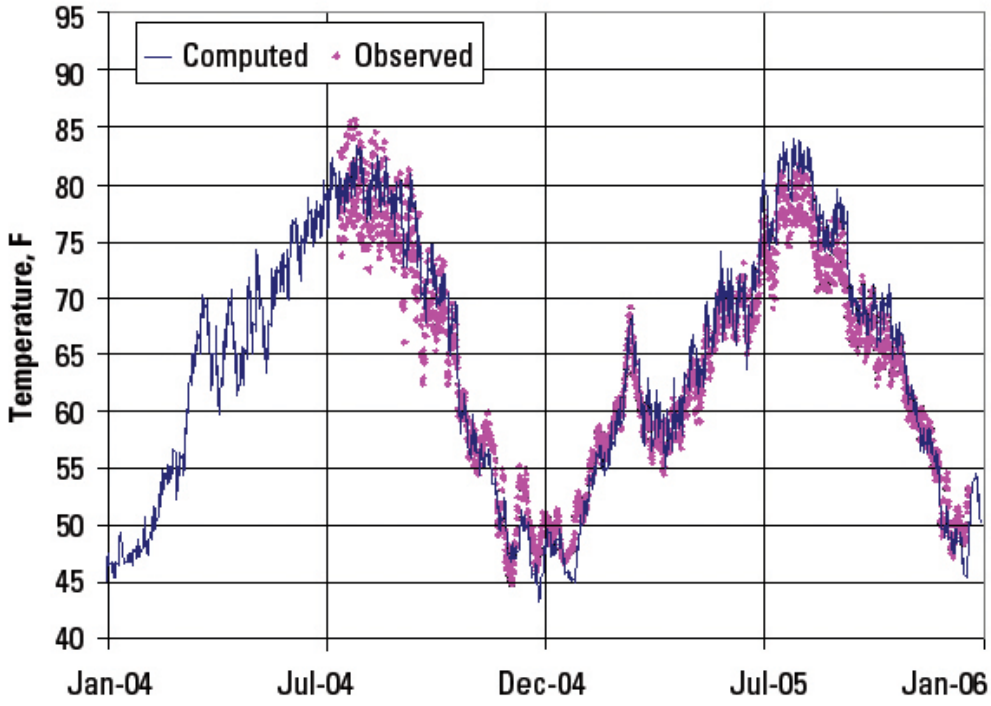

Figure 3. Computed and Observed Temperatures at Crows Landing on The San Joaquin River. (USBR 2007). Crows Landing is within the proposed Southern Expansion Area.

Central Valley steelhead were listed by the Federal government as a threatened species in March 1998. Designated critical habitat for Central Valley steelhead was established in February 2000. Included as part of the critical habitat are all river reaches potentially accessible to steelhead in the San Joaquin River and its tributaries. Excluded are areas of the San Joaquin River upstream of the Merced River confluence. In designating critical habitat, protection is granted to essential features of the habitat, including spawning sites, food sources, water quality and quantity, and

riparian vegetation. With designation of critical habitat, Federal agencies are provided with a clear indication as to which areas may require special management considerations.

Population Trends

There are a variety of indications that self-sustaining stocks of rainbow trout continue to exist in the San Joaquin River system. Presently, winter-run steelhead are the only race found in the Central Valley and are native to the Sacramento and San Joaquin River Basins. The major populations of Central Valley steelhead currently occur in the Sacramento River Basin. In the San Joaquin River Basin, steelhead populations have been reduced to remnant levels. The available information indicates that steelhead occur in most of the Central Valley watersheds, but are generally present in low numbers especially in the San Joaquin River tributaries. Zimmerman et al. (2009) used otolith microchemistry to show that O. mykiss of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries. The sampling trawls annually conducted near Mossdale by the California Department of Fish and Game and the Service capture steelhead smolts, although usually in very small numbers (NMFS 2012).

Although it is likely that steelhead once inhabited most of the streams used by Chinook salmon for spawning, they probably traveled farther upstream into smaller tributaries (Moyle et al. 1996). These passages are now blocked by dams. There is also little or no historic record of escapement available. Current annual escapements of steelhead in the San Joaquin River Basin do not exist due to the long-term scarcity or absence of steelhead in the basin.

Because of their similarity to salmon, many of the same conditions that have caused the decline of salmon have also affected steelhead. These conditions include isolation from historic spawning areas, loss of habitat, and impaired conditions for adults and juveniles, including decreasing flows and increased water temperatures, blockages, and entrainment.

Steelhead Trout Migration

In a review of numerous studies, Washington Department of Ecology (WDOE 2002) concluded that daily average temperatures of 69.8-75.2 °F are associated with avoidance behavior and migration blockage in steelhead trout. WDOE suggests that the Maximum Weekly Maximum Temperature (MWMT) should not exceed 62.6-64.4 °F, and daily maximum temperatures should not exceed 69.8-71.6 °F to be fully protective of adult steelhead migration, as shown in Table 2. Although the information depicted in Table 2 reflects WDOE and Environmental Protection Agency Region 10 standards, these same standards have been used by the California State Water Quality Control Board in northern California streams (Noyo River Redwood Creek), and by the EPA on the Eel River. Dr. Peter Moyle's book, Inland Fishes of California (1976), states that for rainbow trout, the optimum range for growth and completion of most life stages is 55.4-69.8 F, which is similar to the temperatures depicted in Table 2. These temperatures are exceeded in the San Joaquin River at Crows Landing and Vernalis in all but the winter months, as shown in Figure 4, Figure 5, and Figure 6.

Table 2. Effects of Temperature in Considering Adult Steelhead and Migration (Carter 2005)

<table>
<tr><th>°F</th><th colspan="3">Migration</th></tr>
<tr><td>75.2 °F</td><td rowspan="4">69.8-75.2 °F Average daily temperature associated with avoidance and migration blockage (2)</td><td colspan="2">71.6-75.2 °F Temperature range which eliminates salmonids from an area (3,4)</td></tr>
<tr><td>73.4 °F</td></tr>
<tr><td>71.6 °F</td><td colspan="2" rowspan="2">69.8-71.6 °F Daily maximum temperature should not exceed this to be fully protective (2)</td></tr>
<tr><td>69.8 °F</td></tr>
<tr><td>68 °F</td><td colspan="2">68 °F MWMT should not exceed this in water bodies used almost exclusively for migration.
Should be used in conjunction with a narrative provision about protecting/restoring the natural thermal regime for rivers with significant hydrologic alterations (1)</td><td rowspan="4">64.4-71.6 °F
Temperature range at which transition in dominance from salmonids to other species occurs (4)</td></tr>
<tr><td>66.2 °F</td><td colspan="2"></td></tr>
<tr><td>64.4 °F</td><td rowspan="2">62.6-64.4 °F MWMT should not exceed this to be fully protective (2)</td><td>64.4 °F MWMT should not exceed this where migration
and non-core rearing occur (1)</td></tr>
<tr><td>62.6 °F</td><td></td></tr>
</table>

(Temperatures converted from Celsius to Fahrenheit)
References
1 USEPA 2003 (reviewed many literature sources to make assessments of temperature needs)
2 WDOE 2002 (reviewed many literature sources to make assessments of temperature needs)
3 USEPA 2001 (reviewed many literature sources to make assessments of temperature needs)
4 USEPA 1999 (reviewed many literature sources to make assessments of temperature needs)

Central Valley Fall Chinook Salmon

Fall Chinook salmon (*Oncorhynchus tshawytscha)* are currently the most abundant race of salmon in California (Mills et al. 1997). In the San Joaquin Basin, fall Chinook historically spawned in the mainstem San Joaquin River upstream of the Merced River confluence and in the mainstem channels of the major tributaries. Dam construction and water diversion dewatered much of the mainstem San Joaquin River, limiting fall Chinook to the three major tributaries where they spawn and rear downstream of mainstem dams.

Summer rearing habitat

Juvenile Chinook salmon appear to prefer pools that have cover provided by banks, overhanging vegetation, large substrates, or large woody debris (LWD). Juvenile densities in pools have been found to increase with increasing amounts of cover (Steward and Bjornn, unpublished data, as cited in Bjornn and Reiser 1991).

Water temperature may also influence juvenile habitat use. In the South Umpqua River basin, Roper et al. (1994) observed lower densities of juvenile Chinook where water temperatures were higher. In areas where more suitable water temperatures were available, juvenile Chinook salmon abundance appeared to be tied to pool availability. Temperatures also have a significant effect on juvenile Chinook growth rates. On maximum daily rations, growth rate increases with temperature to a certain point and then declines with further increases. Reduced rations can also result in reduced growth rates; therefore, declines in juvenile salmonid growth rates are a function of both temperature and food availability. Laboratory studies indicate that juvenile Chinook salmon growth rates are highest at rearing temperatures from 18.3 to 21.1 °C (65 to 70 °F) in the presence of unlimited food (Clarke and Shelbourn 1985, Banks et al. 1971, Brett et al. 1982, Rich 1987), but decrease at higher temperatures, with temperatures >23.3 °C (74 ° F) being potentially lethal (Hanson 1990).

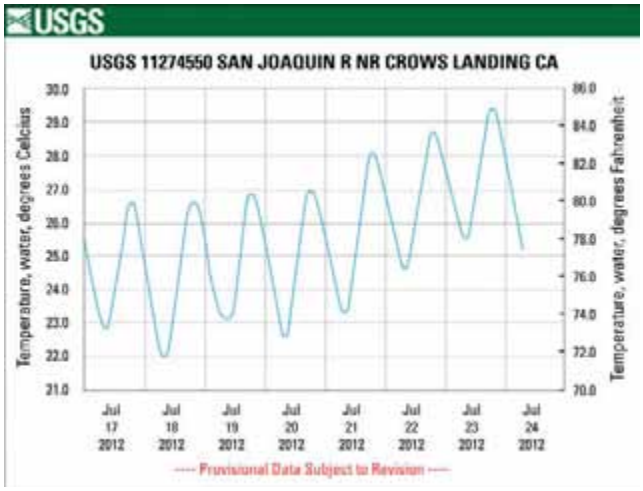

Figure 4. USGS Temperature Graph for Crow's Landing, CA.

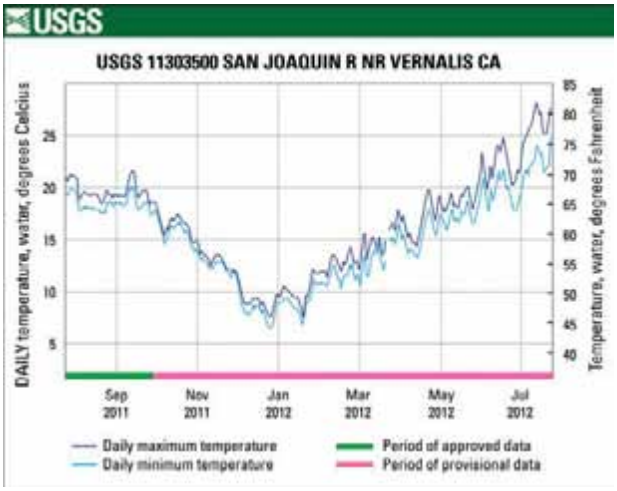

Figure 5. USGS Temperature Graph for Vernalis, CA.

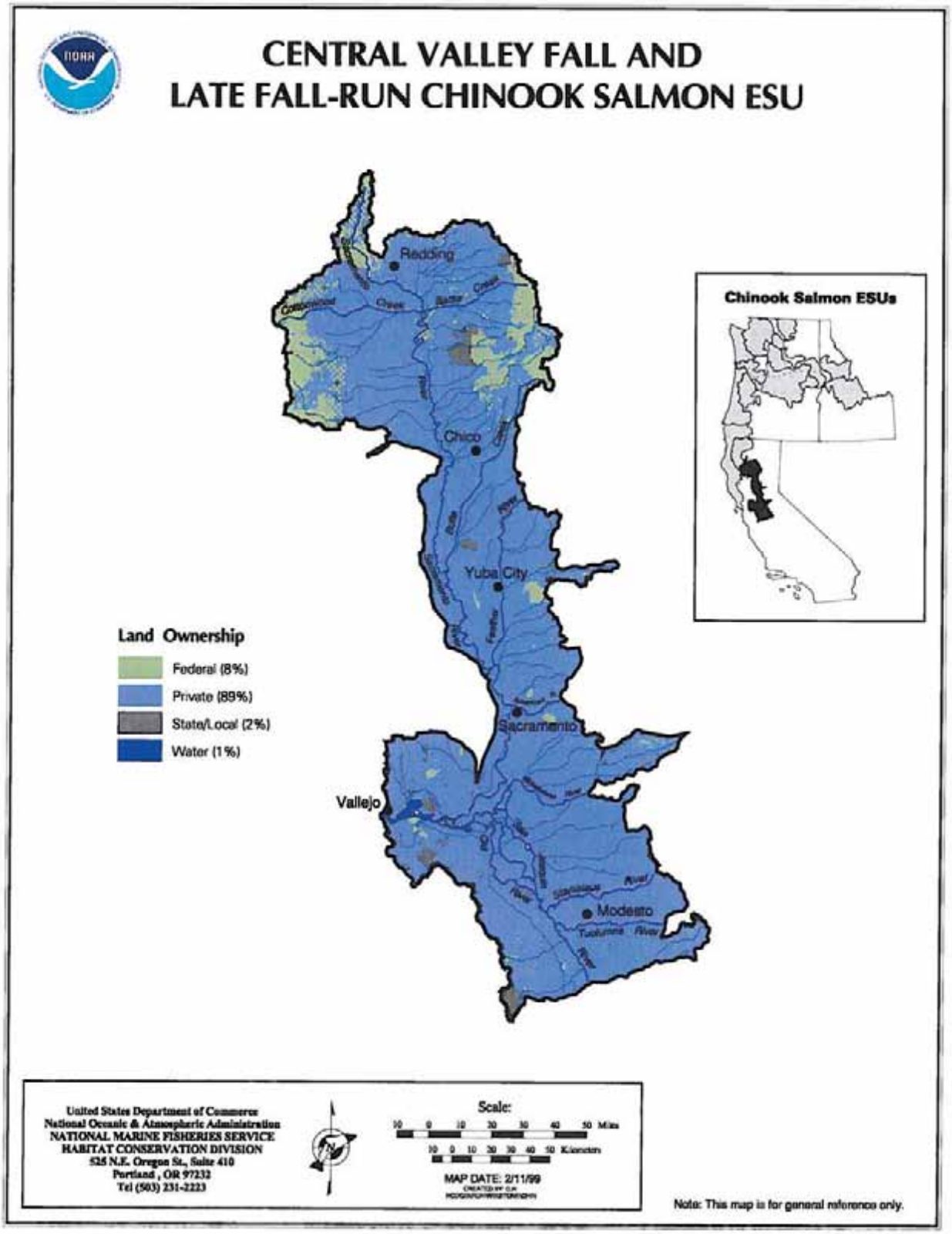

Figure 6. Central Valley Fall and Late Fall Chinook ESU Map

3.3.6 Mammals

Although the largest mammal species of the San Joaquin Valley were reduced or eliminated during the settlement period (grizzly bears, tule elk, pronghorn antelope, mountain lion), mid-size and small carnivores are prevalent in the area and comprise approximately one-fifth of the potential mammalian community. The most common carnivores/omnivores in the study area include the coyote, raccoon, striped skunk, northern river otter, long-tailed weasel, and Virginia opossum, while the gray fox, mink, ringtail, and bobcat are present but rarely encountered. Mountain lions do show up in the Valley occasionally, they are most likely young males looking for new territory.

Rodent and rabbit species make up the largest segment of the mammals found on the Refuge (approximately one third), as in most areas (Eisenberg 1981). Three rabbit species occur in the area, including the desert cottontail, black-tailed hare, and the endangered riparian brush rabbit. Both the hare and the desert cottontail are conspicuous species at the Refuge. Large rodents, which are also conspicuous on the Refuge, include the aquatic muskrat and beaver—both of which leave obvious signs and play important roles in aquatic systems. Dominant rodents at the Refuge, which also act as keystone species because of their grazing/seed predation and/or tunneling, include the deer mouse, California vole, and California ground squirrel. The endangered riparian woodrat, as well as the introduced black rat, also occur on the Refuge.

An inventory of the bat community has not been conducted in the proposed study area, although by potential species number, they make up a sizable component of the mammalian fauna. The most common species probably include the big brown bat, western pipistrelle, little brown bat, and Brazilian free-tailed bat. The western red bat is a Central Valley resident that would benefit greatly from riparian restoration, particularly recruitment of cottonwood/sycamore and reinstatement of natural flood regimes (Pierson et al. 2000).

3.3.7 Birds

The Refuge was initially established due to its importance to migratory birds, particularly the Aleutian cackling goose. A majority of the proposed expansion area is within an Audubon listed Important Bird Area and has the potential to provide habitat for all the avian species known to occur in the Central Valley, which includes over 225 species of birds. Although there may be differences in the amount of bird use between the proposed northern and southern expansion areas, 95 percent or more of the birds share the same area. Located within the Bird Conservation Region (BCR) 32, the existing Refuge includes 40 of 46 species within the BCR. Birds that are placed on the BCR list represent the Service's highest conservation priorities (NABCI 2000).

Waterbirds

The most spectacular existing bird use within the proposed expansion area is by waterbirds, especially waterfowl. Close to 30 species of ducks, geese, and swans make use of the existing Refuge and neighboring protected areas, and the most common include the Aleutian cackling goose, snow goose, white-fronted goose, green-winged teal, northern shoveler, mallard, northern pintail, cinnamon teal, gadwall, widgeon, and ruddy duck. Other conspicuous Refuge waterbirds include the pied-billed grebe, double-crested cormorant, white-faced ibis, white pelican, sandhill crane, American coot, moorhen, killdeer, black-necked stilt, American avocet, greater yellowlegs, western sandpiper, least sandpiper, as well as long- and short-billed dowitchers. Colonial nesting waterbirds maintain colonies on riparian habitat within the Refuge, such as the great blue heron, great egret, and double-crested cormorant.

Neotropical Migratory Birds

Aside from waterbirds, the proposed expansion area is an important area to many other resident and migratory bird species. Many species of neotropical migrants have been detected in the study area, including the lazuli bunting, blue grosbeak, ash-throated flycatcher, western wood-pewee, black-headed grosbeak, savannah sparrow, horned lark, yellow warbler, Nashville warbler, orange-crowned warbler, yellow-rumped warbler, Pacific-slope flycatcher, and ruby-crowned kinglet. Compared to other habitats, oak woodlands and riparian habitats, which support multiple vegetation layers, have the highest diversity of bird species in the proposed study area. Typically, natural habitats support the greatest diversity of bird species, whereas crop fields and fallow agricultural lands support less bird diversity.

Bird Focal Species

The Riparian Bird Conservation Plan (RHJV 2004), a collaborative effort of the Riparian Habitat Joint Venture and California Partners in Flight, was developed to guide riparian conservation, and provides a vital link between science and habitat management (Golet 2001). The Riparian Bird Conservation Plan (RBCP) relies on the requirements of 17 species that were selected by ornithologists based on the criteria listed in the following text. These species were also selected because they depend on differing successional stages and types of vegetation and/or critical ecosystem elements associated with riparian systems (Geupel and Elliott 2001, Golet 2001).

Based on the methods advanced by Chase and Geupel (2005), the Central Valley Joint Venture (CVJV) selected 7 of the 17 focal species found in the RBCP to develop its conservation objectives. The yellow-billed cuckoo was removed from the list in this document as the CVJV does not have a population goal in the San Joaquin Basin for this species. The CVJV added the spotted towhee as it meets the criteria listed here (RHJV 2006).

In the CVJV Implementation Plan (2006), it is estimated that the San Joaquin Basin has 12,249 acres of existing riparian habitat and approximately 188,000 acres of restorable riparian habitat. The Service will be using CVJV focal species to guide several components of this conservation planning effort: (1) the selection and design of habitat reserves, (2) habitat restoration and management, and (3) population monitoring, both of population trends over time and effects of management actions. Riparian songbirds are expected to benefit from habitat restoration. Focal species of riparian songbirds found in the CVJV Implementation Plan include: song sparrow, yellow-breasted chat, black-headed grosbeak, common yellowthroat, yellow warbler, and the spotted towhee. One waterbird focal species in the CVJV Implementation Plan is the snowy egret, which has a habitat goal in the San Joaquin Basin of 1,000 riparian acres. These focal species meet at least one of the following criteria:

- Use riparian habitat as a principal breeding habitat in most basins throughout the Central Valley.
- Warrant special management status or have experienced reduction in breeding range or populations in the Central Valley.
- Are useful for monitoring effects of management actions because they are:
    - Abundant in riparian habitats throughout the Central Valley or basin in order to provide adequate sample sizes for statistically valid analyses.
    - Amenable to monitoring (e.g., nests can be found and adults are tolerant of researcher disturbance).

- Indicate quick strong and/or consistent responses to habitat management or restoration (CVJV 2006).

Table 3. Current and Potential Population Densities and Population Targets for Breeding Riparian Songbirds in the San Joaquin Basin. (Central Valley Joint Venture Implementation Plan 2006)

Species	Current Birds/Acre (±standard error)[1]	Current Population Size (±standard error)	Target Birds/Acre[2]	Target Population Size
Song sparrow	2.867(±0.088)	5.757(± 438)	0.68	128,901
Yellow- breasted chat	0.00	0	0.21	40,425
Black-headed grosbeak	0.3667 (± 0.0282)	736 (± 140)	0.15	28,984
Common yellowthroat	0.2247 (±0.021)	451 (±100)	0.20	38,137
Yellow warbler [3]	0.0538 (±0.0163)	108 (± 81)	0.13	24,491
Spotted towhee	3.302 (± 0.0787)	6,629 (±390)	0.78	146,444

Table based on 12,249 existing riparian acres and 188,394 restorable riparian acres in the San Joaquin Valley.
1 Current density estimates are derived from Point Reyes Bird Observatory (PRBO) point count survey.
2 Target densities were based on the 75th percentile value of all point counts in the San Joaquin Valley, adjusted by a detectability coefficient.
3 Target densities for yellow warbler were based on spot-map densities from Clear Creek study plots, which are outside CVJV basins.

Current population estimates from a specific area can be derived by multiplying appropriate estimates (birds per hectare) by the area of current available habitat as mapped by the best available Geographic Information System (GIS) layers. Population targets may be derived by multiplying the target density by the amount of area to be restored or enhanced, also based on GIS-based habitat layers. This process was used to derive population estimates for riparian focal species in the Central Valley Joint Venture's current implementation plan (CVJV 2006).

As a way to measure success of restoration efforts, PRBO Conservation Science, in collaboration with The Nature Conservancy and Audubon California, has designed and implemented a new regional monitoring program for riparian breeding birds in the Central Valley. As a way to measure success, these organizations plan on keeping track of riparian gains and losses over time, and combining that information with current bird monitoring data.

3.3.8 Special Status Species

Several threatened and endangered species occur or have the potential to occur in the study area. The Refuge was originally established for the Aleutian cackling goose, which was listed as endangered in 1967. More than 95 percent of the world's Aleutian cackling goose population winters on the Refuge. Aleutian cackling goose populations have recovered dramatically and have been delisted as a federally threatened species. Managing and monitoring the Aleutian cackling goose population continues on the Refuge.

The following are sensitive species that occur on or near the Refuge. Their status under the Federal ESA is in parenthesis: the riparian brush rabbit (endangered), riparian woodrat (endangered), least Bell's vireo (endangered), San Joaquin kit fox (endangered), giant garter snake (threatened), Central Valley fall and late fall Chinook salmon (species of concern), Central Valley steelhead (threatened), delta smelt (threatened), and Valley elderberry longhorn beetle (threatened). A full list of Federal and State special status species and their habitats can be found in Table 4.

Riparian Brush Rabbit (*Sylvilagus bachmanii riparius*). Photo by Lee Eastman

Riparian Brush Rabbit

The endangered riparian brush rabbit is a subspecies of brush rabbit. Its original distribution was the most limited of all the brush rabbit subspecies, restricted to a small stretch of the San Joaquin River and some of its tributaries (Orr 1940). Approximately 95 percent of the riparian woodland along the San Joaquin River was lost to agriculture and infrastructure development, which destroyed most of the species habitat.

At the time of listing, the Service described one extant population of riparian brush rabbits on protected property within the 104-hectare (258-acre) Caswell MSP located on the northern bank of the Stanislaus River in San Joaquin County, California. In 1998, a second extant population of riparian brush rabbits was confirmed in small, degraded remnants of riparian habitat in the south part of California's Sacramento-San Joaquin River Delta (the South Delta) (Williams et al. 2000, Williams et al. 2002). Riparian brush rabbits were subsequently discovered in approximately nine other small South Delta riparian remnants, all in the same area of the South Delta: near Stewart

Tract and the town of Lathrop. These nine small south Delta remnants are considered as one south Delta population (Williams et al. 2002, Lloyd and Williams 2003, Hamilton et al. 2010).

Due to the urgent threats faced by the Caswell MSP population and the South Delta population, a reintroduction project was initiated (Williams et al. 2002). In November 2001, the Endangered Species Recovery Program (ESRP) at California State University, Stanislaus, began raising riparian brush rabbits in a controlled propagation facility. The ESRP has reintroduced riparian brush rabbits in suitable habitat located within their historical range, including in restored habitat on the Refuge. Currently, there are three known populations of riparian brush rabbits—Caswell MSP, the South Delta, and the Refuge. Since the time of listing, recurring floods, fires, and other natural events have adversely affected both native and the translocated riparian brush rabbit populations. All riparian brush rabbit populations remain at risk of imminent extinction from these stochastic threats (USFWS 2012 *in lit.*)

Existing riparian vegetation, along with restored riparian habitat on the Refuge, has provided this subspecies the largest block of contiguous habitat in its existing range. Restoration of parcels within the proposed expansion area could serve as additional habitat for many native species, including the riparian brush rabbit. Principal existing threats to the riparian brush rabbit can be summarized in order of importance as: 1) stochastic environmental processes, wildfire, and flood; 2) additional habitat loss and degradation due to urbanization and conversion to agriculture; 3) increased predation from domestic and feral cats and dogs due to urban development adjacent to existing inhabited sites; and 4) genetic and demographic stochasticity in small populations (Williams et al. 2002).

Riparian Woodrat

The endangered riparian woodrat uses similar habitat as the riparian brush rabbit, with the addition of overstory trees. Small numbers of the woodrat occur on the existing Refuge, while Caswell MSP, which is upstream from the Refuge on the Stanislaus River, has estimates of between 637 and 437 individuals (Cook 1992, Williams 1993). The distribution of this subspecies of dusky-footed woodrats is apparently restricted by factors such as their limited dispersal abilities, daily water requirements, and the availability of dense, brushy habitat (Carey 1991). With a minimum daily requirement for water of 10.2 percent of their body mass (Carpenter 1966), riparian woodrats tend to be restricted to habitats that are in close proximity to a year-round water supply. They are primarily nocturnal, showing peak activity at dawn and dusk. The riparian woodrat is a social animal that lives in colonies of conical houses constructed with sticks, bark, plant cuttings, and other objects (Carraway and Verts 1991). Individual colonies are relatively stable, with the number of adults remaining fairly constant (Wallen 1982).

The range of the riparian woodrat is far more restricted today than it was in 1938 (Williams 1986). The only verified population was restricted to about 252 ac (102 ha) of riparian forest at Caswell MSP on the Stanislaus River. Recently, one woodrat was seen on the Refuge, but there are no estimates on population size. Loss, fragmentation, and degradation of habitat are the principal reasons for the decline of the riparian woodrat (USFWS 1997). No specific conservation measures for the riparian woodrat are in place, but the species does receive some protection through the management plans for the riparian brush rabbit at the Refuge and Caswell MSP.

Least Bell's Vireo

In 2005, a pair of endangered least Bell's vireos successfully bred twice in a three-year-old riparian restoration site at the Refuge. This was the first confirmed record of breeding in the Central Valley in over 50 years; breeding records for least Bell's vireos outside of their southern California range have been rare in the past 20 years (Howell et al. 2010). The two main causes of decline for this species is loss of breeding habitat, and cowbird parasitism. It is anticipated that increased riparian restoration along the San Joaquin River will provide for colonization of this and possibly other rare avian species in the Central Valley. Cowbird control would only be considered if it is determined that they are a significant hindrance to reestablishing a population within the Refuge.

Least Bell's Vireo at nest. Moose Peterson/USFWS

Listed and Sensitive Fish

One listed fish and one species of concern—Central Valley steelhead, and Central Valley fall and late-fall Chinook salmon, respectively—occur on the Refuge and within the rivers within the proposed expansion area. All of the proposed expansion area is critical habitat for the Central Valley Steelhead Distinct Population Segment. Another listed fish, the delta smelt (Figure 7), historically occur near the boundary of the proposed northern expansion area, and critical habitat includes most of the proposed northern expansion area. The Sacramento splittail is found within the proposed expansion area; though the splittail was listed under the Endangered Species Act in 1999, it was removed in 2000 as a result of a lawsuit.

Other Listed Species

The threatened Valley elderberry longhorn beetle is present near the Refuge and potentially in the proposed expansion area; it is dependent on the elderberry plant for its life cycle. The giant garter snake is federally listed as threatened and requires permanent water as habitat. Suitable habitat appears to exist in the proposed expansion area, and there have been documented records for the giant garter snake in the nearby Volta State Wildlife Area (approximately 4.8 miles from the San Luis NWR). No records exist for the endangered San Joaquin kit fox in the proposed study area, although there are records within 20 miles.

State Listed Species

California State listed threatened and endangered species that occur in the proposed expansion area include the greater sandhill crane, western yellow-billed cuckoo, least Bell's vireo, Swainson's hawk, willow flycatcher, and bank swallow. The greater sandhill crane annually winters on and

around the Refuge. Existing pastures, agricultural lands, and wetlands are used for foraging and roosting (Lewis et al. 1977, Iverson and Tacha 1982, Walker and Schemnitz 1987). Unlike lesser sandhill cranes, greater sandhill cranes within the Pacific Flyway have shown precipitous population declines because of destruction of wetlands and riparian habitat, lack of nesting habitat, and low productivity (Pogson and Lindstedt 1991). This area is one of eight geographic regions in which greater sandhill cranes winter in the Central Valley.

The western yellow-billed cuckoo, which relies upon riparian woodland, has not been documented at the Refuge, although there are records that a small population was present at the confluence of the Stanislaus and San Joaquin Rivers in the late 1960s and early 1970s. Planned habitat restoration activities will likely create additional habitat that may be suitable for this species. The western yellow-billed cuckoo is a State endangered neotropical migrant that breeds in riparian forests. The Service has listed the western population of cuckoos as a distinct population segment (dps) and as a candidate for Federal listing. Historically common in riparian areas of the Central Valley and southern California, it now breeds primarily in three locations in California:

- Sacramento Valley,
- Kern River, and
- Lower Colorado River.

Within the Central Valley today, they are only found in the Sacramento Valley. Loss of riparian habitat throughout the State has likely contributed to the decline in cuckoo population size. Laymon and Halterman (1989) concluded that sites larger than 200 acres and wider than 1,950 feet are optimal for the cuckoo.

Little willow flycatchers (Empidonax traillii brewsteri) are an occasional migrant along the San Joaquin River riparian corridor and have been recorded on the Refuge in 2007 and 2009, though no nests were found. The results of bird surveys conducted in 2012 have not been reported by PRBO Conservation Science yet. Bank swallows require large cut banks for their breeding colonies; although such areas exist at the Refuge, they have not been recorded there. Bank swallows have been seen nearby along the San Joaquin River near the Modesto wastewater treatment facility in 2012. The California State threatened Swainson's hawk is conspicuous at the Refuge, which provides habitat for several breeding pairs.

Table 4. Special Status Wildlife Species that May Occur In the Project Area

Species	Federal/ State	Habitats
Invertebrates		
Valley elderberry longhorn beetle *Desmocerus californicusdimorphus*	T/--	Riparian and oak savannah habitats with elderberry shrubs; below 2,000 feet elevation.

Species	Federal/ State	Habitats
Amphibians and Reptiles		
California tiger salamander *Ambystoma tigrinum californiense*	T/T	Small ponds, lakes, or vernal pools in grasslands and oak woodlands for larvae; rodent burrows, rock crevices, or fallen logs for cover for adults and for summer dormancy.
California red-legged frog *Rana aurora draytonii*	T/SSC	Permanent and semipermanent aquatic habitats such as creeks and coldwater ponds with emergent and submerged vegetation and riparian species along the edges; may estivate in rodent burrows or cracks during dry periods.
Giant garter snake *Thamnophis couchi gigas*	T/T	Sloughs, canals, and other small waterways, where there is a prey base of small fish and amphibians; requires grassy banks and emergent vegetation for basking, and areas of high ground protected from flooding during winter.
Western pond turtle *Clemmys marmorata*	--/SSC	Permanent ponds, lakes, streams, and irrigation ditches; basking sites, such as logs, rocks, mud banks, or mats of floating vegetation required; nests constructed in sandy banks or on hillsides up to 325 feet from water.
Fish		
Central Valley fall and late fall Chinook salmon *Oncorhynchus tshawytscha*	SC/--	Fall-run Chinook salmon spawn over gravel soon after arriving at the spawning grounds. After emerging from gravel, juvenile Chinook salmon move downstream, mostly at night. They rear in the mainstem rivers or the Delta before migrating to the ocean. Chinook salmon generally mature at three to four years and can reach five to eight years. A small number return to the river as sexually mature two-year-olds.
Central Valley steelhead *Oncorhynchus mykiss*	T/--	At present, the winter-run is the only form which migrates upstream to spawn from late September to mid-February. Central Valley steelhead spends one to three years in their natal streams before smolting and migrating to the ocean in December through May. The proposed expansion area is critical habitat for this distinct population segment.

Species	Federal/ State	Habitats
Delta smelt *Hypomesus transpacificus*	T/SE	For a large part of their one-year life span, delta smelt live along the freshwater edge of the mixing zone (saltwater-freshwater interface), where the salinity is approximately 2 ppt. Records indicate delta smelt use the river as far south as the Mossdale, and critical habitat has been designated as far south as the confluence of the Stanislaus and San Joaquin Rivers. Shortly before spawning, adults migrate upstream from the brackish water habitat associated with the mixing zone and disperse widely into river channels and tidally influenced backwater sloughs. They spawn in shallow, fresh or slightly brackish water upstream of the mixing zone.
Green sturgeon *Acipenser medirostris*	T/--	Green sturgeon spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Early life history stages reside in fresh water 1-4 years, with adults returning to freshwater to spawn when they are more than 15 years of age and more than 4 feet (1.3 m) in size. Spawning is believed to occur every 2-5 years.
Birds		
Aleutian cackling goose *Branta hutchinsii leucopareia*	Delisted/--	Winters in the San Joaquin Valley; forages on pastures, harvested fields, and wetlands; roosts on flooded fields and ponds at night.
Bald eagle *Haliaeetus leucocephalus*	Delisted/E	Requires large, old-growth trees or snags in mixed stands near large bodies of water or free-flowing rivers with abundant fish. Roosts communally in winter in dense, sheltered, remote conifer stands in proximity to feeding areas.
Bank swallow *Riparia riparia*	--/T	Nests in bluffs or banks adjacent to water where the soil consists of sand or sandy loam to allow digging.
California yellow warbler *Dendroica petechia brewsteri*	--/SSC	Nests and feeds in riparian deciduous habitats; preferred species include cottonwoods, willows, and alders.
Cooper's hawk *Accipiter cooperii*	--/SSC	Dense stands of live oak, riparian deciduous or other forest habitats near water used most frequently.
Greater sandhill crane *Grus canadensis tabida*	--/T	Summers in open terrain near shallow lakes or freshwater marshes; winters in plains and valleys near bodies of fresh water.

Species	Federal/ State	Habitats
Loggerhead shrike *Lanius ludovicianus*	SC/SSC	Found in a wide variety of lowland habitats, including valley foothill hardwood, hardwood-conifer, valley foothill riparian, and pinyon-juniper.
Least Bell's vireo *Vireo bellii pusillus*	E/E	For breeding, they require fairly dense riparian shrubbery, preferably where flowing water is present. Willow, wild rose, and other dense vegetation are used for nesting.
Long-billed curlew *Numenius americanus*	--/SSC	Breeds on grazed, mixed-grass and short grass prairies, and wetlands; feeds in a variety of wetlands and flooded or wet fields.
Mountain plover *Charadrius montanus*	C/SSC	Frequents open plains below 3,200 feet elevation with low herbaceous or scattered shrub vegetation; plowed fields with little vegetation; avoids high and dense cover.
Northern harrier *Circus cyaneus*	--/SSC	Frequents meadows, grasslands, open rangelands, and wetlands; nests in emergent wetland or along rivers or lakes; less frequently nests in grasslands and grain fields.
Prairie falcon *Falco mexicanus*	--/SSC	Associated primarily with perennial grasslands, savannahs, rangelands, and some agricultural fields; uses open terrain for foraging and nests in adjacent canyons, cliffs, or rock outcrops.
Sharp-shinned hawk *Accipiter striatus*	--/SSC	Prefers but not restricted to riparian habitats; forages in openings at edges of woodlands, brushy pastures, and shorelines where there is an abundance of migrating birds.
Swainson's hawk	--/T	Found in open country such as grassland, shrubland, and agricultural areas. Valley populations frequently nest in Valley oaks and Fremont cottonwoods within riparian zone.
Western least bittern *Ixobrychus exilis hesperis*	--/SSC	Nests in fresh emergent wetlands in the Central Valley; rests, roosts, and hides in dense emergent vegetation; often feeds along the edge of emergent vegetation on the open-water side.
White-tailed kite *Elanus leucurus*	--/P	Forages in agricultural areas and grasslands; uses trees with dense canopies for cover; nests in dense oak, willow, or other tree stand.
Little willow flycatcher *Empidonax traillii brewsteri*	--/E	Riparian areas and large, wet meadows with abundant willows for breeding; usually occurs in riparian habitats during migration.

Species	Federal/ State	Habitats
Western yellow- billed cuckoo *Coccycus americanus occidentalis*	C/T	The presence of depositional point bars and low woody vegetation were significant variables determining the presence of cuckoos on the Sacramento River. This indicates the importance of a meandering riparian system with healthy hydraulics that is constantly eroding and depositing and creating young riparian habitat. They were recorded on the confluence of the San Joaquin and Stanislaus Rivers in the late 1960s and early 1970s.
Mammals		
Riparian woodrat *Neotoma fuscipes riparia*	E/SSC	Prefers areas with a mixture of trees and shrubs with moderate canopy and brushy understory. Builds communal stick houses, and occasionally uses cavities in trees, snags, or logs for nesting. In the San Joaquin Valley, suitable habitat restricted primarily to riparian areas where trees and brush are found. Only known from along the San Joaquin, Stanislaus, and Tuolumne Rivers.
Riparian brush rabbit *Sylvilagus bachmani riparius*	E/E	Found only along the San Joaquin and Stanislaus Rivers, occupies dense thickets of riparian shrubs including wild rose (*Rosa* sp.), willows (*Salix* sp.), and blackberries (*Rubus* sp.). Also uses weedy fields adjacent to shrubs.
San Joaquin kit fox *Vulpes macrotis mutica*	E/T	Saltbush scrub, valley grassland, oak woodlands, and freshwater scrub.

Notes:
Federal Status
E = Listed as endangered under the Federal Endangered Species Act
T = Listed as threatened under the Federal Endangered Species Act
PE = Proposed for Federal listing as endangered under the Federal Endangered Species Act
C = Candidate for listing under the Federal Endangered Species Act
SC = U.S. Fish and Wildlife Service species of concern

State
E = Listed as endangered under the California Endangered Species Act
T = Listed as threatened under the California Endangered Species Act
SSC = California Department of Fish and Game species of special concern
P = fully protected in California
-- = No status

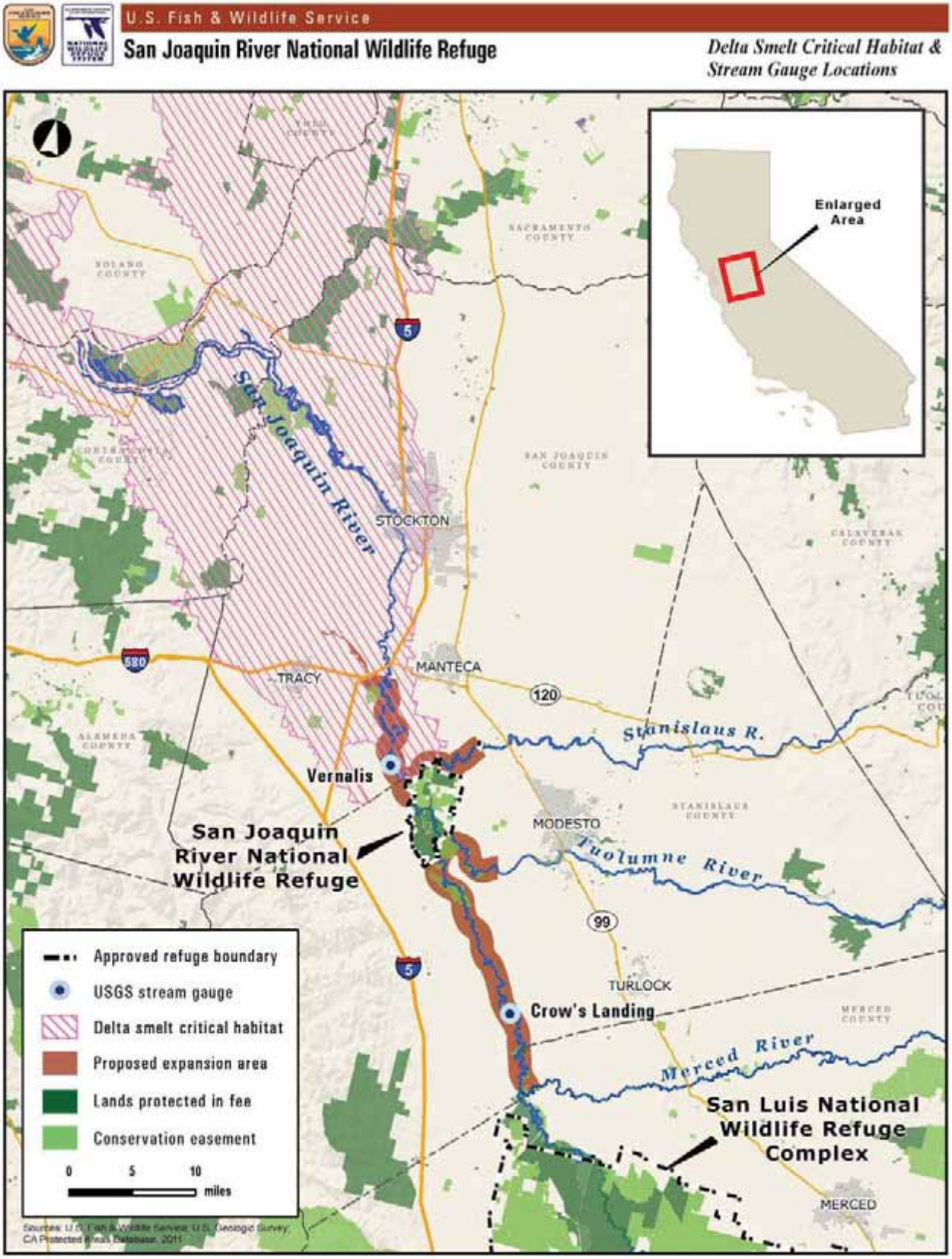

Figure 7. Delta Smelt Critical Habitat Map

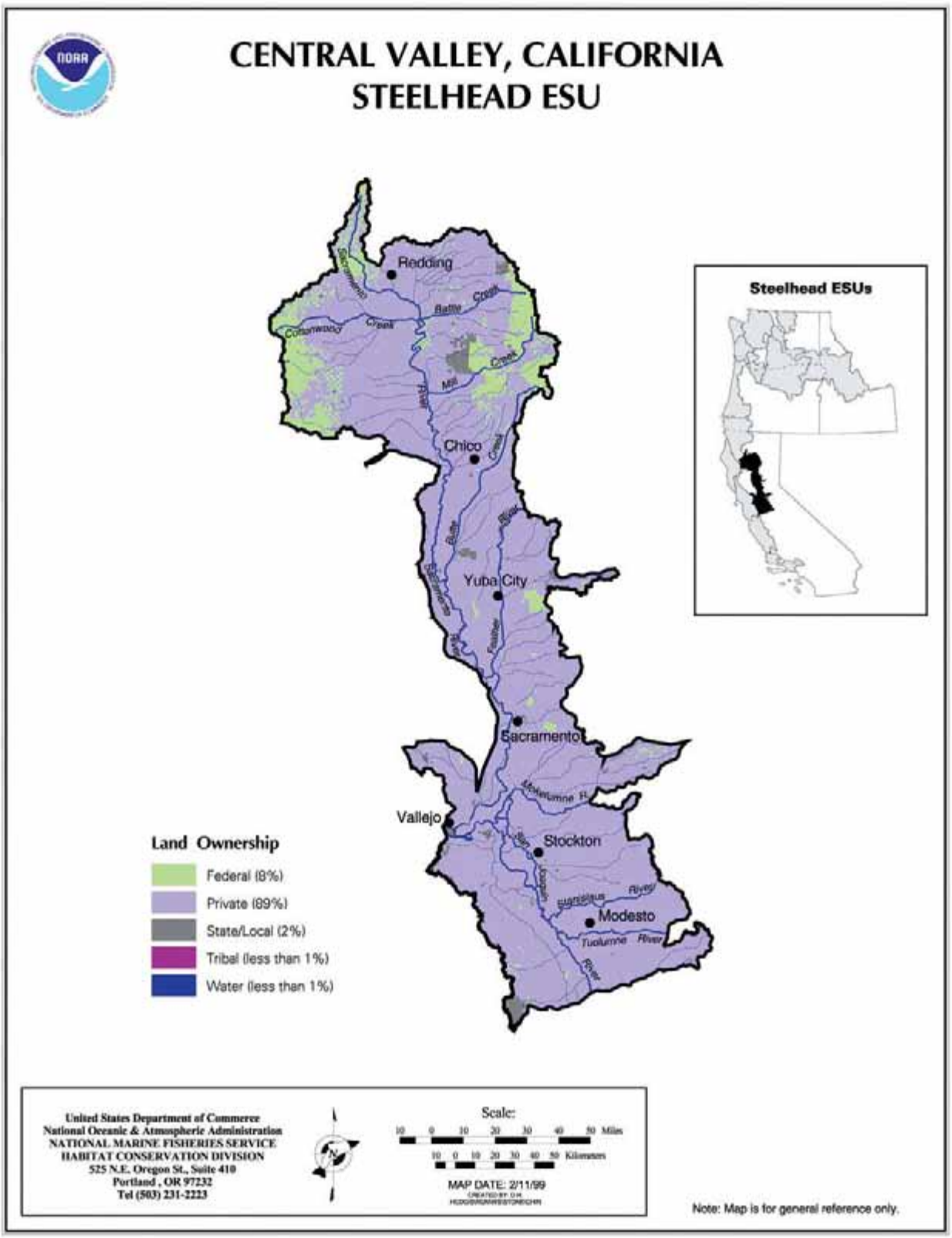

Figure 8. Central Valley, California Steelhead ESU Map

3.4 Social and Economic Environment

3.4.1 Cultural Resources

Cultural resources are physical remains, sites, objects, records, oral testimony, and traditions that connect us to our nation's history and the land's past. Cultural resources include archaeological and historical artifacts, sites, landscapes, plants, animals, sacred locations, and cultural properties that play an important role in the traditional and continuing life of a community.

Little formal cultural resources survey work has been conducted within the existing San Joaquin National Wildlife Refuge boundary. The known cultural resources in and within one mile of the existing boundary consist of eight prehistoric sites and two historic sites. Cultural resources, especially archaeological sites, are fragile and nonrenewable. Most consist of worked stone, fire-altered rocks, and organically enriched soil on or close to the surface. When compared to the surrounding landscape and contemporary cultural features, such as roads, ditches and structures, archaeological sites are small and subtle. Development, flooding, levee construction, and channelization could have damaged or destroyed archeological sites in the proposed expansion area. Nonetheless, there may be relatively or completely intact archaeologically significant sites in the proposed expansion area that qualify as historic resources and/or historic properties.

Prehistory

The proposed expansion area is in the homeland of several Indian groups collectively known as the Northern Valley Yokuts. Within the Refuge, one group, the Tuolumne aboriginal group, has been identified. The Tuolumnes' home was east of the San Joaquin River, between the Stanislaus and Tuolumne Rivers (True 1981). The Refuge borders the territory of, and at various times, was probably occupied by, the Miwok tribe (Silverstein 1978). As neighbors, the Yokuts and Miwok traded, intermarried, and shared many cultural practices. Acorns (valley oak) and salmon were dietary staples, as were tule elk, antelope, and jackrabbit (Levy 1995). Major Northern Valley Yokuts settlements were located within a short distance of the San Joaquin River banks and along major tributaries. As the San Joaquin and Tuolumne Rivers have changed and meandered considerably over the years, these sites may appear most anywhere on the Refuge. Villages were typically built on ground higher than the surrounding area, situated to best exploit the rich subsistence resources without being consistently flooded. The Yokuts would mainly congregate in the winter; during spring, summer, and fall, groups would disperse to gather different resources (Jensen 1996). Villages were typically a scatter of four or five to several dozen structures. Each house served as a home to one family. Large villages might also have a great communal earth lodge for ceremonial use.

History

Spanish colonization of California began with the readily accessible coastal areas, avoiding the interior valleys during the 18th century. Early in the 19th century, military explorers and missionaries moved away from the coast and to the inland valleys. Early settlement by the Spanish in California was accomplished through the mission system, where livestock and farming were mainstays. The arrival of the Spanish into California shifted the use of the land from hunting/gathering to an agrarian use. However, Spanish soldiers forced the Native American population from their villages on the banks of the San Joaquin and removed them to the Mission San Juan Bautista. In 1832-1833, the Yokuts were victims of epidemics of malaria and cholera, which eliminated approximately 75 percent of the population. In 1856, two reservations were created in the Valley, and the last 1,300 Yokut people were resident upon them; by 1910, only 600 remained.

The Spanish also introduced both cattle and sheep into California; at the height of the mission period, there were 400,000 cattle and 300,000 sheep (Schoenherr 1992). During the late 1840s, there was a decline in the Spanish/Mexican influence in California, particularly during the gold rush years; however, livestock production continued as a major agricultural activity. Due to a rapid increase in miners and settlers during the gold rush years, numbers of livestock were vastly increased to meet this new demand. By the 1860s, there were 3 million cattle and 9 million sheep in the State. Damage to California's rangeland from overgrazing was extensive by the 1870s, and it has never fully recovered (Schoenherr 1992). Agriculture continued to be the primary land use of the Central Valley into the 1900s. Dry farming (i.e., farming without irrigation) for wheat became popular in the late 1880s, but declining wheat prices brought an end to this practice during the 1920s. Irrigated agriculture in the Central Valley was common in the 1850s but became widespread during the 1900s, as it is today. The Central Valley remains an agricultural center as it was under the Spanish. The primary agriculture products from the Central Valley are dairy products, beef, grapes, rice, orchard crops, and cotton. Hay and alfalfa production for livestock are also common agricultural products.

Under Federal ownership, archaeological and historical resources within the proposed land addition of the San Joaquin River National Wildlife Refuge would receive protection under Federal laws mandating the management of cultural resources. These laws include but are not limited to the Archaeological Resources Protection Act, Archaeological and Historic Preservation Act, Native American Graves Repatriation Act, and National Historic preservation Act (NHPA).

The Service currently does not propose any project, activity, or program that would result in changes in the character of, or that would potentially adversely affect, any historic cultural resource or archaeological site. When such undertakings are considered, the Service would take all necessary steps to comply with Section 106 of the NHPA of 1966, as amended. The Service would also pursue proactive compliance with Section 110 of the NHPA to survey, inventory, and evaluate cultural resources.

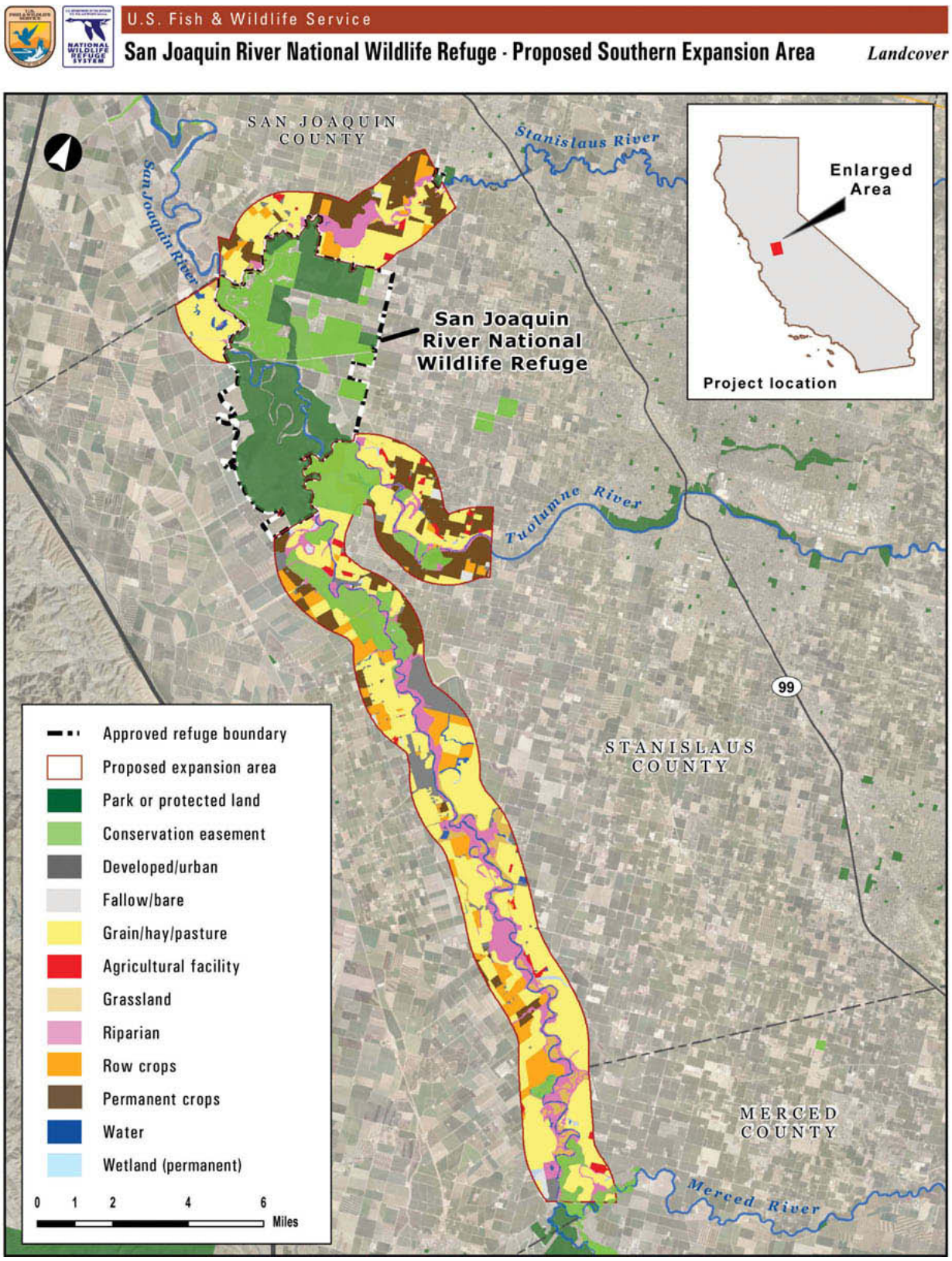

Figure 9. Southern Expansion Landcover Map

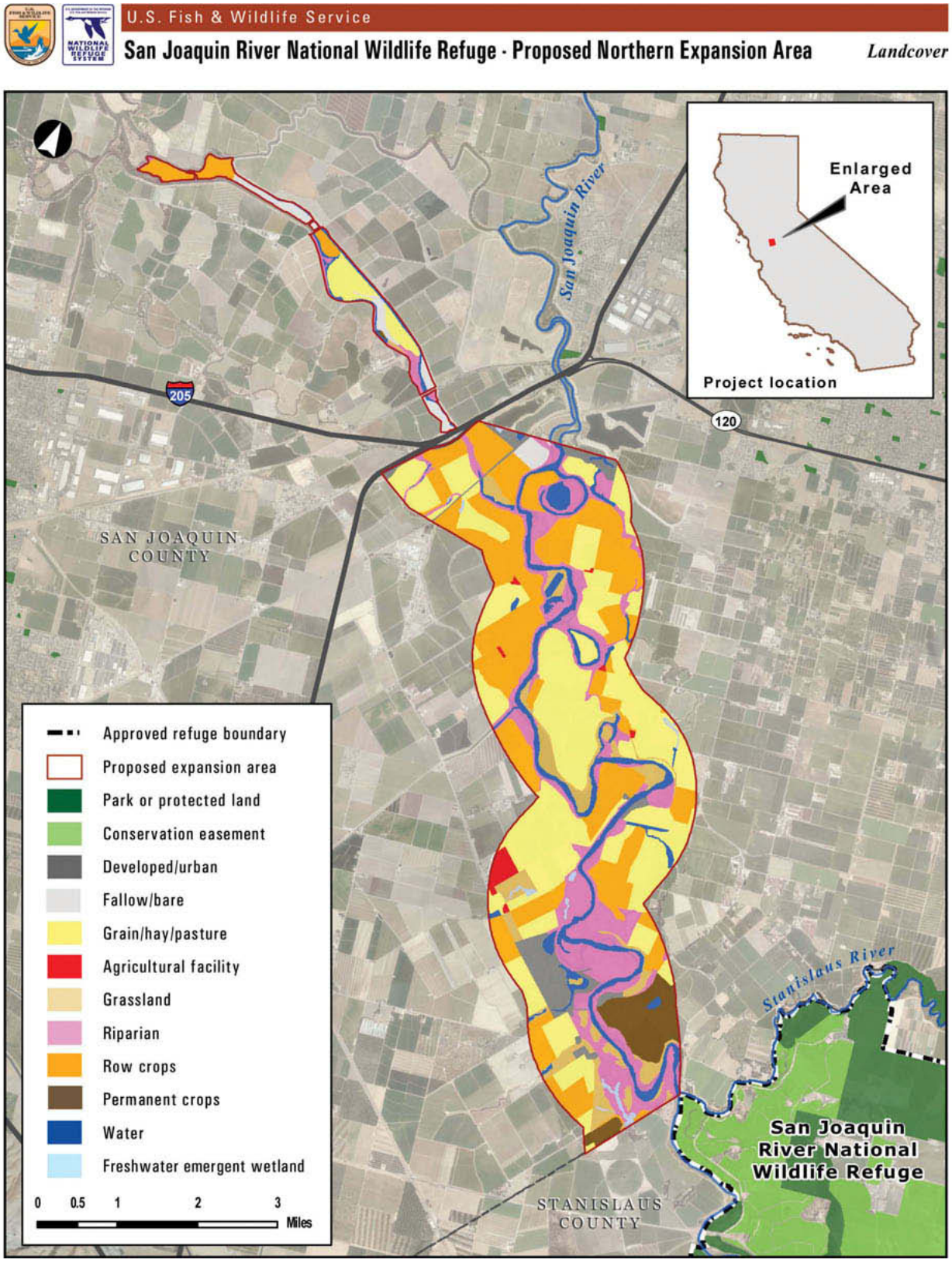

Figure 10. Northern Expansion Landcover Map

3.4.2 Economic Environment

Population

The Refuge and the lands within the proposed expansion areas are located in the northern portion of California's Central Valley, spanning Merced, San Joaquin, and Stanislaus Counties. Population statistics for these counties are provided in Table 5. This three-county area experienced tremendous growth over the past decade, as restrictive land use policies have contributed to increases in housing prices in the neighboring San Francisco Bay Area (Kok et al. 2010). Between 2000 and 2010, the San Joaquin Valley grew more than 50 percent faster than the Bay Area as many households migrated east in search of more affordable housing (U.S. Census Bureau 2010). While statewide figures indicate California grew nearly 10 percent over the last decade, these three San Joaquin Valley counties experienced growth in excess of 18 percent, growing to an estimated 1.46 million residents in 2010 (U.S. Census Bureau 2010).

Population growth in the three-county area is expected to continue to grow at a rate that well exceeds statewide projections. Statewide forecasts project California will grow more than 19 percent between 2010 and 2030 (California Department of Finance 2012). During this same time period, local growth in the three-county area is expected to approach 35 percent, with the greatest projected increases occurring in rural Merced and San Joaquin Counties (40.4 percent and 36.3 percent, respectively) (California Department of Finance 2012).

Table 5. Population Statistics for the Three-County Area Surrounding the San Joaquin River National Wildlife Refuge

	Residents 2010[a]	Persons per square mile 2010[a]	Percentage Population Change (2000-2010)[a]	Percentage Population Change (2010-2030)[b]
California	37,253,956	239.1	9.7	19.5
Merced Co.	255,793	132.2	21.5	40.4
San Joaquin Co.	685,306	492.6	21.6	36.3
Stanislaus Co.	514,453	344.2	15.1	29.3

Sources: [a](U.S. Census Bureau 2010); [b](California Department of Finance 2012)

Employment Overview

In 2010, total employment in the three-county region was around 568,000 jobs, with about half of these jobs located in San Joaquin County. Fifty-three percent of the total employment in the three county study area came from five main sectors: educational, health, and social services (12 percent); public administration (13 percent); retail trade (11 percent); professional, scientific, management, administration, and waste services (9 percent); and manufacturing (8 percent).

Jobs in agriculture, forestry, mining, fishing, and hunting accounted for 8 percent of total employment in the 3 county study area, and collectively represented the seventh largest sector in the three-county area. In 2010, farm employment accounted for 5 percent of total employment in the study area, with over 28,000 jobs in the three counties coming from farm employment.

The three-county region was much more dependent on farm earnings (eight percent of total income in the three-county area from farm income) than the State of California (one percent of total earnings from farming). Of the three counties in the study area, farm earnings in Merced County represented the largest share of total earnings (16 percent of total earnings) and San Joaquin County reported the smallest share of earnings from farming (5 percent) (Bureau of Economic Analysis 2012).

Agriculture

Much of the proposed acquisition area not currently protected is privately-owned prime farmland. The parcels along the river tend to be farmed close to the river, with narrow bands of remnant riparian woodland habitat immediately adjacent to the river in disjunct locations. The San Joaquin Valley is one of the most productive agricultural regions in the world, and the three counties of the study area are consistently among the most productive counties in the Valley. In 2007, agricultural activities in the San Joaquin Valley were valued at $26 billion and supported nearly 173,000 jobs (U.S. Department of Agriculture 2007, California Employment Development Department 2010). In terms of harvested acres, the top five crops in the three-county region in 2007 included forage (i.e., land used for all hay, grass silage, and greenchop), almonds, corn for silage, grapes, and cotton (U.S. Department of Agriculture 2007).

In recent decades, agricultural production in the San Joaquin Valley has shifted away from wildlife-friendly crops such as grain, hay, and alfalfa in favor of higher valued crops. This trend is most apparent in the increased production of almonds and wine grapes in the Valley. About 80 percent of all California-grown almonds are produced in the Valley, and Merced and Stanislaus Counties are some of the largest producers in the region (U.S. Department of Agriculture 1999). Almond production in the Valley has nearly doubled over the past decade, reaching nearly 1.4 pounds in the 2010-2011 crop year (San Joaquin Valley Regional Planning Agenices 2012). The California wine industry has also developed rapidly. Since the 1960s, the culture of grapes for wine production in San Joaquin County has grown dramatically in order to accommodate changing consumer preferences. In 2010, San Joaquin County was California's largest producer of grapes for wine (San Joaquin County Department of Agriculture 2010). Table 6 shows land use and the value of agricultural products in California and in the three-county area.

Table 6. Land Use and the Value of Agricultural Production in California and the Three-County Area

	California[b]	Merced County[c]	San Joaquin County[d]	Stanislaus County[e]	Three-County Area
Land Use, 2007[a]					
Number of Farms	81,033	2,607	3,624	4,114	10,345
Proportion of land area in farms	25%	84%	83%	82%	83%
Land in Farms (acres)	25,364,695	1,041,115	737,503	788,954	2,567,572
Croplands	9,464,647	537,716	492,032	351,195	1,380,943

	California[b]	Merced County[c]	San Joaquin County[d]	Stanislaus County[e]	Three-County Area
Woodlands	1,270,720	3,164	4,548	7,382	15,094
Permanent pasture and rangeland	13,275,042	456,195	206,363	403,786	1,066,344
Land in farmsteads, buildings, livestock facilities, etc.	1,354,286	44,040	34,560	26,591	105,191
Cash Receipts, 2010 ($1,000)					
Field Crops	$3,534,345	$329,114	$314,357	$234,083	$877,554
Vegetable Crops	$6,880,466	$317,794	$256,261	$244,263	$818,318
Fruit and Nut Crops	$13,495,410	$465,648	$935,155	$703,874	$2,104,677
Apiary Products	$3,751,416	$45,855	$76,931	$114,363	$237,149
Nursery Goods	$333,476	$27,596	$13,349	$48,630	$89,575
Livestock and Livestock Products	$8,119,467	$1,109,815	$417,427	$775,745	$2,302,987
Poultry and Poultry Products	$1,426,520	$430,024	$47,313	$406,243	$883,580

Sources: [a](U.S. Department of Agriculture 2009), [b](California Department of Food and Agriculture 2010), [c](Merced County Department of Agriculture 2010), [d](San Joaquin County Department of Agriculture 2010), [e](Stanislaus County Department of Agriculture 2010)

Production within the three-county area is diverse and is attributed with earning 19 percent of California's cash receipts in 2010, or roughly $7.3 billion (California Department of Food and Agriculture 2010, Merced County Department of Agriculture 2010, San Joaquin County Department of Agriculture 2010, Stanislaus County Department of Agriculture 2010). The top five most valuable commodities produced in the area include: milk, almonds and walnuts, poultry, cattle and calves, and grapes. County reports indicate this region produces more than half of all California poultry, cherries, asparagus, and pumpkins, and more than 90 percent of the State's blueberries (Merced County Department of Agriculture 2010, San Joaquin County Department of Agriculture 2010, Stanislaus County Department of Agriculture 2010). For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

Conservation and Ecosystem Service Values

Ecosystems are integrated natural communities stemming from the interactions among and between humans, animals, and the physical environment. The natural functions maintained by a healthy ecosystem provide ecological goods and services that preserve the natural capital required to maintain biodiversity and provide for the social, cultural, and economic needs of humans. The beneficial outcomes of these ecological processes provide "provisioning services" such as food,

water, and timber; "regulating services" such as flood and disease regulation; "cultural services," including recreational and spiritual services; and "supporting services" such as soil formation and nutrient cycling (Millennium Ecosystem Service Assessment 2005).

The value of natural ecosystems stems from their implicit non-market values, which are often overlooked in private decision-making processes. Since the economic value of ecosystem services is equal to the total social benefits they provide, it is important to account for both the market and non-market values of these resources (Freeman 1993). Undervaluation of ecosystem resources is known to cause the under provision of natural capital; thus, conservation and restoration efforts usually stem from the coordination of government agencies and public trusts. Conservation easements and fee title acquisitions can protect non-market values associated with biodiversity and wildlife abundance, maintain aesthetic beauty, and protect social and culturally significant features of landscapes and livelihoods (Ehrlich and Ehrlich 1992, Daily 1997, Millennium Ecosystem Service Assessment 2005). Ecosystem services, such as flood mitigation, water purification, oxygen production, pollination, and waste breakdown, are also maintained and/or enhanced through land preservation (Millennium Ecosystem Service Assessment 2005). These services can have significant impacts on the welfare of those living in the area and beyond.

The primary public benefit of Service conservation easements and fee title acquisitions is enhanced and preserved wildlife habitat. Conservation easements on private lands strengthen the resiliency of species habitat and provide opportunities for wildlife movement and adaptation. Land acquired by the Refuge through fee title purchases will be restored to provide important habitat and resources for endangered species, migratory birds, fish, and native plants. These types of habitat preservation have been shown to stabilize and increase wildlife populations (Reynolds et al. 2001).

Benefits to the Local Community

Protected lands act as a buffer that benefits residents through increased biodiversity, recreational quality, and hunting opportunities on publicly accessible wildlife refuges and on some private lands (Rissman et al. 2007). Open space carries positive values to local residents and communities, as well as to passers-by (McConnell and Walls 2005), as evidenced by the success of open space preservation ballot initiatives at the local, county, and State levels. Banzhaf and others (2006) point out that between 1997 and 2004, over 75 percent of the more than 1,100 referenda on open space conservation that appeared on ballots across the United States passed, most by a wide margin.

Open space and protected natural areas can also increase surrounding property values (see McConnell and Walls 2005 for a comprehensive review). The reciprocating value of open space on property values will vary depending on landscape characteristics and location attributes (for example, distance to the conserved area) (Kroger 2008). The permanence of the open space is also an influencing factor. Typically, open space that is permanently protected (such as Refuge lands and lands protected with perpetual conservation easements) will generate a higher enhancement value of local properties than land that has the potential for future development (Geoghegan et al. 2003). Location and demographic factors in the region can also influence the relative level of property enhancement value. For instance, open space may generate larger amenity premiums for property in more urbanized areas and where median incomes are higher (Netusil et al. 2000); this is not to say there isn't the chance for property values to increase substantially in rural areas as well, such as the areas surrounding the proposed San Joaquin River National Wildlife Refuge expansion areas (Phillips 2000, Crompton 2001, Thorsnes 2002).

Canoeing on the San Joaquin River. Photo by Chris Acree

Conservation easement and fee title purchases would also inject new money into the local economy. The sale of conservation easements and fee title lands provides landowners with additional revenue. Some percentage of these funds may be spent in the local economy, including purchasing new real estate, consumer goods, or services in the local area. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

Tax Revenue

Local governments collect revenue through intergovernmental transfers, property taxes, sales taxes, personal income taxes, and other charges, such as permitting. These revenues are then spent to provide community services such as fire and police services, schools, infrastructure, and public spaces. Local government cost-to-revenue ratios are largely determined by land uses within their jurisdictions. Areas with residential development tend to have high cost-to-revenue ratios because these areas require the greatest number of municipal services. Conversely, areas with predominately agricultural and open space uses tend to have lower cost-to-revenue ratios (American Farmland Trust 2001). Like agricultural properties, national wildlife refuges tend to require fewer local government services and thus represent lower costs to local government. However, national wildlife refuges do not pay property taxes on their holdings. Property taxes constitute the largest source of local governments' own revenue (Urban Institute and Brookings Institution 2008). The purchase of fee title lands at fair market value will reduce the amount of

property tax revenue collected by local governments in the three-county area. Under Federal fee title ownership, counties would qualify for reimbursement of some property tax revenue foregone under the Refuge Revenue Sharing Act (RRS) of 1935, which allows the Service to make annual payments to local governments in areas where fee title purchases have removed land from the tax rolls. Under provisions of the RRS Act, local counties receive an annual payment for lands that have been purchased by full fee title acquisition by the Service. Payments are based on the greater of 75 cents per acre or 0.75 percent of the fair market value. The exact amount of the annual payment depends on Congressional appropriations, which in recent years have tended to be substantially less than the amount required to fully fund the authorized level of payments. For the years 2001 through 2009, RRS payments averaged 46.5 percent of the full 0.75 percent of the fair market value. In fiscal year 2009, actual RRS payments were 30.7 percent of authorized levels, and in fiscal year 2010, actual RRS payments were 21.6 percent of authorized levels. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

Refuge Operations

The San Joaquin River National Wildlife Refuge purchases a wide variety of supplies and services for Refuge operations and maintenance activities, and many of these supplies and services are purchased within the local three-county area. Refuge purchases made in the three-county area contribute to the local economic impacts associated with the Refuge. This section presents an analysis of the economic impacts to the three-county area of current Refuge non-salary expenditures.

The Refuge currently spends an average of $400,000 annually on non-salary expenditures. Major local expenditures include services and supplies related to habitat and grounds improvements and treatments, equipment and structure maintenance and repair, office supplies, equipment purchases, and environmental and other technical consulting services. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

3.4.3 Relationship to County Plans

One of the main goals of the General Use Plans for the San Joaquin, Stanislaus and Merced Counties is growth accommodation. The San Joaquin General Use Plan specifically aims to, "plan sufficient land to accommodate the growth assumed by this Plan either within urban communities, rural communities, or rural areas" (Vol. I, The County General Plan Concept, pg 3). With regards to agricultural areas, the Plan is designed to, "accommodate minimal growth because open space and agricultural preservation are paramount in these areas" (Vol. I,The County General Plan Concept, pg 3). These same goals are echoed in the General Plans of Stanislaus and Merced Counties. According to the General Use Plans, it is of great importance that agricultural lands and open space are protected, but that goal does necessarily prohibit development. Instead, an objective of the plans is to continue to protect these valuable areas, but increase access in a way that will not cause harm to the area. Additionally, the plans dictate that where development occurs, it will be done so in a way that protects the land currently under production. The management of water quality and supply are also key issues addressed in the General Use Plans. As water demands increase, it is imperative that the counties properly manage the current resources in the area. Finally, the plans each address the importance of vegetation, fish and wildlife habitat and establish key policies to preserve these areas, including the protection of wetlands, the habitat of species of concern and fisheries.

One of the greatest threats to agriculture in the area is the subdividing of parcels, which can result in "leap frog" development. This type of development creates parcels of land that are insufficient to be under commercial agricultural production, but are not efficient for residential housing units. Furthermore, the creation of these types of developments can disrupt agricultural production on the adjacent lands. In the Refuge expansion region, "antiquated subdivisions" exist, which are small parcels of land designated as development sites in the beginning of the 20th century. Due to increased stringency in zoning standards, these subdivisions could not be established today, but remain areas of possible development as a result of their historical designation. Many of these subdivisions are currently undeveloped or only partially developed and are located in the middle of agricultural lands. The development of these subdivisions poses an enormous threat to the agricultural community within the counties.

The protection of water quality is a key issue for the area. Due to the continued growth of the area, demand for water is ever increasing. In addition to supply concerns, agricultural production, the greater production of waste water and recreational use each increases the risk of water quality degradation. Current and future management is charged with balancing increasing demands for water quantity and continued improvements of water quality.

Wildlife is a major factor for consideration for the General Plans of the three counties. San Joaquin County is home to four important areas for vegetation and wildlife; the Delta, the southwest foothills, the Sierra Nevada foothills, and the Valley Floor. These areas provide habitat for several endangered and protected species including the Central Valley steelhead, Swainson's hawk, and the riparian brush rabbit. The growth in population continues to pressure these areas and decrease the area of habitat that remains undisturbed (Vol. III, Resources, Vegetation, Fish and Wildlife Habitat, pg 2). The General Plan for Stanislaus County ensures the protection of the rivers to allow salmon migration (Chapter 3, pg 22), while the General Plan for Merced County also focuses on the conservation of wildlife habitat and the protection of native plant species (Part II, Natural Resources Element, pg 3).

3.5 Recreation

Due to the agricultural nature of the area, aside from the existing Refuge lands, there are limited recreational opportunities for the general public within the proposed San Joaquin River expansion area.

In its 2009 Central Valley Vision Implementation Plan, a 20-year roadmap for improving State parks in the Central Valley, the California Department of Parks and Recreation noted that residents from the Central Valley must travel twice the distance that southern California and San Francisco Bay area residents must travel to reach a recreation area. The plan stated that the Central Valley lacked a well-developed regional park system, with particularly few State parks to serve its growing population (California State Parks 2009).

Newly-acquired and restored Refuge lands would provide additional water access points, trails, and wildlife viewing opportunities which will benefit local residents. These new and/or enhanced recreational opportunities are also anticipated to draw additional non-local visitors to the Refuge, thus increasing economic activity associated with visitor spending in the local economy. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

3.5.1 Outdoor Recreation Activity Participation and Demand

In 2002, a survey was conducted by the California State Parks Planning Division to determine levels of participation in and unmet demand for various recreation activities (California State Parks 2003). Table 7 summarizes the results of this survey for outdoor recreation activities. Both wildlife viewing and fishing were among the top 10 ranked activities in terms of unmet demand.

Table 7. Statewide Participation in and Unmet Demand for the Primary Recreation Activities Pursued Within California

Recreational Activity	Participation (Percent)	Participation Rank (out of 55)	Unmet Demand Rank (out of 55)
Walking for fitness and fun	91	1	3
Driving for pleasure, sightseeing, driving through natural scenery	90	2	15
Visiting outdoor nature museums, zoos, or arboretums	80	6	7
Picnicking in developed sites	77	7	12
Wildlife Viewing, bird watching, viewing natural scenery	75	8	4
Swimming in freshwater lakes, rivers, and/or streams	47	13	18
Jogging and fitness running	36	11	5
Fishing - freshwater	34	19	9
Paddle sports (Kayaking, rowing, canoeing, and rafting)	23	27	21
Hunting (large and small game)	9	49	34
Orienteering/geocaching	5	53	55

3.5.2 San Joaquin River Blueway Vision

The San Joaquin River Partnership has worked with the National Park Service, the Service, and others in identifying potential sites for increased river access. Their Blueway Vision document shows four potential future river access sites within the proposed expansion area—two within the proposed northern expansion area, and two within the proposed southern expansion area.

3.5.3 Commercial/Private Recreational Facilities

There are a number of commercial camping facilities and sportsmen's clubs with boat ramps along the San Joaquin River in the proposed expansion area. From north to south they are:

- Turtle Beach Fish Camp
- Eagal Lakes Sports Resort
- Two Rivers RV Park
- Old Fisherman's Club
- Turlock Sportsmen's Club
- Catfish Camp
- Martin's Mobile Court
- Fishermen's Bend Campground

3.5.4 County Parks

Several county parks are located in the proposed expansion area. Many of these parks have been affected by the recent economic downturn, with reduced maintenance and closure of some areas.

Stanislaus County Parks Department has three areas near the San Joaquin River: the Las Palmas Fishing Access, a 3-acre park a few miles east of the town of Patterson, contains a concrete boat ramp and day use facilities; Laird Park, a 97-acre park, two miles east of the town of Grayson, provides river access and day use facilities; and the Shiloh fishing access site, on Shiloh Road, provides access to the Tuolumne River near its confluence with the San Joaquin River. The Shiloh fishing access site is approximately two acres in size with swimming available.

As of July 1, 2011, the Las Palmas and Shiloh fishing accesses are closed (among others). No restrooms, trash receptacles, or maintenance service is provided in the closed areas. All restroom facilities in community parks that are maintained by Stanislaus County Department of Parks and Recreation are closed until further notice.

The San Joaquin County Parks Department maintains the Mossdale Crossing Regional Park; a large, two-lane boat ramp with floating dock gives access to the San Joaquin, Middle, and Old Rivers, and is located near the I-5 crossing at Lathrop. Further upstream is Dos Reis Regional Park, where fishing access to the San Joaquin River is available via the park's floating dock and boat launch. The County had maintained Durham Ferry State Recreation Area, which was once a 176-acre multi-use park that has since been transferred to the County Department of Education and is maintained by Venture Academy, which hosts the Durham Ferry School of Agriculture for grades 6-12; it is no longer a recreational site.

3.5.5 State Facilities

The 2009 Central Valley Vision Implementation Plan had proposed expansion of some parks and additions to the State park system. Since then, there has been discussion of park closures due to lack of funding. In May of 2011, California State Parks announced a plan to close up to 70 of its 279 parks due to budget cuts. The closures were deemed necessary to achieve an $11 million reduction in fiscal year 2011-2012, with that amount increasing to $22 million in fiscal year 2012-2013 (California State Parks 2012).

Enjoying nature on the pelican trail, SJRNWR. Photo by Rick Kimball

Caswell MSP is adjacent to the San Joaquin River Refuge on the banks of the Stanislaus River, downstream from the town of Ripon. The park protects a fine example of the threatened and still declining riparian oak woodland, which once flourished throughout California's Central Valley. Caswell is home to several endangered animal species, including the endangered riparian brush rabbit and riparian woodrat. Caswell has a host of activities, including camping (65 sites), swimming, fishing, foot trails, a campfire program, and group camping. There are also picnic tables, a boat launch, and showers. The Implementation Plan had proposed expanding Caswell MSP by 200 acres and adding more campsites, picnic, and interpretive areas. Given the current budget constraints, these expansion plans seem to be in doubt at this time. The West Hilmar Wildlife Area, on the west bank of the San Joaquin River a few miles downstream of the Merced River confluence, is a 340-acre State wildlife area accessible only by boat, with no facilities. Also near the confluence of the Merced and San Joaquin Rivers is the George J. Hatfield State Recreation Area, a small developed park unit consisting of 47 acres, with a 40-person group camp site. The park provides access to the Merced River for boating, fishing, swimming, picnicking, and hiking on short trails. Currently, there are no facilities aside from chemical toilets at the park.

The North Grasslands Wildlife Area (China Island Unit) is at the extreme southern end of the proposed expansion area between the towns of Newman and Gustine. The 7,069-acre wildlife area has a boat ramp and allows fishing, waterfowl and pheasant hunting, wildlife viewing, and camping at the hunter check station. The park is at the northernmost part of the larger Grasslands Ecological Area (GEA) of Federal, State, and private lands, all managed for wildlife values.

3.5.6 National Wildlife Refuges

The San Joaquin River National Wildlife Refuge (Refuge)

Part of the San Luis National Wildlife Refuge Complex, the Refuge has been closed to the public until recently. For many years the Refuge maintained a public observation platform at the end of Beckwith Road that overlooked a corn field which attracted hundreds of thousands of geese. However, the Refuge was not considered open to public use because the platform is on county land adjacent to Refuge lands.

In March 2011, the Refuge opened the Pelican Trail, which was the first public use permitted on the Refuge. The Pelican Trail has an established trailhead that leads to four miles of looping trails through various wetland, riparian, and riverside habitats. The Pelican Trail features various interpretive riparian plantings and includes a large parking area, bathrooms, kiosks, and picnic tables.

The Refuge management guidance document, the Comprehensive Conservation Plan (CCP), includes an objective of implementing a wildlife observation and photography program for the public on the Refuge by developing five public use facilities within the next five years, followed by another five public use facilities within the following five years. These facilities and programs are contingent on anticipated funding and staffing levels that may or may not come to fruition. The CCP also states its strategies for increasing visitor services include:

- One or more car-top boat launching facilities;
- Within five years, develop a recreational hunt program;
- Within 10 years, develop a visitor contact station;
- Within 10 years, develop a recreational fishing program.

Last year, the Refuge provided environmental education to approximately 1,000 children from local schools, and approximately 8,950 people either used the Pelican Trail or the Beckwith Road (off-Refuge) viewing area.

San Luis and Merced National Wildlife Refuges

The following refuges are within the Grasslands Ecological Area, and although the proposed expansion connects to the San Luis, Merced, and Grasslands units of the Refuge System, they are not within the footprint of the proposed expansion area.

The San Luis Complex includes the San Luis National Wildlife Refuge, which encompasses over 26,600 acres of wetlands, riparian forests, native grasslands, and vernal pools. The Refuge has three auto tours routes with associated nature trails and observation decks for the public to view and photograph wildlife and nature. The Refuge also allows fishing at designated sites and has a large waterfowl hunting program.

Another of the Complex's refuges, the Merced National Wildlife Refuge, encompasses 10,262 acres of wetlands, native grasslands, vernal pools, and riparian areas. Merced National Wildlife Refuge has an auto tour route, three nature trails, and two wildlife observation platforms to view and photograph wildlife and nature, in addition to a waterfowl hunt program.

The Grasslands Wildlife Management Area, another of the Complex's refuges, is comprised of privately-owned lands on which perpetual conservation easements have been purchased. These easements preserve wetland and grassland habitats and prevent conversion to croplands or other uses not compatible with migratory bird and other wildlife values. Daily management operations

remain under the landowner's control. The majority of easement properties are wetlands managed for waterfowl hunting. Due to the private ownership of these lands, public use is prohibited.

Table 8. 2011 Recreational Use Visits Within the San Luis National Wildlife Refuge Complex

Activities	San Joaquin River NWR	San Luis NWR	Merced NWR	Grasslands WMA
Hunting	-	9,775	840	X (Private, easements)
Fishing	-	4,000		-
Wildlife observation (nature trail)	8,950	4,000	4,900	X (Private, easements)
Wildlife photography	75	1,000	800	X (Private, easements)
Environmental education	1,000	575	260	-
Interpretation	175	450	480	-
Auto Tour	-	72,000	35,000	Public roads

(- = Not available)

Otter using revegetated site on the San Joaquin River NWR. Photo by Rick Kimball

4. Environmental Consequences

Section 1.8 of this Environmental Assessment lists the following issues identified during scoping;

- Recreation and Public Use
- Refuge Management (including mosquito control)
- Water Management
- Refuge Proximity to Private Lands
- Wildlife Management (including water quality)
- Flood Control
- Habitat Restoration
- Economic Effects (including agriculture)

Aside from the economic effects of the proposed Refuge expansion, all of these issues are addressed for the existing Refuge lands in the Comprehensive Conservation Plan (USFWS 2006), which is incorporated by reference. The CCP guides the management of the existing Refuge until 2021 unless it is formally revised or amended within that period. In addition, a Land Protection Plan, Conceptual Management Plan, Economic Analysis, Species List and Summary of Scoping Comments for the proposed expansion area are included with this assessment as Appendix A, B, C, D, and E respectively.

4.1 Alternative 1: No Action

The No Action alternative represents no change from the existing management of lands and waters in the study area. Under this alternative, the Service would not acquire interest in the lands in the study area for the purpose of expanding the boundary of the San Joaquin River National Wildlife Refuge.

The distribution, general location, and extent of land use in the study area and vicinity would continue to be guided by each county's general plan and zoning codes. The general plan is the official overall policy statement of the county relating to land use and planning issues and provides a broad outline of future land use patterns. Under the No Action alternative, existing land uses in the study area would remain unchanged in the short term. The SJRRP will continue its congressionally mandated work upstream of the Refuge, and the San Joaquin River Partnership will continue their work on promoting their Blueway Vision. However, long-term protection and restoration of the area's wildlife habitat downstream of the SJRRP is uncertain without some type of incentive to the landowners, and the outcome of such efforts, particularly without the Federal government's support, cannot be predicted.

4.1.1 Soils and Geology

Under the No Action alternative, the majority of soils would continue to be used in agriculture. For most crops, cultivation and weed control require that fields be kept in a bare soil condition in fall and winter annually or at least every few years. Soil surfaces are often disked or loosened, accelerating the rate of soil loss through erosion by wind and water. Some highly soluble pesticides bind strongly with soil. The more clay particles and organic matter that are in the soil, the more the pesticide is held by the soil and becomes immobile. Strongly adsorbed pesticide molecules do not leach or move unless the soil particles to which they are adsorbed move (erosion)

with water. The longer the molecules of a pesticide are held, the more likely it is that microbiological degradation will occur, which reduces the risk of leaching and runoff (Cornell University Cooperative Extension 2012). Soil amendments are used on many farms due to the lack of natural restoration of soils. There would be no known geological impacts.

4.1.2 Surface Water Quality

The EPA and the California State Water Quality Control Board will continue to work toward reducing the amount of pollutants entering the San Joaquin River System. The EPA has not completed reviewing agricultural pesticides with the National Marines Fisheries Service, and as farm pesticides are continuing to be used in the proposed expansion area, there is the continued risk of these materials affecting the environment beyond their intended use.

Sediment-laden agricultural runoff from tributaries and the numerous drains within the proposed expansion area may carry potentially harmful chemical pollutants in solution, or adsorbed to suspended sediment particles in the runoff. Agricultural tailwater and runoff can drain into adjacent waterways, adversely affecting water quality and aquatic habitat in receiving waters.

4.1.3 Flood Management

Under Alternative 1, flood management within the proposed expansion area is expected to remain the same. All lands within the proposed expansion area are within the 100-year flood zone. The Corps of Engineers would likely continue to evaluate the feasibility of a flood bypass near Paradise Cut.

4.1.4 Groundwater

Under the No Action alternative, agricultural inputs are likely to continue to pollute groundwater resources. Agriculture is a major contributor to nitrate contamination of groundwater (Puckett et al. 2011). Although groundwater overdraft does not seem to be a problem in the proposed expansion area, it is a problem within the San Joaquin Basin. Increased pumping of groundwater can contribute to increased stream flow capture, whereas a gradient leading away from the river causes water to flow from the river into the groundwater.

4.1.5 Climate Change

Under Alternative 1, flooding is likely to increase if precipitation in the form of snow decreases, and precipitation in the form of rain increases, as predicted in climate change scenarios. In the proposed expansion area, fruit trees of many varieties will have reduced viability, winters will be wetter, and summers dryer and hotter. The frequency of fires is expected to increase, and risks to the sustainability of native plants and animals are expected to increase (Cloern et al. 2011). Without a functioning riparian corridor, the amount of trees providing shade and the cooling effect of evapotranspiration along the San Joaquin River is unlikely to have a noticeable contribution in reducing summer surface water temperatures or providing cooling refugia at the land-water interface. Increased water temperature reduces the level of dissolved oxygen, which in turn reduces the rate of decomposition of organic material and the capacity to support aquatic organisms (Binford and Buchenau 1993).

California's agricultural industry will have to adjust to the predicted impact of warming, such as crop yield changes, changes in crop types and cultivars, increased temperature extremes, reduced winter chill temperatures, new weed invasions/expanded ranges of existing weeds, new disease pest invasions/expanded ranges of existing diseases and pests, increased flooding and crop pollination changes, heat waves and stress, among others (Merrill et al. 2011).

4.1.6 Biological Environment

Plant Communities

Under Alternative 1, the native habitats along the San Joaquin River would likely remain degraded throughout most of the proposed expansion area. While it is likely that some habitats may be restored by entities aside from the Service, these projects have historically been relatively small and localized. Levee maintenance and invasive plants will continue to reduce the ecological contributions of the remnant riparian area. Just as with agriculture, it is likely that the native communities will be experiencing the following due to climate change: new weed invasions/expanded ranges of existing weeds, new disease pest invasions/expanded ranges of existing diseases and pests, flooding and pollination changes, heat waves and stress, among others.

4.1.7 Wildlife

Invertebrates

Under this alternative, populations of invertebrates within the proposed expansion area will likely continue to be reduced through pest control activities, particularly if they are perceived as likely to have an effect on crop production.

Reptiles and Amphibians

With no action, reptiles and amphibians are likely to continue to be affected by agriculture due to land use practices such as fertilizing, pesticide use, disking, plowing, and harvesting. Lack of a functioning riparian corridor limits the effective dispersal ability of these species.

Fish

Under the No Action alternative, the SJRRP will continue to work to restore fisheries upstream of the proposed expansion area and provide water in areas of the San Joaquin River that have not been flowing for 50 years.

The San Joaquin River is on the impaired waters list (303(d)) for pollutants and temperature. Without a functioning riparian corridor, fisheries are not likely to prosper, as lack of shaded riverine aquatic habitat would not allow the river reduce its temperature during the summer and would limit the amount of food, cover, and structural habitat diversity that a fully functioning riparian corridor would provide.

Mammals

Under this alternative, without a continuous riparian corridor, dispersal continues to be difficult for some species. Without adequate native riparian habitat providing food and cover for these species, their populations are likely to remain low. Due to the lack of refugia, floods could reduce the population of most native terrestrial mammals, depending on the intensity and duration of the flooding.

Birds

Under Alternative 1, the degraded riparian habitat within the expansion areas would likely continue to be unsuitable for least Bell's vireo, yellow-billed cuckoo, willow flycatcher, and a variety of other migratory birds that historically occurred there. The black tern is considered quasi-extirpated from the San Joaquin Valley, as it has shifted its use from wetlands to rice fields, and the yellow warbler and least bittern are nearly extirpated as well. Unless some other entity begins restoring lands with the purpose of returning neotropical migratory birds along the San

Joaquin River, it is unlikely that these birds will return or increase in number—it is more likely that numbers will continue to diminish in the upper San Joaquin Valley.

Special Status Species

Under Alternative 1, special status species within the proposed expansion area will continue to experience a number of threats, including a lack of sustainable populations. All of the special status species have small isolated populations, and based on stochastic event theory, small, isolated populations are often more prone to local extirpations than larger, more widespread populations (Gitay et al. 2002, Davis et al. 2005, Lovejoy and Hannah 2005). For instance, the Recovery Plan for Upland Species of the San Joaquin Valley (1998) states that riparian brush rabbits need to have a minimum of four protected populations at carrying capacity to be eligible for further distribution. There are three known populations within the proposed expansion area: a small remnant population near Paradise Cut (Stewart Tract) in the Delta, the reintroduced rabbits at the Refuge, and a population at Caswell MSP. There are no other adequately-sized habitat patches to establish another self-sustaining population within its historic range at this time.

Although there have been captive breeding successes with the riparian brush rabbit, no one has attempted to breed riparian woodrats in captivity. In addition to the threat of random natural events such as flooding and fire, the riparian woodrat is expected to continue to be prone to the effects of ongoing threats such as disease, predation, and potential competition with the exotic black rat (Rattus rattus).

Aside from the present restoration efforts on the Refuge, the remaining riparian forests are small, isolated, and vulnerable to major flood events (Williams and Basey 1986); whether they can support viable populations of these subspecies over the long-term is questionable. Historical habitat and refugia from flooding in surrounding lands are now unsuitable for these subspecies, as these lands consist primarily of leveled, cultivated fields, orchards, and vineyards (Williams and Basey 1986). Since restoration efforts began on the Refuge, elevated mounds have been created, and those mounds and five miles of levees heavily vegetated, to provide some refugia from flooding. Wildfire, flooding, brush clearing, predation, competition, disease, and use of rodenticides imperil the continued existence of these two subspecies in their last known population center.

Other listed species, such as least Bell's vireo, are unlikely to occur in the proposed expansion area due to a lack of adequate sized patches of riparian vegetation. With the exception of elderberry plants on the existing Refuge and Caswell MSP, there likely will continue to be little habitat for the Valley elderberry longhorn beetle within the proposed expansion area.

The threatened delta smelt and Central Valley steelhead will continue to be impacted by pollutants in the San Joaquin River, which is listed on the EPA's 303(d) list of impaired waters.

4.1.8 Social and Economic Effects

Cultural Resources

Potential adverse impacts of the No Action alternative include but are not limited to continued damage from existing agricultural practices, erosion, and vandalism. Cultural resources on private lands in the proposed expansion area could be afforded less protection under Alternative 1 than if Federal or State jurisdiction were established over the area.

Agriculture

Under Alternative 1, most of the 14,794 acres of croplands within the proposed expansion area are expected to remain in production. However, some agricultural lands may be converted to other land uses, such as recreational, housing, or business facilities.

Tax Revenue

Under the No Action alternative, taxes collected within the proposed expansion area are expected to remain relatively stable.

Refuge Operations

There would be no foreseeable change to Refuge expenditures under the No Action alternative.

Relationship to County Plans

There would be no change from the present conditions.

Recreation

The goals and objectives for increasing visitor services are found in the Refuge CCP. Under this alternative, with the Blueway Vision proposal going forward, there is likely to be increased recreational uses of the river. This may create the need for increased public education, trails and signage, and law enforcement, all of which will help to alleviate the degree of disturbance on the existing Refuge.

Currently, non-local Refuge visitors spend approximately $186,000 in the local economy annually. This spending directly accounts for an estimated one job, $49,900 in labor income, and $82,200 in value added. Secondary or multiplier effects generate one additional job, $30,300 in labor income, and $52,300 in value added. Accounting for both the direct and secondary effects, spending by non-local visitors currently generates total economic benefits of two jobs, $80,200 in labor income, and $134,500 in value added to the local three-county economy. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion.*

4.2 Alternative 2: Southern Expansion

4.2.1 Soils and Geology

Alternative 2 would result in the restoration of up to 10,441 acres of farmlands to natural habitats, such as wetlands, grasslands, oak savannah, and riparian forests. Site-specific impacts of restoration projects would be evaluated in separate NEPA analysis conducted at a later date. In general, restoration activities would result in temporary increases in soil erosion and increased sedimentation in waterways. These impacts would be minimized through the use of best management practices during construction. However, in the long term, restoration efforts are expected to result in reductions in soil erosion, decreased sedimentation of watercourses, and increased organic input with decreased agricultural chemical pollutant runoff.

4.2.2 Surface Water Quality

Under Alternative 2, impacts are likely to be negligible until restoration is initiated. Adverse impacts associated with restoration may include temporary increases in erosion associated with land disturbance, temporary increases in turbidity. Long-term beneficial impacts include nutrient retention, stream bank stabilization, reduced farm chemical runoff, and reduced stream temperatures during summer.

Riparian vegetation can act as a buffer zone to trap and possibly treat pollutants down slope. Many studies have measured large declines in NO_3 concentrations along shallow groundwater flow paths beneath riparian zones (Lowrance et al. 1984, Peterjohn and Correll 1984, Haycock and Burt 1993, Hill 1996). De-nitrification, the process which bacteria reduce NO_3 to N gases in the absence of O_2, has been identified as the primary mechanism of NO_3 removal in stream riparian zones (Cooper 1990, Pinay et al. 1993, Verchot et al. 1997, Martin et al. 1999, Hill et al. 2000). Riparian vegetation can reduce the amount of other nutrients that flow into the river, depending on the configuration, species, size of the riparian area, soil type, and distance from pollution source.

4.2.3 Flood Management

Under Alternative 2, the Service may propose additional nonstructural flood control projects, depending on the feasibility. Any such proposals for nonstructural flood control or setback levees on the Refuge would be subject to NEPA review and permitting from the U.S. Army Corps of Engineers. The purpose of any nonstructural flood control project would be to restore the floodplain hydrology for riparian vegetation, with the side benefit of reducing the flood stage if the project is large enough.

Figure 11. 2006 Flood Waters Overtopping the West Stanislaus Canal, Adjacent to the Laura Unit of the Refuge.
Photo: River Partners

4.2.4 Groundwater

Under Alternative 2, if lands are allowed to flood, either through levee setbacks or nonstructural flood control, groundwater could be recharged to a greater extent than under Alternative 1. With some reduction of agricultural pesticides and fertilizers along the river corridor, groundwater pollution will likely be reduced to a commensurate level.

4.2.5 Climate Change

Alternative 2 provides increased resilience of the San Joaquin River corridor to the effects of climate change over Alternative 1. Shade and evapotranspiration from increased riparian vegetation moderates stream and streamside temperatures, which benefits terrestrial and aquatic species. When shade from streamside vegetation is removed from streams, there are measurable increases in summer water temperatures and decreases in winter water temperatures (Knight and Bottorff 1984).

With restoration, riparian plantings will sequester carbon, reduce stream temperatures and provide thermal refugia for both terrestrial and aquatic wildlife. The restored sites will be more resilient to the changes predicted with climate change, such as increased flooding, higher temperatures, wetter winters and drier summers.

The impacts of climate change will extend beyond the boundaries of any single refuge and will therefore require large-scale, landscape level solutions that extend throughout California and beyond. A goal of the proposed expansion is to build resilience in ecological systems and communities, so as climate conditions change, the San Joaquin River will support native biodiversity and ecological processes. Resilience can be defined as "*the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks*" (Walker et al. 2004: 2).

Riparian forests reduce solar heating of stream water by shading (Brown and Krygier 1970). Riparian vegetation also provides cooling by evapotranspiration of soil water and shallow groundwater (Beschta 1984, Theuer et al. 1984, Sinokrot and Stefan 1993).

Riparian systems are naturally resilient, and increasing that resilience includes maintaining intact, interconnected landscapes, and restoring disjointed or impaired landscapes (Seavy et al. 2009). Riparian systems are adapted to disturbances such as flooding and debris flows, and some species require disturbance events (e.g., flooding) to reproduce, such as cottonwoods. Disturbances such as these are expected to increase with climate change (Seung-Ki Min et al. 2011). These disturbances may affect one portion of the river bank and leave another relatively untouched, thus creating differing successional phases of vegetation along the river, allowing various animal species to utilize their specific habitat niches according to their needs.

Riparian systems provide linear habitat connectivity, provide an interface between aquatic and terrestrial ecosystems, and create thermal refugia for wildlife. These characteristics can contribute to ecological adaptation to climate change (Seavy et al. 2009). Key climate change adaptation concepts include: 1) building resistance to climate related stressors, 2) planning for and allowing climate related transitions to occur, and 3) resilience, which, in an adaptation context, generally refers to the ability for a system to recover from disturbance or change with minimal loss of function or structure, and the ability to return to a given ecological state, rather than shift to another state (Gunderson 2000). Carbon sequestration would also occur as a result of riparian tree planting.

A primary adaptation strategy to climate change and even current climate variability is to reduce and manage the other stresses on species and ecosystems. The following stressors have been identified by the California Department of Fish and Game in their Wildlife Action Plan for the Central Valley and Bay-Delta:

- Growth and development (including urban, residential, and agricultural)
- Water management conflicts and reduced water for wildlife
- Water pollution
- Invasive species
- Climate change

Small isolated populations are often more prone to local extirpations than larger, more widespread populations (e.g., Gitay et al. 2002, Davis et al. 2005, Lovejoy and Hannah 2005). With increased native vegetation along the river, the Service anticipates other native species populations will increase. Although connectivity, genetic diversity, and population size are important current conservation goals, climate change increases their importance.

Rainbow on the San Joaquin River. Photo by Chris Acree

4.2.6 Biological Environment

Plant Communities

The adverse environmental impacts expected from riparian restoration projects under either action alternative would be short-term and construction related impacts. Because the properties have not been acquired, a detailed analysis of impacts from this alternative is difficult, as some land owners may not sell their property or agree to an easement.

The magnitude of environmental impacts would generally be a function of the extent and duration of construction. Adverse impacts may include temporary increases in erosion associated with land disturbance, temporary increases in turbidity, temporary increases in noise from construction activities, and short-term increases in air pollution from construction equipment. Mitigation measures (i.e., use of BMPs) would be included to minimize these short-term impacts and would be considered on a project-by-project basis. The long-term impacts would be beneficial to the area's natural resources by, for example, providing additional fish and wildlife habitat, protecting and improving water quality, increasing recreational opportunities, and providing greater resilience in the face of climate change, greater than Alternative 1.

Native plant communities continue to be impacted through levee maintenance and clearing, and by invasive, non-native species that compete for water and land, such as arundo, tree-of-heaven, and star thistle. These invasive species provide little (if any) habitat for wildlife.

Wildlife

Invertebrates

Alternative 2 will result in increased habitat over Alternative 1 for invertebrates in the form of native vegetation and habitat diversity with a protected transition zone for aquatic insects. Once riparian vegetation is established, minimal human intervention would be the norm. Increased vegetation and cover, along with reduced chemical use, would benefit invertebrates in the long term. Riparian areas provide food resources for animals throughout the food web. Riparian vegetation along streams and lakes is critical as a primary food source to invertebrates from all the guilds (filter feeders, shredders, scrapers, and predators). It also provides a landing substrate for adult insects (such as midges, stoneflies, and mayflies) emerging from a water body (Benke and Wallace 1990). The importance of this flux of insects in riparian areas to migratory and resident birds has received increased attention from ornithologists. The structural diversity of plant species in riparian areas creates a wide variety of feeding niches for herbivores and carnivores alike.

Turtles basking on a log at the San Joaquin River National Wildlife Refuge. Photo by Rick Kimball

Reptiles and Amphibians

Under Alternative 2, reptiles and amphibians would benefit more than Alternative 1 by the addition of increased native terrestrial and wetland habitat and shaded, structurally diverse environments, cover, thermal refugia, and food. Connections to uplands within and beyond the riparian area are important to reptiles and amphibians and need to be managed. Many species of

amphibians rely on aquatic habitat during the breeding season and then spend most of their lives in upland habitat, often at a considerable distance away. The reverse is true for many reptiles as they need dry upland sites for nesting. Fallen trees and snags (remaining dead trees) are used as shelter and a source of food for many species of amphibians and reptiles (NRCS 2007).

Fish

Riparian restoration of the proposed southern expansion area will support the recovery of native fisheries greater than Alternative 1 by creating more potential shaded riverine aquatic habitat in the proposed expansion area, as well as increasing terrestrial inputs such as vegetation, woody debris, and insects to the aquatic environment. These inputs provide increased food, habitat diversity, and cover. Riparian restoration, in combination with the SJRRP efforts, should provide increased habitat and resiliency from stressors in the aquatic environment. Since the San Joaquin River is listed as impaired for temperature, riparian vegetation should help to reduce the temperature during the summer. Temperature changes caused by the presence or absence of riparian vegetation have been shown to account for variability in trout populations (Barton et al. 1985, Wesche et al. 1987).

Floodplain restoration is expected to increase the export of production downstream, providing increased food supplies (phytoplankton, zooplankton, insects, and small fish) for pelagic fish species such as delta smelt and longfin smelt (Kneib et al. 2008). Studies indicate links between carbon produced on floodplains and the downstream food web (Sobczak et al. 2005, Opperman 2010). Ahearn and co-authors (2006) found that floodplains that are wetted and dried in pulses can act as a "productivity pump" for the lower estuary.

Mammals

Riparian habitat protection and restoration under Alternative 2 would benefit several different mammal species greater than under Alternative 1. Mature riparian forests provide important habitat for small to large mammals. Mature trees can contain cavities that bats can use. Mule deer make use of these areas for forage and cover. Land mammals use riparian areas as corridors for movement and routinely hunt along waterways. Many mammals use riparian areas as travel corridors as they disperse from their dens, and the current amount of riparian vegetation is inadequate for mammal dispersal. Mammals commonly associated with riparian areas are beaver, mink, muskrat, and river otter. Other common mammals that benefit from an intact riparian area include raccoon, stripped and spotted skunk, coyote, bobcat, and weasel, among others.

Birds

Under Alternative 2, a variety of bird species would benefit from the protected and restored riparian and wetland habitats. This alternative would have a positive effect on birds compared to Alternative 1. Most bird species respond predictably at the home range or territory scale to variations to habitat and vegetation, but at larger scales, the variables are diverse with conflicting responses at different locales. The restoration component of this proposed expansion will be occurring at various times within a span of at least 45 years, and the various plantings will be at differing seral stages. Due to this, bird use at various sites is likely to be different, depending on the vegetation and habitat features present at the time. Flood events or other disturbances such as fire could also keep the vegetation and habitat features diverse within each patch area also. Any increase of birds is not expected to affect agricultural fields.

Multiple species of neotropical migratory birds will use the structurally diverse vegetation for breeding, migration stopover, and overwintering. Vegetation cover and habitat structure are key elements in restoring riparian vegetation for the benefit of migratory birds. Avian diversity and

density increases as (1) vertical layers of vegetation increase (ground, shrub, canopy); (2) vegetation diversity increases; (3) the width of the riparian zone increases; (4) riparian areas are connected to each other; and, (5) riparian areas are connected to healthy upland habitat (MacArthur and MacArthur 1961, Whitmore 1975, Finch 1989, Croonquist and Brooks 1993). Shorebirds, waterfowl, and wading birds would benefit from increased native habitat restoration also, as restoration will include wetlands and open water.

In estimating bird focal species population objectives for the proposed southern expansion area, the existing riparian habitat and open water acreage was subtracted from the 14,306 acres proposed, for a total of 10,441 acres. Using the birds-per-acre targets found in the CVJV Implementation Plan (2006), the population targets for Alternative 2 are shown in Table 9.

Table 9. Current and Potential Population Densities and Population Targets for Breeding Riparian Songbirds in the San Joaquin Basin. (Central Valley Joint Venture Implementation Plan2006)

Species	Current Birds/Acre (±SE)[1]	Current Population Size (±SE)	Target Birds/Acre[2]	Target Population Size For Alternative 2[4]	Target Population Size for San Joaquin Valley
Song sparrow	1.161(±0.088)	5,757(± 438)	0.68	7,099	128,901
Yellow-breasted chat	0.00	0	0.21	2,192	40,425
Black-headed grosbeak	0.3667 (± 0.0282)	736 (± 140)	0.15	1,566	28,984
Common yellowthroat	0.2247 (±0.021)	451 (±100)	0.20	2,088	38,137
Yellow warbler[3]	0.0538(±0.0163)	108 (± 81)	0.13	1,357	24,491
Spotted towhee	3.302 (± 0.0787)	6,629 (±390)	0.78	8,143	146,444

Table based on 12,249 existing riparian acres, and 188,394 restorable riparian acres in the San Joaquin Valley.

1 Current density estimates are derived from PRBO point count survey, converted to acres.
2 Target densities were based on the 75th percentile value of all point counts in the San Joaquin Valley, adjusted by a detectability coefficient.
3 Target densities for yellow warbler were based on spot-map densities from Clear Creek study plots, which are outside CVJV basins.
4 Target population based on restorable acres under Alternative 2.

Special Status Species

The proposed expansion under Alternative 2 would provide a key element for the recovery of the riparian brush rabbit and riparian woodrat. Parcels acquired in fee would be restored to appropriate riparian habitat, if feasible, to provide a corridor of high-quality habitat. If only an

easement interest is acquired, the easement encumbrance could be crafted to allow the restoration of riparian vegetation if necessary. The size, location, and proximity of these potential restoration sites would dictate their value to listed and sensitive species.

The riparian brush rabbit and riparian woodrat will benefit from the abundance of low, dense shrub cover that will provide nesting habitat for reproduction and predator cover for survival and dispersal. During flood events, constructed high ground refugia and re-vegetated natural topography inside the levee will provide important flood refugia, as well as increased food and cover for the endangered riparian brush rabbit and woodrat and other mammals in the area. This action will allow for the recovery task of establishing another population within the rabbit's former habitat.

The delta smelt, which is listed as threatened under the ESA, is not included in the southern expansion. There is no evidence that delta smelt use the river south (upstream) of Mossdale, though their critical habitat includes the San Joaquin River upstream to the confluence of the Stanislaus River. The Central Valley steelhead would benefit from riparian restoration creating more potential shaded riverine aquatic habitat in the proposed expansion area and increasing terrestrial inputs such as vegetation, woody debris, and insects to the aquatic environment. These inputs provide increased food, habitat diversity, and cover. Water temperatures would be reduced with riparian restoration through increased shade and evapotranspiration.

As stated before, the endangered least Bells' vireo is likely to benefit from increased riparian habitat, as it has nested two years in a row at another riparian restoration site within the Refuge, after a 50-year hiatus. The riparian brush rabbit, riparian woodrat, giant garter snake, Central Valley steelhead, and Valley elderberry longhorn beetle would all benefit from increased habitat protection and restoration, which provides increased food, cover, thermal refugia, and a migratory corridor for dispersal.

4.2.7 Social and Economic Effects

Cultural Resources

Construction and restoration activities do have the potential to locate undiscovered cultural resources. If any previously unrecorded cultural resources were discovered during this action, all project-related activities would cease immediately, and the consultation process outlined in Section 800.13 of the Advisory Council on Historic Preservation's regulations (36 CFR 800) would be initiated. Under Federal ownership, archaeological and historical resources within the Refuge receive protection under Federal laws mandating the management of cultural resources, including but not limited to the Archaeological Resources Protection Act, the Archaeological and Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and the NHPA. Should any additional cultural resources be discovered at the Refuge, the Service would take all necessary steps to comply with section 106 of the NHPA of 1966, as amended, for all the action alternatives.

Agriculture

The majority of the land acquired under Alternative 2 will be agricultural lands. Removing land from agricultural use could result in direct losses in agricultural production and employment, which could in turn result in secondary losses to agricultural support sectors due to a reduction in purchases of farming related inputs. Croplands within the proposed expansion area for Alternative 2 (the southern expansion area) include approximately 10.1 thousand acres (12.6 thousand acres of production) and produce an estimated $15.2 million in direct output. These croplands account for 0.7% of total cropland acres, 0.8% of the total acres of production, and 0.5% of total output in the three-county area.

Possible economic effects of the proposed future land acquisitions are discussed in the Economic Impact Analysis (Appendix C), but the total economic impacts are not estimated because the needed assumptions are speculative due to being forecast by greater than 45 years. The degree of economic impacts associated with the conversion of croplands to Refuge lands will be a function of the specific lands that are acquired, the time at which they are acquired, farming technology, commodity markets, and the evolution of the regional economy. Additionally, landowners are financially compensated when they enter into a purchase or easement agreement with the Service. Though it is unknown how those dollars would be spent, it is common for landowners to use their allotment to purchase additional lands for agricultural production. This can include lands that are currently in production as well as lands that are idle. Tax Revenue

Under Alternative 2, lands acquired through fee title purchases would be managed by the Service and would be removed from county tax rolls. Reductions in county taxes would be partially replaced by RRS payments; however, given the declining trend in RRS appropriations, RRS payments are expected to make up only a small portion of the reduction in property taxes collected. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion.*

Refuge Operations

The San Joaquin River National Wildlife Refuge purchases a wide variety of supplies and services for Refuge operations and maintenance activities, and many of these supplies and services are purchased within the local three-county area. Refuge purchases made in the three-county area contribute to the local economic impacts associated with the Refuge.

The Refuge currently spends an average of $400,000 annually on non-salary expenditures. Major local expenditures include services and supplies related to habitat and grounds improvements and treatments, equipment and structure maintenance and repair, office supplies, equipment purchases, and environmental and other technical consulting services.

Refuge personnel estimate that non-salary costs associated with Refuge operations and maintenance will increase by approximately 10 percent under both Alternatives 2 and 3. In the long run, economic impacts associated with additional non-salary expenditures are expected to add less than one new job, approximately $28,000 in additional labor income, and $36,000 in additional value added to the local economy. Restoration activities with this alternative on Service lands will support jobs and generate income and value added in the local economy through the purchase of materials and services from local businesses. Many of the same businesses and employees that could be adversely impacted by reduced agricultural activity will be positively impacted by restoration activities, thus limiting the overall impact on the agricultural sector. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion.*

Relationship with County Plans

While the proposed expansion of the Refuge area will result in a net decrease in agricultural lands, this land will not be lost to the development of antiquated subdivisions. Instead, the Refuge expansion will preserve these lands from any type of development in the future. This meets with the goal of the General Plans to accommodate minimal growth and preserve open space. Additionally, the expansion of the Refuge will meet many other aims of the General Use Plans, including increased water supply, improvement in water quality, and the preservation of wildlife habitat. The expansion and subsequent riparian restoration will provide the area with several ecosystem services, including enhanced water quality, through natural filtration and erosion

control, as well as improved wildlife habitat and native vegetation. The expansion will also increase the natural habitat for the protected species found in the area, and this in turn will allow for increased movement and adaption of wildlife.

Recreation

The goals and objectives for increasing visitor services are found in the Refuge CCP (2006). Beyond the CCP goals, under this alternative, it is expected that newly acquired and restored Refuge lands would provide additional water access points, trails, and wildlife viewing opportunities that will benefit local residents. These new and/or enhanced recreational opportunities are also anticipated to draw additional non-local visitors to the Refuge, thus increasing economic activity associated with visitor spending in the local economy.

The Blueway Vision document shows four potential future river access sites within the proposed expansion area: two within the proposed northern expansion area and two within the proposed southern expansion. With the Blueway Vision proposal and upstream restoration progressing, there is likely to be increased recreational uses of the San Joaquin and the Stanislaus Rivers. This may create the need for increased public education, trails and signage, and law enforcement, all of which will help to alleviate the amount of disturbance on the expanded Refuge.

With increased visitation comes increased spending by visitors. Currently, non-local Refuge visitors spend approximately $186,000 in the local economy annually. This spending directly accounts for an estimated one job, $49,900 in labor income, and $82,200 in value added. Secondary or multiplier effects generate one additional job, $30,300 in labor income, and $52,300 in value added. Accounting for both the direct and secondary effects, spending by non-local visitors currently generates total economic impacts of two jobs, $80,200 in labor income, and $134,500 in value added to the local three-county economy. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

The implementation of Alternative 2 is expected to double Refuge visitation, which may create some disturbance to special status species due to increased public use. To alleviate any negative effects, areas that are known to have sensitive species will have restricted public access and may have temporary closures instituted for protection during critical lifecycle periods.

4.3 Alternative 3: Northern and Southern Expansion

Alternative 3 would expand the Refuge boundary to the south and gain all the benefits of Alternative 2; it includes approximately 4.6 miles of San Joaquin River corridor to the north, as the crow flies, or 19 river miles. This northern reach is considered part of the Sacramento/San Joaquin Delta. Combined with the southern reach, this alternative consists of approximately 22,156 acres of potential habitat for protection and future restoration. Because Alternative 3 is larger than Alternative 2, the impacts and benefits of Alternative 3 are greater than for Alternative 2.

4.3.1 Soils and Geology

Alternative 3 would result in the restoration of up to 16,561 acres of farmland to natural habitats, such as wetlands, grasslands, oak savannah, and riparian forests. Conversion of cultivated farmland to natural vegetated habitats would result in increased long-term reductions in soil erosion, decreased sedimentation of watercourses, increased organic input, and an expected decrease in agricultural chemical runoff once restoration is complete on those lands. The impacts and benefits to soils are greater under Alternative 3 than Alternatives 1 or 2.

4.3.2 Surface Water Quality

Impacts are likely to be negligible until restoration is initiated. Adverse impacts associated with restoration may include temporary increases in erosion associated with land disturbance, temporary increases in turbidity. Beneficial impacts include nutrient retention, stream bank stabilization, reduced soil erosion, reduce farm chemical runoff, and reduced stream temperatures during summer. The impacts and benefits are greater under Alternative 3 than Alternatives 2 or 1.

4.3.3 Flood Management

Under this alternative, the Service may propose additional nonstructural flood control projects, depending on the feasibility. Any such proposals for nonstructural flood control or setback levees on the Refuge would be subject to NEPA review and permitting from the U.S. Army Corps of Engineers.

4.3.4 Groundwater

Under Alternative 3, if lands are allowed to flood, either through levee setbacks or nonstructural flood control, groundwater could be allowed to recharge to a greater extent than Alternatives 1 or 2. In addition, the greater amount of restoration under this alternative is expected to result in greater benefits to groundwater quality due to the reduction in sources of contaminants such as agricultural pesticides.

4.3.5 Climate Change

Alternative 3 provides the greatest protection of the San Joaquin River corridor to the effects of climate change. These benefits are similar but of greater magnitude than those explained in Alternative 2.

4.3.6 Biological Environment

Plant Communities

Implementation of Alternative 3 would result in the restoration of several hundred to several thousand acres of farmland to natural habitats, such as wetlands, oak savannahs, and riparian forests. Conversion of cultivated farmland to natural vegetated habitats would result in short- and long-term reductions in soil erosion, less sedimentation of watercourses, and less agricultural chemical use greater than the other alternatives. Reduced erosion, less agricultural chemical use, and lower pollutant levels of suspended sediment are considered beneficial impacts.

Wildlife

Invertebrates

This alternative will result in increased, structurally diverse habitat for aquatic and terrestrial invertebrates in the form of native vegetation and a protected transition zone for aquatic insects. Once riparian vegetation is established, minimal human intervention would be the norm. Reduced pesticide use will result in long-term benefits for invertebrates. Riparian areas provide food resources for animals throughout the food web. Riparian vegetation along streams and lakes is critical as a primary food source to invertebrates from all the guilds (filter feeders, shredders, scrapers, and predators). It also provides a landing substrate for adult insects (such as midges, stoneflies, and mayflies) emerging from a water body (Benke and Wallace 1990). The importance of this flux of insects in riparian areas to migratory and resident birds has received increased attention from ornithologists. The structural diversity of plant species in riparian areas creates a wide variety of feeding niches for herbivores and carnivores alike.

Reptiles and Amphibians

Under this alternative, reptiles and amphibians would likely benefit the greatest by the addition of increased native terrestrial and wetland habitat and shaded, structurally diverse environments, cover, thermal refugia, and food. Connections to uplands within and beyond the riparian area are important to reptiles and amphibians and need to be managed. Many species of amphibians rely on aquatic habitat during the breeding season and then spend most of their lives in upland habitat, often at a considerable distance away. The reverse is true for many reptiles, as they need dry upland sites for nesting. Fallen trees and snags (remaining dead trees) are used as shelter and a source of food for many species of amphibians and reptiles (NRCS 2007).

Fish

Under Alternative 3, riparian restoration of the proposed Refuge expansion area will support the recovery of native fisheries by creating more potential shaded riverine aquatic habitat in the proposed expansion area, as well as increasing terrestrial inputs such as vegetation, woody debris, and insects to the aquatic environment, greater than the other alternatives. These inputs provide increased food, habitat diversity, and cover. Riparian restoration, in combination with the SJRRP efforts, should provide increased habitat and resiliency from stressors in the aquatic environment. Since the San Joaquin River is listed as impaired for temperature, riparian vegetation should help reduce the temperature during the summer through increased shade and evapotranspiration. Temperature changes caused by the presence or absence of riparian vegetation have been shown to account for variability in trout populations (Barton et al. 1985; Wesche et al. 1987).

Floodplain restoration is expected to increase the export of production downstream, providing increased food supplies (phytoplankton, zooplankton, insects, and small fish) for pelagic fish species such as delta smelt and longfin smelt (Kneib et al. 2008). Studies indicate links between carbon produced on floodplains and the downstream food web (Sobczak et al. 2005, Opperman 2010). Ahearn and coauthors (2006) found that floodplains that are wetted and dried in pulses can act as a "productivity pump" for the lower estuary.

Mammals

Alternative 3 provides the most riparian habitat for small to large mammals, which provides food, cover, water, and a dispersal corridor. Riparian areas often have mature trees with cavities that some species of bats can use, such as the western red bat, hoary bat, and Yuma myotis, while others use structures such as barns, houses, and bridges for roost sites. Mule deer make use of these areas for forage and cover. Land mammals use riparian areas as corridors for movement and routinely hunt along waterways. Many mammals use riparian areas as travel corridors as they disperse from their dens. Mammals commonly associated with riparian areas are beaver, mink, muskrat, and river otter. Other common mammals that benefit from an intact riparian area include raccoon, stripped and spotted skunk, coyote, bobcat, and weasel, among others.

Birds

Under Alternative 3, a variety of bird species would benefit from the protected and restored riparian and wetland habitats. These beneficial effects are described under Alternative 2. However, this alternative would haves a greater positive effect on birds compared to Alternative 1 or 2 due to the larger area that would be protected and restored.

In estimating bird focal species population objectives for the proposed southern expansion area, the existing riparian habitat and open water acreage was subtracted from the 22,156 acres

proposed, for a total of 16,561 acres. Using the birds-per-acre targets found in the CVJV Implementation Plan (2006), the population targets for Alternative 3 are shown in Table 10.

Table 10. Current and Potential Population Densities and Population Targets for Breeding Riparian Songbirds in the San Joaquin Basin. (2006 Central Valley Joint Venture Implementation Plan)

Species	Current Birds/Acre (±SE)[1]	Current Population Size (±SE)	Target Birds/Acre[2]	Target Population Size For Alternative 3[4]	Target Population Size for San Joaquin Valley
Song sparrow	1.161(±0.088)	5,757(± 438)	0.68	11,261	128,901
Yellow-breasted chat	0.00	0	0.21	3,477	40,425
Black-headed grosbeak	0.3667 (± 0.0282)	736 (± 140)	0.15	2,484	28,984
Common yellowthroat	0.2247 (±0.021)	451 (±100)	0.20	3,312	38,137
Yellow warbler[3]	0.0538(±0.0163)	108 (± 81)	0.13	2,152	24,491
Spotted towhee	3.302 (± 0.0787)	6,629 (±390)	0.78	12,917	146,444

Table based on 12,249 existing riparian acres, and 188,394 restorable riparian acres in the San Joaquin Valley.

1 Current density estimates are derived from PRBO point count survey, converted to acres.
2 Target densities were based on the 75th percentile value of all point counts in the San Joaquin Valley, adjusted by a detectability coefficient.
3 Target densities for yellow warbler were based on spot-map densities from Clear Creek study plots, which are outside CVJV basins.
4 Target population based on restorable acres under Alternative 3.

Sensitive Species

Alternative 3 provides the greatest benefits (of the alternatives considered) to sensitive species such as the riparian brush rabbit and riparian woodrat. Sensitive species will benefit from the abundance of low, dense shrub cover in this planting design, which will provide nesting habitat for reproduction and predator cover for survival and dispersal. During flood events, constructed high ground refugia and re-vegetated natural topography inside the levee will provide important flood refugia, as well as food and cover for the endangered riparian brush rabbit and other mammalian species. This action will allow for the recovery task of establishing another population within the rabbit's former range.

One species listed as threatened under the ESA is only included in the northern expansion: the delta smelt. There is evidence that delta smelt use the river north of Mossdale, though critical

habitat is designated upstream to the confluence of the Stanislaus River on the San Joaquin River. The Central Valley steelhead uses the river, and the proposed expansion area is included in the critical habitat designation for this fish. Providing native habitat restoration and protection for these species should benefit them through the thermal effects of riparian vegetation, as well as the habitat diversity anticipated via a robust riparian corridor.

The riparian brush rabbit, riparian woodrat, giant garter snake, and Central Valley steelhead would all benefit from the increased habitat protection and restoration, which provides increased food, cover, thermal refugia, and a migratory corridor for dispersal.

Heron rookery on the San Joaquin River NWR. Photo by Chris Acree

4.3.7 Social and Economic Effects

Cultural Resources

Construction and restoration activities have the potential to locate undiscovered cultural resources. If any previously unrecorded cultural resources were discovered during this action, all project-related activities would cease immediately and the consultation process as outlined in Section 800.13 of the Advisory Council on Historic Preservation's regulations (36 CFR 800) would be initiated. Under Federal ownership, archaeological and historical resources within the Refuge receive protection under Federal laws mandating the management of cultural resources, including but not limited to the Archaeological Resources Protection Act, the Archaeological and Historic Preservation Act, the Native American Graves Protection and Repatriation Act, and the NHPA. Should any additional cultural resources be discovered at the Refuge, the Service would take all necessary steps to comply with section 106 of the NHPA of 1966, as amended, for all the action alternatives.

Agriculture

It is expected that some farms will be sold, some parcels split, conservation easements will be established, and conservation agreements will be signed. This proposed alternative is likely to take more than 45 years to acquire 50 per cent of the proposed expansion area. The Refuge was established in 1987, and there still is privately-owned farm land within the Refuge boundary.

The majority of the land acquired under Alternative 3 will be agricultural lands. Removing land from agricultural use could result in direct losses in agricultural production and employment, which could in turn result in secondary losses to agricultural support sectors due to a reduction in purchases of farming related inputs. Possible economic effects of the proposed future land acquisitions are discussed in the Economic Impact Analysis (Appendix C), but the economic impacts are not estimated because the needed assumptions are speculative, due to the time frames involved. Croplands within the proposed expansion area for Alternative 2 (the southern expansion area) include approximately 10.1 thousand acres (12.6 thousand acres of production) and produce an estimated $15.2 million in direct output. These croplands account for 0.7% of total cropland acres, 0.8% of the total acres of production, and 0.5% of total output in the three-county area. The addition of the proposed northern expansion area adds 4.9 thousand acres (4.7 thousand acres of production) and an estimated $9.3 million in direct output. Including the southern and northern expansion areas, croplands within the proposed expansion area for Alternative 3 account for 1.1% of total cropland acres, 1.1% of the total acres of production, and 0.8% of total output in the three-county area.

The degree of economic impacts associated with the conversion of croplands to Refuge lands will be a function of the specific lands that are acquired, the time at which they are acquired, farming technology, commodity markets, and the evolution of the regional economy. Additionally, landowners are financially compensated when they enter into a purchase or easement agreement with the Service. Though it is unknown how those dollars would be spent, it is common for landowners to use their allotment to purchase additional lands for agricultural production. This can include lands that are currently in production as well as lands that are idle.

Tax Revenue

Under this alternative, lands acquired through fee title purchases would be managed by the Service and would be removed from county tax rolls. Reductions in county taxes would be partially replaced by Refuge Revenue Sharing (RRS) payments; however, given the declining trend in RRS appropriations, RRS payments are expected to make up only a small portion of the reduction in property taxes collected.

Refuge Operations

The San Joaquin River National Wildlife Refuge purchases a wide variety of supplies and services for Refuge operations and maintenance activities, and many of these supplies and services are purchased within the local three-county area. Refuge purchases made in the three-county area contribute to the local economic impacts associated with the Refuge.

The Refuge currently spends an average of $400,000 annually on non-salary expenditures. Major local expenditures include services and supplies related to habitat and grounds improvements and treatments, equipment and structure maintenance and repair, office supplies, equipment purchases, and environmental and other technical consulting services.

Refuge personnel estimate that non-salary costs associated with Refuge operations and maintenance will increase by approximately 10 percent under both Alternatives 2 and 3. In the

long run, economic impacts associated with additional non-salary expenditures are expected to add less than one new job, approximately $28,000 thousand in additional labor income, and $36,000 in additional value added to the local economy. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

Relationship with County Plans

The impacts associated with implementing the Preferred Alternative would be similar to the impacts described under Alternative 2, with a greater amount of land taken out of agricultural production.

Recreation

The goals and objectives for increasing visitor services are found in the Refuge CCP. Newly acquired and restored riparian Refuge lands would provide additional water access points, trails, and wildlife viewing opportunities which will benefit local residents. These new and/or enhanced recreational opportunities are also anticipated to draw additional non-local visitors to the Refuge, thus increasing economic activity associated with visitor spending in the local economy. The Blueway Vision document shows four potential future River access sites within the proposed expansion area, two are within the proposed northern expansion area, and two are found within the proposed southern expansion. With the Blueway Vision proposal and upstream restoration progressing, there is likely to be increased recreational uses of the river. This may create the need for increased public education, trails and signage, and law enforcement, all of which will help to alleviate the degree of disturbance on the expanded Refuge.

With increased visitation comes increased spending by visitors. Currently, non-local Refuge visitors spend approximately $186,000 in the local economy annually. This spending directly accounts for an estimated 1 job, $49,900 in labor income, and $82,200 in value added. Secondary or multiplier effects generate an additional one job, $30,300 in labor income, and $52,300 in value added. Accounting for both the direct and secondary effects, spending by non-local visitors currently generates total economic impacts of two jobs, $80,200 in labor income, and $134,500 in value added to the local three-county economy. For further details, see Appendix C, *Economic Impacts of the Proposed San Joaquin River National Wildlife Refuge Expansion*.

The implementation of Alternative 3 is expected to triple Refuge visitation, which could create some disturbance to special status species due to increased public use. To alleviate any negative effects, areas known to have sensitive species will have restricted public access and may have temporary closures instituted for protection during critical lifecycle periods.

Table 11. Environmental Consequences of Alternatives for the Proposed Expansion of the San Joaquin River National Wildlife Refuge

Affected Environment	Alternative 1 *Current Management* (No Action)	Alternative 2 *Southern Expansion*	Alternative 3 *Northern and Southern Expansion*
Physical Environment ***Soils and Geology***	No Change	Temporary increases in erosion likely. Erosion would decrease once vegetation is established. Soil is remediated through chemical and biological processes.	Temporary increases in erosion likely (greater than in Alternative 2). Erosion would decrease once vegetation is established. Soil is remediated to a greater degree than Alternative 2, through chemical and biological processes.
Surface Water Quality	Clean Water Act Section 303(d) List for aquatic toxicity.	Temporary increases in turbidity likely. Long term increases in water quality.	Temporary increases in turbidity likely (greater that in Alternative 2). Long term increases in water quality.
Groundwater	Areas of poor quality water.	Riparian restoration could lead to increased recharging of the groundwater, nutrient retention, and reduced farm chemical inputs.	Same as Alternative 2, with greater land area.
Climate Change	Increasing temperatures will lead to vegetation changes.	By restoring riparian vegetation, carbon sequestration is occurring, cooler summer riparian area and river water due to increased shading and evapotranspiration, and resiliency to the riparian system is being developed.	Greater resiliency and increased carbon sequestration than Alternative 2. Cooler summer riparian area and water due to increased shading and evapotranspiration than Alternative 2.
Flood Management	No Change.	Nonstructural flood control projects may be proposed, if feasible. Such proposals are subject to NEPA and Corps of Engineers permitting.	Nonstructural flood control projects may be proposed, if feasible. Such proposals are subject to NEPA and Corps of Engineers permitting.
Biological Environment ***Vegetation***	Primarily agricultural use and the associated chemicals used to maintain that use.	Reduced agriculture along river corridor. Lands that the Service purchases an interest in will be restored to native vegetation when feasible.	Reduced agricultural vegetation along river corridor. Lands in which the Service purchases an interest will be restored to native vegetation when feasible.

Affected Environment	Alternative 1 *Current Management* (No Action)	Alternative 2 *Southern Expansion*	Alternative 3 *Northern and Southern Expansion*
Wildlife	Habitat limited.	Restored lands will provide increased habitat, cover, and food.	Restored lands will provide maximum habitat, cover, and food.
Fish	Impaired habitat.	Restored lands will benefit fisheries due to reduction in farm chemical use, increased habitat diversity, food, cover, and reduced stream temperatures in summer.	Restored lands will benefit fisheries greater than Alternative 2.
Endangered Species	Habitat limited/impaired habitat.	Restored lands would benefit most endangered species by providing increased food, cover, habitat diversity, and thermal refugia.	Restored lands should benefit endangered species by providing increased habitat diversity, increased food, cover, and thermal refugia.
Cultural Resources	No Change.	Any cultural resources would be placed under Federal protection.	Any cultural resources would be placed under Federal protection
Agricultural Lands	No Change.	Lands purchased in fee-title would be restored to riparian habitat. Approximately 4,000 acres of agricultural lands would be restored to riparian habitat within 45 years.	Increased lands purchased in fee-title would be restored to riparian habitat. Approximately 11,000 acres of agricultural lands would be restored to riparian habitat within 45 years.
Recreation	Moderate use increase w/time.	Greater use increase than Alternative 1.	Greater use increase than Alternative 2.
Economic	No Change	Reduced tax revenue to counties, reduced agricultural production, increased ecosystem services, increased Refuge visitation, restoration and economic inputs.	Same as Alternative 2, but with increased land area.

5. Coordination, Consultation, and Compliance

5.1 Agency Coordination and Public Involvement

The proposed expansion of the San Joaquin River National Wildlife Refuge has been discussed with landowners; conservation organizations; Federal, State, county, and city governments; and other local agencies, interested groups, and individuals.

The Service has invited and continues to encourage public participation through public notices and planning updates, public meetings, and meeting with government agencies and private organizations.

This EA will be available for a 45-day public review and comment period from the date of release. A public meeting will be scheduled during that 45-day comment period. Notice of this meeting will be mailed out under a separate cover.

5.2 Environmental Review and Consultation

5.2.1 National Environmental Policy Act (NEPA)

As a Federal agency, the Service must comply with provisions of NEPA. An environmental analysis is required under NEPA to evaluate reasonable alternatives that will meet the stated objectives and to assess the significance of possible environmental, social, and economic impacts to the human environment. The EA serves as the basis for determining whether implementation of the proposal would constitute a major Federal action significantly affecting the quality of the human environment. The EA facilitates involvement of government agencies and the public in the decision making process.

5.2.2 National Historic Preservation Act (NHPA)

The Service has considered the potential effects of establishing the acquisition boundary for the San Joaquin River National Wildlife Refuge on cultural resources of the area. Effects on archeological and historic resources from implementing the action alternative would not be expected to differ significantly from the No Action alternative. A copy of the EA has been provided to the California State Historic Preservation Officer for review and comment. The Service will be required to complete additional compliance under the NHPA and other cultural resource preservation laws for any future restoration and management actions if the proposed expansion is approved.

5.2.3 Endangered Species Act

The Service's office of refuge planning will initiate an informal Intra-Service Section 7 consultation under the requirements of the ESA for the proposed expansion of the San Joaquin River National Wildlife Refuge. The Service's Endangered Species Division will provide a determination. The Service will be required to complete additional consultations under Section 7 of the ESA with both the Service and the National Marine Fisheries Service for any restoration or management program that would be developed subsequent to expansion of the Refuge.

5.2.4 Other Federal Laws, Regulations, and Executive Orders

In one of its last actions of the session, the 102nd Congress passed multipurpose water legislation that was signed into law October 30, 1992. Previously referred to as H.R. 429, Public Law 102-575 contains 40 separate titles providing for water resource project throughout the West. Title 34, the

Central Valley Project Improvement Act, mandates changes in management of the Central Valley Project, particularly for the protection, restoration, and enhancement of fish and wildlife.

In undertaking the proposal, the Service would comply with the following Federal laws, Executive orders, and legislative acts: Responsibilities of Federal Agencies to Protect Migratory Birds (Executive Order 13186); Floodplain Management (Executive Order 11988); Intergovernmental Review of Federal Programs (Executive Order 12372); Protection of Historical, Archaeological, and Scientific Properties (Executive Order 11593); Protection of Wetlands (Executive Order 11990); Management and General Public Use of the National Wildlife Refuge System (Executive Order 12996); Departmental Policy on Environmental Justice (Executive Order 12898); Hazardous Substances Determinations (Secretarial Order 3127); Uniform Relocation Assistance and Real Property Acquisition Policy Act of 1970, as amended; Refuge Recreation Act, as amended; Refuge System Administration Act, as amended; and the National Wildlife Refuge Improvement Act.

5.3 Partner Organizations

Partnerships are important to the management of national wildlife refuges. These partnerships can be with other agencies, private groups, and/or individuals and have a focus on accomplishing some aspect of the refuge's mission. The San Joaquin River National Wildlife Refuge has formed significant partnerships for a variety of natural resource management issues and activities. Partnerships are beneficial to the Service, not only in accomplishing projects that would not have been possible with limited Refuge staff and funds, but also by expanding public outreach for the Refuge, bringing community input and support into the management process and providing for natural resource management on a landscape scale.

Refuge partnerships have resulted in land acquisition, enhanced programs for endangered and threatened species, natural resource monitoring, and habitat restoration activities, among other projects. The following list shows partners with which the Refuge has worked and will likely continue to work.

Audubon California - Audubon's mission is to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity.

California Department of Water Resources - Manages the water resources of California in cooperation with other agencies, to benefit the State's people, and to protect, restore, and enhance the natural and human environments.

California Department of Fish and Game - The Mission of the Department of Fish and Game is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.

California State University, Stanislaus, Endangered Species Recovery Program - The Endangered Species Recovery Program was formed to assist the Service and the Bureau of Reclamation in carrying out certain tasks specified in a Biological Opinion regarding water contracts in the Central Valley Project's Friant Division. Those tasks include conducting surveys to determine the status of listed and candidate species on natural lands in the Valley, conducting population studies necessary for developing recovery plans for those species, and developing recovery plans.

Central Valley Joint Venture - Conserving migratory birds and their habitats for the benefit for wildlife and the public. The CVJV is a partnership of the California Waterfowl Association, California Association of resource Conservation Districts, Defenders of Wildlife, Ducks Unlimited,

Inc., National Audubon Society, PRBO Conservation Science, River Partners, The Nature Conservancy, and the Trust for Public land.

Ducks Unlimited - Conserves, restores, and manages wetlands and associated habitats for North America's waterfowl—habitats that also benefit other wildlife and people. They are a participant in the San Joaquin River Partnership.

Migratory Bird Conservation Partnership - Collaboration among Audubon California, The Nature Conservancy, and PRBO Conservation Science. Their goal is to protect the wetlands and agricultural lands that support migratory bird populations in California.

National Oceanic and Atmospheric Administration (NOAA) Fisheries Service - Stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems.

Natural Resources Defense Council (**NRDC**) **-** is a New York City-based, non-profit, non-partisan international environmental advocacy group, with offices in Washington, D.C., San Francisco, Los Angeles, Chicago, and Beijing. Founded in 1970, NRDC initially filed the lawsuit against the Federal government for blocking flows for salmon in the San Joaquin River.

PRBO Conservation Science is dedicated to conserving birds, other wildlife, and ecosystems through innovative scientific research and outreach**.**

Revive the San Joaquin - Revive the San Joaquin is a grassroots non-profit organization committed to the successful restoration of the San Joaquin River and the conservation of its natural resources.

River Partners - The mission of River Partners is to create wildlife habitat for the benefit of people and the environment. River Partners protects the environment by implementing large-scale restoration along streams and rivers—specifically on the major river systems of the western United States.

San Joaquin River Conservancy - The mission of the San Joaquin River Conservancy is to provide leadership and acquire, preserve, manage, and promote access to lands within the floodplain on both sides of the San Joaquin River from Friant Dam to Highway 99.

San Joaquin River Partnership - The San Joaquin River Partnership includes an array of scientists, volunteers, and conservationists with decades of experience eager to participate in bringing the river back to life. Their member organizations have implemented projects to improve water quality and supplies, provide flood protection, remove invasive species, and provide educational and recreational opportunities to their communities. Collectively, they have extensive experience acquiring and managing land, and engaging in policy discussions at all levels of government.

Trust for Public Land - The Trust for Public Land is a national non-profit that conserves land for people to enjoy as parks, gardens, historic sites, rural lands, and other natural places. They work from the inner city to the wilderness, ensuring livable communities for generations to come.

Tuolumne River Trust - The Tuolumne River Trust is the voice for the river. They promote stewardship of the Tuolumne through education, community outreach and adventures, collaboration with a diverse array of stakeholders, on-the-ground restoration projects, advocacy, and grassroots organizing to demonstrate public support for their work

U.S. Army Corps of Engineers - The Corp provides vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risks from disasters.

U.S. Bureau of Reclamation – This agency's mission is to assist in meeting the increasing water demands of the West while protecting the environment and the public's investment in these structures.

5.4 Distribution and Availability

Copies of the EA, Land Protection Plan, and Conceptual Management Plan were sent to Federal and State legislative delegations, tribes, agencies, landowners, private groups, and other interested individuals.

Additional copies of the document are available from the following offices and websites.

U.S. Fish and Wildlife Service
Region 8, Refuge Planning
2800 Cottage Way, W-1916
Sacramento, CA 95825
http://www.fws.gov/cno/refuges/sanjoaquin/SJRNWR-expansion.cfm

U.S. Fish and Wildlife Service
San Luis National Wildlife Refuge Complex
P.O. Box 2176
Los Banos, CA 93635

Habitat connectivity is a characteristic feature of natural environments. Protection and restoration of connectivity is not an artificial change to the landscape: rather, it is the loss of connectivity and the isolation of natural environments that is an artificial change (Noss 1991).

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