United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-01-I-3305

September 27, 2001

Memorandum

To: Regional Director, Mid-Pacific Region, Bureau of Reclamation, Sacramento, California

From: for Acting Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Transmittal of Final Biological Opinion for the Grasslands Bypass Project, October 1, 2001 - December 31, 2009

This memorandum transmits the Fish and Wildlife Service (Service) final biological opinion for the Grasslands Bypass Project. This opinion is provided in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 et seq.).

If you have questions regarding this opinion, please contact Joy Winckel or David Wright of our Endangered Species Division at (916) 414-6650, or Dr. Steven Schwarzbach of our Environmental Contamiants Division at (916) 414- 6590.

Attachment

cc: San Luis & Delta Mendota Water Authority
USFWS, San Luis National Wildlife Refuge Complex, Los Banos
USFWS, Regional Office, Endangered Species Division, Portland
CDFG, Manager, Los Banos Wildlife Area
NMFS, Protected Resources Division, Sacramento
California Regional Water Quality Control Board, Central Valley Region
Grassland Water District
ARD (ES) Portland, Oregon

Final Biological Opinion, Grassland Bypass Project Operation, Merced and Fresno Counties, California,

September 27, 2001
File Number 1-1-01-F-0153

U. S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Endangered Species Division
2800 Cottage Way, W-2605
Sacramento, California 95825-1846

Introduction

Species Included in this Consultation

This is in response to the request from the U.S. Bureau of Reclamation (Reclamation) and the San Luis & Delta Mendota Water Authority (Water Authority; the applicant) for formal consultation with the U.S. Fish and Wildlife Service (Service), dated February 15, 2001, on the Grassland Bypass Project in Merced and Fresno Counties, California. Your request was received in our office on February 16, 2001. This document represents the Service's biological opinion on the effects of the action on the following species and critical habitat:

San Joaquin kit fox (*Vulpes macrotis mutica*) (E)
mountain plover (*Charadrius montanus*) (PT)
giant garter snake (*Thamnophis gigas*) (T)
delta smelt (*Hypomesus transpacificus*) (T)
delta smelt critical habitat
Sacramento splittail (*Pogonichthys macrolepidotus*) (T)
Conservancy fairy shrimp (*Brachinecta conservatio*) (E)
longhorn fairy shrimp (*Branchinecta longiantenna*) (E)
vernal pool fairy shrimp (*Branchinecta lynchi*) (T)
vernal pool tadpole shrimp (*Lepidurus packardi*) (E)

in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act).

The Service concurs with Reclamation's assessment that following species would not likely be adversely affected by this project: giant kangaroo rat (*Dipodomys ingens*) (E), Fresno kangaroo rat (*Dipodomys nitratoides exilis*) (E), riparian woodrat (*Neotoma fuscipes riparia*) (E), riparian brush rabbit (*Sylvilagus bachmani riparius*) (E), California red-legged frog (*Rana aurora draytonii*) (T), Hoover's eriastrum (=woolly-star)(*Eriastrum hooveri*) (T), Hoover's spurge (*Chamaesyce hooveri*) (T), and palmate-bracted bird's-beak (*Cordylanthus palmatus*) (E). This determination is based on Reclamation's finding that either these species are 1) located outside of the project area, or 2) no suitable habitat exists for the species in the project area. Because of this determination, these species are not considered further in this biological opinion. We have also concluded that the proposed action described in this opinion, including implementation of all relevant conservation measures, is not likely to adversely affect the following listed species: bald eagle (*Haliaeetus leucocephalus*) (T), blunt-nosed leopard lizard (*Gambelia (=Crotaphytus) sila*) (E), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (T), and Colusa grass (*Neostapfia colusana*) (T). Because these species are considered not likely to be adversely affected by the proposed action, they are not considered further in this biological opinion. The Aleutian Canada goose (*Branta canadensis leucoparia*) was delisted on March 20, 2001 (66 FR 15643), and we do not anticipate serious impacts to this subspecies. Unless new information reveals that the proposed action may affect listed species in a manner or to an extent not considered, or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the Act is necessary for the species listed in this paragraph.

Conclusion

We conclude in this biological opinion that the continuation of the Grassland Bypass Project will likely adversely affect but is not likely to jeopardize the continued existence of, or adversely modify critical habitats for, the following listed species: San Joaquin kit fox , mountain plover, giant garter snake, delta smelt, Sacramento splittail, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Reasonable and prudent measures, with terms and conditions, and conservation recommendations are provided to minimize the effects on the species.

This biological opinion is based on information provided in the February 2001 biological assessment (USDI-BOR 2001a); the Final Environmental Impact Statement and Environmental Impact Report (EIS/EIR) dated May 25, 2001 (USDI-BOR 2001b); the Final Draft Agreement for the Use of the San Luis Drain dated April 30, 2001; a telephone conversation with Chris Eacock on May 22, 2001 and a followup e-mail with a map of the Grassland Bypass Project area on May 23, 2001; telephone conversations with Chris Eacock and Mike Delamore on June 7, 2001 of Reclamation's South Central California Area Office; a field tour of the Grasslands Bypass Project Area on April 6, 2000; a site visit by Dr. Joseph Skorupa of the Service's SFWO to the In-Valley-Treatment site of the Grasslands Bypass Project on May 22, 2001; avian tissue analyses collected from the In-Valley Treatment site of the Grasslands Bypass Project on May 22, 2001; Amendments to the 1996 Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Agricultural Subsurface Drainage Discharges (Grassland Amendments); the Staff Report of the California Regional Water Quality Control Board, Central Valley Region on the Review of Selenium Concentrations in Wetland Water Supply Channels in the Grassland Watershed, dated May 2000; data from Reclamation collected as part of its Delta-Mendota Canal water quality monitoring program including data from the sumps in the Firebaugh Canal Water District which pumped into the Delta Mendota Canal (Firebaugh sumps); the Environmental Assessment and supporting documentation related to the Mendota Pool Exchange Agreement; monthly data reports of the Grassland Bypass Project, especially March and April 2001; tentative Waste Discharge Requirements and Revisions to Tentative Waste Discharge Requirements for San Luis & Delta Mendota Water Authority and Reclamation for the Grassland Bypass Project (Phase II) from the California Central Valley Regional Water Quality Control Board (Regional Board) dated July 16, 2001 and August 9, 2001, respectively; the California Toxics Rule (CTR) issued by the Environmental Protection Agency on May 18, 2000 (65 **FR** 31682), the Services' biological opinion on the CTR (Service File No.1-1-98-F-21); the December 16, 1999 letter from EPA to the Service and the National Marine Fisheries Service providing environmental commitments to conclude formal consultation on EPA's CTR; information from the Service's ongoing consultation with the EPA on the Grassland Amendments (Service File No. 1-1-00-F-0054); and other sources of information. A complete administrative record of this consultation is on file in the Service's Sacramento Fish and Wildlife Office.

Consultation History

September 15, 1993: The Service informally consulted on Reclamation's proposed San Luis Drain/North Mud Slough Agricultural Drain Water Project, Merced County, California. The proposed project involved discontinuing the use of South Mud Slough and Salt Slough and reopening the San Luis Drain. The Service concurred that the project would not adversely affect delta smelt, giant garter snake, and the candidate western pond turtle, providing there would be no increase in selenium loading to the San Joaquin River (1-1-93-I-1016). No incidental take statement was issued.

September 11, September 25 and October 26, 1995: The Service informally consulted on the proposed construction of the San Luis Drain/North Mud Slough Project, supplying guidance and clarification so as to avoid impacts to delta smelt and giant garter snake. The Service concurred with Reclamation's assessment of "not likely to adversely affect" for the giant garter snake, providing Reclamation's proposed conservation measures during construction were followed. No incidental take statement was issued. The Service recommended a program monitoring selenium, and toxicological studies to ascertain effects to delta smelt (1-1-95-I-1462 and 1-1-95-I-67). Reclamation and the Water Authority signed an "Agreement for Use of the San Luis Drain" on November 3, 1995. This Use Agreement and its extension in 1999 allows the use of the San Luis Drain for the Grassland Bypass Project for a 5-year period that concludes September 30, 2001.

June 6, 1996: Informal consultation on the Operation and Maintenance of the San Luis Drain.

August 1999: In August1999, Reclamation and the Water Authority initiated the NEPA/CEQA process to continue the Grassland Bypass Project through 2009.

September 30, 1999: Reclamation asked the Service's Sacramento Fish and Wildlife Office for assistance in preparing a biological effects section of a combined EIS/EIR for continuation of the Grassland Bypass Project from 2001 to 2009.

February 8, 2000: Reclamation requested that Service develop a draft biological assessment for the Grassland Bypass Project.

February 9, 2000: The Service's Sacramento Fish and Wildlife Office provided a comprehensive list of 23 animal species (five mammals, three birds, two reptile, two amphibians, five fish, four invertebrates, two plants) that are federally-listed as endangered, threatened or proposed as endangered or threatened under the Federal Endangered Species Act and that have the potential to occur within the 22 USGS 7 2 minute quadrangles of the project area. The list also included 17 plant and animal species that are considered as sensitive and species of concern.

December 21, 2000: The Service submitted a draft biological assessment to Reclamation.

January 31, 2001: Updated species list from the Service's Sacramento Fish and Wildlife Office provided to Reclamation.

February 16, 2001: Reclamation submitted a final biological assessment to the Sacramento Fish and Wildlife Office's Endangered Species Division, and requested initiation of formal consultation.

June 25, 2001: The Service receives a letter, dated June 22, 2001, from the Water Authority, regarding concerns over the Service exceeding their 135 day timeline to complete a biological opinion on the Grassland Bypass Project.

June 26, 2001: Reclamation submits a memo regarding concerns of Service exceeding 135 day timeline to complete biological opinion on the Grassland Bypass Project.

June 27, 2001: The Service verbally requests an extension beyond the 135 day timeline (July 1, 01).

June 28, 2001: Reclamation agrees to an extension for completion of a final biological opinion on the Grassland Bypass Project. Reclamation and the Service agree to the following dates: the Service will provide Reclamation with draft terms and conditions for review on July 12, 2001, and final biological opinion by July 27, 2001.

July 3, 2001: Letter from Reclamation to Mr. Dan Nelson, Manager of the Water Authority, agreeing to grant applicant status for the ongoing section 7 consultations with the Service and the National Marine Fisheries Service regarding the Grassland Bypass Project.

July 12, 2001: The Service transmits to Reclamation via e-mail an electronic copy of draft terms and conditions for the Grassland Bypass Project.

July 19, 2001: The Service receives a memo, dated July 18, 2001, from Reclamation transmitting Reclamation and the Water Authority's comments on the draft incidental take statement from the biological opinion on the Grassland Bypass Project.

July 23, 2001: The Service requests via e-mail to Reclamation that commitments in the that were included in the effects section of the Biological Assessment but not the project description, be added to the project description .

July 25 and 26, 2001: Reclamation's deputy environmental officer provides the Service an extension for the biological opinion until Monday July 30, 2001 if the Service can provide a revised copy of the draft terms and conditions to Reclamation by July 26, 2001 for review.

July 26, 2001: Reclamation transmits a revision to the Biological Assessment for the Grassland Bypass Project to include all commitments contained within the text of the Biological Assessment.

July 26, 2001: The Service hand carries a revised hard-copy draft of the conclusion/incidental take statement, and terms and conditions for the Grassland Bypass Project to Reclamation for review and comment.

July 30, 2001: Reclamation submits a memo with comments to the Conclusion and Terms and Conditions and that provides an extension to the due date for a draft biological opinion from the Service to August 3, 2001.

August 3, 2001: The Service transmits to Reclamation an administrative draft biological opinion for the Grassland Bypass Project.

August 8, 2001: Reclamation submits via e-mail draft comments to the Service on the administrative draft biological opinion and the incidental take statement. Representatives of the Service meet with Reclamation and the Water Authority and Summers Engineering to discuss their comments to the August 3, 2001 administrative draft biological opinion.

August 13, 2001: Reclamation submits a memo to the Service transmitting revisions to the Biological Assessment for the Grassland Bypass Project.

August 16, 2001: Reclamation submits a memo to the Service transmitting comments on the August 3, 2001, administrative draft biological opinion on the Grassland Bypass Project.

September 5, 2001: The Service transmits to Reclamation a second draft biological opinion (as a hard-copy and electronically) for the Grassland Bypass Project.

September 18, 2001: Reclamation submits a memo to the Service transmitting comments on the September 5, 2001, draft biological opinion on the Grassland Bypass Project.

September 19, 2001: Representatives of the Service meet with Reclamation and the Water Authority and Summers Engineering to discuss their comments on the September 5, 2001, draft biological opinion on the Grasslands Bypass Project.

September 24, 2001: The Service transmits to Reclamation via e-mail revised versions of: assumption number 2 from the effects section, and chapter 4 of the biological opinion for the Grasslands Bypass Project (including the conclusion, incidental take statement, and terms and conditions).

September 25, 2001: Reclamation requests that the Service provide a final biological opinion by no later than 12:00 noon on September 27, 2001.

BIOLOGICAL OPINION

Background

Drainage Problems in the Grasslands Area

In some areas of the western San Joaquin Valley, deep percolation of groundwater is inhibited by the hydraulic properties of soils and other subsurface materials. As a result, the groundwater table rises, potentially threatening crop production (through flooding of the root zone, often with saline water). Evaporation and capillary action also can draw dissolved solids in shallow groundwater to the surface, resulting in salinization of soils. High salinity in shallow groundwater and/or soils adversely affects agricultural productivity by reducing crop yields and limiting the diversity of crops that can be grown (SJVDP 1990). In general, for irrigated agriculture to be productive and sustainable, the groundwater table must not be allowed to rise into the crop root zone for extended periods of time and a salt balance must be achieved and maintained (i.e., the volume of salts introduced to the land through irrigation must not exceed that lost through deep percolation, lateral ground-water movement, plant uptake, surface drainage, and artificial collection and removal of shallow groundwater (Moore et al., 1990).

During the 1950's and 1960's, farmers on the west side of the San Joaquin Basin (north of Westlands Water District) began installation of subsurface drainage systems. Drainage water collected by those systems was commingled with agricultural tailwater and other waters and discharged into sloughs and creeks of the western Grasslands area enroute to the San Joaquin River. That commingled water was also used for management of tens of thousands of acres of wetlands in the area. In light of the findings of Kesterson Reservoir studies, contamination surveys were conducted in the San Joaquin River beginning in the fall of 1984. The contamination surveys revealed elevated concentrations of salts, arsenic, boron, and/or selenium in waters, sediments, food-chain organisms, fish and wildlife collected from the area (Moore et al., 1990).

In 1985, drainwater stopped being used as a water supply for the Grassland public and private wetlands. The discovery of avian developmental abnormalities, caused by selenium contamination from drainwater disposal in surface water and disposal impoundments, resulted in changes in management by wetlands managers in the Grasslands area. Between 1985 and 1996, channels in the Grassland Water District (GWD) were used to convey both drainwater and fresh water. Through an agreement between the GWD and the surrounding agricultural districts, drainage entered the southern portion of the GWD through the Agatha Canal or the Camp13 Ditch. When one channel was carrying drainwater, the other was used to convey fresh water to the wetlands. Then the system was switched so that the wetlands along the other channel could receive fresh water deliveries. This "flip-flop" system required flushing of the channel for 24 hours, and the flushing was an inefficient use of fresh water. Use of the "flip-flop" system was halted in 1996 with the implementation of the first Grassland Bypass Project. With implementation of the Grassland Bypass Project from 1996 through 2001, approximately 93 miles of Grassland wetland supply channels no longer conveyed drainage from farmlands in the Grassland Drainage Area. The continued use of the San Luis Drain and implementation of the Grassland Bypass Project requires a revised Use Agreement and additional environmental compliance.

Basin Plan Amendments for Regulation of Subsurface Drainage

The Regional Water Quality Control Board, Central Valley Region (Regional Board), initially adopted a Basin Plan for the Sacramento River and San Joaquin River Basins in 1975. In 1988, the Regional Board adopted an amendment to the Basin Plan for regulation of agricultural subsurface drainage discharges from the Grassland Watershed of Merced and Fresno Counties. That amendment included site-specific molybdenum, boron, and selenium water quality objectives for the San Joaquin River, Mud Slough (north), and Salt Slough. Selenium objectives were also adopted for wetland water supplies. The water quality objectives varied depending on the location of the water body relative to the Merced River. The reason for the difference was the amount of assimilative capacity available in the water bodies upstream and downstream of the Merced River. The San Joaquin River and its tributary sloughs upstream of the Merced River had less stringent objectives, since the flow and quality of these water bodies are governed by agricultural irrigation and wetland return flows (effluent-dominated), while the objectives for the San Joaquin River downstream of the Merced River are more stringent because the natural flow of the San Joaquin River is dominated by the higher quality inflows from eastside tributaries. A critically-dry year relaxation in objectives for boron and selenium also applied to the San Joaquin River downstream of the Merced River, since natural flow from the eastside tributaries drops significantly during droughts.

The focus of the implementation plan adopted as part of the 1988 Basin Plan Amendment was on reductions of drainage volume and pollutant loads through adoption of on-farm best management practices (BMPs) – primarily water conservation. Progress toward meeting water quality objectives was to be documented in annual Drainage Operation Plans (DOPs) which would describe the progress individual water and drainage districts were making toward adoption of BMPs. Waste discharge requirements were to be considered only if water quality objectives were not met by the compliance dates. The Regional Board also adopted a prohibition against activities that would increase the discharge of poor quality agricultural subsurface drainage.

The State Water Resources Control Board (State Board) approved the Regional Board's Basin Plan amendment in September 1989, but disapproved the proposed beneficial uses of Mud Slough (north) and Salt Slough. Following the State Board's action, the U.S. Environmental Protection Agency (EPA) disapproved many of the adopted objectives, including the selenium objective of 10 μg/L for the effluent-dominated water bodies upstream of the Merced River. These water bodies included Mud Slough (north), Salt Slough, and the San Joaquin River upstream of the Merced River. In addition, EPA disapproved the critical year selenium objective of 8 μg/L for the San Joaquin River downstream of the Merced River. In 1990, EPA approved the 5 μg/L monthly mean selenium objective in the San Joaquin River downstream of the Merced River, as well as the 2 μg/L monthly mean selenium objective for the water delivered to wetland areas within the Grassland watershed.

In December 1992, as part of a national rulemaking (the "National Toxics Rule"), EPA promulgated a 5 μg/L, 4-day average selenium water quality criterion for all of the water bodies (except Grassland wetland supply channels) that were covered by the 1988 Regional Board Basin Plan Amendment. This promulgation also superseded the 5 μg/L monthly mean selenium objective originally approved by EPA for the San Joaquin River downstream of the Merced River. In December 1994, the Regional Board adopted an extensive set of amendments to the Basin Plan that included deletion of all of the Plan's previous selenium water quality objectives that had been superseded by the EPA promulgation.

The 1988 amendment was considered to be a first step in efforts to control agricultural subsurface drainage. Testimony received by the Regional Board in 1988 indicated that there was not a strong understanding of the relationship between dilution flows and discharge, especially in the effluent-dominated water bodies receiving the drainage, and it was recognized that a revision to the Basin Plan's implementation plan for regulating agricultural subsurface drainage discharges would be needed as new information became available. EPA's promulgation, in 1992, of more stringent water quality criteria again raised a question regarding the adequacy of the previously adopted water quality objectives and the implementation plan outlined in the Basin Plan. Studies conducted for the Regional Board subsequently showed that the on-farm water conservation measures that had been emphasized in the1988 amendment were not sufficient as a primary method for meeting water quality objectives and reducing pollutant loads to meet water quality objectives for selenium, neither in the sloughs or the San Joaquin River downstream of the Merced River.

The Regional Board adopted new Basin Plan amendments in 1996, as part of a set of amendments that focused on the control of selenium-bearing agriculture subsurface drainage discharges in and from the Grasslands watershed. The complete series of amendments are commonly referred to as the "Grasslands Amendments." The need to reduce selenium loadings and concentrations in the Grasslands wetland water supplies and downstream waters, in order to protect wildlife including threatened and endangered species, was one of the motivations behind the Regional Board's adoption of the Grasslands Amendments. The Grasslands Amendments were adopted May 3, 1996 by the Regional Board via Regional Board Resolution 96-147, and approved by the State Board in State Board Resolution 96-078 and by the State Office of Administrative Law on January 10, 1997.

Chapter IV of the Regional Board's Grasslands Amendments provides a compliance schedule for water quality objectives in the Grasslands Area and San Joaquin River. The schedule calls for compliance with performance goals and water quality objectives for agricultural subsurface drainage discharges containing selenium no later than the dates specified in Table IV-4 of the Grassland Amendments, and reproduced in Table 1 below (water quality objectives are shown in **bold type**; performance goals are shown in *italics*):

Table 1. Regional Board Compliance Schedule for Meeting the 4-day Average and Monthly Mean Water Quality Objectives for Selenium.

Water Body/Water Year Type[1]	1 Oct. 1996	1 Oct. 2002	1 Oct. 2005	1 Oct. 2010
Salt Slough and Wetland Water Supply Channels listed in Basin Plan Appendix 40	**2 µg/l monthly mean**			
San Joaquin River below the Merced River, Above Normal and Wet Water Year types		*5 µg/l monthly mean*	**5 µg/l 4-day average**	
San Joaquin River below the Merced River; Critical, Dry, and Below Normal Water Year types		*8 µg/l monthly mean*	*5 µg/l monthly mean*	**5 µg/l 4-day average**
Mud Slough (north) and the San Joaquin River from Sack Dam to the Merced River				**5 µg/l 4-day average**

[1] The water year classification will be established using the best available estimate of the 60-20-20 San Joqauin Valley water year hydrologic classification (as defined in Footnote 17 for Table 3 in the State Water Resources Control Board's *Water Quality Control Plan for the San Francisco Bay/Sacramento + San Joaquin Delta Estuary*, May 1995) at the 75% exceedance level using data from the Department of Water Resources Bulletin 120 series. The previous water year's classification will apply until an estimate is made of the current water year.

The Grassland Amendments further established the following be implemented:

1) Incorporate selenium load reduction requirements into waste discharge requirements as effluent limits, as necessary, to ensure that the selenium water

quality objectives in the San Joaquin River downstream of the Merced River inflow are achieved; and to implement a Total Maximum Daily Load (TMDL) after public review;

2) Apply selenium effluent limits, via waste discharge requirements, to the discharge of subsurface drainage water from the Grassland watershed. In the absence of a regional entity to coordinate actions on the discharge, the Regional Board will consider imposing the effluent limits on each discharger to ensure that beneficial uses are protected at all points downstream;

3) Review the waste discharge requirements and compliance schedule at least every 5 years;

4) Require all parties that discharge or contribute to the generation of agricultural subsurface drainage to submit a 5-year drainage management plan designed to meet interim milestones, and a long-term drainage management plan designed to meet final water quality objectives;

5) Require contributors to the generation of agricultural subsurface drainage to conduct an annual review of the effectiveness of control actions;

6) Coordinate with EPA and the dischargers on a study plan to support the development of a site specific water quality objective for the San Joaquin River and other effluent dominated waterbodies in the Grassland watershed.

Total Maximum Monthly Loads for Discharges from the San Luis Drain

The lower San Joaquin River between Mendota Pool and Vernalis has been designated by the State Board as an impaired waterbody for selenium under Clean Water Act Section 303(d). Pursuant to this listing, the State Board was required to develop a TMDL, which would help meet Water Quality Objectives in the San Joaquin River downstream of the confluence of the Merced River, as stipulated by the EPA. The Regional Board prepared a Total Maximum Monthly Load (TMML) Model for the San Joaquin River in a staff report written in 1994 (Karkoski 1994). The compliance schedule for meeting the 4-day average and monthly mean water quality objectives for selenium for the San Joaquin River was used to develop load limits. The TMML for the San Joaquin River was developed to determine the allowable load of selenium that could be discharged into the San Joaquin River given the lowest flows observed in the San Joaquin River for the water year type and monthly grouping. A monthly load limit was developed rather than a daily limit because monthly control measures were deemed more feasible than daily control due to the diffuse nature of selenium loading. The Regional Board issued a staff report in June 2001 titled, "Selenium Total Maximum Daily Load for the Lower San Joaquin River" which contains a TMML designed to meet the Clean Water Act requirements under Section 303(d). The TMML is the total load that the San

Joaquin River can assimilate without exceeding the applicable water quality objective at a specified frequency. The U.S. EPA allows violations of standards at a frequency no greater than once every three years. The TMML is apportioned among background sources of selenium (wetlands, the Merced River, and the San Joaquin River upstream of Salt Slough), a margin of safety (established as 10% of the TMML) and a load allocation (discharges from the Grassland Drainage Area).

Waste Discharge Requirements

The Regional Board issued Waste Discharge Requirements (WDR's) for discharges from the San Luis Drain on July 24, 1998 (Order No. 98-171). The WDR's established selenium discharge load values (pounds of selenium monthly and annually), requiring a 15 percent reduction from the average historical load to the San Joaquin River by the fifth year. The WDR's remain in effect through the term of the current Grassland Bypass Project (September 30, 2001). Unless replacement WDR's are in place to take effect after September 30, 2001, a stated schedule of TMML values will be applied when the Grassland Bypass Project continues.

On July 16, 2001, the Regional Board issued a notice containing Tentative WDR's for the Grassland Bypass Project (Phase II), which was adopted at the Regional Board's meeting in September 2001. On August 9, 2001, the Regional Board issued revisions to the tentative WDR's for the Grassland Bypass Project (Phase II). Because the revised WDR's proposed by the Regional Board were adopted September 2001, the old WDR's were rescinded and the new WDR's apply to these discharges. The revised WDR's include a compliance schedule for meeting 4-day average and monthly mean water quality objectives for selenium, monthly and annual loads of selenium that can be discharged by the Grassland Bypass Project, a monitoring and reporting program and criteria for notification and monitoring of storm water releases into Grassland wetland supply channels. The selenium load limits for the years 2005-2009 provided in the revised WDR's differ from the selenium load limits in the Use Agreement for the Grassland Bypass Project (USDI -BOR 2001b). At the time this biological opinion was finalized, it was unclear why these selenium load limits differ and which load limits would be enforced during the 2005-2009 time period.

The revised WDR's include Discharge Prohibitions and Effluent Limitations for the Grassland Bypass Project that Reclamation and the Water Authority must comply with, as follows:

A. Discharge Prohibitions
   1. The discharge of waste classified as 'hazardous' as defined in Section 2521(a) of Title 23, CCR, Section 2510, et sec., is prohibited.
   2. The discharge of agricultural subsurface drainage water to Salt Slough and the wetland water supply channels identified in Appendix 40 of the Basin

Plan is prohibited unless water quality objectives for selenium are being met.

3. The discharge of selenium from agricultural subsurface drainage systems in the Grassland Watershed to the San Joaquin River is prohibited in amounts exceeding 8,000 pounds/year.

California Toxics Rule

The Water Quality Objectives Implementation Schedule from the Grasslands Amendments, the selenium TMML's and TMDL's and the WDR's for the discharges from the Drain all are based on a water quality criterion of 5 μg/L selenium for protection of aquatic life. The Service issued a draft jeopardy biological opinion on EPA's proposed rule for the California Toxics Rule which included a 5 μg/L selenium standard for protection of aquatic life (Service File No. 1-1-98-F-21). In the draft jeopardy biological opinion, the Service concluded that 5 μg/L would likely jeopardize the continued existence of the following federally listed species: California clapper rail, California least tern, light-footed clapper rail, Yuma clapper rail, marbled murrelet, delta smelt, Sacramento splittail, razorback sucker, bonytail chub, desert pupfish, giant garter snake and the California red-legged frog.

EPA issued a final California Toxics Rule on May 18, 2000 (65 **FR** 31682). This rule promulgated legally enforceable water quality criteria for the state of California for inland surface waters, enclosed bays and estuaries, for all programs and purposes under the Clean Water Act. When completed these criteria are available to the State for immediate adoption and subsequent use by the State and Regional Boards for their use in permit writing and identification of impaired waters. The rule also authorizes a compliance schedule provision in the preamble allowing the Regional Boards to give existing dischargers up to five years after their first permit renewal following the final rule to come into compliance. The maximum time that the California Toxics Rule allows for a compliance schedule is ten years after the adoption of the final rule, regardless of how many years after the final rule the first permit renewal occurred.

The Service issued a final biological opinion to EPA on the effects of the California Toxics Rule on March 24, 2000 (Service File No. 1-1-98-F-21). The Service concurred with EPA's determination that implementation of the rule as revised and finalized was not likely to adversely affect listed species and critical habitats. The rule included proposed acute and chronic aquatic life criteria for selenium.. The Service reached a not likely to adversely affect determination based on commitments EPA made on several criteria, including selenium. These commitments (modifications) were made in writing in a December 16, 1999 letter from EPA to the Service and the National Marine Fisheries Service to conclude formal consultation on EPA's California Toxics Rule. These modifications were incorporated by reference into section M of the preamble of

EPA's final promulgation of the rule. The modifications regarding selenium are as follows:

I. <u>EPA Modifications Addressing the Services' April 9, 1999 draft Reasonable and Prudent Alternatives for Selenium</u>:

A. EPA will reserve (not promulgate) the proposed acute aquatic life criterion for selenium in the final California Toxics Rule.

B. EPA will revise its recommended 304(a) acute and chronic aquatic life criteria for selenium by January 2002. EPA will propose revised acute and chronic aquatic life criteria for selenium in California by January of 2003. EPA will work in close cooperation with the Services to evaluate the degree of protection afforded to listed species by the revisions to these criteria. EPA will solicit public comment on the proposed criteria as part of its rulemaking process, and will take into account all available information, including the information contained in the Services' Opinion, to ensure that the revised criteria will adequately protect federally listed species. If the revised criteria are less stringent than those proposed by the Services in the Opinion, EPA will provide the Services with a biological evaluation/assessment on the revised criteria by the time of the proposal to allow the Services to complete a biological opinion on the proposed selenium criteria before promulgating final criteria. EPA will provide the Services with updates regarding the status of EPA's revision of the criterion and any draft biological evaluation/assessment associated with the revision. EPA will promulgate final criteria as soon as possible, but no later than 18 months, after proposal. EPA will continue to consult, under Section 7 of ESA, with the Services on revisions to water quality standards contained in Basin Plans, submitted to EPA under Clean Water Act section 303, and affecting waters of California containing federally listed species and/or their habitats. EPA will annually submit to the Services a list of NPDES permits due for review to allow the Services to identify any potential for adverse effects on listed species and/or their habitats. EPA will coordinate with the Services on any permits that the Services identify as having potential for adverse effects on listed species and/or their habitat in accordance with procedures agreed to by the Agencies in the draft MOA published in the Federal Register at 64 Fed. Reg. 2755 (January 15, 1999) or any modifications to those procedures agreed to in a finalized MOA.

C. EPA will utilize existing information to identify water bodies impaired by selenium in the State of California. Impaired is defined as water bodies for which fish or waterfowl consumption advisories exist or where water quality criteria necessary to protect federally listed species are not met. Pursuant to Section 303(d) of the Clean Water Act, EPA will work, in cooperation with the Services, and the State of California to promote and develop strategies to identify sources of selenium contamination to the impaired water bodies where federally listed species exist, and use existing authorities and resources to identify, promote, and implement measures to reduce selenium loading into their habitat.

Project Description

Grasslands Bypass Project

The Project area, as described in the revised Biological Assessment for the Project (L. Allen, in litt. August 13, 2001), is bounded by the GDA on the south, the San Joaquin River to the east, Hills Ferry Road on the north, and Highway I-5 to the west. The project area includes approximately 98,000 acres of agricultural lands in Fresno and Merced Counties that have historically contributed a large proportion of subsurface agricultural drainage to the San Joaquin River. For the purposes of this biological opinion, this area of agricultural land is referred to as the Grassland Drainage Area, or GDA. The GDA includes all of Broadview Water District, Camp13 Drainage District (the Camp 13 Area of Central California Irrigation District), Charleston Drainage District, Firebaugh Canal Water District, Pacheco Water District, Panoche Drainage District, Widren Water District, and lands not within any district (USDI-BOR 2001b). Figure 1 shows the CVP districts included in the GDA.

The GDA is adjacent to the Grasslands wetlands--publicly and privately managed lands that comprise the largest tract of wetland habitat remaining in the San Joaquin Valley. These include private wetlands in the Grassland Water District, and publicly owned and managed wetlands in the Los Banos Wildlife Area and the San Luis National Wildlife Refuge Complex (including San Luis and Kesterson National Wildlife Refuges) and are referred to in this opinion as the "Grasslands wetlands." Approximately 93 miles of natural and human-made water channels deliver freshwater to the Grassland wetlands, as listed in Appendix 40 of the 1996 Basin Plan Amendment. For the purposes of this biological opinion, these water supply channels are referred to as the "Grasslands wetland supply channels." The Grassland wetland supply channels have been and are currently used to convey some agricultural drainage to the San Joaquin River. The water quality objective in these channels is 2 μg/L (ppb) selenium or less (monthly mean) as adopted by the Regional and State Water Resources Control Board in the Basin Plan amendments of 1996.

In November 1995, Reclamation signed a five-year Use Agreement for the Grasslands Bypass Project with the San Luis and Delta-Mendota Water Authority, acting on behalf of its members who had formed the Grassland Basin Drainage Management Activity Agreement. This activity agreement includes all of the organized drainage entities, plus one additional association, that discharge subsurface drainage from the Grassland

Drainage Area into channels reaching the Grassland wetland supply channels. The organized drainage entities include Broadview Water District, the Camp13 Drainage District (the Camp 13 Area of Central California Irrigation District), Charleston Drainage District, Firebaugh Canal Water District, Pacheco Water District, Panoche Drainage District, Widren Water District and lands not within any district. The Grassland Bypass Project separated this drainage from the Grassland wetland supply channels, conveying drainage into a 28-mile segment of the San Luis Drain between South Dos Palos and Gustine, California, and from there through the last six miles of Mud Slough (North) to the San Joaquin River above its confluence with the Merced River. Mud Slough (North) passes through the Kesterson Unit and China Island Wildlife Management Area. This discharge was regulated by a Waste Discharge Requirement issued by the Regional Board.

The purposes of the first Grassland Bypass Project (from 1996-2001) were to :

1) remove unusable agricultural drainage water from wetland water supply channels, on an interim basis
2) gain a better understanding and quantification of selenium loading and in-transit selenium deposition from the Grasslands Basin
3) gain a better understanding and determine whether a single regional drainage conveyance facility will facilitate drainage management and promote improved water quality in the San Joaquin River (USBR, November 1995, Grassland Bypass Channel Project - Finding of No Significant Impact and Supplemental Environmental Assessment).

The purposes of the proposed action, the continuation of the Grasslands Bypass Project , are to:

1) continue the separation of unusable agricultural drainage water attributable to the GDA from Grassland wetland water supply conveyance channels for the period October 1, 2001 - December 31, 2009, and
2) facilitate drainage management that maintains the viability of agriculture in the GDA while the parties involved work toward reducing selenium loading into the San Joaquin River.

In addition to the purposes noted above, the Final Grassland Bypass Project EIS/EIR (May 25, 2001, Volume 1, page 1-3) states that the Project is to meet applicable water quality objectives (USDI-BOR 2001b).

The extended Grassland Bypass Project would collect drainwater from the GDA and may collect drainwater from an adjacent1,100 acres and place it into the San Luis Drain at a point near South Dos Palos, California. The drainwater would continue to travel in the San Luis Drain to its northern terminus near Gustine, California. From there, the drainwater would enter Mud Slough (North) for six miles before reaching the San

Joaquin River at a location three miles upstream of its confluence with the Merced River (USDI-BOR 2001b). Figure 2 shows the location of the Grassland Bypass Project.

The Grassland Bypass Project would be periodically reviewed by an inter-agency Oversight Committee, comprised of agency managers from Reclamation, the Service, EPA, California Department of Fish and Game, and the California Central Valley Regional Water Quality Control Board (Regional Board). The National Marine Fisheries Service will be participating on the Technical and Policy Review Team of the Grassland Bypass Project.

Existing Features of Proposed Action

Existing features of the current Grassland Bypass Project that would continue under the Proposed Action include the following (see Figure 2):

- The removal of GDA agricultural drainwater from 93 miles of conveyance channels in the Grassland wetlands and wildlife refuges. These channels are shown on Figure 2.
- The use of the Grassland Bypass Channel, a 4-mile-long earthen ditch that conveys drainwater from the GDA to the San Luis Drain at Russell Avenue.
- The use of 28 miles of the San Luis Drain to its northern terminus near Gustine, to convey drainwater from the GDA.
- Disposal of drainwater into Mud Slough (North) for 6 miles before reaching the San Joaquin River at a location 3 miles upstream of its confluence with the Merced River.
- The maximum flow of drainwater from the GDA shall not exceed 150 cubic feet per second (cfs), primarily to prevent suspension of sediments within the Drain.

New Features of Proposed Action

New features of the Proposed Action include:

- Negotiation with between Reclamation and the GDA (and other stakeholders) for a new 2001 Use Agreement for the Drain, including an updated compliance monitoring plan, revised selenium load limits, and a new WDR from the Regional Board.
- As noted above, the proposed action may include the possible addition of approximately 1,100 acres of farmland to the GDA, found immediately adjacent to the GDA, south of the Drain and east of the Grassland Bypass Channel, that currently drain to wetland channels (See Figure 2). This would require the construction of up to three short culverts from existing sumps to the Channel through disturbed embankments.
- Other drainage management actions to meet water quality objectives/load limits.

In-Valley Treatment/Drainage Reuse

The Proposed Action would include an In-Valley Treatment (IVT) element also known as the San Joaquin River Water Quality Improvement Project (SJRIP) on up to 6,200 acres of land within the GDA (Figure 3). This component of the Grassland Bypass Project would dedicate specific lands for the irrigation of salt-tolerant crops with subsurface drainwater to reduce drainwater volume; treat the concentrated drainwater to remove salt, selenium, and boron; and dispose of the removed materials "in-valley" to prevent them from discharging to the San Joaquin River. The location of the IVT is shown on Figure 3. At the present time, a portion of the site (1,200 acres) is being irrigated with drainwater of about 3,000 ppm total dissolved solids.

The IVT element is planned to handle half of the total drainwater produced in the GDA (50 percent of 35,000 acre-feet or approximately 17,000 acre-feet annually) and would include three phases:

Phase I - Purchase of land and planting to salt-tolerant crops, by 2003. Drainwater from the GDA (12,000 acre-feet) would be used to irrigate salt- tolerant crops (alfalfa, pasture mix, bermuda grass, bermuda/pasture mix, and grains such as winter wheat) on land formerly irrigated with Central Valley Project (CVP) water in the Mercy Springs Water District and land outside of any water district and farmed with non-CVP water. Ongoing monitoring of soil and water constituents will be done to assure no irreversible changes occur and to protect groundwater (Panoche Drainage District 2000) The land is adjacent to the collected Grassland drainwater, so the water can easily be captured and placed on the land. Since this land is also the lowest in elevation within the drainage area, no downstream collection of drainwater occurs. The land is now owned by the Panoche Drainage District. Salt-tolerant crops will be irrigated with salty subsurface drainwater, preventing that water from being discharged to the San Joaquin River. Grazing pasture could increase from 250 to 1,000 acres on the site (Panoche Drainage District 2000).

Phase II - Installation of subsurface drainage and collection systems, initial treatment system, by 2007: To continue to apply the salty water to the lands developed in Phase I, it will be necessary to install subsurface drainage and collecting system (tile) systems so the soil can be leached and a salt balance maintained. The water percolating below the root zone would be captured in the drainage system and passed on to the next, more salt-tolerant crop. The salt, selenium, and other constituents would be collected in the water coming out of the subsurface drainage systems. The system would sequentially reuse about 14,000 acre-feet of drainwater on increasingly salt-tolerant crops to concentrate and decrease the volume of drainwater. An initial phase of treatment, designed to tie in at any point in the reuse system, is planned to remove the salt and the selenium and much of the other constituents from the water, leaving usable water for agriculture or possibly other beneficial uses. The salt would be deposited in approved waste units and not discharged to the San Joaquin River, resulting in additional projected reductions in salt and selenium discharges to the river.

Phase III Completion of construction of treatment removal and salt disposal systems, by 2009: This final phase would be necessary to provide for maximum improvement to water quality in the San Joaquin River and to meet the ultimate reductions needed to meet future water quality objectives. This phase would include expansion of initial treatment (under Phase II) with additional construction of treatment facilities as well as additional waste disposal units. It would handle 17,000 acre-feet of drainwater per year.

Each phase of the IVT is intended to reduce the quantity of drainwater discharged to the San Joaquin River. The treatment systems are also anticipated to produce water sufficient in quality for reuse on agricultural lands within the GDA. The IVT element of the Proposed Action would be designed to meet applicable water quality objectives for Water Year 2006 (October 1, 2005). The applicable annual selenium load limit for 2006 (based on the current applicable TMML) is 3,087 lbs. In comparison, the load value in the existing 1995 Use Agreement for Water Year 2001 is 5,661 lbs. Such a large reduction requires implementation of additional methods of drainage management.

Phase I of the facility was evaluated in the Initial Study of the Proposed Project (Panoche Drainage District 2000). Phases II and III of the facility are evaluated in the Grassland Bypass Project EIS/EIR (USDI-BOR, 2001). The later construction phases were deferred to the EIS/EIR because Phase I has independent utility and does not foreclose consideration of alternatives to the larger project or to the project site. Also, the changes in proposed cropping patterns are reversible should the later phases not be implemented. Reclamation and the Authority will consult with the Service if it is determined that the construction and operation of Phase III facilities may affect listed species.

Other Drainage Management Actions

Other drainage management actions that would occur with implementation of the Proposed Action include the following:

- Drainage recycling systems to mix subsurface drainwater with irrigation supplies under strict limits.
- Continuing current land retirement policies listed in the *Long-Term Drainage Management Plan for the GDA*. Key among these is that land retirement should be voluntary (GAF and Authority 1998).
- Continuing the operation of a regional drainage management entity to perform management, monitoring, and funding of necessary control functions.
- An active land management program to utilize subsurface drainage on salt-tolerant crops.

- Low-interest loans for irrigation system improvements, such as gated pipe, sprinkler, and drip irrigation systems.
- An economic incentive program including tiered water pricing and tradable loads.
- A no-tailwater policy that would minimize silt from being discharged into the San Luis Drain and promote the secondary benefits of irrigation water management.
- Drainwater displacement projects such as using drainwater to grow salt-tolerant crops and using subsurface drainage for dust control on roadways.
- Meeting with landowners as necessary to implement projects and policies cited above.

Environmental Commitments from the Use Agreement

Environmental commitments are included in the Agreement for Use of the San Luis Drain between the Reclamation and the Water Authority (Use Agreement). The Use Agreement succeeds and supersedes the first Use Agreement between Reclamation and the Water Authority. The purposes of the Use Agreement are to: 1) continue the separation of unusable agricultural drainage water discharged from the GDA from wetland water supply conveyance channels for the period October 1, 2001 to December 31, 2009; 2) facilitate drainage management that maintains the viability of agriculture in the project area and promotes continuous improvement in water quality in the San Joaquin River.

A few of the environmental commitments in the Use Agreement are as follows:

- <u>Control of Drainage and Compliance with Applicable Requirements and Laws</u>: The Authority shall be responsible for ensuring that only drainage water from the GDA enters the San Luis Drain, and that such drainage water is controlled and monitored to ensure that its quality and composition comply with the Use Agreement and all applicable federal, state and local standards, requirements, regulations and laws.
- <u>Long-Term Management Plan</u>: The Authority shall develop a Long-Term Management Plan as required by the Regional Board that provides compliance with water quality objectives for selenium and salinity in receiving waters.
- <u>Oversight Committee</u>: The Drainage Oversight Committee will meet annually, or more frequently as needed. The Oversight Committee will review the progress and operation of the Grassland Bypass Project including modifications to project operation, appropriate mitigative actions, and termination of the Use Agreement, if necessary. The Oversight Committee will comprised of agency managers from Reclamation, the Service, the U.S. EPA, California Department of Fish and Game, and the Regional Water Quality Control Board. The Oversight Committee may appoint one or more subcommittees comprised of experts to help in the analysis of biological or water quality monitoring data or other information relevant to the drainage issue as needed.

- Mud Slough Compliance Plan: The Authority shall develop a Mud Slough Compliance Plan by 2006 for consideration by the Oversight Committee, to identify how water quality objectives in Mud Slough will be met by the Regional Board's compliance date specified in the Grasslands Amendments Table IV-4.
- Advance Notice of Changes in Flow and Quality to Downstream Entities: The Authority will provide advance notice to such parties of operations which may cause sudden changes in flow or quality and will develop procedures to coordinate with such parties on such operations. The Authority will work cooperatively with downstream entities regarding the timing of discharges and establish procedures which will ensure advance notice to, and coordination with, downstream diverters of upcoming releases.
- Selenium Load Reduction Goals: Selenium Load Reduction assurances specified in Appendix C of the Use Agreement are incorporated and made a part of the Use Agreement. Load reduction values may be revised according to Appendix D of the Use Agreement if the Regional Board submits to U.S. EPA a Total Maximum Monthly Load for selenium that is different from that contained in the Grassland Amendments.
- Drainage Incentive Fee: If the attributable discharge of selenium exceeds the applicable selenium load value in any given month or year during the term of the Use Agreement, a Drainage Incentive Fee shall be calculated in accordance with the Performance Incentive System as stated in section IV.B. of the Use Agreement and the Agreement may be subject to termination pursuant to Section VII.B.
- Incentive Credits: A credit toward future incentive fees will be given if the annual selenium or salinity Attributable Discharge is below the annual Load Value for such constituent.
- Potential Mitigative Actions: If the Oversight Committee determines, based on monitoring data or otherwise, that adverse environmental impacts have occurred and the Oversight Committee finds those impacts to be significant, the Oversight Committee will identify appropriate mitigative actions. The costs of mitigation, as well as required clean-up, shall be born by the Draining Parties (the Authority member agencies as described on page 7 of the Use Agreement).
- Comprehensive Monitoring Program: The Authority shall be responsible for implementing a comprehensive monitoring program that meets the following objectives: 1) provide water quality data for purposes of determining the Draining Parties' compliance with Selenium Load Values and Salinity Load Values as set forth in the Use Agreement; 2) provide biological data to allow an assessment of whether or not any environmental impacts constitute "Unacceptable Adverse Environmental Effects" that have resulted from the Use Agreement; 3) provide data on sediment levels, distribution, and selenium content. Data collected in the course of the monitoring program may be utilized as appropriate to meet requirements of biological opinions issued in relation to the Use Agreement. Reclamation and the Authority will compile the results of the monitoring program into an Annual Report and present it for review by the Oversight Committee. On a

regular basis, and at least monthly, the results of the monitoring program, including the monitoring results pertaining to the discharges of selenium and salts being delivered from the Drain to Mud Slough, shall be submitted to Reclamation, to the Oversight Committee, and to other interested parties. The Authority shall be responsible for implementing this monitoring program up to Crows Landing (site N) on the San Joaquin River.

- Annual Review: The Oversight Committee will meet at least annually to review the Grassland Bypass Project.

The Use Agreement may be terminated for cause, on account of resumption of subsurface drainage discharges into the Grassland wetland supply channels by participants in the Grassland Bypass Project, based on exceedence of annual selenium loads by 20% or more, or for unacceptable adverse environmental effects. Exceptions can be made in the case of unforeseen and uncontrollable events and unusually high rainfall. A special exemption also applies to flows from the Panoche Creek watershed, which may naturally carry elevated amounts of selenium.

Conservation Measures for Endangered Species

In addition to the primary drainage management actions associated with the Grassland Bypass Project that will reduce exposure to selenium and improve water and habitat quality in the Grasslands wetlands, the following conservation measures have been included in the project description by Reclamation to avoid or minimize impacts to listed species and species proposed for listing, especially during any construction:

IVT and Mountain Plover

Pilot programs irrigating with subsurface drainwater on the surface of agricultural fields sometimes result in highly seleniferous ponding, creating hazards to birds. The potential for similar hazards developing in the IVT is unknown. However, careful management of irrigation water and tailwater may be sufficient to avoid or minimize the potential for ponding. The IVT project description discusses general protective measures for wildlife. If ponding occurs despite careful management, wildlife risks will be evaluated (by Service or Service-approved biologists) and if adverse wildlife exposure to contaminants is detected, irrigation of the IVT field will cease until an irrigation method that does not cause ponding is identified and implemented (USDI-BOR 2001b).

To assure protection of mountain plover, the project proponents will cease irrigation of the IVT field immediately if mountain plover are present. The risk to mountain plover will be evaluated (by Service or Service-approved biologists) and if adverse exposure to contaminants is detected the project proponents will coordinate with the Service to develop protection measures for the mountain plover.

IVT and San Joaquin kit fox

Attached to the Biological Assessment in Appendix D are the 1999 *U.S. Fish and Wildlife Service Standardized Recommendations for Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance.* The Grassland Bypass Project proponents have agreed to follow these protocols.

At the recommendation of Service biologists, Grassland Bypass Project proponents in the IVT area agree to adopt an additional practice to the above San Joaquin kit fox protocols. San Joaquin kit foxes may locate dens in soil banks along the edge of farms (S. Jones, Service, pers. comm.). A common farming practice is to remove all exotic vegetation with herbicides down to bare soil. This is known as "clean farming." To ensure protection of denning San Joaquin kit foxes in the IVT area, especially during pupping season, Grassland Bypass Project proponents agree to plant, and mow when necessary, drought tolerant native species on soil banks within the IVT facility. The National Resource Conservation Service provides informational handbooks on native plants for erosion control, landscaping and maintenance along rights-of-way. These plants can be planted without fertilizers, and, once established, can ward off weeds and be maintained without herbicides.

A monitoring program and contingency plan will be designed with recommendations from the Service to address potential San Joaquin kit fox exposure to selenium. Selenium uptake by salt-tolerant crops irrigated with drainwater at the IVT will continue to be monitored. If selenium concentrations in these crops reach the Level of Concern threshold for dietary effects on mammals (3 mg/kg), a contingency plan and monitoring program will be instituted to determine selenium dietary effects on the small mammal prey of San Joaquin kit fox. In addition, the county trapper can be engaged to shoot coyotes (San Joaquin kit fox predators and competitors) foraging in the area. Shooting is preferred to leg-traps, which can capture San Joaquin kit fox as well. Hair or blood can be sampled to determine selenium bioaccumulation levels in the coyotes. The monitoring will be elevated to San Joaquin kit foxes, in coordination with the Service (a permit is required), if the risk reaches a Level of Concern based on coyote monitoring or other small mammal monitoring at the IVT site and selenium effects on mammals.

Construction of facilities may impact San Joaquin kit fox habitat in Phase II (subsurface drainage collection system) and Phase III (treatment facilities construction). Most construction will be across agricultural land. In the future, when the construction details of Phase III treatment facilities are known, and should it be determined such facilities are needed, such construction will be evaluated for potential to impact San Joaquin kit fox prey base and habitat. A separate ESA section 7 consultation will likely be needed for the design, construction, and operation of Phase III of the IVT . Conservation measures have been incorporated into the project description to avoid and minimize negative effects to San Joaquin kit fox for Phases I and II of the IVT .

agricultural drainage has the potential for significant impacts on CTS or vernal pool invertebrates.

Giant garter snake

Giant garter snakes may occur in permanent aquatic habitat or habitats seasonally flooded during the snakes' active season (early-spring through mid-fall), such as marshes, sloughs, ponds, low gradient streams, irrigation and drainage canals, and rice fields. If habitat is present in the IVT area, a giant garter snake survey will be conducted at least six months before construction begins. If giant garter snakes are found or their habitat may be affected, consultation with the Service will be required. Subject to the requirements of any resulting biological opinion, further minimization measures are proposed below.

Construction activity within giant garter snake habitat will be limited to May 1 through October 1, when the snakes are usually active. Other construction times would require additional guidance from the Service to determine if additional measures are necessary, as giant garter snakes are more susceptible to take in the form of injury or mortality when occupying underground burrows or crevices. The IVT project area will be surveyed for the snake 24 hours prior to construction activities, and any sightings reported to the Service. Survey of the IVT project area will be repeated if a lapse in construction activity of two weeks or greater has occurred. IVT construction personnel will receive Service-approved worker awareness training to instruct workers to recognize the snake and its habitat.

Giant garter snake habitat within and adjacent to IVT construction sites will be flagged as environmentally sensitive areas. Movement of heavy equipment to and from IVT project sites, staging areas, or borrow sites will be confined to existing roadways to minimize habitat disturbance. Equipment and construction activities will keep at least 200 feet from giant garter snake aquatic habitat to avoid impacts. If construction activities must occur less than 200 feet from habitat, the affected area will be confined to the minimum necessary for construction activities. A Service-approved biologist will be on site during clearing and grubbing of wetland vegetation. Any dewatered habitat will remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat. If a snake is encountered during construction, activities will stop until it successfully escapes the project area or until capture and relocation have been completed by a Service-approved biologist. Disturbed areas will be returned to pre-project conditions following construction.

A Service-approved biologist will inspect the sites of proposed culverts from the 1,100 acre annexation. The same protocols will be implemented for pre-construction surveys, monitoring, and avoidance of giant garter snakes.

Conservation measures have been incorporated into the revised project description of the Grassland Bypass Project's Biological Assessment, to avoid and minimize negative effects to giant garter snake. In order to further recovery of the giant garter snake and to avoid or minimize negative effects to giant garter snakes, the project proponents will work to implement the following conservation measures:

(1) Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop an appropriate study plan, such as a mark and recapture survey or augmentation of ongoing surveys as appropriate, to assess population and distribution of giant garter snake in the Grassland Wetlands, Grassland wetland supply channels, and Mud Slough (North). Reclamation, together with the Service and other appropriate agencies, will seek to obtain funding and initiate the study plan within 1 year of this opinion.

(2) Either in conjunction with number (1) above or separately, Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop a study plan on the effects of contaminants (specifically selenium and mercury) on giant garter snakes in the Grassland wetlands, Grassland wetland supply channels, and Mud Slough (North). Reclamation, together with the Service and other appropriate agencies, will seek to obtain funding and initiate the study plan within 1 year of this opinion.

(3) Reclamation and/or the Authority will eliminate subsurface agricultural drainage (attributable to the GDA) from Grassland wetland supply channels. In addition, within their ability and respective authorities, Reclamation and the Authority will work cooperatively with other agencies to maintain Grassland wetland supply channels in a manner that protects and maintains giant garter snake habitat.

(4) Reclamation will determine the amount of existing giant garter snake habitat in the Grassland wetlands and Mud Slough (North).

(5) Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop a contingency plan should it be determined that selenium discharge from the GDA into Mud Slough (North) is negatively impacting giant garter snakes.

Sacramento splittail:

Conservation measures to be implemented by Reclamation and/or the Authority to avoid and minimize negative effects to Sacramento splittail include:

(1) Reclamation and/or the Authority, together with the Service and other appropriate agencies, will support ongoing studies to assess potential impacts of

selenium on Sacramento splittail. Reclamation, together with the Service and other appropriate agencies, will seek to obtain adequate funding for this measure.

(2) Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop a contingency plan should it be determined that selenium discharged from the GDA into Mud Slough (North) is negatively impacting Sacramento splittail.

Monitoring

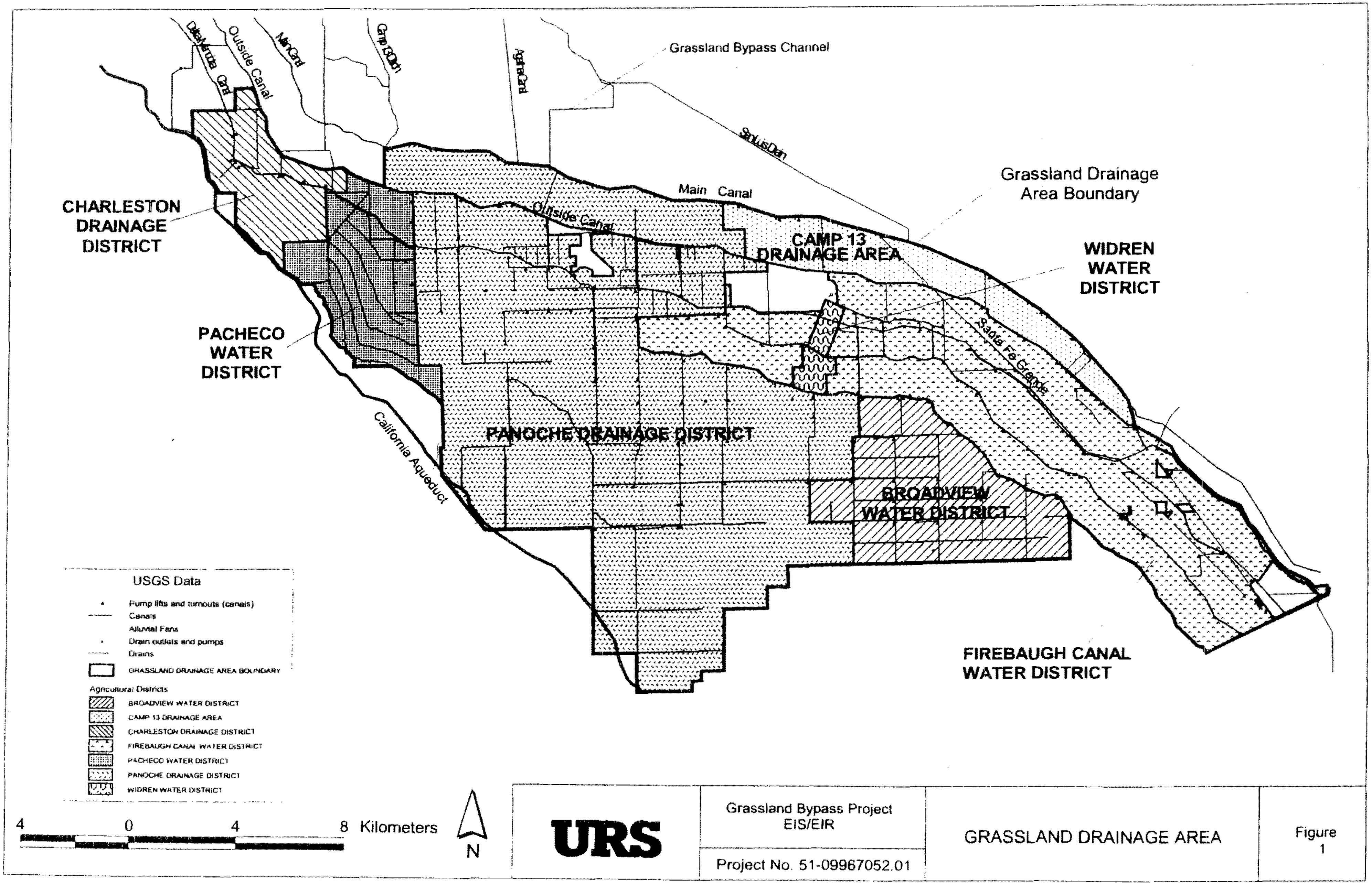
The Grassland Bypass Project will include a monitoring program to provide data with which to evaluate whether the terms and conditions of the Use Agreement are being met. The monitoring program will be updated in 2001 with the coordination and cooperation of Reclamation, the Service, the U.S.Geological Survey, the U.S. Environmental Protection Agency, the Regional Board, the California Department of Fish and Game, and the Water Authority.

Thirteen monitoring stations are located throughout the Project Area, in the San Luis Drain, Mud Slough, Salt Slough, Grassland wetland supply channels, and San Joaquin River (see Figure 3). The following parameters will be monitored: flow, water quality, biotic tissue sampling, chronic toxicity testing, and sediment quantity and quality (USDI-BOR *et al.* 1996).

Annual summary reports have been produced to document multi-agency data collection efforts. Each report builds on previous information, allowing evaluation of changes of conditions over time. Monthly data reports are intended to be published on a public web page; however the web page is being revised and a URL for this site was not available at the time this biological opinion was completed.

This completes the description of the action as proposed by Reclamation. The conservation measures as proposed are part of the actions evaluated by the Service in this biological opinion. Any change in the Grassland Bypass Project including conservation measures or their implementation that might adversely affect listed species, either directly or indirectly, requires reinitiation of consultation with the Service, as set forth in the final paragraphs of this document.

Figure 1



URS

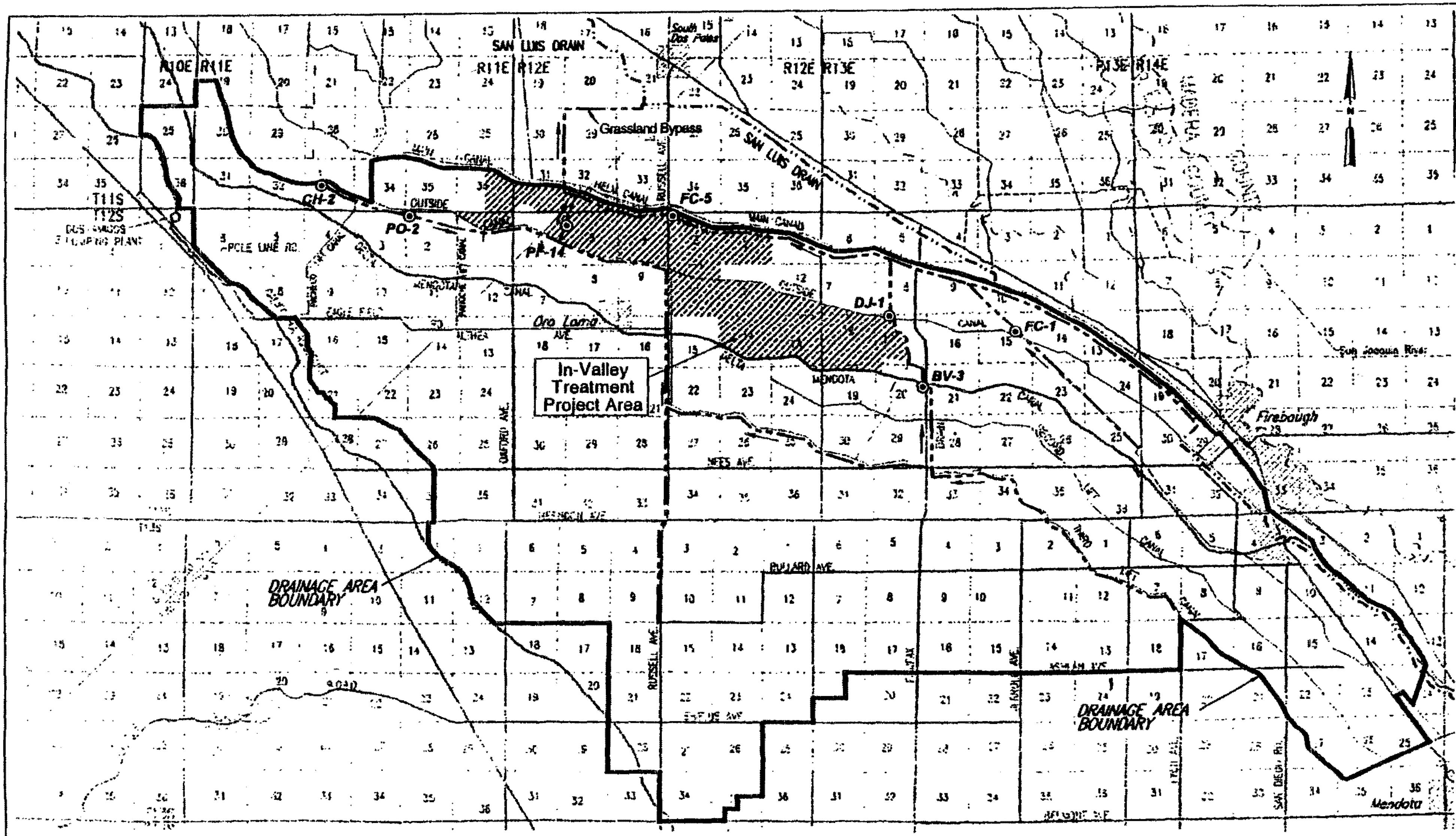
Grassland Bypass Project EIS/EIR

Project No. 51-09967052.01

GRASSLAND DRAINAGE AREA

Figure 1

Figure 3



LEGEND

FC-5 ◎ Monitoring Sites

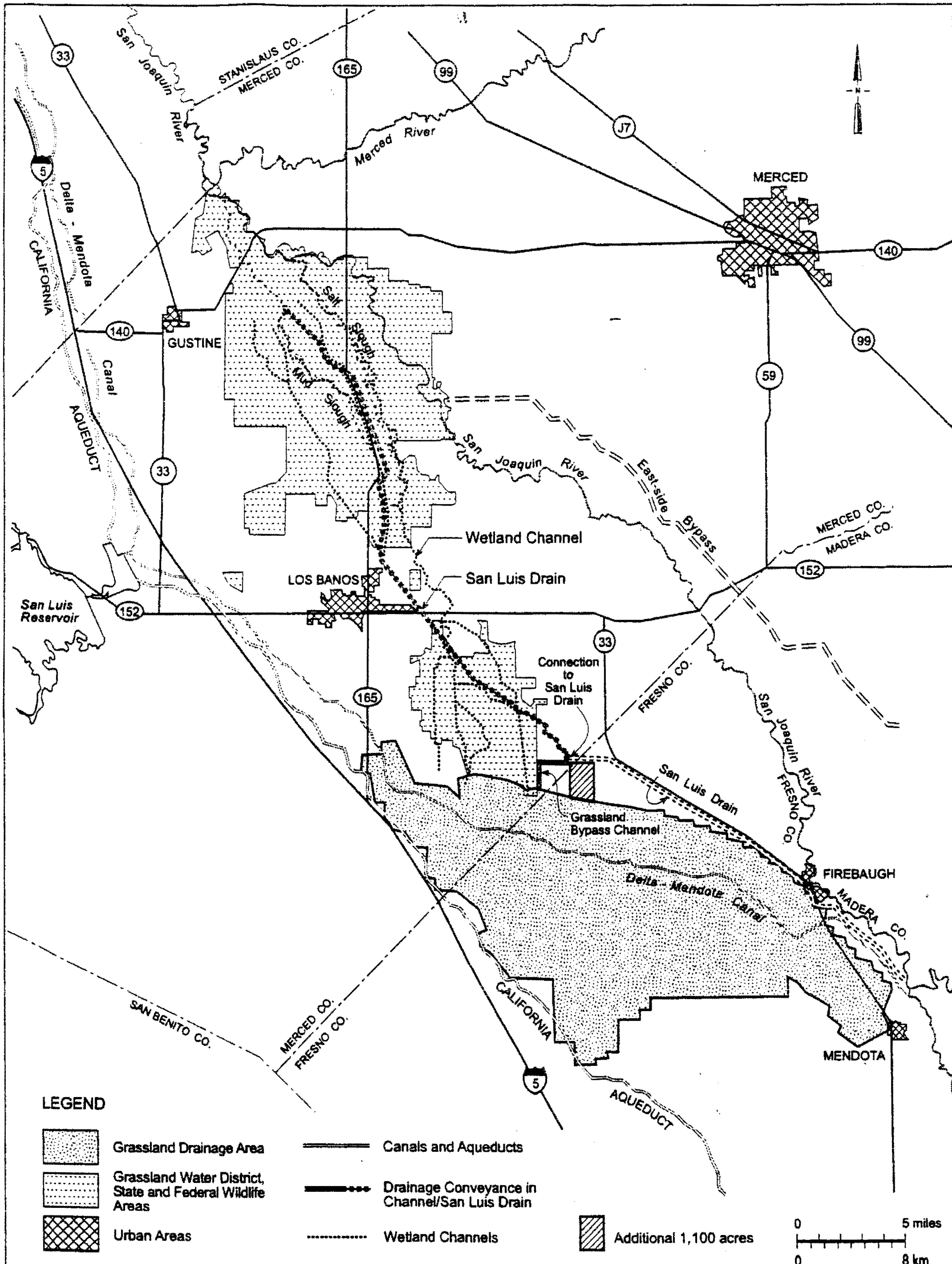
Major Drains

Source: San Luis & Delta-Mendota Water Authority
Drainage Area Boundary, July 2000

Project No. 51-09967052.01	Grassland Bypass Project EIS/EIR	PROPOSED ACQUISITION AREA FOR IN-VALLEY TREATMENT AND DRAINAGE REUSE FACILITY	Figure 2-3

51-09967052.01-00100/100800/gos

Figure 2



Project No. 51-09967052.01	Grassland Bypass Project EIS/EIR	PROJECT FEATURES MAP INCLUDING WETLAND CHANNELS	Figure 2-2

Status of Species and Environmental Baseline

San Joaquin Kit Fox (*Vulpes macrotis mutica*)

Description of Species: The San Joaquin kit fox was federally listed as endangered on March 11, 1967 (32 **FR** 4001) and listed by the State as threatened on June 27, 1971. The kit fox is the smallest canid species in North America with the males averaging 2.3 kilograms (5 pounds), and the females averaging 2.1 kilograms (4.6 pounds) (Morrell 1972). The kit fox has relatively large ears set close together and a long, bushy, distinctly black-tipped tail that is typically carried low and straight. Fur color varies geographically and seasonally, but is most commonly described as buff or tan in the summer, and yellowish gray or silver gray in the winter (McGrew 1979, Morrell 1972).

Historic and Current Distribution: The San Joaquin kit fox historically was distributed within an 8,700-square mile range in central California from the vicinity of Tracy in the upper San Joaquin Valley south to the general vicinity of Bakersfield. The current range of the San Joaquin kit fox is divided into two areas, with a northern range in Contra Costa, Alameda, San Joaquin and Stanislaus counties, and a cental-southern range in Merced, Madera, Fresno, Kings and San Benito counties. San Joaquin kit foxes are currently limited to remaining grassland, saltbush, open woodland, alkali sink valley floor habitats, and other similar habitats located along bordering foothills and adjacent valleys and plains. In the area around the city of Los Banos, and the San Luis National Wildlife Refuge, which is neighboring the Grassland Bypass Project area, the California Department of Fish and Game's Natural Diversity Data Base lists one occurrence of San Joaquin kit fox. However, other information within this office discloses numerous sightings in the area (Service file # 1-1-00-F-0104; Dennis Woolington, Service, pers. comm.). In the northern geographic range, agricultural and residential development in the Valley floor have pushed the kit fox populations to the foothills on the western edge of the Valley, and today, is concentrated west of Interstate 580 and the California Aqueduct in eastern Contra Costa County and Alameda County. The largest extant populations are in the Elk Hills and Buena Vista Petroleum Reserve in Kern County and the Carrizo Plain Natural Area in San Luis Obispo County.

Reason for Decline and Threats to Survival: Reasons for decline are attributed to a combination of loss of habitat, barriers to migration, competition and predation by red fox (*Vulpes vulpes*) and coyotes (*Canis latrans*), direct and indirect poisoning by rodenticides, reduction in prey, illegal shooting and trapping, and vehicle strikes. Rodent (ground squirrel) eradication programs were carried out by many counties in the 1930's through the 1970's. By the late 1970's, the counties passed the choice of rodent control to private landowners, most of whom continued the process (Bell 1994). Kit foxes can be poisoned by either directly ingesting the poison, or feeding on a ground squirrel or other rodents that have ingested poison. Conversion of natural lands to agriculture has restricted the kit fox to the eastern portions of Alameda and Contra Costa counties and western border of San Joaquin Valley. Intensive agriculture, urbanization, and other land-modifying actions have eliminated extensive portions of habitat and are the most significant causes of this species endangerment.

Environmental Baseline: Loss and degradation of habitat by agricultural, industrial, urban development, and associated practices continue, decreasing the carrying capacity of remaining habitat and threatening kit fox survival. Less than 20% of the habitat within the historical range of the kit fox remained when the subspecies was listed as federally endangered in 1967, and with the continuing net loss of habitat since that time, less than 150,000 acres of Valley floor habitat remains uncultivated and undeveloped. During 1990 to 1996, a gross total of approximately 71,500 acres of habitat was converted to farmland in 30 counties within the Conservation Program Focus area of the Central Valley Project. This figure includes 42,520 acres of grazing land, such as is found in the south Grasslands area, and 28,854 acres of "other" land, which is predominantly comprised of native habitat. During this same time period, approximately 101,700 acres were converted to urban land use within the Conservation Program Focus area (CDFG 1992, 1998). This figure includes 49,705 acres of farmland, 20,476 acres of grazing land, and 31,366 acres of "other" land, which is predominantly comprised of native habitat. Because these assessments included a substantial portion of the San Joaquin Valley and adjacent foothills, they provide the best scientific and commercial information currently available regarding the patterns and trends of land conversion within the kit fox's geographic range.

The San Joaquin kit fox population around the Los Banos and Santa Nella area has been strongly impacted by land conversions, road development and urbanization. From 1999 to present, the Service has authorized incidental take for at least 10 projects within Kern, San Luis Obispo, Merced, Madera, Tulare and Kings counties resulting in approximately 16,300 acres of San Joaquin kit fox habitat lost or degraded (Service 2001). From 1991 to 2000, in the northern portion of the San Joaquin kit fox range, the Service has authorized incidental take for twelve projects in Alameda, Contra Costa, San Joaquin, and Stanislaus Counties that have resulted in the loss or degradation of 2,503.5 acres of San Joaquin kit fox habitat (Service 2001). Compensation measures for these projects protected or will protect 2,908 acres of kit fox habitat within this area. However, many of these conservation measures are in the form of conservation easements, and for the most part, the lands are not actively managed for kit fox.

Although there have been sightings of kit fox in the northern range through the years by certified biologists, population studies in this area have been largely limited. In 1982 and 1983, a family of kit fox was radio collared and monitored near Bethany Reservoir (Hall 1983). From 1985 to 1989, kit fox surveys in the Kellogg Creek watershed found a total of 114 potential and possibly active dens, most of which were associated with ground squirrel colonies (Jones & Stokes Associates 1989). Service biologists estimate that remaining suitable habitat can support approximately 17 to 20 breeding pairs of kit foxes (Bell 2000, personal communication).

The small size of the population and its isolation from other established populations make this northern most population vulnerable to extinction owing to predation and competition from coyotes and red foxes, inbreeding, catastrophic events, and disease epidemics (White *et al.* 2000). Genetic studies conducted by Schwartz *et al.* (2000) found that the Los Banos population near San Luis Reservoir only interbreeds with the northern population in Alameda and Contra Costa counties. Thus, projects in Alameda and Contra Costa County that significantly reduce travel corridors and population size could potentially impact the Los Banos kit fox population. The long term viability of both population depends, at least in part, on periodic immigration and gene flow from between the populations.

In the northern population, Interstate 580, as it turns west through the Altamont Pass area, impedes the north-south travel of San Joaquin kit foxes. And although the canal system facilitates north-south migration along its length, it also impedes lateral kit fox travel. Recent development proposals are further threatening to permanently isolate the northern population.

California Department of Transportation (Caltrans) is currently planning the expansion of a truck bypass where Highway 580 merges with Highway 205 east of the Midway exit. This and future plans to expand Highway 580 as it crosses the Altamont Pass will further impede the north-south movement of the kit fox. Additionally, natural habitats and pasture lands that serve as habitat and corridor for the kit fox are rapidly being converted to irrigated croplands, residential or commercial developments.

Along Midway Road, the vast pastures that once covered the area have been subdivided into small ranchettes. The Altamont Speedway attracts thousands of visitors on the weekends, significantly increasing vehicle traffic on Midway Road at dusk when kit foxes are most active. Further south on Midway Road, Pacific Gas and Electric Company (PG&E) is expanding the Tesla substation to meet current and future development needs. PG&E is currently working with the Service to obtain an incidental take permit for this expansion, and construction is expected to start in October 2000. Just to the east of the substation, the development and expansion of the Musco Olive processing plant removed 220 acres of natural habitat. Further east, the planned development of Golden Gate Auto Auction and Patterson Pass Business Park would impede the movement of kit fox through the otherwise open corridor between California Aqueduct and Delta Mendota Canal.

The San Joaquin kit fox is already at a point where its survival and recovery are tenuous and cannot be ensured in the long-term owing to the magnitude of historical habitat losses, an expanding agricultural base, and increasing municipal and industrial development. Hence, any future, unmitigated land conversions that contribute to a net loss of habitat, or result in the removal of native habitat, can reasonably be expected to reduce the likelihood of both the survival and recovery of the kit fox. Therefore, the status of kit fox, which has been declining since its listing, is expected to continue in a downward trend unless measures to protect, restore, and sustain remaining habitats, and the ecosystem processes upon which they depend, are immediately implemented. The protection of the remaining travel corridor, particularly west of Interstate 5, and the California aqueduct, is vital to the survival of this population. In response the drastic loss of habitat, CalTrans and the Service convened a San Joaquin Kit Fox Conservation and Planning Team to address the rapid decline of kit fox habitat in the northern range, and increasing barriers to kit fox dispersal. Consisting of Federal, state, and local agencies, local land trusts, environmental groups, researchers, and other concerned individuals, the goal of this team is to proactively implement actions that will recover the species, and troubleshoot threats to San Joaquin kit foxes as they emerge (e.g., 580 highway expansion, increasing red fox population).

Mountain Plover (*Charadrius montanus*)

Species description and life history: The mountain plover was proposed for Federal listing as threatened on February 16, 1999 (64 **FR** 7587). The mountain plover is about 9 inches in length, and is slightly smaller than the killdeer, both of which are in the plover family (Charadriidae). The mountain plover is drab and brownish in winter, the season when it can be found in California's Central Valley. Breeding occurs in the summer in the western plains states. California lists the mountain plover as a Species of Special Concern.

The mountain plover is associated with shortgrass and shrub-steppe landscapes throughout its breeding and wintering range. Mountain plovers evolved on grasslands populated by large numbers of grazing animals such as the bison, pronghorn, and elk, and inhabited by burrowing animals such as kangaroo rats, badgers, and prairie dogs (Knopf 1996a). These herbivores dominated both the wintering and breeding areas, and their grazing, wallowing, and burrowing activities created and maintained a mosaic of vegetated and bare areas to which the mountain plover became adapted (Dobkin 1994, Knopf 1996a). Unlike most plovers, mountain plovers are rarely found near water. Habitat in its wintering grounds includes open fields, heavily denuded areas, and other open areas. Mountain plovers forage for insects and can be seen running rapidly along the ground and suddenly stopping. Although cultivated land is used by plovers, Knopf and Rupert (1995) found that plovers showed a preference for alkali flats, burned grasslands, and grazed annual grasslands to cultivated sites. Mountain plovers spend about five months in wintering habitat, and begin leaving winter habitat about mid-March (Knopf and Rupert 1995, 1996).

In California, mountain plovers use habitat that is also commonly used by the federally listed giant kangaroo rat and blunt-nosed leopard lizard. Mountain plovers also occur on cultivated lands and sod farms. However, research in the San Joaquin, California has determined that while mountain plovers are commonly seen on agricultural lands, they actually prefer the remaining natural landscapes to the agricultural lands.

Historical and current distribution: Mountain plovers spend the summer in the Great Plains, and migrate across the Rocky Mountains in both spring and fall. Historically, mountain plovers have been observed wintering in California, Arizona, Texas, Nevada, the coastal islands of San Clemente Island, Santa Rosa Island and the Farallon Islands (Strecker 1912, Swarth 1914, Alcorn 1946, Jurek 1973, Garrett and Dunn 1981, Jorgenson and Ferguson 1984). In Mexico, wintering mountain plovers have been spotted in Baja California, Chihuahua, Coahilla, Sonora, Nuevo Leon, and San Luis Potosi (Russell and Lamm 1978).

Winter range of the mountain plover is primarily in the Sacramento, San Joaquin, and Imperial valleys of California and approximately 90 percent of mountain plovers are frequently reported from two areas–the Central Valley west of Highway 99 and south of Sacramento, and the Imperial Valley of southern California. Throughout these areas, sightings occur on agricultural fields and noncultivated sites; noncultivated sites are preferred habitat (Knopf and Rupert 1995). Within the Central Valley, flocks of up to 1,100 birds have been seen recently in Tulare County (Knopf and Rupert 1995). The Carrizo Plain Natural Area in San Luis Obispo County also is recognized as an important wintering site, with wintering birds reliably reported from the west side of the Carrizo Plain Natural Area since 1971 (S. Fitton, in litt., 1992). The Sacramento Valley portion of the Central Valley also provides wintering habitat for flocks of mountain plovers within Solano and Yolo Counties. During the 1998 census, 230 and 187 mountain plovers were observed within each of these counties, respectively (Hunting and Fitton, in press). Wintering populations of plovers in California have been declining (Garrett and Dunn 1981, Andrews and Righter 1992).

Reasons for decline: Breeding Bird Surveys from 1966-1987 show a 61 percent range wide decline in mountain plover populations. Conversions of grassland habitat, agricultural practices (including heavy pesticide use), livestock management practices, and the decline of native herbivores are factors that have likely contributed to the decline of mountain plover populations. In particular, pesticides are applied to mountain plover wintering areas while plovers are present (Knopf 1996b). Secondary effects of pesticides on breeding behavior and reproductive success may also be contributing to the population decline. Shorebird and mountain plover habitat contamination in the San Joaquin valley and the Grasslands Ecological Area has occurred from agricultural drain water used to flood wetlands and resulted in biological accumulation of selenium sufficient to harm reproduction of shorebirds and other wildlife (Ohlendorf *et al.* 1987).

Mountain plovers are attracted to sites that are disturbed by grazing and burning. Consequently, mountain plovers are found on sites that are heavily grazed, have been burned to manipulate the vegetative structure and composition, or that have been cultivated in the spring. The most recent data show that the type of implement used for tillage and the timing of tillage are important factors in mountain plover survival on cultivated lands.

Environmental Baseline: Most of the California wintering mountain plovers, principally in the San Joaquin Valley, an area experiencing high rates of human population growth. Today the mountain plover is considered endangered in Canada, a species of special interest or concern in Montana and Oklahoma, extirpated in North Dakota and South Dakota, on the watch list in Kansas, threatened in Nebraska and proposed as threatened in California. The U.S. Fish and Wildlife Service is considering listing the mountain plover as endangered or threatened throughout its range. Current population trends estimate mountain plover numbers to be less than 10,000, and the population has declined by at least 50 percent since 1966, according to 30 years of Breeding Bird Survey data, which is the highest rate of decline of any other grassland bird.

On wintering grounds in California, as many as 10,000 mountain plovers were repeatedly counted in the San Joaquin Valley during the 1960's (J. Engler, U.S. Fish and Wildlife Service, in litt., 1992). The 1998 California Bird Census found a total of 2,179 mountain plovers in 10 California counties, including Imperial, Kings, Los Angeles, Monterey, Riverside, San Benito, San Luis Obispo, San Bernardino, Solano, and Yolo counties (Hunting and Fitton, in press). Plovers are believed also to winter in portions of Kern County.

Giant Garter Snake (*Thamnophis gigas*)

Species Description and Life History: The Service published a proposal to list the giant garter snake as an endangered species on December 27, 1991 (56 **FR** 67046). The Service reevaluated the status of the giant garter snake before adopting the final rule. The giant garter snake was listed as a threatened species October 20, 1993 (58 **FR** 54053).

The giant garter snake is one of the largest garter snakes, reaching a maximum total length of at least 64 inches (160 centimeters). Females tend to be slightly longer and proportionately heavier than males. The weight of adult female giant garter snakes is typically 1.1-1.5 pounds (500-700 grams). Dorsal background coloration varies from brownish to olive with a checkered pattern of black spots, separated by a yellow dorsal stripe and two light-colored lateral stripes. Background coloration and prominence of the black checkered pattern and the three yellow stripes are geographically and individually variable. The ventral surface is cream to olive or brown and sometimes infused with orange, especially in northern populations (Hansen 1980). Garter snakes from the Grasslands/Los Banos are generally lighter colored than those from elsewhere (Wylie 1998).

Endemic to wetlands in the Sacramento and San Joaquin valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals and rice fields, and the adjacent uplands. Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941, Hansen 1980, Hansen 1988). Essential habitat components consist of: (1) adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) upland habitat with grassy banks and openings in waterside vegetation for basking; and (4) higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter (Hansen 1980). Giant garter snakes are typically absent from larger rivers and other water bodies that support introduced populations of large, predatory fish, and from wetlands with sand, gravel, or rock substrates (Hansen 1980, Rossman and Stewart 1987, Brode 1988, Hansen 1988). Riparian woodlands do not typically provide suitable habitat because of excessive shade, lack of basking sites, and absence of prey populations (Hansen 1980).

Foraging ecology - Giant garter snakes are extremely aquatic, are rarely found away from water, forage in the water for food, and will retreat to water to escape predators and disturbance. This species occupies a niche similar to some eastern water snakes (*Nerodia* spp.). Giant garter snakes are active foragers, feeding primarily on aquatic prey such as fish and amphibians. Historically, prey likely consisted of Sacramento blackfish (*Orthodon microlepidotus*), thick-tailed chub (*Gila crassicauda*), and red-legged frog (*Rana aurora*). Because these species are no longer available (the thick-tailed chub is extinct, the red-legged frog is extirpated from the Central Valley, and the blackfish is declining/in low numbers), the predominant food items are now introduced species such as carp (*Cyprinus carpio*), mosquito-fish (*Gambusia affinis*), bullfrogs (*Rana catesbiana*), and Pacific tree frogs (*Pseudacris regilla*) (Fitch 1941, Rossman *et al.* 1996).

The breeding season extends through March and April, and females give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 (Hansen and Hansen 1990). At birth young average about 20.6 cm snout-vent length and 3-5 g. Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by one year of age (G. Hansen, personal communication). Sexual maturity averages three years in males and five years for females (G. Hansen, personal communication.).

The giant garter snake inhabits small mammal burrows and other soil crevices above prevailing flood elevations throughout its winter dormancy period (i.e., November to mid-March). Giant garter snakes typically select burrows with sunny exposure along south and west facing slopes. Giant garter snakes also use burrows as refuge from extreme heat during their active period. The Biological Resources Division (BRD) of the USGS (Wylie *et al.* 1997) has documented giant garter snakes using burrows in the summer as much as 165 feet (50 meters) away from the marsh edge. Overwintering snakes have been documented using burrows as far as 820 feet (250 meters) from the edge of marsh habitat.

During radiotelemetry studies conducted by the BRD, giant garter snakes typically moved little from day to day. However, total activity varied widely between individuals. Snakes have been documented moving up to 5 miles (8 kilometers) over the period of a few days (Wylie *et al.* 1997). In agricultural areas, giant garter snakes were documented using rice fields 19-20% of the observations, marsh habitat 20-23% of observations, and canal and agricultural waterway habitats 50-56% of the observations (Wylie *et al.* 1997). Within canal and agricultural waterway habitats, giant garter snakes are likely to prefer drainage rather than delivery canals, because drainage canals are often less heavily maintained and are allowed to become vegetated.

Historic and Current Distribution: Fitch (1941) described the historical range of the species as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield, in Kern County. Prior to 1970, the giant garter snake was recorded historically from 17 localities (Hansen and Brode 1980). Five of these localities were clustered in and around Los Banos, Merced County, and the paucity of information makes it difficult to determine precisely the species' former range. In 1998, eleven giant garter snakes were captured in the Grasslands Basin area. Of these, ten were from the northern Grasslands region: seven were caught in Los Banos National Wildlife Refuge (NWR) and three were from Volta NWR (Wylie, 1998). Eleven additional individuals were captured in 1999 from the Volta Wildlife Area (Beam *et al.* 1999). These records coincide with the historical distribution of large flood basins, fresh water marshes, and tributary streams. Reclamation of wetlands for agriculture and other purposes apparently extirpated the species from the southern one-third of its range by the 1940's-1950's, including the former Buena Vista Lake and Kern Lake in Kern County, and the historic Tulare Lake and other wetlands in Kings and Tulare Counties (Hansen and Brode 1980, Hansen 1980). Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley.

As recently as the 1970s, the range of the giant garter snake extended from near Burrel, Fresno County (Hansen and Brode 1980), northward to the vicinity of Chico, Butte County (Rossman and Stewart 1987). California Department of Fish and Game (CDFG) studies (Hansen 1988) indicate that giant garter snake populations currently are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn Counties; along the western border of the Yolo Bypass in Yolo County; and along the eastern fringes of the Sacramento-San Joaquin River delta from the Laguna Creek-Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County. This distribution largely corresponds with compatible agricultural land uses throughout the Central Valley.

Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley. Currently, the Service recognizes 13 separate populations of giant garter snakes, with each population representing a cluster of discrete locality records (58

FR 54053). The 13 extant population clusters largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley (Hansen 1980, Brode and Hansen 1992): (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin–Willow Slough, (6) Yolo Basin–Liberty Farms, (7) Sacramento Basin, (8) Badger Creek--Willow Creek, (9) Caldoni Marsh, (10) East Stockton--Diverting Canal and Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrel/Lanare. These populations span the Central Valley from just southwest of Fresno (i.e., Burrel-Lanare) north to Chico (i.e., Hamilton Slough). The 11 counties where the giant garter snake is still presumed to occur are: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo.

In 1994, the BRD (formerly the National Biological Survey [NBS]) began a study of the life history and habitat requirements of the giant garter snake in response to an interagency submission for consideration as an NBS Ecosystem Initiative. Since April of 1995, the BRD has further documented occurrences of giant garter snakes within some of the 13 populations identified in the final rule. The BRD has studied populations of giant garter snakes at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, and at the Badger Creek area of the Cosumnes River Preserve within the Badger Creek-Willow Creek area (Wylie *et al.* 1997). These populations, along with the American Basin population of giant garter snakes represent the largest extant populations. With the exception of the American Basin, these populations are largely protected from many of the threats to the species. Outside of these protected areas, giant garter snakes in these population clusters are still subject to all threats identified in the final rule. The remaining nine population clusters identified in the final rule are distributed discontinuously in small isolated patches and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes. All 13 population clusters are isolated from each other with no protected dispersal corridors. Opportunities for recolonization of small populations which may become extirpated are unlikely given the isolation from larger populations and lack of dispersal corridors between them.

Reasons for Decline and Threats to Survival: The current distribution and abundance of the giant garter snake are much reduced from former times. Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in former wetlands associated with the historic Buena Vista, Tulare, and Kern lake beds. These lake beds once supported vast expanses of ideal giant garter snake habitat, consisting of cattail and bulrush dominated marshes. Vast expanses of bulrush and cattail floodplain habitat also typified much of the Sacramento Valley historically. Prior to reclamation activities beginning in the mid to late 1800's, about 60 percent of the Sacramento Valley was subject to seasonal overflow flooding in broad, shallow flood basins that provided expansive areas of giant garter snake habitat (Hinds 1952). All natural habitats have been lost and an unquantifiable small percentage of semi-natural wetlands remain extant. Only a small percentage of these wetlands currently provide habitat suitable for the giant garter snake. Valley floor wetlands are subject to the cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development. Although some giant garter snake populations have persisted at low levels in artificial wetlands associated with agricultural and flood control activities, many of these altered wetlands are now threatened with urban development. Cities within the current range of the giant garter snake that are rapidly expanding include: (1) Chico, (2) Yuba City/Marysville, (3) Sacramento, (4) Galt, (5) Stockton, (6) Gustine, and (7) Los Banos.

A number of land use practices and other human activities currently threaten the survival of the giant garter snake throughout the remainder of its range. Ongoing maintenance of aquatic habitats for flood control and agricultural purposes eliminate or prevent the establishment of habitat characteristics required by giant garter snakes and can fragment and isolate available habitat, prevent dispersal of snakes among habitat units, and adversely affect the availability of the garter snake's food items (Hansen 1988, Brode and Hansen 1992). Livestock grazing along the edges of water sources degrades habitat quality in a number of ways: (1) eating and trampling aquatic and riparian vegetation needed for cover from predators, (2) changes in plant species composition, (3) trampling of snakes, (4) water pollution, (5) and reducing or eliminating fish and amphibian prey populations. Overall, grazing has contributed to the elimination and reduction of the quality of available habitat at four known locations (Hansen 1982, 1986).

In many areas, the restriction of suitable habitat to water canals bordered by roadways and levee tops renders giant garter snakes vulnerable to vehicular mortality. Fluctuation in rice and agricultural production affects stability and availability of habitat. Recreational activities, such as fishing, may disturb snakes and disrupt basking and foraging activities. Non-native predators, including introduced predatory game fish, bullfrogs, and domestic cats also threaten giant garter snake populations. While large areas of seemingly suitable giant garter snake habitat exist in the form of duck clubs and waterfowl management areas, water management of these areas typically does not provide summer water needed by giant garter snakes. Although giant garter snakes on National Wildlife Refuges are relatively protected from many of the threats to the species, water quality continues to be a threat to the species both on and off NWRs.

Populations in vicinity of selenium contamination - San Joaquin Valley sub-populations of giant garter snakes have suffered severe declines and possible extirpations over the last two decades. Prior to 1980, several areas within the San Joaquin Valley supported populations of giant garter snakes. Until recently, there were no post-1980 sightings from Stockton, San Joaquin County, southward, despite several survey efforts (Hansen 1988). Surveys during 1986 of prior localities did not detect any giant garter snakes. During 1995 surveys of prior locality records and adjacent waterways, one road-killed giant garter snake was found, and three presumed giant garter snakes were observed but not captured. Two sightings occurred at Mendota Wildlife Area, and two occurred several miles south of the town of Los Banos (Hansen 1996). In April 1998 the Dixon Field Station of the Western Ecological Research Center (U.S. Geological Survey) began a survey for giant garter snakes in the San Joaquin Valley. The effort yielded the capture of seven female and four male giant garter snakes, for a total of 11 individuals. The majority of the snakes were caught in the North Grasslands; seven were caught in Los Banos Creek west of Kesterson National Wildlife Refuge, three were caught at the Volta State Wildlife Area, and one was caught in the South Grasslands. Snake densities in the San Joaquin Valley seemed extremely low in comparison to study areas in the Sacramento Valley (Wylie 1998). In 1999, surveys for giant garter snake were conducted by the California Department of Fish and Game out of the Los Banos Wildlife Area and were performed according to U.S. Geological Survey protocols. Fourteen new giant garter snakes were captured and eleven were recaptured as part of this effort. No captures were made in the Los Banos Wildlife Area. Fifteen snakes were captured in Los Banos Creek, and eleven at Volta State Wildlife Area. All of these recent sightings were in areas to the west of surface waters that have been impacted by agricultural drainage discharges.

In addition to California Department of Fish and Game surveys in 1999, M. Paquin of the U.S. Geological Survey conducted walking surveys in the South Grasslands during May and June 1999. Three snakes were located as a result of the surveys, two road kills and one live-capture. The live snake was captured in the Agatha Canal, one road kill was found on Santa Fe Grade Road, and one on Mallard Road near the Agatha Canal (Beam *et al.*, 1999). The sightings are within or near the Grassland Wetland Supply Channels, where water quality has improved since the onset of the Grassland Bypass Project.

Although habitat has been lost or degraded throughout the Central Valley, there have been many recent sightings of giant garter snakes in the Sacramento Valley while there have been very few recent sightings within the San Joaquin Valley. The 1995 report on the status of giant garter snakes in the San Joaquin Valley (Hansen 1996) indicates that Central San Joaquin Valley giant garter snake numbers appear to have declined even more dramatically than has apparently suitable habitat. Factors in addition to habitat loss may be contributing to the decline. These are factors that affect giant garter snakes within otherwise suitable habitat and include interrupted water supply, poor water quality, and contaminants (Hansen 1996). The recent survey data indicate that giant garter snakes are still extant in two localities within the San Joaquin, but in extremely low to undetectable numbers.

Selenium contamination and impaired water quality have been identified in the final rule listing the giant garter snake as a threat to the species and a contributing factor in the decline of giant garter snake populations, particularly for the North and South Grasslands subpopulation (i.e., Kesterson NWR area). The bioaccumulative food chain threat of selenium contamination on fish, frogs, and fish-eating birds has been well documented. Though there is little data specifically addressing toxicity of selenium (Se), mercury (Hg), or metals to reptiles, it is expected that reptiles would have toxicity thresholds similar to those of fish and birds. (58 **FR** 54053 under Factor E - Contaminants)

Threats due to contaminants and impaired water quality: The range of the giant garter snake occurs entirely within the Central Valley of California, putting giant garter snakes at risk of exposure to numerous contaminants from agricultural, urban, and industrial/mining runoff. Current water sources and supplies to areas supporting giant garter snakes indicate that the species is at risk of exposure to both mercury and selenium. Many areas that once supported populations of giant garter snake have received water from agricultural drainage, which may contain elevated levels of selenium or other contaminants. Selenium contamination of drain water has been identified in the San Joaquin Valley giant garter snake subpopulations (58 **FR** 54053 and references therein). In addition, streams draining the coastal ranges may contribute selenium to aquatic systems within the Central Valley.

Summary of contaminants threats to giant garter snakes: The giant garter snake has a restricted distribution and is entirely dependent on its aquatic ecosystem. The thirteen population clusters identified in the final rule are distributed discontinuously in small isolated patches and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes. The small number of individual giant garter snakes found within the extensive wetland areas of the Grasslands Water District of the San Joaquin Valley, which for much of the last twenty years received seleniferous irrigation drainage water, may be circumstantial evidence of a selenium effect on this top aquatic predator. It is that elevated selenium levels in the San Joaquin Valley contributed to the severe decline or extirpation of the giant garter snake from the majority of this area. The remaining giant garter snake populations are exposed to impaired water bodies and existing or potential sources of selenium. As top predators, giant garter snakes are at risk of exposure to elevated levels of contaminants such as mercury and selenium. Over the life of the giant garter snake it is possible to accumulate contaminants that can impact the growth, survival, and reproduction of individuals, leading to declines in distribution. Water quality impairment of aquatic habitat that supports giant garter snakes could also reduce the prey base, contribute to bioaccumulation, impair essential behaviors, and reduce reproductive success.

Delta Smelt (*Hypomesus transpacificus*)

Species Description and Life History: The delta smelt was federally listed as a threatened species on March 5, 1993 (58 **FR** 12854). On December 19, 1994, a final rule designating critical habitat for the delta smelt was published in the Federal Register (59 **FR** 65256). Critical habitat for delta smelt was originally proposed in the lower Sacramento-San Joaquin Delta and Suisun and Honker bays. However, after considerable debate, critical habitat was reproposed and is now contained within Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties. Critical habitat was designated for the delta smelt in 1994. Critical habitat for this species encompasses Suisun Bay (including Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; and the existing contiguous waters of the Delta, as defined in section 12220 of the California Water Code.

The delta smelt is a slender-bodied fish with a steely blue sheen on the sides, and appears almost translucent (Moyle 1976). They have an average length of 60 to 70 mm (about two to 3 inches).

Final Biological Opinion, September 27, 2001
Regional Director, Mid-Pacific Region, U.S. Bureau of Reclamation

The delta smelt is a euryhaline species (tolerant of a wide salinity range) that spawns in fresh water and has been collected from estuarine waters up to 14 parts per thousand (ppt) salinity (Moyle *et al.* 1992). For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone (a saltwater-freshwater interface; also called X2), where the salinity is approximately two ppt (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993).

The delta smelt is adapted to living in the highly productive San Francisco Bay/Delta Estuary (Estuary) where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively constant suitable habitat conditions for the delta smelt because it could move upstream or downstream with the mixing zone (P.B. Moyle, personal communication 1993).

Feeding ecology: Delta smelt feed primarily on planktonic copepods, cladocerans (small crustaceans), amphipods, and to a lesser extent, insect larvae. Larger fish may also feed on the opossum shrimp (*Neomysis mercedis*). The most important food item for all age classes is the euryhaline copepod (*Eurytemora affinis*). Delta smelt are a pelagic fish and their food source is within the water column.

Spawning and rearing: Shortly before spawning, adult delta smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966, Moyle 1976, Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Project's (CVP) Tracy Pumping Plant from late December 1990 to April 1991 (Wang 1991). Spawning locations appear to vary widely from year to year (DWR and USDI 1993). Sampling of larval delta smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Dale Sweetnam, Calif. Dept. Of Fish and Game, personal communication, Wang 1991). Delta smelt also may spawn north of Suisun Bay in Montezuma and Suisun sloughs and their tributaries (Dale Sweetnam, Calif. Dept. Of Fish and Game, personal communication.).

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976, Wang 1986, 1991, Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), the adhesive, demersal eggs are thought to attach to substrates such as cattails, tules, tree roots, and submerged branches (Moyle 1976, Wang 1991).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were most common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1994 as cited in DWR & USDI 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Laboratory observations indicate that delta smelt are broadcast spawners that spawn in a current, usually at night, distributing their eggs over a local area (Lindberg 1992 and Mager 1993 as cited in DWR & USDI 1994). The eggs form an adhesive foot that appears to stick to most surfaces. Eggs attach singly to the substrate, and few eggs were found on vertical plants or the sides of a culture tank (Lindberg 1993 as cited in DWR & USDI 1994).

Delta smelt eggs hatched in nine to 14 days at water temperatures ranging from 13° to 16° C during laboratory observations in 1992 (Mager 1992 as cited in Sweetnam and Stevens 1993). In this study, larvae began feeding on phytoplankton on day four, rotifers on day six, and *Artemia* nauplii at day 14. In laboratory studies, yolk-sac fry were found to be positively phototaxic, swimming to the lightest corner of the incubator, and negatively buoyant, actively swimming to the surface. The post-yolk-sac fry were more evenly distributed throughout the water column (Lindberg 1992 as cited in DWR & USDI 1994). After hatching, larvae and juveniles move downstream toward the mixing zone where they are retained by the vertical circulation of fresh and salt waters (Stevens *et al.* 1990). The pelagic larvae and juveniles feed on zooplankton. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980).

Swimming behavior: Observations of delta smelt swimming in the swimming flume and in a large tank show that these fish are unsteady, intermittent, slow-speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<three body lengths per second), and during spontaneous, unrestricted swimming in a 1-meter tank, delta smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50 percent for "stroke and glide" swimming compared to steady swimming. However, the maximum speed delta smelt are able to achieve using this preferred mode of swimming, or gait, is less than three body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Juvenile delta smelt proved stronger swimmers than adults. Forced swimming at these speeds in a swimming

flume was apparently stressful; the fish were prone to swimming failure and extremely vulnerable to impingement. Unlike fish for which these types of measurements have been made in the past, delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (e.g., metabolic scope for activity; Brett 1952).

Historic and Current Distribution: The delta smelt is endemic to Suisun Bay upstream of San Francisco Bay through the Delta in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California. Historically, the delta smelt is thought to have occurred from Suisun Bay upstream at least to the city of Sacramento on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993). The Interagency Ecological Program's (IEP) 20mm Survey recorded smelt south of Stockton, at the Mossdale sampling site on the San Joaquin River, in 1996, 1997, 1999 and 2000 (California Department of Fish and Game, unpublished data, 2000). In 1996, 1998, 1999, and 2000 smelt were also collected in the Napa River.

Reasons for Decline and Threats to Survival: The delta smelt is adapted to living in the highly productive Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively consistent spring transport flows that moved delta smelt juveniles and larvae downstream to the mixing zone (P. Moyle, personal communication). Since the 1850's, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to increased siltation and alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992).

In addition to the degradation and loss of estuarine habitat, the delta smelt has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of drought and the steadily increasing proportion of river flow being diverted from the Delta by the CVP and State Water Project (SWP) (Monroe and Kelly 1992). The relationship between the portion of the delta smelt population west of the Delta as sampled in the summer tow-net survey and the natural logarithm of Delta outflow from 1959 to 1988 (DWR and USDI 1994) indicates that the summer tow-net index increased dramatically when outflow was between 34,000 and 48,000 cubic feet per second (cfs), which placed X2 between Chipps and Roe islands. Placement of X2 downstream of the Confluence, Chipps and Roe islands provides delta smelt with low salinity and protection from entrainment, allowing for productive rearing habitat that increases both smelt abundance and distribution.

Recreation in the Delta has resulted in the presence and propagation of predatory non-native fish such as striped bass (*Morone saxatilis*). Additionally, recreational boat traffic has led to a loss of habitat from the building of docks and an increase in the rate of erosion resulting from boat wakes. In addition to the loss of habitat, erosion reduces the water quality and retards the production of phytoplankton in the Delta.

Reduced water quality from agricultural runoff, effluent discharge and boat effluent has the potential to harm the pelagic larvae and reduces the availability of the planktonic food source. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). The introduction of the Asian clam (*Potamocorbula amurensis*), a highly efficient filter feeder, presently reduces the concentration of phytoplankton in this area.

Please refer to the Service (USDI-FWS 1994, 1996) and Department of Water Resources and United States Department of Interior - Bureau of Reclamation (DWR and USDI 1994) for additional information on the biology and ecology of this species.

Delta Smelt Critical Habitat

Primary Constituent Elements of Critical Habitat: In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration.

Spawning habitat: Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

Larval and juvenile transport: Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin Rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the "entrapment zone" or zone where particles, nutrients, and plankton are "trapped," leading to an area of high productivity, is associated with its location. Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.

Rearing habitat: An area extending eastward from Carquinez Strait, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts of export pumping and salinity intrusion from the beginning of February to the end of August.

Adult migration: Adequate flow and suitable water quality are needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods.

Delta smelt critical habitat has been affected by activities that destroy spawning and refugial areas and change hydrology in Delta waterways. Critical habitat also has been affected by diversions that have shifted the position of X2 upstream of the confluence of the Sacramento and San Joaquin rivers. This shift has caused a decreased abundance of delta smelt. Existing baseline conditions and implementation of the Service's 1994 and 1995 biological opinions concerning the operation of the CVP and SWP, provide a substantial part of the necessary positive riverine flows and estuarine outflows to transport delta smelt larvae downstream to suitable rearing habitat in Suisun Bay outside the influence of marinas, agricultural diversions, and Federal and State pumping plants.

Environmental Baseline of Delta smelt

According to the seven abundance indices which provide information on the status of the smelt, this species was consistently at low population levels through the 1980's (Stevens *et al.* 1990). These same indices also showed a pronounced decline from historical levels of abundance (Stevens *et al.* 1990).

For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone, where the salinity is approximately 2 ppt (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993). The relationship between the portion of the smelt population west of the Delta as sampled in the summer tow-net survey and the natural logarithm of Delta outflow from 1959 to 1988, indicates the summer tow-net index increased dramatically when outflow was between 34,000 and 48,000 cfs, placing X2 between Chipps and Roe islands (DWR and USDI 1994).

Specifically, the summer tow-net abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959). The summer tow-net abundance index measures the abundance and distribution of juvenile smelt and provides data on the recruitment potential of the species. Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found. These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence.

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration. The index that is calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled. Until recently, except for 1991, this index has declined irregularly over the past 20 years (California Department of Fish and Game, unpublished data, 1999). Since 1983, the smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded. The 1994 FMWT index of 101.2 was a continuation of this trend. This occurred despite the high 1994 summer tow-net index for reasons unknown. The low 1995 summer tow-net index value of 3.3 was followed by a high FMWT index of 839, reflecting the benefits of large transport and habitat maintenance flows due to an extremely wet year.

The final summer tow-net index for 2000 was 8.0, a decline from the 11.9 index for the 1999 summer tow-net. Both of these indices represent an increase from the 1998 index of 3.3. However, both 1999 and 2000 indices are still below the pre-decline average of 20.4 (1959-1981, no sampling 1966-1968).

The 1999 FMWT index of 717, which is an increase from 1998's index (417.6), is the third highest since the start of decline of smelt abundance in 1982. The FMWT abundance index (127) for 1996 represented the fourth lowest on record. The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer tow-net index (4.0). Despite this recent trend, the recovery criteria, including both abundance and distribution criteria, which is based on numbers derived from the FMWT, have not been met to date.

During May and June of 1999, over 100,000 smelt were incidentally taken at the State and Reclamation water project pumps. The allocated incidental take for those two months is 20,478. Additionally, in May and June 2000, 92,000 smelt were taken at the project pumps in the south Delta in the spring of 2000, potentially reducing the population's ability to recover (USDI-BOR, unpublished data, 2000). Smelt remained in the Delta for an extended period of time in the spring of 1999 and it was hypothesized that this was a result of cooler water temperatures.

Sacramento Splittail (*Pogonichthys macrolepidotus*)

Species Description and Life History: On January 6, 1994, a proposed rule to list the Sacramento splittail (*Pogonichthys macrolepidotus*) as a threatened species was published in 59 **FR** 862. The final rule listing the Sacramento splittail as a threatened species was published on February 8, 1999, and became effective March 10, 1999 (64 **FR** 5963).

The Sacramento splittail is a large cyprinid that can reach greater than 12 inches in length (Moyle 1976). Adults are characterized by an elongated body, distinct nuchal hump, and a small blunt head with barbels usually present at the corners of the slightly subterminal mouth. This species can be distinguished from other minnows in the Central Valley of California by the enlarged dorsal lobe of the caudal fin. Sacramento splittail are a dull, silvery-gold on the sides and olive-grey dorsally. During the spawning season, the pectoral, pelvic and caudal fins are tinged with an orange-red color. Males develop small white nuptial tubercles on the head.

Feeding Ecology: Sacramento splittail are benthic foragers that in the early 1980's fed on (in rough order of importance) opossum shrimp (*Neomysis mercedis*), amphipods (*Corophium)*, and harpactacoid copepods (Daniels and Moyle 1983). Splittail feed on the bottom and apparently forage mainly during the day (Caywood 1974). After *N. mercedis* populations collapsed, mysid shrimp ceased being important in the diet, even though other, smaller mysid species have partially replaced *N. mercedis; Corophium* amphipods assumed the position of dominant prey (Feyrer and Matern 2000). In 1986, the Asiatic clam (*Potamocorbula amurensis*) invaded the Bay-Delta. This species was previously known only in the estuaries of northeastern China, Korea and Japan (Luoma and Presser, 2000). *P. amurensis* eventually replaced several other resident species in Suisun Bay after the invasion, and is now a primary food of adult splittail in the Delta (R. Stewart, USGS, pers. comm.). Predators of Sacramento splittail include striped bass and other piscivores.

Spawning behavior: Sacramento splittail are long-lived, frequently reaching five to seven years of age. Generally, females are highly fecund, producing more than 100,000 eggs each year (Daniels and Moyle 1983). Populations fluctuate annually depending on spawning success. Spawning success is highly correlated with freshwater outflow and the availability of shallow-water habitat with submersed, aquatic vegetation (Daniels and Moyle 1983). Sacramento splittail usually reach sexual maturity by the end of their second year at which time they have attained a body length of 180 to 200 mm. There is some variability in the reproductive period because older fish reproduce before younger individuals (Caywood 1974). The largest recorded individuals of the Sacramento splittail have measured between 380 and 400 mm (Caywood 1974, Daniels and Moyle 1983). Adults migrate into fresh water in late fall and early winter prior to spawning. The onset of spawning is associated with rising water temperature, lengthening photoperiod, seasonal runoff, and possibly endogenous factors from the months of March through May, although there are records of spawning from late January to early July (Wang 1986). Spawning occurs in water temperatures from 9° to 20°C over flooded vegetation in tidal freshwater and euryhaline habitats of estuarine marshes and sloughs, and slow-moving reaches of large rivers. The eggs are adhesive or become adhesive soon after contacting water (Caywood 1974, Bailey, UCD, personal communication 1994, as cited in DWR and USDI 1994). Larvae remain in shallow, weedy areas close to spawning sites and move into deeper water as they mature (Wang 1986).

Sacramento splittail can tolerate salinities as high as 10 to 18 ppt (Moyle 1976, Moyle and Yoshiyama 1992). Splittail are found throughout the Delta (Turner and Kelley 1966), Suisun Bay, and the Suisun and Napa marshes. They migrate upstream from brackish areas to spawn in freshwater. Because they require flooded vegetation for spawning and rearing, Sacramento splittail are frequently found in areas subject to flooding. Please refer to the Service (USDI-FWS 1994, 1996), and Department of Water Resources and United States Department of Interior - Bureau of Reclamation (DWR and USDI 1994) for additional information on the biology and ecology of the Sacramento splittail.

Historic and Current Distribution: Sacramento splittail are endemic to California's Central Valley where they were once widely distributed in lakes and rivers (Moyle 1976). Historically, Sacramento splittail were found as far north as Redding on the Sacramento River and as far south as the site of Friant Dam on the San Joaquin River (Rutter 1908). Rutter (1908) also found Sacramento splittail as far upstream as the current Oroville Dam site on the Feather River and Folsom Dam site on the American River. Anglers in Sacramento reported catches of 50 or more Sacramento splittail per day prior to damming of these rivers (Caywood 1974). Sacramento splittail were common in San Pablo Bay and Carquinez Strait following high winter flows up until about 1985 (Messersmith 1966, Moyle 1976, and Wang 1986 as cited in DWR & USDI 1994).

In recent times, dams and diversions have increasingly prevented upstream access to large rivers and the species is restricted to a small portion of its former range. Sacramento splittail enter the lower reaches of the Feather (Jones and Stokes 1993) and American rivers on occasion, but the species is now largely confined to the Delta, Suisun Bay, and Suisun Marsh (USDI-FWS 1994). Stream surveys in the San Joaquin Valley reported observations of Sacramento splittail in the San Joaquin River below the mouth of the Merced River and upstream of the confluence of the Tuolumne River (Saiki 1984 as cited in DWR & USDI 1994). In June 1998, Sacramento splittail were found in Mud and Salt sloughs for the first time since monitoring of biota in the Grasslands began in 1992 (Beckon *et al.* 1999). This was likely due to El Nino storms and extended high flows allowing the fish greater access to potential shallow water breeding areas in the San Joaquin Valley.

Reasons for Decline and Threats to Survival: The decline of the Sacramento splittail has been documented over the past 10 years using fall midwater trawl data. This decline has largely been due to hydrologic changes in the estuary and loss of shallow water habitat due to dredging and filling (Monroe and Kelly 1992). These changes include increases in water diversions during the spawning period of January through July. Most of the factors that caused delta smelt to decline have also influenced the decline of the Sacramento splittail. Diversions, dams and reduced contaminants.

Overutilization for commercial, recreational, scientific, or educational purposes is not currently thought to be a significant factor, though recreational and subsistence fishing has the potential to become problematic. Limited surveys have determined that at least several hundred adult splittail are captured by anglers during each spawning season. During droughts, when the splittail population is low and spawning is confined to river margins, angler catch may take an appreciable number of fish.

Disease is thought to be a factor contributing to the decline of the species. Though post-spawn adults are naturally susceptible to disease due to rigorous courtship efforts, environmental contaminants may be contributing to reduced immune system response and thus, higher than normal post spawn adult mortality. The effects of environmental contaminants are addressed in subsequent paragraphs, as their influence is beyond just increased vulnerability to disease.

Predation on splittail is thought to be significant primarily in regards to individuals migrating downstream. Spent, post-spawn adult splittail are at increased risk of predation from native and non-native predatory fish as they move from the protective isolation of floodplains to the deeper, swifter waters adjoining riprapped banks. Juvenile splittail, migrating downstream through progressively worsening habitat conditions, as well as habitat conditions that favor non-native predators, are also at a high risk of predation. Three species of non-native estuarine jellyfish have also been found in the estuary, and each is capable of preying on juvenile splittail. The presence and potential for further introductions of non-native species, and habitat conditions that favor their occurrence over native forms, is likely to have increased, and to continue to increase, splittail predation beyond historic levels. This reduces and will continue to the reproductive potential of the adult population in subsequent years as well as the recruitment of new individuals.

Non-native species also threaten the splittail via competition for finite habitat and food resources. Introduced fish, such as red shiners, golden shiners, and inland silversides may use the same floodplain habitat and their larvae compete with splittail larvae for food. Non-native jellyfish are also a threat as they compete with larval splittail for food. The jellyfish, as have Chinese mitten crabs, could also reach concentrations sufficient to impede the operation of fish screens and salvage facilities. Lastly a native copepod has been largely supplanted by three non-native forms. One of these non-native forms is difficult for larval fishes to catch because it is fast swimming and has an effective escape response. Reduced feeding efficiency and ingestion rates can weaken and slow the growth of splittail young and make them more vulnerable to starvation or predation. Reduced recruitment of new fish results in fewer fish in the population, and fewer fish which may spawn in the future.

Existing regulatory mechanisms remain inadequate to protect the species from further decline.

Section 404 of the Clean Water Act likely is being implemented with little or no tracking of the cumulative effects of projects, water pumping and diversion facilities, levee construction or repair, snagging and clearing, bank protection activities, deepwater navigation channel dredging and dredge spoil disposal projects, sand and gravel extraction, marina and bridge construction, diking of wetlands for conversion to farmland, ecosystem restoration, vessel salvage and tidal gate or barrier installation. Without an analysis of the past splittail habitat loss incurred by these activities, there is no way to evaluate the effects of present and future actions on the species.

Exports of water from the CVP and SWP pumps continue to threaten the splittail. Fish entrained at these pumps can suffer mortality from salvage, handling, and release. Predation is likely to be elevated at the release point. Continued mortality at the pumps may reduce the resilience of the splittail population and put at risk the long-term viability of the species in the estuary.

Environmental contaminants are a threat to the continued survival of splittail. Particularly near inputs of acid mine drainage within the Sacramento River watershed and in the vicinity of highly industrialized near shore areas of the lower San Francisco Bay estuary, metals such as copper, zinc, and cadmium can be directly toxic to splittail, especially in their sensitive larval stages. These metals damage gills and alter liver and nervous system functions causing death, behavioral changes, and reduced growth and reproduction. These metals can have the same effects on food items of the splittail, reducing their prey base and placing additional stress on the splittail.

Three other contaminant threats are of far greater strategic concern specifically for the continued existence of the splittail: (1) mercury, (2) selenium, and (3) agriculturally-applied organochlorine compounds. In part, these contaminant threats are of great concern because they are focused, to varying degrees, on habitat features and biological characteristics tentatively identified as particularly relevant to splittail conservation (Moyle *et al.*, 2001 Draft White Paper).

Literature exists documenting the existence of methylated mercury (primarily monomethyl mercury) in the Sacramento River and the Estuary. Research by the US Geological Survey (USGS) indicates that elevated levels of mercury in water, sediment, and biota are found throughout the Sacramento River, its tributaries, the Delta, and San Francisco Bay. The primary source of this contamination is from mercury mines in the Coast Range and from gold mines in the Sierra Nevada range. Of particular threat to splittail are the recent findings that Delta locales with the most elevated biotic mercury concentrations were linked to the Cosumnes River and Yolo Bypass systems (Slotton *et al.* 2000), which are both primary spawning areas for splittail (Moyle *et al.*, 2001, Draft White Paper). Furthermore, the Yolo Bypass apparently is hydrologically connected to Suisun Marsh, the core rearing area for splittail (Moyle *et al.*, 2001, Draft White Paper). Cosumnes River sediments have been identified as a significant source of methyl mercury (Gill 2000), the toxicologically important form, which is particularly relevant to a demersal species such as splittail which ingests large amounts of sediment associated detrital matter.

Human health advisories have been issued for mercury in certain waterfowl and fish species from the Delta and San Francisco Bay. The levels at which human health advisories are issued also are levels at which deleterious effects on fish and wildlife can be expected. Splittail are relatively long-lived fish (e.g., average life span of five to seven years), making them more susceptible to mercury bioaccumulation than shorter-lived fish. Mercury accumulated in a female fish is transferred to the embryo where it causes reduced hatching, developmental abnormalities, altered growth, and behavioral changes.

Suchanek *et al.* (2000) are investigating the role of wetland restoration involving re-flooding of mercury-contaminated soils. There is concern that reestablished wetlands could become effective pathways for the introduction of toxic methyl mercury in the Delta. Ecosystem restorations at Clear Lake, the watershed of which includes runoff from the Sulphur Bank Mercury Mine, threaten to introduce methyl mercury to Cache Creek and thus, to the Sacramento River. The Clear Lake splittail (*Pogonichthys ciscoides*), endemic to Clear Lake, is now extinct (64 **FR** 5963), though the role of mercury contamination in its loss is not known.

The Yuba River, a tributary to the Sacramento River via the Feather River, is the site of extensive deposition of historic hydraulic mining debris. Historic mining often involved the use of elemental mercury to amalgamate gold, and much was lost downstream. Current operation within the goldfields, whereby the sediments are dredged for gold, can liberate waste mercury back into the river system. The Bear River and Deer Creek watersheds, adjacent to the Yuba, also are contaminated with mercury (May *et al.* 2000, Alpers and Hunerlach 2000). Any disturbance of sediments such as from sand and gravel mining or bridge replacement in these and any other mercury-contaminated tributary stream threatens to liberate mercury presently stored in the alluvium and release it to the ecosystem, where it can adversely affect the splittail.

Recent analyses of fifteen samples of splittail collected at the Tracy Pumping Plant during May-August, 2000, revealed whole body mercury concentrations as high as 600 ug/kg (parts per billion; ppb) wet weight. Two-thirds of the samples exceeded 70 ppb mercury. Mercury intoxication of rainbow trout embryos has been observed at whole body concentrations of 70 to 100 ppb (Wiener 1995). Baker Matta *et al.* (2001) recently reported increased adult mortality among mummichogs (a euryhaline estuarine cyprinodontid fish) at whole body concentrations of 200-470 ppb, and altered sex ratios among offspring from adults whose whole body mercury concentrations were 440-1,100 ppb. At whole body mercury concentrations of 1,100-1,200 ppb transgenerational suppression of reproductive success was observed. Despite many unknowns associated with the preliminary samples from the Tracy Pumping Plant, such as the unknown origin of the fish, the unknown effect of fish size (age), and the unknown representativeness of the results (samples from the pumps are subject to whatever biases predispose individuals to being entrained), the real and present threat of mercury toxicity appears to be substantive.

Significant exposure to selenium from other sources than the San Joaquin River system may also pose a threat to splittail throughout much of its range, including the Yolo Bypass. Studies at wetlands along Willow Slough just upstream of the Yolo Bypass have documented consistent and widespread exposure of breeding mallards to selenium. Mallard eggs have contained greater than 20 mg/kg (parts per million, ppm) of selenium dry weight and about a 6 percent selenium-caused depression in egg viability has been documented via artificial incubation studies (City of Davis and USDI-FWS, unpublished data). The mallards in this study are known to feed both in the Yolo Bypass and in upstream areas adjacent to Willow Slough. Because mallards are birds, not fish, the potential significance of these findings for splittail is simply to affirm that biologically damaging aquatic selenium contamination is present just upstream of the Yolo Bypass.

Protection afforded to other listed fish, such as the delta smelt, is not sufficient to protect the splittail from the effects of contaminants. The delta smelt life history differs in that it is short lived and therefore relatively less susceptible to chronic contaminant accumulation. The delta smelt forages in midwater on organisms that themselves tend to accumulate contaminants in lower amounts. The Sacramento splittail is longer lived and is a benthic forager with a high fraction of detritus in its diet. These factors make the splittail much more vulnerable to certain contaminants and effects will be evident far earlier than they would be with delta smelt.

Pesticides are also believed to be a threat to Sacramento splittail. All major rivers that are tributary to the Delta Estuary are exposed to large volumes of agricultural and industrial chemicals that are applied in the Central Valley watershed (Nichols *et al.* 1986). Agricultural chemicals and their residues, as well as chemicals originating in urban runoff, find their way into the rivers and Estuary. Approximately 10 percent of the total pesticide use in the United States occurs in the Sacramento and San Joaquin River watersheds (Kuivila and Foe 1995). Recently, high concentrations of organophosphate and carbamate pesticides from agricultural uses have been documented entering the Delta Estuary. These pesticides are acutely and chronically toxic to zooplankton and fishes as far west as Martinez in Suisun Bay and as far south as Vernalis on the San Joaquin River (Foe 1995, Bailey *et al.* unknown date). The periods of pesticide use coincide with the timing of migration, spawning, and early development of splittail. During rainfall runoff events, acutely toxic pulses of pesticides move down the rivers and through the Estuary with remarkable persistence and relatively little dilution (Kuivila and Foe 1995).

Splittail are also very vulnerable to agriculturally applied pesticides, particularly organochlorines (including historic use), because the most important extant flood plain spawning areas are actively farmed using high-chemical techniques during the non-flood seasons. The worst known case of this phenomenon occurred at Lake Apopka, Florida, when the re-flooding of the farmed lake bed (about 13,000 acres) lead to catastrophic organochlorine poisoning of fish-eating birds (Greg Masson, Service, pers. comm.). Two of the primary chemicals implicated in the Lake Apopka event were toxaphene and DDE. Re-flooding of the Sutter and Yolo Bypasses and the use of other flooded agricultural lands by splittail for spawning will result in agriculture-related chemical exposures. Significantly, chemical analyses of the splittail samples collected at the Tracy Pumping Plant revealed elevated whole body tissue levels of both toxaphene and DDE that are either very close to, or exceeding levels known to be toxic to tested species of fish. Toxaphene concentrations in splittail ranged as high as 241 ppb wet weight. Somewhere between 200 and 400 ppb toxaphene, on a whole body basis, adverse reproductive impacts begin occurring in fish (Jarvinen and Ankley 1999). Elevated toxaphene concentrations in splittail are especially threatening because toxaphene's original use before its widespread use as an agricultural pesticide was as a piscicide (a specific "fish poison") (Eisler 1985a). DDE concentrations in splittail ranged as high as 639 ppb wet weight. Tissue concentrations as low as 290 ppb have been demonstrated to reduce the survival of salmonid fry (although adults and juveniles can tolerate higher exposures) (Jarvinen and Ankley 1999). Samples from the Tracy Pumps do not target fish known to have used flooded agricultural lands, and therefore, are certain to underestimate the true threat from organochlorine chemicals. In addition, most organochlorines are known endocrine disrupting chemicals which generally assert their effects at concentrations far below those required for direct mortality (Goodbred *et al.* 1997).

Toxicology studies of rice field irrigation drain water of the Colusa Basin Drainage Canal have documented significant toxicity of drain water to striped bass embryos and larvae, *Oryzias latipes* larvae (in the Cyprinodontidae family), and opossum shrimp, which is the major food organism of striped bass larvae and juveniles (Bailey *et al.* 1991), as well as all age classes of splittail. This drainage canal flows into the Sacramento River just north of the City of Sacramento. The majority of drain water samples collected during April and May 1990 were acutely toxic to striped bass larvae (96 hour exposures); this was the third consecutive year rice irrigation drain water from the Colusa Basin was acutely toxic (Bailey *et al.* 1991). Splittail may be similarly affected by agricultural and industrial chemical run-off, particularly, because like striped bass, adults migrate upriver to spawn, and young rear upriver until waters recede in late spring.

In summary, there are substantive contaminant threats that specifically apply to the splittail because of their reliance on flooded agricultural lands for spawning areas, because of their shifting dietary reliance on Asiatic clams in a region where the clams already contain enough selenium to be toxic to fish (and the clams'selenium content is still climbing), because artificial stressors, such as salvage operations associated with entrainment at the State and Federal pumping plants make splittail especially vulnerable to interaction effects with contaminants, and because juvenile growth rates prior to out-migration are crucial for successful recruitment, yet current levels of contaminant exposure are consistent with the growth inhibition already showing up in splittail growth curves. Dangerously elevated exposures to mercury, selenium, toxaphene, and DDE have already been directly confirmed for various portions of splittail populations. Foreseeable trends in contaminant loadings to splittail environments, and in splittail feeding ecology, will lead to a worsening of contaminant threats in the near-term future.

Sources of selenium contamination into the habitat of Sacramento splittail other than those associated with this project include: non-point source runoff from Coast Range ephemeral streams flowing into the westside San Joaquin Valley (exacerbated by overgrazing of livestock), oil refinery wastewater disposal in San Francisco Bay and west Delta, and concentrated animal feeding operations (where feedlots supplement animal food with selenium) upstream of the Delta.

Environmental Baseline of Sacramento splittail: The IEP's spring 1999 20mm survey shows a significant decrease in splittail young of the year abundance (R. Baxter, pers. comm.). These surveys and spring 2000 20 mm surveys also identified a portion of the population to be found in the central and south Delta in the spring and early summer (Department unpublished data 1999). In May and June 2000, the State and Federal Water Projects in the south Delta entrained over 79,000 splittail (California Department of Fish and Game, unpublished data, 2000).

Analyses of survey data collected from 1967 to 1993 (Meng 1993, Meng and Moyle 1995), and data from 1967 to 1997 by the Service, Department, UCD, and biologists from several different studies noted the following trends:

1. Overall, splittail abundance indices have declined. Splittail populations are estimated to be 35 to 60 percent of what they were in the 1940's, and these estimates may be conservative (Moyle *et al.*, 2001). FMWT data indicate a decline from the mid-1960s to the late 1970s, followed by a resurgence, with yearly fluctuations, through the mid-1980s. From the mid-1980s through 1994, splittail numbers have declined in the Delta, with some small increases in various years. 1998 FMWT index of 281 was the largest on record, however, in 1999 the index dropped to 39, which is below mid 1980 levels.

2. Overall splittail abundances vary widely between years. Sommer *et al.* (1997) also found that splittail recruitment success fluctuates widely from year to year and over long periods of time. During dry years abundance is typically low. During the dry years of 1980, 1984, 1987, and 1988 through 1992, splittail abundance indices for young-of-the-year were low, indicating poor spawning success. Additionally, all year class abundances were low during these years. In 1994, the fourth driest year on record, all splittail indices were extremely low.

   Wet years are assumed to provide essential habitat for splittail and allow populations to rebound from dry years. Successful reproduction in splittail is often highly correlated with wet years. Large pulses of young fish were observed in wet years 1982, 1983, 1986, and 1995. In 1995, one of the wettest years in recent history, an increase in all indices was recorded, as in 1986, which was another wet year following a dry year. However, young of the year taken per unit effort (for example, either the number of fish per net that is towed or the number of fish per volume of water sampled) has actually declined in wet years, from a high of 12.3 in 1978 to 0.3 in 1993. The updated data from the Department demonstrate this same decline in wet years, from 37.3 in 1978 to 0.6 in 1993. The abundance indices of young of the year splittail during the years of 1995, 1996, and 1997 were 44.5, 2.1, and 2.6, respectively. In 1995, a very wet year, splittail abundances were high. However in 1996 and 1997, both wet years, abundance indices were low. 1998 was a wet year with a large splittail year class produced.

3. Concentration of splittail in shallow areas suggests that they are particularly vulnerable to reclamation activities, such as dredging, diking, and filling of wetlands.

The above data indicate that splittail abundances vary widely in response to environmental conditions, and show that the general population numbers are declining.

The current distribution of splittail is similar to the historic in terms of the maximum upstream limits of occurrence in main stem rivers, but the areal extent has been significantly reduced. Reclamation of land has appreciably reduced the areal extent of the distribution. The diking and reclamation of river channels, Delta Islands, and Tulare Lake have removed formerly suitable aquatic habitats. The splittail has evidently been extirpated from Coyote Creek in south San Francisco Bay. The Napa and Petaluma marshes have been diked in a manner similar to the Delta. The splittail appears to have made a transition from a widely ranging Central Valley species primarily to a species largely confined to the Delta and Suisun Marsh/Suisun Bay.

Vernal Pool Crustaceans

The vernal pool fairy shrimp (*Branchinecta lynchi*) was listed as threatened, and the Conservancy fairy shrimp (*B. conservatio*), longhorn fairy shrimp (*B. longiantenna*) and vernal pool tadpole shrimp (*Lepidurus packardi*) were listed as endangered in the final rule published on September 19, 1994 (59 **FR** 48136). Additional information on the life history and ecology of these species may be found in the final rule, Eng *et al.* (1990), Simovich *et al.* (1992), and Helm (1998).

Fairy shrimp have a delicate elongate body, large stalked compound eyes, no carapace, and 11 pairs of swimming legs. They swim or glide gracefully upside down by means of complex beating movements of the legs that pass in a wave-like anterior to posterior direction. Fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus. The females carry eggs in an oval or elongate ventral brood sac. The eggs are either dropped to the pool bottom or remain in the brood sac until the female dies and sinks. The "resting" or "summer" eggs are known as cysts and are capable of withstanding heat, cold, and prolonged desiccation. When the pools fill in the same or subsequent seasons, some, but not all, of the eggs may hatch. The egg bank in the soil may consist of eggs from several years of breeding (Donald 1983). The eggs hatch when the vernal pools fill with rainwater. The early stages of the fairy shrimp develop rapidly into adults. These non-dormant populations often disappear early in the season long before the vernal pools dry up.

The primary historic dispersal method for the fairy shrimp likely was large scale flooding resulting from winter and spring rains which allowed the animals to colonize different individual vernal pools and other vernal pool complexes (J. King, pers. comm., 1995). This dispersal currently is non-functional due to the construction of dams, levees, and other flood control measures, and widespread urbanization within significant portions of the range of this species. Waterfowl and shorebirds likely are now the primary dispersal agents for fairy shrimp (Eriksen and Belk 1999). The eggs of these crustaceans are either ingested (Krapu 1974, Swanson *et al.* 1974, Driver 1981, Ahl 1991) and/or adhere to the legs and feathers where they are transported to new habitats.

Fairy shrimp are restricted to vernal pools/swales, an ephemeral freshwater habitat in California that forms in areas with Mediterranean climates where slight depressions become seasonally saturated or inundated following fall and winter rains. Due to local topography and geology, the pools are usually clustered into pool complexes (Holland and Jain 1988). In southern California, these pools/swales typically form on mesa tops or valley floors and are surrounded by very low hills, usually referred to as mima mounds (Zedler 1987). None of these listed branchiopods are known to occur in permanent bodies of water, riverine waters, or marine waters. Water remains in these pools/swales for a few months at a time, due to an impervious layer such as hardpan, claypan, or basalt beneath the soil surface. Water chemistry is one of the most important factors in determining the distribution of fairy shrimp (Belk 1977, Branchiopod Research Group 1996).

The genetic characteristics of these species, as well as ecological conditions, such as watershed continuity, indicate that populations of these animals are defined by pool complexes rather than by individual vernal pools (Fugate 1992, J. King, pers. comm., 1995). Therefore, the most accurate indication of the distribution and abundance of these species is the number of inhabited vernal pool complexes. Individual vernal pools occupied by these species are most appropriately referred to as subpopulations. The pools and, in some cases, pool complexes supporting these species are usually small.

Conservancy Fairy Shrimp: The Conservancy fairy shrimp inhabits vernal pools with highly turbid water. The species has been found in: Vina Plains, north of Chico, Tehama County; south of Chico, Butte County; Jepson Prairie, Solano County; Sacramento National Wildlife Refuge, Glenn County; near Haystack Mountain northeast of Merced in Merced County; Kesterson and San Luis National Wildlife Refuges in western Merced County; and the Lockwood Valley of northern Ventura County.

Longhorn Fairy Shrimp: The longhorn fairy shrimp inhabits clear to turbid grass-bottomed vernal pools in grasslands and clear-water pools in sandstone depressions. This species is known only from four disjunct populations along the eastern margin of the central coast range from Concord, Contra Costa County south to Soda Lake in San Luis Obispo County: the Kellogg Creek watershed, the Altamont Pass area, the western and northern boundaries of Soda Lake on the Carrizo Plain, and Kesterson National Wildlife Refuge in the San Joaquin Valley.

Vernal Pool Fairy Shrimp: Vernal pool fairy shrimp inhabit alkaline pools, ephemeral drainages, rock outcrop pools, ditches, stream oxbows, stock ponds, vernal pools, vernal swales, and other seasonal wetlands (Helm 1998). Occupied habitats range in size from rock outcrop pools as small as one square meter to large vernal pools up to 4.5 hectares (11 acres); the potential ponding depth of occupied habitat ranges from 3 cm (1.2 inches) to 1.2 meters (48 inches). The vernal pool fairy shrimp has been collected from early December to early May. Vernal pool fairy shrimp develop rapidly and may become sexually mature within two weeks after hatching (Gallagher 1996, Helm 1998). Such quick maturation permits fairy shrimp populations to persist in short-lived, shallow bodies of water (Simovich *et al.* 1992). All known populations of vernal pool fairy shrimp inhabit sites in California or southern Oregon.

The vernal pool fairy shrimp is known from 34 populations extending from Stillwater Plain in Shasta County through most of the length of the Central Valley to Pixley in Tulare County, including San Luis National Wildlife Refuge in western Merced County, and along the central coast range from northern Solano County to Pinnacles in San Benito County (Eng *et al.* 1990, Fugate 1992, Sugnet and Associates 1993); additional disjunct populations have been identified in western Riverside County, California, and in Jackson County, Oregon near the city of Medford (CDFG 1998, Helm pers. com. 1998, Eriksen and Belk 1999). In wet years, Fort Hunter Liggett, in southern Monterey County, supports hundreds of pools containing this species. Camp Roberts, which straddles the Monterey-San Luis Obispo county line, also contains pools with vernal pool fairy shrimp. Four additional, disjunct populations exist: one near Soda Lake in San Luis Obispo County; one in the mountain grasslands of northern Santa Barbara County; one on the Santa Rosa Plateau in Riverside County, and one near Rancho California in Riverside County. Three of these four isolated populations each contain only a single pool known to be occupied by the vernal pool fairy shrimp.

Vernal Pool Tadpole Shrimp: Vernal pool tadpole shrimp have large, shield-like carapaces that cover most of their body; dorsal, compound eyes; and a pair of long cercopods, one on each side of a flat caudal plate, at the end of their last abdominal segment. With a carapace typically less than 2.5 cm (1 inch) long, vernal pool tadpole shrimp are primarily bottom-dwelling animals that move with legs down while feeding on detritus and living organisms, including fairy shrimp and other invertebrates (Pennak 1989). Females deposit eggs on vegetation or other objects on the pool bottom. Although some eggs may hatch quickly, others remain dormant as cysts to hatch during later rainy seasons (Ahl 1991). When winter rains refill inhabited wetlands, tadpole shrimp reestablish from dormant cysts and may become sexually mature within three to four weeks after hatching (Ahl 1991, Helm 1998). Some of the cysts hatch immediately and the rest enter diapause and remain in the soil to hatch during later rainy seasons. Reproductively mature adults may be present in pools until the habitats dry up in the spring (Ahl 1991, Simovich *et al.* 1992, Gallagher 1996).

Vernal pool tadpole shrimp inhabit alkaline pools, clay flats, ditches, freshwater marshes, stream oxbows, vernal lakes, vernal pools, vernal swales, and other seasonal wetlands (Helm 1998). Occupied habitats range in size from vernal pools as small as two square meters to large vernal lakes up to 36 hectares (89 acres); the potential ponding depth of occupied habitat ranges from 4 cm (1.5 inches) to 1.5 meters (59 inches).

The genetic characteristics of this species, as well as ecological conditions, such as watershed continuity, indicate that populations of these animals are defined by pool complexes rather than by individual vernal pools (Fugate 1992, J. King, pers. comm., 1995). Therefore, the most accurate indication of the distribution and abundance of the species is the number of inhabited vernal pool complexes. Individual vernal pools occupied by the species are most appropriately referred to as subpopulations. The pools and, in some cases, pool complexes supporting these species are usually small.

The primary historic dispersal method for the vernal pool tadpole shrimp and likely was large scale flooding resulting from winter and spring rains which allowed the animals to colonize different individual vernal pools and other vernal pool complexes (J. King, pers. comm., 1995). This dispersal currently is non-functional due to the construction of dams, levees, and other flood control measures, and widespread urbanization within significant portions of the range of this species. Waterfowl and shorebirds likely are now the primary dispersal agents for vernal pool tadpole shrimp (Brusca, in. litt., 1992, King, in. litt., 1992, Simovich, in. litt., 1992). The eggs of these crustaceans are either ingested (Krapu 1974, Swanson *et al.* 1974, Driver 1981, Ahl 1991) and/or adhere to the legs and feathers where they are transported to new habitats.

Vernal pool tadpole shrimp are restricted to vernal pools/swales, an ephemeral freshwater habitat in California that forms in areas with Mediterranean climates where slight depressions become seasonally saturated or inundated following fall and winter rains. Due to local topography and geology, the pools are usually clustered into pool complexes (Holland and Jain 1988). Tadpole shrimp are not known to occur in permanent bodies of water, riverine waters, or marine waters. Water remains in these pools/swales for a few months at a time, due to an impervious layer such as hardpan, claypan, or basalt beneath the soil surface.

The vernal pool tadpole shrimp is known from 19 populations in the Central Valley, ranging from east of Redding in Shasta County south to Fresno County, including San Luis National Wildlife Refuge in western Merced County, and from a single vernal pool complex located on the San Francisço Bay National Wildlife Refuge in Alameda County. It inhabits vernal pools containing clear to highly turbid water, ranging in size from 5 square meters (54 square feet) in the Mather Air Force Base area of Sacramento County, to the 36-hectare (89-acre) Olcott Lake at Jepson Prairie in Solano County. Vernal pools at Jepson Prairie and Vina Plains (Tehama Co.) have a neutral pH, and very low conductivity, total dissolved solids, and alkalinity (Barclay and Knight 1984, Eng *et al.* 1990). These pools are located most commonly in grass-bottomed swales of grasslands in old alluvial soils underlain by hardpan or in mud-bottomed claypan pools containing highly turbid water.

Vernal Pool Crustaceans Environmental Baseline: These crustaceans are restricted to vernal pools and swales in California. Holland (1978) estimated that about two thirds of the grasslands that once supported vernal pools in the Central Valley had been destroyed by 1973 with an associated loss of nearly 90 percent of vernal pool habitat. In subsequent years, a substantial amount of the remaining habitat for vernal pool crustaceans has been destroyed with estimates of habitat loss ranging from two to three percent per year (Holland 1988). Current data from the Sacramento Fish and Wildlife Office's section 7 consultation database (March 2001) shows a loss of vernal pool grasslands in Fresno County (40.9 acres), Madera County (248.7 acres), and Merced County (897.5 acres) since the 1994 Federal listing of these vernal pool crustaceans (Service Files). Despite the protection the Act provides, these losses occurred subsequent to Federal listing.

State and local laws and regulations have not been passed to protect these species, and other regulatory mechanisms necessary for the conservation of the habitat of these species have proven ineffective. This includes the substantial amount of vernal pool habitat being converted for human uses in spite of Federal regulations implemented to protect wetlands. For example, the Corps' Sacramento District has authorized the filling of 189 hectares (467 acres) of wetlands between 1987 and 1992 pursuant to Nationwide Permit 26 (USDI-FWS 1992). The Service estimates that a majority of these wetland losses within the Central Valley involved vernal pools. The Corps' Sacramento District has several thousand vernal pools under its jurisdiction (Coe 1988), which includes most of the known populations of the vernal pool fairy shrimp. Coe (1988) estimated that, between 1988 and 2008, 60 to 70 percent of the remaining vernal pools within the jurisdiction of the U.S. Army Corps of Engineers, Sacramento District would be lost to development. Current rapid urbanization and agricultural conversion throughout the ranges of the species continue to pose the most severe threats to the continued existence of the fairy shrimp.

The main threat to listed vernal pool crustaceans is the loss of habitat associated with human activities, including urban/suburban development, water supply/flood control development, and conversion of natural lands to intensively farmed agricultural uses. According to the 1997 revised National Resources Inventory, released by the NRCS (2000), California ranked sixth in the nation in number of acres of private land developed between 1992 and 1997, at nearly 695,000 acres. Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, and other activities, as well as modification of surrounding uplands which alters vernal pool watersheds. Other activities which adversely affect these species include off-road vehicle use, certain mosquito abatement measures, and pesticide/herbicide use, alterations of vernal pool hydrology, fertilizer and pesticide contamination, activity, invasions of aggressive non-native plants, gravel mining, and contaminated stormwater runoff. State and local laws and regulations do not protect listed vernal pool crustaceans, while other laws and regulations, including the Clean Water Act, have not effectively maintained habitat necessary to conserve and recover these species. Although developmental pressures continue, only a small fraction of vernal pool habitat is protected from the threat of destruction.

In addition to direct habitat loss, the vernal pool habitat for listed vernal pool crustaceans is also highly fragmented throughout their ranges due to the nature of vernal pool landscapes and the conversion of natural habitat by human activities. Such fragmentation results in small, isolated populations of listed crustaceans which may be more susceptible to extinction due to random demographic, genetic, and environmental events (Gilpin and Soule 1986, Goodman 1987 a,b). Should an extirpation event occur in a population that has been fragmented, the opportunities for recolonization would be greatly reduced due to physical (geographical) isolation from other (source) populations.

Only a small proportion of the habitat of these species is protected from these threats. State and local laws and regulations have not been passed to protect these species, and other regulatory mechanisms necessary for the conservation of the habitat of these species have proven ineffective.

Environmental Baseline of the Grassland Bypass Project

Grassland Bypass Project - Selenium Loads and Concentrations in Water, 1996-2000

In 1996, the year before the Grassland Bypass Project began, the combined selenium load (pounds of selenium discharged/year) for Mud and Salt Sloughs was 9,491 pounds (Table 1). Selenium concentrations in water of Mud Slough (North) averaged 1.4 ug/L (<0.4 to 11.8) in 1996 while Salt Slough averaged 16.0 ug/L (1.0 to 33.5). (Regional Board 1998, USDI-BOR *et al.* 1998)

During the first year of the Grassland Bypass Project, 1997, the annual load target of 6,660 pounds was not met (7,097), and several monthly load targets were exceeded. Selenium concentrations in Mud Slough rose dramatically (avg. 30.7 ug/L) as Salt Slough concentrations dropped (1.0 ug/L) as expected. The Oversight Committee determined that the exceedences were not caused by "unforseen or uncontrollable" conditions and imposed an incentive fee of $60,500 (USBR *et al.* 1998).

In 1998, an El Nino year caused record rainfall in the area continued well into June, leading to the discharge of more than 9,000 pounds of selenium from the Grassland Bypass Project. Monthly load targets and the maximum allowable annual load (6,600 pounds) were not met However, the Oversight Committee agreed with the regional drainage entity that "unforeseeable and uncontrollable" conditions occurred through much of the1998 water year and an incentive fee of $3,400 was imposed for missing monthly targets later in the water year. The average selenium concentration in Mud Slough dropped slightly to 26.6 ug/L even though the maximum concentration detected was 104 ug/L. Salt Slough selenium concentrations stayed about the same as the previous year (Young, 1999).

In 1999, the first year when the load targets were lowered by five percent, selenium loads were met each month and the annual load discharged was 19 percent below the allowable annual load limit of 6,327 pounds. Mud Slough selenium average dropped to 20 ug/L and the Salt Slough average was 1.5 ug/L (Crader 2000, Young 2000).

Table 1. Selenium loads and water concentrations in the Grassland watershed for water years (October - September) 1996 through 1999.

Year	Use Agreement Load Limit (pounds)	Annual Load (pounds)	Mud Slough (ug/L, mean and range)	Salt Slough (ug/L, mean and range)
1996 pre-project	NA	9,491	1.4 (< 0.4 - 11.8)	16.0 (1.0 - 33.5)
1997	6,660	7,722	30.7 (5.0 - 79.6)	1.0 (0.5 - 3.4)
1998	6,660	8,760	26.6 (3.1 - 104)	1.2 (< 0.4 - 5.1)
1999	6,327	5,124	19.9 (6.6 - 50.7)	0.8 (< 0.4 - 1.5)

In water year 2000, all monthly selenium loads and the annual load were below targets. The annual load of 4,603 pounds was 23 percent below the 5,994 pound allowable annual load. The Regional Board with assistance from Reclamation and Grassland area farmers began investigations into the sources of selenium that caused concentrations in wetland supply channels to exceed the 2 ug/L selenium standard (Young, 2001).

The annual loading (by water year) of selenium attributable to the GDA is projected to total 4,491 pounds in water year 2001 (Allen, in litt., August 16, 2001).

Grassland Bypass Project - Selenium in Aquatic Invertebrates and Fish, 1996-2000

Level-of-concern ranges for selenium in invertebrates, fish, and bird eggs have been developed for the Grassland Bypass Project. Within these ranges observable effects of selenium may occur in sensitive species or individuals. For composite samples where the mean concentrations are above the high value in the range, selenium effects are certain to occur in many species. All selenium concentrations of aquatic invertebrates and fish samples provided below are on a dry weight basis. The level-of-concern range for invertebrates is 3 to 7 ug/g; for fish, 4 to 9 ug/g; and for bird eggs, 6 to 10 ug/g (Beckon *et al.*1999). These ranges are used here.

Pre-project, 1996 - Average pre-project (before September 1996) selenium levels in composite aquatic invertebrate and fish samples from Salt Slough were all within or above level-of-concern ranges for invertebrates and fish (Table 2). Waterboatmen (a predatory insect) had 3.4 ug/g and crayfish had 5.0 ug/g. Average concentrations for several fish species ranged from 6.8 ug/g (carp) to11 ug/g (Sacramento blackfish). These data reflect the conditions at the time when drainage water was being routed through Salt Slough and other wetlands channels. In Mud Slough, selenium concentrations in biota were toward the low end or below the level-of-concern ranges. Fish ranged from 1.6 ug/g (carp) to 3.7 ug/g (mosquitofish and fathead minnow). Crayfish in Mud Slough had 3.9 ug/g. In the San Joaquin River below Mud Slough, fish concentrations ranged from 2.6 ug/g (blackfish muscle) to 6.6 ug/g (sunfish muscle), and aquatic invertebrates were below the level-of-concern (Henderson *et al.* 1995, Beckon *et al.* 1999).

First year of Project, 1997 - Overall, concentrations of selenium in all aquatic invertebrates and fish from Salt Slough declined in 1997 compared to pre-project values, but fish were still at a level-of-concern range (Table 3). Average selenium levels in fish from Salt Slough ranged from 4.6 ug/g (mosquitofish) to 7.6 ug/g (carp). Levels in Salt Slough invertebrates also declined. Selenium levels in invertebrates and fish collected from Mud Slough (north) increased significantly because of the initial release of drainwater, resuspension of sediments in the San Luis Drain, and flushing of some contaminated fish from the Drain. However, selenium concentrations in measured quarterly declined later in the year. Fish concentrations ranged from 4.9 ug/g in blackfish to 29 ug/g in mosquitofish a concentration well above the level-of-concern range. Concentrations of selenium in Mud Slough invertebrates did not appear to change. Annual averages of selenium in carp (muscle) and mosquitofish in the San Joaquin River did not change significantly from pre-project levels. However, carp muscle concentrations, measured quarterly, started off low in November 1996 at 3.2 ug/g and slowly increased to 5.5 ug/g by September of 1997 one year after the Drain was used to consolidate drainage discharges. This likely reflects the delayed accumulation of selenium further downstream in the system along with seasonal fluctuations. By September 1998 carp muscle quarterly concentrations in the San Joaquin River declined to 1.8 ug/g (Beckon *et al.* 1999).

During Project, 1998 - In 1998, selenium levels in biota from Salt Slough continued to decline overall with two of the three fish species analyzed falling below the level-of-concern range (Table 4). Carp in Salt Slough remained in the level-of-concern range at 4.3 ug/g. Invertebrate concentrations in Salt Slough remained low. Overall, Mud Slough biota samples decreased significantly from 1997 levels, but quarterly biota samples reflected seasonal increases in selenium resulting from increased selenium discharges during flood flows and peak irrigation periods. Only two fish species could be collected in 1998. Mosquitofish were at 5.3 ug/g and fathead minnows were at 8.0 ug/g, well within the level-of-concern range but down from the 1997 levels of 29 ug/g and 11 ug/g respectively. Selenium concentrations in mosquitofish from the San Joaquin River declined slightly but were still just within the level-of-concern range. Carp muscle concentrations declined from 4.0 ug/g in December of 1997 to 1.8 ug/g in September of 1998 with an annual average of 3.1 ug/g (Beckon *et al.* 1999).

Table 2. Pre-project average selenium concentrations in select biota from Mud Slough, Salt Slough, and the San Joaquin River downstream of the Grassland Bypass. Pre-project values are averages of composite samples collected quarterly from 1992 to 1996. The range of individual composite samples for the time period is in parentheses. San Joaquin River data from California Department of Fish and Game, Mud and Salt Slough data from U. S. Fish and Wildlife Service. Carp, sunfish and blackfish data from the San Joaquin River is muscle tissue, all other data is whole body.

Year/Location	Invertebrates (average and range, ug/g dry wt.)		Fish (average and range, ug/g dry wt.)		Bird Eggs (median and range, ug/g dry wt.)	
Pre-project Salt Slough	waterboatman crayfish	3.4 (1.7 - 4.7) 5.0 (2.9 - 6.8)	mosquitofish fathead minnow blackfish mixed sunfish carp	7.3 (4.7 - 15) 9.3 (7.0 - 15) 11 (7.2 - 15) 7.6 (2.5 - 13) 6.8 (2.0 - 10)	mixed ducks	3.0 (1.3 - 5.0)
Mud Slough	waterboatman crayfish	2.2 (0.7 - 7.3) 3.9 (0.9 - 8.7)	mosquitofish fathead minnow blackfish mixed sunfish carp	3.7 (1.8 - 12) 3.7 (1.9 - 6.1) 2.2 (2.0 - 3.1) 3.2 (2.5 - 4.0) 1.6 (1.6)	mixed ducks	2.7 (2.0 - 3.1)
San Joaquin River	waterboatman crayfish	1.2 (0.8 - 1.5) 2.1 (0.9 - 3.8)	mosquitofish fathead minnow blackfish mixed sunfish carp	3.3 (1.9 - 5.0) 5.8 (5.5 - 6.1) 2.6 (1.7 - 3.2) 6.6 (3.3 - 11) 4.6 (2.3 - 9.0)	NA	
Level-of-concern		3 - 7		4 - 9		6 - 10

Table 3. Average selenium concentrations in 1997 for select biota from Mud Slough, Salt Slough, and the San Joaquin River downstream of the Grassland Bypass. Values are annual averages of results from composite samples collected quarterly. The range of individual composite samples is in parentheses. San Joaquin River data from California Department of Fish and Game, Mud and Salt Slough data from U. S. Fish and Wildlife Service. Carp, sunfish and blackfish data from the San Joaquin River is muscle tissue, all other data is whole body.

Year/Location	Invertebrates (average and range, ug/g dry wt.)		Fish (average and range, ug/g dry wt.)		Bird Eggs (median and range, ug/g dry wt.)	
1997 Salt Slough	waterboatman crayfish	1.9 (1.7 - 2.0) 2.6 (2.6)	mosquitofish fathead minnow blackfish mixed sunfish carp	4.6 (3.1 - 6.6) 6.1 (2.9 - 7.9) 6.0 (5.1 - 7.2) 6.1 (4.3 - 8.1) 7.6 (7.6)	mixed ducks	2.0 (1.6 - 3.6)
Mud Slough	waterboatman crayfish	2.6 (1.9 - 3.2) 3.3 (3.3)	mosquitofish fathead minnow blackfish mixed sunfish carp	29 (7.3 - 65) 11 (5.5 - 14) 4.9 (4.9) NA 11 (11)	mixed ducks	2.8 (1.8 - 4.2)
San Joaquin River	waterboatman crayfish	NA NA	mosquitofish fathead minnow blackfish mixed sunfish carp	3.6 (2.9 - 4.5) NA NA NA 4.3 (2.3 - 7.7)	NA	
Level-of-concern		3 - 7		4 - 9		6 - 10

Table 4. Average selenium concentrations in 1998 for select biota from Mud Slough, Salt Slough, and the San Joaquin River downstream of the Grassland Bypass. Values are annual averages of results from composite samples collected quarterly. The range of individual composite samples is in parentheses. San Joaquin River data from California Department of Fish and Game, Mud and Salt Slough data from U. S. Fish and Wildlife Service. Carp, sunfish and blackfish data from the San Joaquin River is muscle tissue, all other data is whole body.

Year/Location	Invertebrates (average and range, ug/g dry wt.)		Fish (average and range, ug/g dry wt.)		Bird Eggs (median and range, ug/g dry wt.)	
1998 Salt Slough	waterboatman crayfish	2.1 (1.9 - 2.2) 2.2 (0.9 - 3.2)	mosquitofish fathead minnow blackfish mixed sunfish carp	2.8 (2.5 - 3.9) NA NA 2.5 (2.0 - 3.5) 4.3 (4.0 - 4.6)	mixed ducks	2.6 (1.6 - 3.3)
Mud Slough	waterboatman crayfish	2.5 (1.1 - 6.8) 3.1 (3.1)	mosquitofish fathead minnow blackfish mixed sunfish carp	5.3 (4.4 - 6.2) 8.0 (8.0) NA NA NA	mixed ducks	3.1 (1.8 - 6.6)
San Joaquin River	waterboatman crayfish	1.7 (1.7 - 1.8) 1.4 (1.2 - 1.6)	mosquitofish fathead minnow blackfish mixed sunfish carp	3.3 (1.8 - 4.3) NA NA 1.7 (1.7 - 1.7) 3.1 (1.8 - 4.1)	NA	
Level-of-concern		3 - 7		4 - 9		6 - 10

During Project, 1999 - Selenium concentrations in 1999 from biota in Salt Slough continued to decrease while Mud Slough biota continued to be at a level-of-concern range (Table 5). Selenium concentrations for Salt Slough fish (average of all fish composites, 2.3 ug/g) were all below the level-of-concern range, as were those for invertebrates (also 2.3 ug/g). Even the maximum selenium concentration in fish (red shiner composite, 3.4 ug/g) was below the level-of-concern range. In contrast, the mean of all Mud Slough fish composites samples was 5.3 ug/g, still within the level-of-concern range, with concentrations tending to increase through the year. Invertebrates from Mud Slough were scarce in water year 1999. All crayfish samples in Mud Slough below the Grassland Bypass Project discharge exceeded the 3.0 ug/g level of concern threshold while the other invertebrates concentrations were between 2 and 3 ug/g. Fish composites from the San Joaquin River below the confluence of Mud Slough averaged 2.3 ug/g while crayfish samples averaged 1.1 ug/g (Beckon and Dunne, 2000).

During Project, 2000 - Concentrations of selenium in fish from Salt Slough (2.6 ug/g) continue to be below the level of concern (<4.0 ug/g). The mean invertebrate composite concentration was 2.1 ug/g, also below levels of concern. The mean of fish composite samples from Mud Slough below the Grassland Bypass Project discharge was 5.0 ug/g, still above the 4.0 ug/g level of concern threshold. Fish composite samples from a backwater area further downstream in Mud Slough averaged 6.7 ug/g with all samples in the month of August exceeding the 9 ug/g toxicity level. The average invertebrate concentration in backwater areas of Mud Slough was 5.6 ug/g. Selenium concentrations in fish from the San Joaquin River below Mud Slough ranged from 1.3 to 3.5 ug/g with an average of 2.9 ug/g. Invertebrate concentrations in the San Joaquin River were well below the 3.0 ug/g level of concern (Beckon *et al.* 2001).

In summary, the Grassland Bypass Project to date has succeeded in lowering selenium concentrations in water and biota in Salt Slough, at the cost, as anticipated, of increased levels in Mud Slough. Selenium concentrations in Mud Slough fauna were most elevated in 1997, suggestive of a large "slug" of selenium moving through the system, and since then have been considerably lower although still generally above levels of concern in invertebrates and fish.

Table 5. Average selenium concentrations in 1999 for select biota from Mud Slough, Salt Slough, and the San Joaquin River downstream of the Grassland Bypass. Values are annual averages of results from composite samples collected quarterly. The range of individual composite samples is in parentheses. San Joaquin River data from California Department of Fish and Game, Mud and Salt Slough data from U. S. Fish and Wildlife Service. Carp, sunfish and blackfish data from the San Joaquin River is muscle tissue, all other data is whole body.

Year/Location	Invertebrates (average and range, ug/g dry wt.)		Fish (average and range, ug/g dry wt.)		Bird Eggs (median and range, ug/g dry wt.)	
1999 Salt Slough	waterboatman crayfish	2.5 (2.5) 2.3 (1.4 - 2.8)	mosquitofish fathead minnow blackfish mixed sunfish carp	2.4 (1.9 - 2.8) 2.5 (2.2 - 2.8) 2.2 (1.8 - 2.5) 2.4 (2.0 - 2.8) 2.3 (2.3)	NA	
Mud Slough*	waterboatman crayfish	2.5 (2.1 - 3.4) 5.3 (4.3 - 7)	mosquitofish fathead minnow blackfish mixed sunfish carp	4.8 (3.3 - 6.3) 5.6 (5.0 - 6.3) NA 6.1 (4.6 - 8.1) 6.5 (4.4 - 10)	mixed ducks	6.2 (2.4 - 10)
San Joaquin River	waterboatman crayfish	Pending "	mosquitofish fathead minnow blackfish mixed sunfish carp	Pending " " " "	NA	
Level-of-concern		3 - 7		4 - 9		6 - 10

* Mud Slough 1999 invertebrate data from site downstream of regular site since no samples are available for the regular site.

Effects of the Proposed Action and Cumulative Effects

This biological opinion analyzes the reasonably foreseeable effects of implementation of the renewal of the Grassland Bypass Project from October 1, 2001 to December 31, 2009 as described in the Project Description of this opinion.

Key Assumptions of Effects Analysis

Because of the complex history as well as the complex present environmental and regulatory context of the Grasslands Bypass Project, we have had to make a number of assumptions about likely future events in order to conduct a reasonable effects analysis. While not exhaustive, the following list of key assumptions has been central to our effects analysis and jeopardy findings. As such, the failing of any key assumption should be considered reason for reinitiating consultation on the Grassland Bypass Project.

1. All conservation measures and environmental commitments described in this Project Description will be implemented in the manner and schedule described. Any item not explicitly scheduled is to be implemented immediately. Reclamation and the Authority, as applicable, will obtain sufficient funding to carry out their responsibilities in implementing all conservation measures and environmental commitments described in this Project Description.
2. The EPA is required under the biological opinion for the California Toxics Rule to propose and promulgate a new selenium standard that would apply to all waters of the Grassland Bypass Project area (see the discussion of the California Toxics Rule in the Background section). We assume that all applicable, selenium-related commitments in the California Toxics Rule biological opinion will be met. Accordingly, EPA should propose revised acute and chronic aquatic life criteria for selenium in California by January of 2003, and finalize the criteria no later than July, 2004. We assume that these revisions for selenium water criteria and standards will be adequately protective of Sacramento splittail, giant garter snake, and other listed species. This process will include adoption of any new selenium objectives for selenium into the State of California, Regional Water Quality Control Board (Central Valley Region) Basin Plan and approval by the State Water Resources Control Board and the State Office of Administrative Law. Ultimately, any new objectives would then be incorporated into revised Waste Discharge Requirements for the Grassland Bypass Project. Since the Mud Slough Compliance Plan is required in 2006 (see section on Environmental Commitments from the Use Agreement), any new water quality objectives would be considered as part of this planning effort. This would be an appropriate juncture for Reclamation and the Service to re-evaluate the Grassland Bypass Project in light of ongoing research and monitoring,

the new EPA rule (as approved by the State of California), and new Waste Discharge Requirements.

3. The Grassland Bypass Project will meet water quality objectives that are applicable within the 2001-2009 period (page 1-3, Final Grassland Bypass Project EIS and EIR, Volume 1, May 25, 2001). Further, the project proponents will work cooperatively with the Service and other agencies to maintain clean-water delivery channels in a manner that protects and maintains giant garter snake habitat. For the purposes of this biological opinion, in the absence of data closely relevant to the species, the Service assumes that adherence to the Federal/State water quality standard of 2 ppb (monthly mean) for Grassland wetland supply channels wetland water supplies in the Grasslands will provide adequate protection from selenium in the food chain to prevent impacts to any giant garter snakes in these channels.
4. Contaminant threats to listed species can be reduced through application of appropriately protective State and Federal application of appropriately protective water quality criteria to the water bodies occupied by listed species and evaluated in this opinion. Any future adjustment(s) of the selenium criteria will consider the bioaccumulative nature of selenium in aquatic systems.
5. Reclamation will implement the Project Description in a manner consistent with implementation of any listed species recovery plans, including the 1998 Recovery Plan for Upland Species of the San Joaquin Valley, the1999 draft Recovery Plan for Giant Garter Snakes, and the 1996 Recovery Plan for the Sacramento / San Joaquin Delta Native Fishes.
6. Reclamation will implement in a timely manner relevant environmental commitments, mitigation and conservation measures, and terms and conditions from other biological opinions, including but not limited to: Interim Water Contract Renewal Consultation (February 29, 2000, Service File No., 1-1-00-F-0056) and Implementation of the CVPIA and Continued Operation and Maintenance of the CVP (November 21, 2000, Service File No., 1-1-98-F-0124). Other CVP-related, non-CVPIA (Central Valley Project Improvement Act) actions benefitting fish, wildlife, and associated habitats and related to effects or monitoring of the Grassland Bypass Project will continue, with at least current funding levels, including:
    - Implementation of the Comprehensive Mapping Program;
    - Implementation of the Land Use Monitoring and Reporting Program;

- Reclamation, in cooperation with the Regional Board and other appropriate agencies and entities, will 1) quantify the selenium concentration and loading in the Delta Mendota Canal (DMC) between O'Neill Forebay, and Mendota Pool, 2) determine the monthly loading of selenium (in pounds of selenium per month) entering the Central Valley Project (CVP) source water including, but not necessarily limited to, loads from the six Firebaugh sumps that pump shallow groundwater into the DMC, pumping of groundwater into the Mendota Pool, and pumping of groundwater into the DMC as part of a Warren Act Contract, and 3) identify and implement any necessary corrective actions for selenium loads within Reclamation's or other appropriate agencies' control or authority.

Action Area

The action area is defined in 50 CFR 402.14(g)(3) as the immediate area involved in the action and the entire area where effects to listed species extend as a direct and indirect effect of the action. Two hydrologic areas are affected by the Grassland Bypass Project. The first is the Grassland watershed, which is a valley floor sub-basin along the western side of the San Joaquin River from the Mendota Pool to the confluence with the Merced River. Because the discharges from the Grasslands Bypass Project flow to downstream waters and benthic sediments, for the purposes of this biological opinion, the action area includes watersheds as described above and the San Joaquin River downstream to and including the Sacramento-San Joaquin Delta Estuary and San Francisco Bay. Also included are all areas of the giant garter snake San Joaquin Valley recovery unit supporting populations of the snake that may communicate with (disperse to) the Grasslands watershed, since factors that inhibit the increase and maintenance of the giant garter snake population in the Grasslands watershed will affect snakes dispersing there.

Effects Overview

We expect the Grassland Bypass Project to have two main categories of effects to listed and proposed species: contaminant transport and exposure, and, on a relatively small scale, ground disturbance and habitat loss or degradation due to construction activities.

The Grassland Bypass Project exists to remove excessive selenium loading from agricultural drainage from sensitive Grassland wetland habitats. As in the past, in the proposed continuation of the Grassland Bypass Project, this benefit will in large part be achieved by shunting drain water around the Grasslands and into Mud Slough. This transports contaminants downstream, where other habitats and organisms may be exposed. The Grassland Bypass Project also contributes to continuing irrigated agriculture which applies CVP water to soils bearing high selenium concentrations. Although in small amounts selenium is an essential nutrient to many animals, in not very much larger amounts this element is toxic. Because it is an atomic element, selenium does not degrade or decay in any way. Another serious concern is that selenium at elevated concentrations tends to become increasingly concentrated as it is transferred between organisms in the food chain (bioaccumulates).

Most of the discussion in our analysis of contaminants is about selenium, but the Grassland Bypass Project may also move other compounds from the GDA into Mud Slough and the San Joaquin River. We have little information on amounts or timing of such compounds in waters conveyed by the Grassland Bypass Project. The drain waters carry well-documented amounts of boron (another element) and salts. Both may be toxic to plants and animals at sufficient concentrations.

Effects on San Joaquin Kit Fox and Mountain Plover

Selenium Toxicity to Birds and Mammals: Potential effects of selenium poisoning on avian species include: gross embryo deformities, winter stress syndrome, depressed resistance to disease due to depressed immune system function, reduced reproductive success, reduced juvenile growth and survival rates, mass wasting, loss of feathers (alopecia), embryo death, altered hepatic enzyme function, and mortality (Ohlendorf 1996; O'Toole and Raisbeck, 1998). The potential effects of selenium on mammal species include: gross embryo deformities, reduced longevity, winter stress syndrome, depressed resistance to disease due to depressed immune system function, reduced juvenile growth and survival rates, food aversion and mass wasting, loss of hair and nails, reduced reproductive success, skin lesions, respiratory failure, lameness, paralysis, and mortality (Eisler 1985b; O'Toole and Raisbeck, 1998).

Selenium toxicity can be aggravated under certain situations. Species are often exposed to multiple stressors that can make them more vulnerable to exposure to selenium. There are at least three well known multiple-stressor scenarios for selenium. These are winter stress syndrome, immune system dysfunction, and chemical synergism. Lemly (1996c) presents a general case for winter stress syndrome as a critical component of hazard assessments, whereby animals exposed to selenium are less likely to survive when exposed to winter stressors. It can be further generalized that any metabolic stressor (cold weather, migration, pathogen challenge, etc.) would interact similarly to lower the toxic thresholds for dietary exposure to selenium. Numerous studies have confirmed the physiological and histopathological bases for selenium-induced immune system dysfunction in wildlife (Fairbrother and Fowles 1990; Schamber *et al.* 1995; Albers *et al.* 1996). Selenium in combination with other chemical stressors can also cause synergistic effects (i.e., the effects of the stressors combined is greater than the sum of the individual stressors). At least one field study of birds also provides circumstantial evidence of lowered toxicity thresholds for selenium-induced reproductive impairment in the presence of mercury contamination (Henny and Herron 1989).

Chronic exposure to diets with selenium concentrations as low as 1 ppm (dry weight) can cause adverse effects on mammals (intestinal lesions and longevity in rats, Eisler 1985). Reproductive impairment has been reported at a dietary exposure of 3 ppm (rats, Olson 1986). In dogs (in the same family as kit fox) sublethal effects were found at a dietary exposure of about 7 ppm (Rhian and Moxon 1943). Based on these data, 3 ppm would be a reasonable level of concern threshold, and 7 ppm would be a reasonable toxicity threshold for dietary exposure to selenium applicable to mammals such as the kit fox (Skorupa *et al.*, 1996; Skorupa pers. comm.).

The following GBP recommended Ecological Risk Guidelines for Selenium Concentrations apply to birds:

- Invertebrates and Vegetation, as diet: 3-7 ppm (dry weight) = level of concern; greater than 7 ppm (dry weight) = toxicity threshold.

- Avian egg: 6-10 ppm (dry weight) = level of concern; greater than 10 ppm (dry weight) = toxicity threshold.

Bird and Mammal Selenium Data from Kesterson and Agroforestry Plantations: There is potential for exposure of kit foxes and mountain plovers to selenium in water or in their diet at the IVT project sites. Although limited data has been collected on selenium contamination in biota at IVT lands, biological tissue samples have been collected from other upland sites in the vicinity that are influenced by drainwater contamination: Kesterson Reservoir (post-closure) and agroforestry plantations. This data offers some opportunity to evaluate the potential for bioaccumulation at the IVT site of the Grassland Bypass Project.

The former Kesterson Reservoir was managed as an evaporation pond before it was dewatered in 1988. Even without active irrigation, tissue levels in some bird and mammal species collected from Kesterson continue to be at selenium concentrations that are highly elevated. Since being dewatered, the Kesterson Reservoir was covered with clean topsoil, and is now managed as upland habitat. Although Kesterson is not actively irrigated, it is influenced by selenium in the soil and by a contaminated, shallow groundwater table. Biological monitoring has continued since the Reservoir was converted to upland habitat. Ornate shrews (*Sorex ornatus*), thought to be primarily insectivorous, have consistently been the small mammal experiencing the greatest exposures to selenium at Kesterson (usually averaging >20 ppm whole body selenium dry weight; USDI-BOR 1999). Kit foxes, while not closely related to shrews, probably have a comparable risk of selenium exposure in their food chain, since they also feed on primarily plant-eating prey (seed-eating rodents). In birds, for the cumulative 1989-1999 collections of killdeer eggs from Kesterson Reservoir, the top 5% selenium exposed eggs ranged from 22 to 64 ppm selenium (dry weight), and 25% of the collected eggs exceeded the toxicity threshold of 10 ppm (dry weight) from the GBP Ecological Risk Guidelines for Selenium Concentrations (GBP Selenium Guidelines). By comparison, normal egg concentrations average 2 ppm (dry weight) or less. Mountain plovers are closely related to killdeer, and appear to be at similar risk of selenium exposure, since like the killdeer they are primarily insectivorous and feed in upland areas. Mountain plover may winter in the IVT area.

At two agroforestry plantations in the western San Joaquin Valley (Red Rock Ranch and Mendota demonstration site, formerly known as Murietta Farms in western Fresno County), which like the IVT lands are actively irrigated with drainage water, more than 56% of 30 assessable avian embryos were deformed at one site, orders of magnitude higher than the average deformity rate for normal eggs of 0.2%. Both sites that were sampled yielded avian eggs exceeding 25 ppm selenium (dry weight basis) (Skorupa 1998). These selenium tissue concentrations are well above the toxicity threshold of 10 ppm from the GBP Selenium Guidelines.

Boron Toxicity to Birds: Data collected as part of biomonitoring studies for the Grasslands Bypass Project (W. Beckon *et al.*, unpubl. data; egg concentrations as high as 34 ppm dry weight) have revealed boron concentrations in killdeer eggs from Kesterson that substantively exceed the EC-10 value (concentration at which 10% of samples exhibit an adverse effect) value of 20 ppm (dry weight) for impaired viability of mallard eggs (Sefchick-Edwards 1998). The National Irrigation Water Quality Program (NIWQP) sampled avian eggs from more than 150 sampling sites in 14 different western states and out of more than 5,000 eggs collected only 1 contained a boron concentration exceeding 35 ppm (dry weight) (Seiler *et al.*, in press). Comparison with the NIWQP data is noteworthy because the NIWQP study sites were nonrandomly selected to characterize what were anticipated to be among the nation's worst cases of irrigation-related water quality problems.

Boron content of stilt eggs collected at Red Rock Ranch in western Fresno County (an agroforestry plantation irrigated with subsurface drainage water) during the spring of 2000 was not nearly as elevated as the killdeer eggs collected at Kesterson. None of the Red Rock stilt eggs exceeded 10 ppm boron (dry weight basis). The IVT site is likely to be most similar to the Red Rock Ranch agroforestry plantation. Nonetheless, it is unknown what the hazards posed by boron in drainwater used to irrigate IVT lands will be.

Selenium effects of IVT element on San Joaquin kit fox: The Proposed Action includes an In-Valley Treatment element of up to 6,200 acres of land within the GDA (Phase I). Grazing pasture could increase from 250 to 1,000 acres on the site. No native pasture or habitat will be replaced in this action. Planting of salt-tolerant crops such as alfalfa, pasture, and bermuda grass is likely to provide a low-horizon habitat that is used by San Joaquin kit foxes and their prey. The diet of kit foxes is principally based on seed-eating nocturnal rodents. The potential exists for selenium to bioaccumulate in the food-chain of the San Joaquin kit fox at the IVT site: from applied drain water to plants to prey animals to foxes. Paveglio and Clifton (1988) studied the movements, diet, and selenium accumulation in San Joaquin kit fox and coyotes at Kesterson Reservoir from 1986-88 (pre-closure). Selenium concentrations in voles collected from Kesterson Reservoir were up to 522 times greater as compared to the reference site at the Volta Wildlife Area. Liver selenium levels of 2 coyotes collected from Kesterson Reservoir were within the range associated with chronic selenium toxicosis in domestic dogs. Selenium levels in the blood of coyotes were 20 times higher than in coyotes collected from control sites.

Kit fox forage extensively within a large area of grasslands and cultivated fields, which reduces the potential that these species would ingest toxic quantities of prey from the IVT site. However, impacts to a kit fox may occur if a significant portion of its home range overlaps the IVT area. Kit fox populations are found in the Panoche Hills and east of the San Joaquin River (Harris 2000). Kit fox ranges are not well known in the proposed IVT area, but they may occur there (S. Jones, Service, pers. comm.). The CNDDB lists two occurrences of this species on the 23 quadsheets covering lands within and adjacent to the Grassland Bypass Project area, both more than 15 miles from the IVT area. Available information suggests kit fox densities in the area are very low and that few foxes would encounter the IVT area.

It is not known at the present time the degree to which IVT crops irrigated with drainage water bioaccumulate selenium. Although testing of these crops to date has not demonstrated increased uptake of selenium from drainage reuse (Panoche Drainage District 2000), a more intensive monitoring effort will need to be implemented to assess the effect of irrigation with drainage water on selenium in plants, invertebrates, and vertebrates at the IVT site. As indicated in the project description of this opinion, a monitoring program and contingency plan will be implemented based on recommendations from the Service to minimize potential kit fox exposure to selenium.

Selenium and boron effects of IVT element on Mountain Plover: Irrigation with drainwater, leading to potential ponding of this water in these fields and selenium bioaccumulation in the food chain, may create a contaminant hazard for mountain plovers.

A small number of avian eggs were collected from the IVT site on May 22, 2001. The species and selenium concentrations of the eggs (dry weight) are as follows: mallard (6.5 ppm,), Brewer's blackbird (7.2 and 15 ppm), western kingbird (5.5 ppm), and loggerhead shrike (7.4 ppm). In addition, pellets of burrowing owl and Swainson hawk were collected and were both below 2 ppm selenium (dry weight). The mallard, loggerhead shrike, and one of the Brewer's blackbird eggs fall within the "level of concern" from the GBP Se Guidelines. One egg (the other Brewer's blackbird egg) was found to be above toxicity threshold from the GBP Se Guidelines. Based on the limited data of this sampling effort, the results suggest that some degree of adverse effects to birds, associated with selenium contamination on the IVT site, is likely. Since mallards and blackbirds are "water birds", the effects on these species could be more associated with the operation of an open network of drainage ditches adjacent to and within the IVT, and not necessarily solely related to the management of the IVT site. This limited data set indicate that selenium is accumulating in biota (birds) using the site and continued contaminant monitoring is warranted.

Mountain plovers are "upland" birds that feed primarily on insects, including beetles, grasshoppers and flies. Although no Mountain Plovers have been observed on the IVT site, they do congregate in flocks of fifteen to several hundred birds in their wintering grounds--including the western San Joaquin Valley--feeding in alkaline flats, grazed pastures and plowed fields. Because grazing pasture in the IVT may increase from 250 to 1,000 acres on the site during the life of the project (Panoche Drainage District, 2000), the IVT site will have to be closely monitored during the winter to determine if mountain plovers are attracted to this area.

To assure protection of mountain plover, the project proponents have proposed to cease irrigation of the IVT field immediately if mountain plover are present. The risk to mountain plover will be evaluated (by Service or Service-approved biologists) and if adverse exposure to contaminants is detected the project proponents will coordinate with the Service to develop protection measures for the mountain plover. While watching the IVT area for mountain plovers is a useful measure, we remain concerned that adverse contaminant exposure to mountain plovers may be difficult or impossible to detect even if occurring, especially without additional take of birds or eggs. Therefore, if monitoring finds any concentrations of selenium or boron at levels of concern in killdeer or other bird species or their eggs at the site, we believe any mountain plover should be hazed from the site as a precautionary measure. This will reduce potential feeding area for the species, but not to a significant extent.

Ground disturbance and construction associated with the IVT and other components of the extended Grassland Bypass Project: Both mountain plover and kit fox may suffer small but as-yet unquantified modification or degradation of habitat due to construction of project facilities, such as drain water treatment facilities for IVT Phases II and III. Most construction will be across agricultural land. Some habitat losses will be only temporary (laying of subsurface drains), others essentially permanent (buildings, water treatment plants). Reclamation and the Authority have stated that they will consult separately with the Service if it is determined that the construction and operation of IVT Phase III facilities may affect listed species. Therefore these habitat modification and degradation effects will be analyzed further at that time and are not authorized in this opinion. Without predetermining what finding may be arrived at in any later consultation, but solely for the purposes of this opinion, assuming the provision of adequate avoidance, minimization, and habitat restoration and conservation measures, we do not at this time foresee that these effects would appreciably reduce the likelihood of survival and recovery of either species.

Summary: The effect of applying selenium and boron to IVT lands on San Joaquin kit fox and mountain plover species conservation have yet to be fully determined, but because of low densities or sparse or occasional habitat use, appear likely to be small. If contaminant problems arise on IVT lands, these lands may serve as an attractive nuisance to listed species such as San Joaquin kit fox, and mountain plover. Adequate implementation of the Conservation Measures (e.g. contaminant monitoring, and contingency plans) described in the project description will help reduce the potential for adverse effects to listed species that may use the IVT lands. Any effects to listed species effects due to habitat disturbance by Phase III construction will be covered under separate consultation.

Giant garter snake

Selenium Toxicity in Giant Garter Snake: Toxicity information on reptiles such as the giant garter snake is very limited. Studies on pine snakes (*Pituophis melanoleucus*) have shown that, unlike metals such as lead and mercury, selenium concentrations are greater in body tissue than in skin tissue (Burger, 1992). Endemic to wetlands in the Sacramento and San Joaquin Valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals and rice fields. Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941; Hansen 1980; Hansen 1988). These predatory foraging habits and habitat preference put the giant garter snake at risk of selenium exposure.

Selenium is suspected as being a contributing factor in the decline of the giant garter snake populations, particularly for the North and South Grassland subpopulation (i.e., Kesterson NWR complex) (USDI-FWS 1993). The Grassland Bypass Project discharges agricultural drainage into Mud Slough (North) which contains elevated waterborne concentrations of selenium, boron, and other constituents. Giant garter snakes have not been discovered in Mud Slough (North) but have been found in waterbodies not impaired by selenium and agricultural drainage (e.g., Volta Wildlife Area and Los Banos Creek west of Kesterson National Wildlife Refuge). Agricultural drainage flows result in the discharge of elevated selenium, boron, and other constituents into Mud Slough (North) It is possible that elevated selenium levels in the San Joaquin Valley contributed to the severe decline of the giant garter snake in the majority of this area. The remaining giant garter snake populations are more commonly found in waterbodies not impaired by selenium and agricultural drainage (e.g., Volta Wildlife Area and Los Banos Creek west of Kesterson National Wildlife Refuge). Whether selenium or other contamination may be responsible for the continued depression of giant garter snake population in otherwise apparently suitable habitats of the action area is not currently known.

As top predators, giant garter snakes are at risk of exposure to elevated levels of contaminants that bioaccumulate such as mercury and selenium. Over the life of the giant garter snake it is possible for snakes to accumulate contaminants that can impact the growth, behavior, survival, and reproduction of individuals, leading to declines in numbers and distribution. Water quality impairment of aquatic habitat that supports giant garter snakes could also reduce the prey base for the species.

The Department of the Interior's *Guidelines for the Interpretation of the Biological Effects of Selected Constituents in Biota, Water and Sediment* (USDI Guidelines) summarize background selenium levels in lizards, pine snake hatchlings from New Jersey (USDI-BOR/FWS/GS/BIA 1998), and snakes collected from the San Joaquin Valley. Alligator eggs from Florida suggest that reptile eggs are at the same selenium background level as fish and bird eggs (1-3 ppm). In the San Joaquin Valley, background levels of selenium in frog tissue range from 1.0 ppm to 3.6 ppm dry weight. Livers from gopher snakes in reference sites near Kesterson contained 1 - 4 ppm selenium. Skinless, whole-body pine snake hatchlings (considered representative of snake eggs) from New Jersey averaged 2.6 ppm. The USDI Guidelines state that it is probably safe to assume whole body concentrations at or above 10 times normal background (or ≥20 ppm) are toxic to populations of sensitive species (USDI-BOR/FWS/GS/BIA 1998). Further, the USDI Guidelines state that reproductive impairment is likely to be the most sensitive response and snake eggs with selenium concentrations ≥10 ppm are being reproductively impaired.

In the absence of a species specific selenium toxicity model for the giant garter snake the Service would recommend using an avian risk model for selenium based on the close phylogenetic relationship of birds to reptiles (e.g., Romer 1966; Porter 1972; Storer *et al.* 1972). Although giant garter snakes are live-bearing, newly born garter snakes have yolk sacs like other egg-laying species. Using such an avian risk model, the Service concluded in the draft California

Toxics Rule biological opinion that a selenium criterion of 5 ppb in water would jeopardize the giant garter snake. The Service has stated that a 2 ppb (monthly mean) standard for wetland water supply channels in the Grasslands (which was adopted by the State in the Grasslands Amendments) should be protective of giant garter snakes and their habitat. However, various results for water concentrations of selenium as low as 0.5 ppb suggest that bioaccumulation can sometimes result in problematic selenium levels in benthic organisms and fish (trout) even at selenium levels below 2 ppb in water (Saiki and Palawski 1990; Luoma and Presser 2000).

Mercury levels in fish from the lower San Joaquin River and Mud Slough have been found to be elevated (Davis *et al.* 2000; Slotton *et al.* 2000). The ultimate source is likely the New Idria Mine located in the Panoche/Silver Creek watershed. It has been shown that mercury added to a selenium-enriched test diet of mallards increased the amount of selenium stored in the mallards eggs (Heinz and Hoffman 1998). The potential for this interactive effect between mercury and selenium to occur in giant garter snakes in the Grassland Bypass Project area is of concern and warrants study.

Selenium in Source Water: A purpose of the Grassland Bypass Project is to improve water quality in the channels used to deliver water to wetland habitat areas. The Grassland Bypass Project has resulted in significant drops in the concentration of waterborne selenium in approximately 93 miles of Grassland wetland supply channels when compared with pre-project concentrations. Further, there has been an overall reduction in selenium concentrations in giant garter snake food chain organisms (fish and frogs) of these waters when compared with pre-project concentrations. The average of all composite samples of fish collected from Salt Slough (a Grassland wetland supply channel where biological monitoring has occurred) in water year 2000 was 2.6 ppm (n=66), below the GBP warmwater fish level of concern threshold (4 ppm), and significantly below the pre-Project average (6.7 ppm, n=78). A composite sample of four bullfrog tadpoles collected in Salt Slough in August 1999 had about half the selenium concentration (2.6 ppm) of a single bullfrog tadpole collected in March 1993 (5.8 ppm). However, the selenium concentration was higher in a composite sample of three bullfrog tadpoles in June 2000 (2.9 ppm), and still higher in August 2000 (7.5 ppm in a composite sample of three tadpoles), the August samples being within the GBP level of concern range for warmwater fish (4-9 ppm) from GBP Guidelines (Beckon *et al.*, 2001). The August 2000 tadpole data indicate that selenium in the foodchain of the giant garter snake may still be of concern in the Grassland wetland supply channels, at least during some times of the year and during some water year types.

Although selenium levels in the wetland water supply canals Grassland wetland supply channels have decreased substantially since the implementation of the first Grassland Bypass Project in September 1996, the 2 ppb (monthly mean) water quality objective promulgated by U.S. EPA and adopted by the State to protect Grassland wetland habitat has been exceeded in at least some of these canals on numerous occasions since 1996 (Chilcott, May 2000). Of note are significant exceedences of the 2 ppb water quality standard concentrations observed in wetland water supply channels Grassland wetland supply channels during the months of March and April 2001. According to Reclamation data, there was a spike in selenium concentration during March and April 2001, with water concentrations of 2.38 and 3.32 ppb, respectively, reported at Bass Avenue, the Delta Mendota Canal (DMC) terminus (the DMC is the water supply source for the Grassland wetland supply channels and the agricultural lands in the GDA). These spikes likely influenced the significant exceedences of the 2 ppb water quality standard for Grassland wetland water supply standard during March and April 2001 at 5 sampling locations in the Grasslands, where measured concentrations reached a high of 7.6 ppb at station K (Agatha Canal) on March 7, 2001 (Grassland Bypass Project, Monthly Data Report, May 2001). It is possible that some of this spike in selenium in source waters of the DMC during March and April 2001 could be explained by surface water runoff from Panoche/Silver Creek watershed (outside of the GDA) that occurred on March 5, 2001, subsiding after March 10, 2001 (McGahan, in litt., June 21, 2001). However, the Data Collection and Reporting Team of the Grassland Bypass Project noted that, while the McGahan memo could serve as one hypothesis for exceedences of the 2 ppb (monthly mean) standard, the timing of the peaks of these exceedences in many cases were either before or too long after this storm event to explain all the exceedences.

The source(s), quantities, and timing of selenium contamination in Grassland wetland supply channels is are not currently known. Inflow from shallow groundwater sumps located in the Firebaugh Canal Water District, from which Reclamation pumps groundwater into the DMC, is a likely contributor to this contamination. Additional sources of contamination may include: surface runoff from the Panoche/Silver Creek watershed, flood flows through existing check drains, and groundwater pumping into the Mendota Pool (Chilcott 2000). Selenium concentrations in supply water tend to increase between O'Neill Forebay and the DMC terminus, especially in the reach between Farm Bridge and Washoe Avenue where the sumps are located. Multiplying the DMC inflow in March and April 2001 by the selenium concentrations at the DMC terminus results in a calculated load to the Mendota Pool of 352 pounds in March and 464 pounds in April (Browning, in litt., July 17, 2001). Flow and concentration data from Reclamation collected at the DMC terminus from 1996 to 2000, indicate that annual loading of selenium in the source waters averaged 3,238 pounds of selenium per year with a high of 6,194 pounds of selenium in 1996 (USBR, unpublished data). The selenium load in the DMC source water which has resulted in exceedences of 2 ppb in wetland water supplies could result in elevated levels of selenium in the aquatic food chain and potentially lead to adverse effects in the giant garter snake.

Effects of the Grassland Bypass Project on Giant Garter Snake: The San Luis Drain, and the San Joaquin River do not appear to provide suitable habitat for the giant garter snake. However, aside from selenium and perhaps other drainwater contaminants, the aquatic habitat in Mud Slough appears to be suitable for giant garter snake, but no occurrences of garter snake are documented. It is not unlikely that giant garter snakes may disperse and be attracted to Mud Slough and consume the contaminated fish, tadpoles and frogs. About 23 to 46 percent of fish samples at Site D (Mud Slough 0.2 kilometers below the San Luis Drain outfall) would exceed the toxicity threshold of 9 ppm for warmwater fish from the GBP Guidelines if a critically dry year were to occur in 2001. By 2009, the proportion of fish samples exceeding the toxicity threshold in a critically dry year would be 5-19 percent under existing waste discharge requirements, 7-24 percent under stakeholder load limits, or 8-27 percent under alterative load limits. Since a significant portion of the fish in Mud Slough are at the level of concern and toxicity ranges, giant garter snakes feeding on the prey base in Mud Slough (North) would be exposed to levels of selenium that could impair reproduction.

Selenium concentrations in fish collected from Mud Slough at site I (1.5 kilometers below the San Luis Drain outfall) in August 2000 (10.3 ppm, n=14) were higher than in August 1999 (8.3 ppm, n=18). All fish sampled from Mud Slough site I in August 2000 exceeded the GBP toxicity threshold for warmwater fish (9 ppm) (GBP Guidelines; silversides 12.6 ppm, n=3; mosquitofish 10.2 ppm, n=6; carp 10.0 ppm, n=1; and red shiners 9.1 ppm, n=3). This site represents a better measure of the effects of the Grassland Bypass Project on Mud Slough biota because it is further from the diluting influence of aquatic organisms swimming downstream from the cleaner reach of Mud Slough above the outfall of the San Luis Drain.

Under the Proposed Action, quarterly biological monitoring of Mud Slough will continue to determine the selenium risk levels at Mud Slough for warmwater fish (USDI-BOR 2001). This information can be used to further assess risks to the giant garter snake. Through requirements of the Service's biological opinion on interim water contract renewals (USDI-FWS 2000), Reclamation will support studies on selenium impacts to giant garter snakes. Those studies, however, have yet to be initiated. Implementation of the Conservation Measures (e.g. contaminant monitoring, habitat inventory, population survey, maintenance of clean water delivery channels and contingency plans, as needed) described in the project description may help reduce the potential for adverse effects to giant garter snake.

Construction of facilities may impact giant garter snake habitat in Phase II (subsurface drainage collection system) and Phase III (treatment facilities construction), however, most construction will be across agricultural land. Should there be any giant garter snake habitat discovered in the construction zone, conservation measures have been incorporated into project description to avoid and minimize negative effects to giant garter snake.

Sacramento splittail and delta smelt

Selenium Toxicity to Fish: A large amount of research on toxic effects of selenium on fish has been conducted since the late 1970's. Recently, this body of research was reviewed and summarized by Lemly (1996b). Lemly reports that salmonids are very sensitive to selenium contamination and exhibit toxic symptoms even when tissue concentrations are quite low. Survival of juvenile rainbow trout (*Oncorhynchus mykiss*) was reduced when whole-body concentrations of selenium exceeded 5 ppm (dry weight.). Smoltification (the process by which fish morphologically, behaviorally and physiologically adapt to living in seawater after living in freshwater) and migration to seawater among juvenile chinook salmon (*Oncorhynchus tshawytscha*) were impaired when whole-body tissue concentrations reached about 20 ppm (dry weight). However, mortality among larvae, a more sensitive life stage, occurred when concentrations exceeded 5 ppm (dry weight). Whole-body concentrations of selenium in juvenile striped bass (*Morone saxitilis*) collected from areas in California impacted by irrigation drainage ranged from 5 to 8 ppm (dry weight).

Summarizing studies of warm-water fish, Lemly (1996b) reports that growth was inhibited at whole-body tissue concentrations of 5 to 8 ppm (dry weight) selenium or greater among juvenile and adult fathead minnows (*Pimephales promelas*). Several species of centrarchids (sunfish) exhibited physiologically important changes in blood parameters, tissue structure in major organs (ovary, kidney, liver, heart, gills), and organ weight-body weight relations when skeletal muscle tissue contained 8 to 36 ppm selenium. Whole-body selenium concentrations of only 4 to 6 ppm (dry weight) were associated with mortality when juvenile bluegill (*Lepomis macrochirus*) were fed selenomethionine-spiked commercial diets in the laboratory. When bluegill eggs contained 12 to 55 ppm selenium (dry weight), transfer of the selenium to developing embryos during yolk-sac absorption resulted in edema, morphological deformities, and death prior to the swim-up stage. In a laboratory study of "winter stress syndrome," juvenile bluegill exposed to a diet containing 5.1 ppm selenium (dry weight) and water containing 4.8 ppb selenium exhibited blood changes and gill damage that reduced respiratory capacity while increasing respiratory demand and oxygen consumption. In combination with low water temperature (4 degrees centigrade) these effects caused reduced activity and feeding, depletion of 50 to 80 percent of body fats, and significant mortality within 60 days. Winter stress syndrome resulted in the death of about one-third of exposed fish at whole-body concentrations of 5 to 8 ppm selenium (dry weight).

Based upon a review of more than 100 papers, Lemly (1996b) recommended the following toxic effects thresholds for freshwater and anadromous fish exposed to elevated concentrations of selenium on a dry weight basis: 4 ppm whole body; 8 ppm skinless fillets; 12 ppm liver; and 10 ppm ovary and eggs. He also recommended 3 ppm as the toxic threshold for selenium in aquatic food-chain organisms consumed by fish. Lemly reported that when waterborne concentrations of inorganic selenium (the predominant form in aquatic environments) are in the 7- to 10-ppb range, bioconcentration factors in phytoplankton are about 3,000 (i.e., selenium concentrations in these plankton are 3,000 times higher). He concluded that patterns and magnitudes of bioaccumulation are similar enough among various aquatic systems that a common number, 2 ppb (for filtered samples of water), could be given as a threshold for conditions "highly hazardous to the health and long-term survival of fish".

Effects of GDA Discharges on Delta smelt and its critical habitat: While delta smelt do not currently reach Mud Slough or the San Joaquin River above the Merced River, Grasslands Bypass Project discharges travel downstream via the San Joaquin River to the Delta and delta smelt critical habitat. These discharges carry elevated amounts of selenium, boron, and salts, and may carry other contaminants. The effects of these discharges on the Delta ecosystem and on delta smelt have not been much studied.

Lillebo *et al.* (1988) calculated that a selenium criterion of 0.9 ppb in water was necessary to adequately protect fish associated with the San Joaquin River system, including the southern Delta. The selenium criterion of 5 ppb adopted by the State in the Grasslands Amendments substantially exceeds the criterion calculated by Lillebo *et al.* (1988). An administrative report of a modeling case study by the U.S. Geological Survey (Presser, August 2001) found that Grassland Bypass Project selenium discharges within the established load schedule could result in Delta selenium concentrations in a dry year of 0.9 ppb or greater in some months. The model emulated 1994 water flows, with a projected selenium concentration of 0.91 ppb in August at Chipps Island, far downstream from the San Joaquin River's entry into the legal Delta and delta smelt critical habitat. Measured concentrations of selenium at the south Delta pumps (Tracy Fish Facility) have been documented as high as 4.5 ppb in the month of March 1997 (Craft *et al.*, January 2000), supporting the modeled potential for elevated selenium concentrations in the Delta. Selenium conveyance by the Grassland Bypass Project contributes to total Delta selenium load. See page 3-22 of this opinion for a full description of model assumptions used by the U.S. Geological Survey for this case study.

Little information is available on selenium concentrations in or effects on delta smelt. Unpublished data from the U.S. Geological Survey indicate that delta smelt feed on organisms in the Delta invertebrate foodweb with concentrations of selenium below those usually associated with adverse biological effects (Stewart *et al.*, 2000). Recent data (Bennet *et al.*, July 2001) indicate selenium tissue residues for delta smelt from 1993 to 1995 were below levels known to be associated with adverse effects in fish (n=41, range 0.7-2.3 ppm, dry weight).

The Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes (USDI-FWS, 1996) states that delta smelt are ecologically similar to larval and juvenile striped bass (*Morone saxitilis*). A significant difference is that striped bass are larger and longer lived--delta smelt usually live only one year. Therefore the most appropriate interspecies comparison is between delta smelt and juvenile striped bass. Saiki and Palawski (1990) sampled juvenile striped bass in the San Joaquin River system including three sites in the San Francisco Bay estuary. Juvenile striped bass from the estuary contained up to 3.3 ppm whole-body selenium (dry weight), a value only slightly below Lemly's (1996b) 4 ppm toxicity threshold, despite waterborne selenium typically averaging <1 ppb and ranging no higher than 2.7 ppb in the estuary (Pease *et al.* 1992). Whole-body concentrations of selenium in juvenile striped bass (*Morone saxitilis*) collected from areas in California impacted by irrigation drainage ranged from 5 to 8 ppm (Lemly 1996b), a level of concern for toxicity. Striped bass collected from Mud Slough in 1986, when the annual median selenium concentration in water was 8 ppb (Steensen *et al.* 1997), contained up to 7.9 ppm whole-body selenium, and averaged 6.9 ppm whole-body selenium. These results, while not grave, suggest that water conveyed by the Grassland Bypass Project and fully meeting the 5 ppb criterion could result in delta smelt with whole-body selenium concentrations exceeding the toxic threshold of 4 ppm, perhaps depending on water year and discharge concentrations. This issue deserves closer examination.

Delta smelt spawning sites are currently mostly restricted to the north-Delta channels associated with the selenium-normal Sacramento River and are nearly absent from the south-Delta channels associated with the selenium-contaminated San Joaquin River (USDI-FWS 1996). The extent to which this geographic restriction is due to Grassland Bypass Project contaminants is unknown, but is probably largely due to artificially reduced San Joaquin River flows and contaminant sources other than the continued Grassland Bypass Project.

The effects of the selenium, boron, salts, and other contaminants transported by the Grassland Bypass Project on the Delta ecosystem and delta smelt critical habitat are not well known. Since selenium and mercury are currently mostly a problem for animals higher in the food chain, we project in the absence of data that the plankton food of delta smelt are not measurably affected. However, there is some evidence that small changes in selenium concentrations in water can significantly alter the relative abundance of different plankton species (Imai *et al.* 1996). We are not aware of any existing studies of plankton community structure effects of selenium or mercury in the Delta. Of the thousands of pounds of selenium transported annually to the Delta by the Grassland Bypass Project, we expect that some fraction is deposited or sequestered (e.g., taken up by benthic filter feeders, and ultimately incorporated in organic deposits) in Delta channel sediments without passing out to the Bay and the ocean. Because selenium (and boron, and mercury) is an element and does not biodegrade, it is reasonable to expect that its deposition in sediments may be leading to accumulation of increasing concentrations there. From sediment deposits, selenium would be available for resuspension and reincorporation into the food chain by the activities of benthic or bottom-feeding organisms, or by extreme flow events. We have not examined any data on the magnitude or effects of deposition of long-lived contaminants in sediments in delta smelt critical habitat.

Although life history and feeding behavior indicate that Delta smelt are at a lower risk of from Grassland Bypass Project contaminants in the Delta than other longer-lived fish species, because of the large uncertainties and many unknowns involved we have not been able to exclude the possibility that the Grassland Bypass Project results in take of the smelt and may adversely affect its critical habitat. The commitments in the project description to support studies on selenium contamination in the Delta will further our understanding of the effects of selenium loading in the San Joaquin River on delta smelt.

Selenium Toxicity to Sacramento splittail: Selenium contamination of splittail has major implications for the species' ability to successfully tolerate at least two sources of stress that have been identified in the P. Moyle *et al.* draft White Paper on Sacramento splittail (Moyle *et al.* 2001). Splittail apparently experience substantive post-spawning stress, and are subject to substantial stress during salvage operations at south Delta State and Federal pumping facilities. Toxic thresholds for fish and wildlife dietary exposure to selenium have been identified primarily by means of controlled feeding experiments with captive animals (e.g., see reviews by NRC 1980, 1984, 1989; Heinz 1996; Lemly 1996a; Skorupa *et al.* 1996; USDI-BOR/FWS/GS/BIA 1998). Such experiments are carefully designed to isolate the toxic effects of selenium as a solitary stressor. Consequently, the toxic thresholds identified by such studies are prone to overestimating the levels of selenium exposure that can be tolerated without adverse effects in an environment with multiple stressors, such as is typical of real ecosystems (Cech *et al.* 1998).

Excessive environmental selenium weakens the immune defenses of fish and wildlife, and can also trigger pathogen and toxin challenges that would not otherwise have occurred (Tully and Franke 1935; Whiteley and Yuill 1989; Larsen *et al.* 1997; Wang *et al.* 1997).. For example, a red tide flagellate (Chattonella verruculosa) that causes mortality of fish such as yellowtail, amberjack, red and black sea bream, has recently been discovered to require above-normal exposure to selenium (Imai *et al.* 1996). Only when selenium extracted from contaminated sediments is added to growth media can C. verruculosa sustain rapid growth (i.e., toxic blooms). The level of contamination required to sustain rapid growth is only about twice normal background. Potential effects of selenium-mediated vulnerability to non-chemical stressors must be considered when assessing the threats of exposure of splittail to selenium. Current artificial hydrological conditions and altered ecological conditions are subjecting splittail populations to levels of stress unprecedented in the species prior history, while exposing splittail to artificially elevated selenium concentrations. Each of these factors alone poses serious threats to splittail; together they may pose synergistic threats greater than the sum of the parts. Under current conditions of reduced population and range and environmental stress, splittail are vulnerable to major impacts from epidemic disease, contaminant spills, or other catastrophic events.

Some fish are known to concentrate selenium in their eggs, or in live young in the case of live-bearers. Concentrations of 3 times the female body concentration are not uncommon (W. Beckon, Service, pers. comm. August 2001). This may be of concern because eggs are a highly active developmental stage, and as such are sensitive to developmental disruptors like selenium. We are not aware of studies of this phenomenon in splittail, but given findings of elevated selenium in some splittail we believe it needs further investigation.

Moyle *et al.* (2001) hypothesize that success of juvenile splittail downstream migration is strongly linked to the size that they achieve prior to leaving the spawning areas. A minimum size of 25 mm appears to greatly enhance success of downstream migration. All of the contaminants posing substantive threats to splittail discussed in the baseline and effects sections of this opinion are known to impair juvenile growth rates (Jarvinen and Ankley 1999).

Effects of selenium on Sacramento splittail in Mud and Salt Sloughs: In 1998, Sacramento splittail were caught in both Mud and Salt Sloughs for the first time in the eight year sampling history of the Grassland Byp monitoring program. This was likely due to El Nino storms and extended high flows allowing the fish greater potential shallow water breeding areas in the San Joaquin Valley. Whole body selenium concentrations (dry v basis) of composite samples of these fish from four sites are presented in Table 5. At Salt Slough, ten splittai composited and had selenium concentration at of 3.19 ppm. At Mud Slough upstream of the San Luis Drain discharge, a composite sample of four splittail had a selenium concentration of 4.95 ppm. At Mud Slough bel discharge, selenium in a composite of seven fish was 7.08 ppm, while at a third Mud Slough site further down composite of two fish had 5.2 ppm selenium. Selenium concentrations of splittail at all Mud Slough samplin 1998 were higher than the threshold of concern for adverse effects (4 ppm) and were highest at site D, just bel Luis Drain outfall. Further, concentrations of selenium in the Mud Slough splittail were higher than the comp concentrations in other species of fish at the same time and sites (Beckon *et al.*, 1999).

Based on studies of its selenium effects on salmonids, that negative effects of selenium could be expected to seen at in splittail within a level-of-concern ranging from range of 4 to 9 ppm (dry weight). Adverse effects to splittail associated with body burdens of selenium in this range may include, for example, a reduction in reproductive performance, likely occurs, which results in poor post-hatch survivorship, and reduced recruitment into adults (Lemly 1996b). This means that less splittail young are able to recruit to adulthood. The 1998 splittail data confirm indicate that splittail may be exposed to harmful levels of selenium from drainage discharges into Mud Slough. The data were obtained during a wet year, which may have attracted splittail into more contaminated reaches, and significant concentrations in splittail were found even though selenium concentrations in waters affected by the Grassland Bypass Project discharges (e.g., Mud Slough and the San Joaquin River downstream of the GBP discharges) are generally lower in wet years.

Table 5. Selenium concentrations in Sacramento splittail from June 1998 collection. U.S. Fish and Wildlife S data.

Site Location	Selenium ppm, dry wt.
Site C Mud Slough Upstream of San Luis Drain Discharge	4.95 (n= 4)
Site D Mud Slough Downstream of San Luis Drain Discharge	7.08 (n= 7)
Site I Mud Slough Downstream of San Luis Drain Discharge	5.2 (n=2)
Site F Salt Slough @ San Luis NWR	3.19 (n= 10)
Level-of-concern Range	4 - 9

(n= number of fish in the composite sample)

Water quality in Mud Slough (North) is expected to improve over the life of the Grassland Bypass Project (2001-2009) as more restrictive selenium load reduction assurances take effect as part of the Use Agreement for the Grassland Bypass Project. Nonetheless, the current U.S. EPA waterborne selenium criterion for the protection of aquatic life of 5 ppb will not be applied by the State and will not be met in Mud Slough and the San Joaquin River above the Merced River during the life of the continued Grassland Bypass Project. The Use Agreement for the Grassland Bypass Project does require a Mud Slough Compliance Plan be completed in 1996 to identify how the EPA selenium criterion, which is presently scheduled to become a legally enforceable State standard in October 2010, will be met. Because water quality in Mud Slough (North) and the San Joaquin River upstream of the Merced River will continue to receive subsurface drainage water from the GDA, these waters will remain water-quality impaired and will not provide adequate water quality to Sacramento splittail. During future Grassland Bypass Project implementation, selenium loads from the GDA in Mud Slough are likely to again result in adverse effects to Sacramento splittail that attempt to colonize these waters during high water years.

Effects of drainage disposal in the San Joaquin River on Sacramento splittail: The San Joaquin River is the only current means by which subsurface drainage is removed from the San Joaquin Valley. The disposal of the selenium-laden drainage is problematic because of the potential for ecological damage from selenium contamination in receiving waters and downstream in productive estuarine waters. Segments of the lower San Joaquin River, Mud Slough (North), and the San Francisco Bay-Delta Estuary, all downstream of the agricultural discharge from the Grassland Drainage Area, are listed by the State as water-quality impaired as part of required listing under the Clean Water Act. From 1965-1994 the flows of the San Joaquin River were almost completely diverted and recycled through the State and Federal pumping facilities in the south Delta (CSWRCB, 1994; Luoma and Presser 2000).

Selenium loads in the San Joaquin River are predicted to decline over the course of the proposed action relative to existing conditions. This is a result of load reduction assurances specified in the Use Agreement that are expected to decrease the load of selenium, salts, and boron allowable in the discharge. The annual selenium load values in Appendix C of the Use Agreement begin at 5,328 pounds in calendar year 2002 and end with 3,088 (wet year) and 2,421 pounds (dry year) in calendar year 2009. Load reduction values may be revised according to Appendix D of the Use Agreement if the Regional Board submits to U.S. EPA a Total Maximum Monthly Load for selenium that is different from that contained in the Grassland Amendments.

A large proportion of this the selenium load in the San Joaquin River originates from subsurface agricultural drainage discharges created as a by-product of irrigation within the Central Valley Project Service Area. Grassland Drainage Area discharges accounted for from 58% to 88% of the selenium loading measured at the San Joaquin River near Vernalis from 1995 to 1998. If load reduction assurances identified in the Use Agreement for this Grassland Bypass Project are met, the proportional contribution of selenium load to the San Joaquin River attributable to the GDA should decline over the life of the Grassland Bypass Project.

As was noted in U.S. Geological Survey comments on the Grassland Bypass Project EIS/EIR, however, concern remains for control of loads during wet years and the overall effectiveness of planned actions because of the basin-wide nature of groundwater degradation in the western San Joaquin Valley. Recent data from Grassland Bypass Project annual reports shows annual tile sump discharge from the GDA remains at approximately 10,000 pounds of selenium per year. Control activities to recycle and dispose of drainage on IVT lands has led to mobilized selenium being sequestered, mainly in groundwater aquifers and on land, to meet load limits. These control activities are largely a redistribution of a constant load among groundwater, surface water, and land disposal (T. Presser, USGS, in litt., February 26, 2001). It remains to be seen how long selenium sequestration can be continued without significantly limiting farming capability or returning to surface water disposal of drainage.

Storms and high flow years will be times of increased regional discharge of drainage containing large loads of selenium. It is likely that added loads of selenium which have been redistributed within the GDA will be released to the San Joaquin River during such periods of high water flows. Violations of water quality criteria and load targets could potentially result on a re-occurring basis, if the precipitation-dependence of the selenium inflows is not recognized. The long-term effects of such occurrences on wetlands, wetland channels, the Delta and the Bay are not well understood (T. Presser, USGS, in litt., February 26, 2001).

Toxicity problems may not appear equally in all components of a hydrologic unit because some components may be more sensitive than others. For example, the San Joaquin River, as a flowing water system may be less sensitive to selenium effects (especially if selenate dominates inputs as is the case with drainage from the San Joaquin Valley) than adjacent wetlands, the Delta or the Bay, where residence times and biogeochemical transformations of selenate are more likely. The sources and fate of selenium in the Delta will be a key to determining what actions are necessary to restore the estuary and aid in the recovery of splittail (T. Presser, USGS, in litt., February 26, 2001).

Effects of Selenium in the South Delta: It is not currently well understood how much of the San Joaquin River flows into the Bay-Delta estuary. After the 1994 Bay-Delta Water Accord (CSWRCB, 1994), water management changed, and more selenium may reach the Bay-Delta as less recycling of the San Joaquin River occurs. The amount of selenium-bearing San Joaquin River flow reaching specific locations in the Bay-Delta is can be influenced by: tidal cycles; variable flows of the Sacramento River and San Joaquin River due to seasons and upstream withdrawals, quantity of water diverted from the Delta to the Central Valley Project, State Water Project and local water users; discharge of agricultural drainage from the San Joaquin Valley and drainage inputs within the Delta itself; channel configurations and capacity; and artificial barriers which periodically are constructed to route flows in the Delta. Manipulations of barriers, modification of the channels, or construction of alternative diversion facilities could all affect (or are affecting) how much San Joaquin River flow reaches the Bay-Delta. Better understanding of water movement from the San Joaquin River through the Bay-Delta and processes within the estuary are critical to future evaluations of the effects selenium-laden drainwater on Delta fish and wildlife resources including Sacramento splittail (Luoma and Presser, 2000).

Data from the Tracy Fish Collection Facility from 1997 indicate that water being pumped into the Tracy Pumping Plant can at times contain elevated selenium concentrations. Waterborne selenium concentrations at the Tracy Fish Facility ranged as high as 4.5 ppb in the month of March 1997 (Craft *et al.*, January 2000). Although this concentration is below the current U.S. EPA and State adopted 5 ppb selenium water quality standard, this value is still above background concentrations in water and is well above the selenium concentration in the Sacramento River (0.06 ± 0.2 ppb) (Cutter and San Diego-McGlone, 1990). It has been shown that even in waters containing 1 ppb or less selenium (e.g., Suisun Bay), sufficient bioaccumulation can occur in the food chain to pose a hazard to higher trophic level organisms (Luoma and Presser, 2000). This data suggests that at least during some water years types or months, much of the San Joaquin River flow can be redirected into the Tracy Pumping Plant and influence water quality in CVP diversions and potentially affect splittail which forage near the pumps.

Recent results of chemical analyses from samples of splittail collected at the Tracy Pumping Plant from May 31 to August 2, 2000, revealed wholebody selenium concentrations ranging as high as 3.8 ppm (dry weight). Ten of the fourteen samples exhibited selenium concentrations of less than 2 ppm (normal range; W. Beckon, U.S. Fish and Wildlife Service, unpublished data, August 2001). These fish ranged from 9 to 30 centimeters in length. This could be partly a function of size, if larger splittail accumulate greater body burdens of selenium (Stewart *et al.*, 2000). This hypothesized size/burden relationship, while clearly applicable to mercury burdens, is not obvious for selenium in Beckon's fifteen splittail from the Tracy facility. A size/burden relationship, even if moderately weak, would raise concern that it is the splittail with the highest reproductive potential that are most likely to be adversely impacted by Grassland Bypass Project selenium contamination, since larger female splittail produce more eggs. It is unknown if splittail are being affected by selenium in the South Delta, or why the splittail collected at the Tracy Pumping Plant were less contaminated with selenium than focused sampling of splittail in Suisun Bay and Mud Slough. Further research on the effects of selenium on splittail in the South Delta is warranted.

Effects of selenium in the Delta on Sacramento splittail: Biological sampling in the Suisun Bay has shown that tissue selenium residues in predators and selenium concentrations in their food chain both point to threats to the reproductive health of aquatic listed species in the Delta (Luoma and Presser, 2000) when compared to laboratory and field studies conducted elsewhere (Lemly, 1996a; Skorupa, 1998; Engberg *et al.*, 1998). The magnitude of existing contamination is sufficient to threaten reproduction in key species within the ecosystem. The most severely threatened species appear to in

Sacramento splittail. Populations and catches per unit effort (where known) of all these species are in decline. "Restoration" of the Bay-Delta must include stabilizing or increasing the populations of these species, and one facilitate that goal is to control the stress selenium imposes on these animals (Luoma and Presser, 2000).

Selenium is readily bioaccumulated in the introduced Asiatic clam (*Potamocorbula amurensis*), which became the most common bivalve in the Delta during the 1990s (Luoma and Presser 2000). These clams have selenium concentrations ranging from 6 to 20 ppm (dry weight), the variation coinciding with seasonal changes in mean monthly river inflows to the north Bay (e.g., higher concentrations are observed during low flow periods). Asiatic clams are, in turn, consumed by splittail (Stewart *et al.* 2000). The splittail "White Paper" addresses the recent shifting dietary emphasis of splittail toward Asiatic clams (Moyle *et al.* 2001) and Stewart *et al.* (2000) have used stable isotope analyses to confirm that splittail diets are more characteristic of the clam food chain than the crustacean food chain. Dietary concentrations of 5 to 20 μg selenium per gram dry weight (i.e., almost exactly the range found in Asiatic clams) are known to cause severe reproductive problems in fish (Lemly 1997a, 1997b, 1997c). Stewart *et al.*'s unpublished splittail data cluster relatively close to the data for white sturgeon. Eggs of white sturgeon have already been documented to contain selenium concentrations exceeding those levels that resulted in 65 percent failure of selenium-exposed bluegill eggs (USDI-FWS and NMFS 2000). Stewart *et al.*'s study found that selenium liver concentrations in Sacramento splittail (greater than 170 mm in length) in the Suisun Marsh in the fall of 1999 that were at levels associated with adverse reproductive effects in fish and ranged as high as 20 ppm, dry weight (Stewart *et al.* 2000). Additionally, the selenium concentrations of Asiatic clams in the lower San Francisco Bay estuary have risen significantly in recent years and several realistic future scenarios evaluated for U.S. EPA by USGS scientists predict even further increases of selenium loading to the estuarine Asiatic clam food chain (Luoma and Presser 2000). The relationship between the bioaccumulation of selenium in the clam and its predation by splittail can also be expected to become more dangerous in the near-term future because the clam, via its predation on typical splittail prey items such as estuarine copepods (Eurytemora affinis, and Acartia sp.) (Kimmerer and Peñalva 2000), is creating conditions that promote increasing reliance of splittail on the clam as an alternate food source (Feyrer and Matern 2000). Thus, the most likely near-term scenario for the future is greater reliance of splittail on Asiatic clams as a food supply and possibly further increases of selenium concentrations in both Asiatic clams and splittail.

Moyle *et al.* 2001 (draft White Paper) have already presented data demonstrating statistically significant declining growth rates in Suisun Marsh splittail between 1980 and 1995 (prior to the onset of the first Grassland Bypass Project). The declines in growth rate are likely to be associated with the invasion by the Asiatic clam in the estuary, and the subsequent dietary shift of splittail to a clam-dominated diet. Moyle *et al.* suggested that this trend might reflect poorer energetics of a non-mysid shrimp dominated diet, but it can just as plausibly be suggested that it reflects the cachexia (contaminant-induced weight loss despite calorically sufficient dietary intake) that is a classic symptom of non-lethal selenium poisoning. Contaminant-induced growth depression among juveniles in spawning and rearing areas would mean that longer and longer times would be required to allow enough growth for optimal out-migration of juveniles. Increasing levels of contamination (via the yolk sac or post-larval dietary exposure; i.e., from contamination of the adults in the estuary or of juveniles in places like the Yolo Bypass) as are already foreseeable (Luoma and Presser 2000) conceivably could lead to juvenile growth rates too slow for even the longest contemporary durations of flood plain inundation. Reduced growth also causes a reduction in fecundity because fecundity in splittail is related to body size, as is common among fish.

The U.S. Geological Survey (USGS), developed a model to forecast effects of selenium from various sources in the Delta estuary (Luoma and Presser 2000). At the request of the U.S. EPA and the Service, the USGS used this model to provide monthly forecasts for selenium concentrations in the Delta in a dry year (1994 hydrology) and a wet year (1997 hydrology) using selenium loads limits from Appendix A of the Use Agreement from the Grassland Bypass Project for 2005 (total = 3,996 pounds per year) (Presser, August 2001).

Monthly forecasts for selenium concentrations in a dry year (1994) and a wet year (1997) were calculated in this case study under the following conditions:

- management of loads via the San Joaquin River using load limits from Appendix A of the Use Agreement for the *Grassland Bypass Project* for 2005 (total load = 3996 pounds per year, June-November load, for low flow period = 1728 pounds, December-May load, for high flow period = 2268 pounds).
- all freshwater exports are from the Sacramento River;
- all San Joaquin River inflow enters the Bay-Delta;
- Sacramento River inflow is outflow index minus San Joaquin River discharge;
- Transformation is quantitatively expressed by the distribution of Se between particulate and dissolved forms, the Kd. The effect of speciation and transformation is incorporated by using Kd's observed in previous studies to project a ratio to total Se typical of a given speciation regime. For each combination of Kd and speciation, the incorporation of the form of particulate Se observed under those circumstances at other locations enables a projection of overall bioavailability. Kds = 3000[1] , 1000, and 10,000;
- bivalve bioaccumulation is cast in terms of assimilation efficiencies (AE in percent). AE = 35%, 55%, 63%, and 80%;

---

[1] A Kd is the distribution coefficient, a way to quantitatively describe the partitioning of total selenium between dissolved and particulate states, defined as the ratio of selenium per unit mass particulate material versus selenium per unit volume water, in equivalent units. A Kd equal to 3000 is a conservative estimate of what may actually be occurring in the Delta. Luoma and Presser (2000) indicated that Kd's in their surveys of the Bay-Delta ecosystem routinely were above 10,000.

- refinery cleanup.

In the model run using flow data from 1997, a wet year, the model outcome indicated that clams in the Delta would fall above 3 ppm selenium, dry weight (a level of concern for invertebrates from the GBP Guidelines), for seven months of the year, including all months during the low flow period (June - November). In addition, clams were above the toxicity threshold established for invertebrates in the GBP Guidelines in September and October, with projected clam tissue selenium concentrations of 8.1 and 7.2 ppm, respectively (Presser, August 2001).

In the model run using flow data from 1994, a dry year, the model outcome indicated that clams in the Delta would fall above 3 ppm selenium (dry weight) in all months of the year. In addition, clams were above the toxicity threshold for selenium in invertebrates of 7 ppm from GBP Guidelines during the entire low flow period (June -November). The highest concentrations occurred in August and October with projected clam tissue concentrations of 12.5 and 10.5 ppm, respectively (Presser, August 2001).

Although the model was run based on a number of the assumptions, it does show a potential for significant accumulations of selenium in biota of the Delta especially during dry water years and low flow months. These periods of low San Joaquin River flow combined with agricultural drainage discharges associated with the Grassland Bypass Project could result in an increased risk of adverse effects to Sacramento splittail from selenium exposure in the Delta. Further, during 2001 to 2007 proposed wet and dry year selenium loads (from the Use Agreement) are the same, affording little protection for the San Joaquin River in dry years. These outcomes are consistent with those reported by Luoma and Presser (2000). The most significant impacts of irrigation drainage disposal into the San Joaquin River and the Bay-Delta appear most likely occur during low flow seasons and especially during low-river flow conditions in dry or critically dry years. Dry or critically dry years have occurred in 31 of the past 92 years (34 percent), with critically dry years comprising 15 of those years (16 percent). Any analysis of selenium effects must take the influences of variable river flows into account (Luoma and Presser, 2000). Years of low flow are also the most difficult for splittail reproduction, with spawning and rearing restricted to channel shallows with appropriate habitat.

In Appendix I (Response to Comments), pages I-61 of the Grassland Bypass Project Final EIS/EIR (USDI-BOR 2001), the following was noted, "The elevated selenium levels in these Suisun Bay organisms are caused by selenite discharges from oil refineries around Suisun Bay, entering the food chain through bioconcentration by phytoplankton that preferentially take up selenite...Because selenate is the thermodynamically stable form of selenium in oxygenated water, it is not transformed to selenite and makes a much smaller contribution to selenium in the Suisun Bay food chain than the refinery selenite." While it is true that the refineries once did account for the majority of selenium contamination in Suisun Bay, and the form of selenium discharged was selenite, this is no longer the case. As a result of regulations imposed by the San

Francisco Bay Regional Water Quality Control Board, refinery inputs to the Bay-Delta declined after July 1998. Oil refinery loads from 1986 to 1992 ranged from 11 to 15 pounds of selenium per day; with treatment and cleanup, loads decreased to 3 pound of selenium per day in 1999. Further, treatment technologies in the refineries remove only selenite, so the selenium discharged is mostly selenate since 1999, while historic discharges were over 50% selenite (Luoma and Presser, 2000). Despite the radical decline in refinery discharges of selenium, particularly selenite, the concentration of selenium in suspended particulates in the estuary essentially has not changed between the 1980's and late 1990's (Cutter *et al.*, 2000).

At this time, the source(s) of the selenium contamination in suspended particulates in Susuin Bay is/are not fully understood, although agricultural drainwater disposal into the San Joaquin River, including those loads associated with discharges from the Grassland Bypass Project, appear likely to be a contributing source of this contamination, given the data discussed above. Additional information is needed to determine the fate and impact of selenium discharges from the west-side San Joaquin Valley and oil refineries in the North Bay, and to assess the impacts that agricultural drainage discharges in the San Joaquin River may have in the Delta ecosystem.

Summary Effects of the Grassland Bypass Project on Sacramento Splittail: There are a number of known effects of drainage discharges attributable to the Grassland Bypass Project on splittail. What is known is as follows:

- Selenium loading attributable to the GDA into Mud Slough, the San Joaquin River and the Delta is planned to decline over the life of the Grassland Bypass Project by two-fifths to one-half as load reduction assurances from the Use Agreement take effect;
- The U.S. EPA criterion of 5 ppb selenium will not be met in Mud Slough and the San Joaquin River upstream of the Merced during the life of the Grassland Bypass Project;
- During high water years (e.g., similar to water year 1998), selenium in Mud Slough (North) and the San Joaquin River upstream of the Merced River could result in adverse effects in Sacramento splittail using these waters;

In addition, there are a number of known effects related to selenium contamination in the Delta:

- Particulate selenium concentrations in Suisun Bay have remained unchanged although refinery inputs of selenium have declined;
- Selenium is bioaccumulating to adverse effect levels in the aquatic food chain in portions of the Delta;
- Sacramento splittail over 170 mm in length in Suisun Bay contain body burdens of selenium associated with adverse biological effects in fish.

Remaining uncertainties about the effects of the Grassland Bypass Project are as follows:

- The long-term effects of drainage management in the GDA and redistribution of selenium into the groundwater, surface water and land disposal on selenium discharges during high water events;
- The effects of drainage discharges from GDA on splittail in the Delta;

- The fate and outcome of San Joaquin River selenium loading in the Delta;
- The effects of changes in south Delta hydrodynamics on fate of San Joaquin River loading to Delta;
- The source(s) of selenium contamination in suspended particulates in Suisun Bay.

There are a number of uncertainties and data gaps related to the effects of the continuation of the Grassland Bypass Project on Sacramento splittail. Implementation of the Conservation Measures (load reduction assurances, support of studies to assess the effects of selenium in the Delta and support of a contingency plan to address selenium contamination in the Delta if it is determined that agricultural drainage is having a significant impact on splittail) described in the project description of this opinion will help reduce the adverse effects associated with Grassland Bypass Project drainage discharges to Sacramento splittail. Given the large uncertainties and the possible vulnerability of vital splittail survival and reproductive functions (fecundity, egg development, spawning and rearing in low water years), however, we consider that stronger contingency measures are needed if ongoing or future research should show that the Grassland Bypass Project is significantly impacting splittail in the Delta.

Vernal Pool Crustaceans

The San Luis NWR Complex along Salt and Mud Sloughs has an extensive grassland/vernal pool complex. The 1994 survey of the Complex records listed vernal pool fairy shrimp at the Kesterson NWR, Arena NWR, and West Gallo and East Gallo Units (now called West and East Bear Units) (Peters 1994). No adverse impact is likely to affect this species from construction activities at the Grassland Bypass Project sites.

During flood events, species may be affected when rainwater and drainage flows exceed the capacity of Mud Slough, overflowing onto the refuge floodplain and into nearby vernal pools. Selenium and drainwater constituents can enter the vernal pools, change the water chemistry of the pools, and may evapoconcentrate as the pools dry up. However, because of the Grassland Bypass Project, higher quality project water now flows along the other 93 miles of wetlands and channels thus improving the quality of vernal pools adjacent to these channels. Further, the amount of selenium load released from the GDA into Mud Slough (North) will decrease over the life of the Grassland Bypass Project, as is required by the Regional Board and proposed in the Use Agreement of the Grassland Bypass Project.

Vernal pool water as it evaporates is not likely to concentrate selenium to levels acutely toxic to fairy shrimp or other invertebrates. The waterborne acute toxicity threshold for selenate is around 500 ppb (USDI-BOR/FWS/GS/BIA 1998). No selenium toxicity data in water or prey is available to determine impacts to fairy shrimp or their surrogates. The *Guidelines* background level for selenium bioaccumulation for aquatic invertebrates is 0.4 to 4.5 ppm selenium (dry weight) Experimental studies of dietary toxicity to invertebrates are rare. Midge larvae growth was inhibited on diets of algae ≥2.1 ppm selenium. Amphipods showed no adverse effects due to feeding on algae bearing selenium at levels of 300 ppm selenium (USDI-BOR/FWS/GS/BIA 1998). Vernal pool crustaceans' tolerance of selenium is unknown. Their cysts are capable of withstanding heat, cold and prolonged desiccation, salinity or alkalinity.

Implementation of the proposed Conservation Measures (survey selenium concentrations of sediment/soil and detritus from vernal pools adjacent to Mud Slough, and contingency plans as appropriate) in the project description will help reduce the potential for adverse effects to vernal pool crustaceans.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Cumulative effects on delta smelt, delta smelt critical habitat, and Sacramento splittail within the aquatic ecosystems considered in this biological opinion include:

1. Non-federal water management such as diversions, levee maintenance and riprapping, channel dredging, channel enlargement, flood control projects, drainage pumps, diversion pumps, siphons, non-Federal pumping plants associated with water management in the Sacramento-San Joaquin Delta, intrusion of brackish water, continuing or future non-Federal diversions of water, flood flow releases, and changes in water management.

2. Introduction of non-native fish, wildlife and plants, hybridization with non-native fishes, inbreeding of small populations, and genetic isolation.

3. Discharges into surface waters including point source discharges (permitted), non-point source runoff (e.g., mining runoff), runoff from high-density confined livestock production facilities, runoff from copper sulfate foot baths associated with dairy farms, agricultural irrigation drainwater discharges (surface and subsurface), runoff from overgrazed rangelands, municipal and industrial stormwater discharges (permitted and non-permitted), release of contaminated ballast and spills of oil and other pollutants into enclosed bays, and illegal, non-permitted discharges.

4. Overfishing and overutilization for scientific, commercial, and educational purposes.

5. Wildland fires and land management practices such as timber harvest practices and improper rangeland management resulting in sedimentation of surface waters; and application of pesticides, herbicides, fungicides, fumigants, fertilizers and other soil/water amendments, urban development, and conversion and reclamation of wetland habitats;

6. Recreational disturbances including water sports, illegal fishing, and off-road vehicle use.

Cumulative effects for the giant garter snake considered in this biological opinion include:

1. Water management such as diversions, levee maintenance, channel dredging, channel enlargement, flood control projects, installation of pumps, wells, and drains, non-Federal pumping plants associated with water management in the Sacramento-San Joaquin Delta, intrusion of brackish water, continuing or future non-Federal diversions of water, flood flow releases, and changes in water management.

2. Introduction of non-native fish, wildlife and plants, inbreeding of small populations, and genetic isolation.

3. Discharges into surface waters including point source discharges (permitted), non- point source runoff (e.g., mining runoff), runoff from high-density confined livestock production facilities, agricultural irrigation drainwater discharges (surface and subsurface), runoff from overgrazed rangelands, municipal stormwater runoff, and illegal, release of contaminated ballast and spills of oil and other pollutants into enclosed bays, non-permitted discharges.

4. Overutilization for scientific, commercial, and educational purposes;.

5. Logging, wildland fire and land management practices including fluctuations in agricultural land crop production, plowing, discing, grubbing, improper rangeland management, timber harvest practices, irrigation canal clearance and maintenance activities, levee maintenance, permitted and non-permitted use and application of pesticides, herbicides, fungicides, rodenticides, fumigants, fertilizers and other soil/water amendments, urban development, urban refuse disposal, land conversions, illegal fill of wetlands and conversion and reclamation of wetland habitats.

6. Recreational disturbances, vandalism, road kills, off-road vehicle use, chronic disturbance, noise, disturbances from domestic dogs and equestrian uses.

Cumulative effects for the San Joaquin kit fox and mountain plover considered in this biological opinion include:

1. Habitat loss and degradation affecting both animals and plants continues as a result of urbanization, oil and gas development, road and utility right-of-way management, flood control projects, overgrazing by livestock, and continuing agricultural expansion.

2. Poisoning, shooting, increased predation associated with human development, and reduction of food sources.

3. Pesticide use in the vicinity of the Grassland Bypass Project. Most pesticides have not been consulted on with the Service by EPA. Pesticides of all types, including herbicides, are extremely widely used in California, particularly in the San Joaquin Valley. Chemicals applied nearby may drift or run off into contact with listed species. Certain pesticides are registered by the EPA for use on rangelands, and these may be sprayed directly on vernal pools and upland species habitat. Pesticides are sometimes applied directly to pools, including vernal pools, for mosquito abatement.

4. Recreational disturbances, vandalism, road kills, off-road vehicle use, chronic disturbance, noise, disturbances from domestic dogs and equestrian uses.

Cumulative effects for listed vernal pool crustaceans considered in this biological opinion include:

1. Habitat loss and degradation affecting both animals and plants continues as a result of urbanization, oil and gas development, road and utility right-of-way management, flood control projects, overgrazing by livestock, and continuing agricultural expansion.

2. Pesticide and fertilizer use in the vicinity of the Grassland Bypass Project. Most pesticides have not been consulted on with the Service by EPA. Pesticides of all types, including herbicides, are extremely widely used in California, particularly in the San Joaquin Valley. Chemicals applied nearby may drift or run off into contact with listed species. Certain pesticides are registered by the EPA for use on rangelands, and these may be sprayed directly on vernal pools, and upland species habitat. Pesticides are sometimes applied directly to pools, including vernal pools, for mosquito abatement.

3. Recreational disturbances, vandalism, road kills, off-road vehicle use, chronic disturbance, noise, disturbances from domestic dogs and equestrian uses.

4. Discharges into surface waters including point source discharges (permitted), non- point source runoff (e.g., mining runoff), runoff from high-density confined livestock production facilities, agricultural irrigation drainwater discharges (surface and subsurface), runoff from overgrazed rangelands, municipal stormwater runoff, and illegal, release of contaminated ballast and spills of oil and other pollutants into enclosed bays, non-permitted discharges.

5. Overutilization for scientific, commercial, and educational purposes.

6. Wildland fires and land management practices such as timber harvest practices and improper rangeland management resulting in sedimentation of surface waters; and application of pesticides, herbicides, fungicides,, fumigants, fertilizers and other soil/water amendments, urban development, and conversion and reclamation of wetland habitats;

Conclusion

Findings of Not Likely to Jeopardize or Adversely Modify

After reviewing the current status of the species considered in this opinion, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that continuation of the Grassland Bypass Project as described, is not likely to jeopardize the continued existence of the San Joaquin kit fox, mountain plover, giant garter snake, delta smelt, Sacramento splittail, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp, and is not likely to destroy or adversely modify designated critical habitat of the delta smelt. Critical habitat has not been designated for the other species addressed, therefore none will be affected. This conclusion is based on the assumptions, environmental commitments and conservation measures described. Actions that are not included in, and consistent with, the project description in this document have not been analyzed for their impacts on the survival and recovery of proposed and listed species.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

Some actions related to the proposed action are not covered by this incidental take statement. For example, certain related actions are identified in the November 21, 2000, program-level long-term contracts consultation (Service file 1-1-98-F-0124) as requiring separate section 7 consultation. Related actions that are not covered by this opinion include but may not be limited to: long-term or interim water contract renewals for the Delta Mendota Canal Unit or the San Luis Unit; operations and maintenance activities undertaken for the Delta Mendota Canal and

San Luis & Delta-Mendota Water Authority; water transfers, assignments, and exchanges originating from or delivered to the contractors involved in the Grassland Bypass Project or involving the Delta Mendota Canal, including flood flows (215 water), and Warren Act contracts for conveyance of non-federal water using federal facilities; the operation of sumps in the Firebaugh Canal Water District which are pumped into the Delta Mendota Canal to control seepage; and the Mendota Pool Exchange Agreement and other non-Central Valley Project waters that are pumped into the Mendota Pool. Reclamation should consider whether it may have a duty to avoid irreversible or irretrievable commitments toward related actions before any biological opinion is completed for a related action. This incidental take statement does not authorize any incidental take of listed species resulting from related actions that are not part of or controllable by the Grassland Bypass Project and that are not included in the project description of this biological opinion.

The measures described below are non-discretionary, and must be implemented by Reclamation so that they become binding conditions of any agreement, contract, grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any agreement, contract, permit, or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

Amount or Extent of Take

The Service anticipates that take of listed species in the form of death, injury, harassment and harm is likely to occur as a result of extension of the Grasslands Bypass Project for the period of October 1, 2001 through December 31, 2009.

Giant Garter Snake - The Service expects that incidental take of giant garter snakes will be difficult to quantify for the following reasons: (1) the snakes are secretive and notoriously sensitive to human activities, (2) individual snakes are difficult to detect unless they are observed, undisturbed, at a distance, and (3) the difficulty of detecting and tracking all operations and maintenance activities that may result in take of giant garter snakes. According to Service Policy, as laid out in the Section 7 Handbook, dated March 1998, some detectable measure of effect should be provided in an incidental take statement. For instance, the relative occurrence of the species in the local community or surrogate species in the community or amount of habitat utilized by the species, serve as a measure for take. Take also can be expressed as a change in habitat characteristics affecting the species, such as water quality and flow. For these reasons, the Service is estimating the level of take as injury to all take of giant garter snakes that may occur, during the period covered by this consultation, in six miles of Mud Slough (North) from the San Luis Drain terminus to the confluence with the San Joaquin River, and the San Joaquin River downstream from Mud Slough to Crows Landing, resulting from selenium exposure originating from discharges in the Grasslands Drainage Area during the period covered by this consultation.

Sacramento Splittail and Delta Smelt - The Service anticipates that incidental take of Sacramento splittail and Delta smelt will be difficult to detect since these species (1) are aquatic in nature, and there is a low likelihood of discovering sublethally or lethally affected individuals; (2) may be directly lost to other environmental and human-caused conditions due to a reduced capacity to escape predation or other human induced habitat conditions; (3) are small bodied and/or affected at an early life stage and are not likely to be detected; and (4) losses may be masked by seasonal or inter-annual fluctuation in numbers or by other causes such as hydrological conditions that lie outside the action area. For these reasons, the Service is estimating the level of take as all injury, mortality, and harm of Sacramento splittail and Delta smelt resulting from selenium exposure originating from discharges in the Grasslands Drainage Area into Mud Slough, the San Joaquin River, and the southern Sacramento-San Joaquin Delta during the period covered by this consultation.

San Joaquin Kit Fox and Mountain Plover - Implementation of the Conservation Measures in the project description of this opinion may reduce, but not eliminate, the potential for incidental take of listed species resulting from implementation of the IVT element of the Grassland Bypass Project. The Service expects that incidental take of the San Joaquin kit fox and mountain plover addressed in this opinion will be difficult to detect or quantify for the following reasons: The secretive nature of the species, losses may be masked by seasonal fluctuations in numbers or other causes, and the species occurs in habitat that makes them difficult to detect.

Due to the difficulty in quantifying take of San Joaquin kit fox and mountain plover that may result from the proposed action, the Service is quantifying take incidental to the project as harassment and harm, in the form of habitat modification or degradation, within acreage that may be utilized for the IVT element of the Grassland Bypass Project. Therefore, the Service estimates that up to 6,200 acres of lands managed in the IVT element of the Grassland Bypass Project could become less suitable, unsuitable, or more hazardous to kit fox and mountain plover. No other forms of take of these species are authorized.

Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, Vernal Pool Fairy Shrimp, and Vernal Pool Tadpole Shrimp - Implementation of the Conservation Measures in the project description of this opinion may reduce, but not eliminate, the potential for incidental take of vernal pool crustaceans from discharges into Mud Slough (North) of the Grassland Bypass Project. The Service expects that incidental take of the listed vernal pool crustaceans addressed in this opinion will be difficult to detect or quantify for the following reasons: losses of vernal pool crustaceans may be masked by seasonal fluctuations in numbers or other causes, there is a low likelihood of discovering sublethally or lethally affected individuals, and the species occurs in habitat that makes them difficult to detect. For these reasons, the Service is estimating the level of take as all take of vernal pool crustaceans in vernal pool habitat adjacent to Mud Slough (North) adversely affected by overflow or flooding of Mud Slough (North) containing drainwater discharges or selenium flushing flows from the GDA during the period covered by this consultation.

Effect of the Take

The Service has determined that this level of anticipated take, from implementation of the Grassland Bypass Project, is not likely to result in jeopardy to the listed wildlife species in this opinion or result in destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the impact of extended implementation of the Grassland Bypass Project on mountain plover, San Joaquin kit fox, giant garter snake, Delta smelt, Sacramento splittail, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

I. Minimize the incidental take resulting from selenium discharges from the Grassland Bypass Project in Mud Slough (North), the San Joaquin River, and the Sacramento-San Joaquin Delta for giant garter snake, delta smelt, Sacramento splittail, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

II. Minimize the incidental take from selenium contamination from the Grassland Drainage Area to the Grasslands wetland supply channels on giant garter snake, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

III. Minimize the incidental take of listed species associated with Implementation of the In-Valley-Treatment element of the Grassland Bypass Project for San Joaquin kit fox and mountain plover.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of ESA, Reclamation and/or the Authority must comply with the following terms and conditions, which implement the reasonable and prudent measure(s) described above. These terms and conditions are nondiscretionary.

The following terms and conditions implement reasonable and prudent measure number I, to minimize the incidental take from selenium discharges for giant garter snake, Delta smelt, and Sacramento splittail, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

I.A. Adverse effects to Sacramento splittail from selenium contamination in the benthic foodchain are likely to be occurring in Suisun Bay. It is unknown at this time, how much, selenium from the Grassland Bypass Project and the San Joaquin River is reaching the Delta, or how these discharges may be affecting listed species. As a result, Reclamation, together with the Service and other appropriate agencies, will either seek from CALFED direct funding or will prepare a proposal through the CALFED proposal solicitation process to develop a selenium budget, to determine the sources, fate and impact of all selenium discharges in the San Joaquin River including those from the proposed action to presently impaired downstream water bodies used by listed species (e.g., giant garter snake, delta smelt and Sacramento splittail) including Mud Slough (North), the San Joaquin River, and the North Bay (e.g., Suisun Bay) and Sacramento-San Joaquin Delta. This effort will be implemented in coordination with the Service's Sacramento Fish and Wildlife Office, the U.S. Geological Survey, the State, including the State Water Resources Control Board, the California Regional Water Quality Control Board, and other appropriate agencies and entities. The selenium budget should include the following elements:

1. Track selenium loading, including loads from the Grassland Drainage Area into the San Joaquin River, the Sacramento-San Joaquin Delta, and the North Bay (e.g., Suisun Bay). Monitoring should provide spatial coverage and will be at a frequency relevant to determine trends in selenium contamination.
    a. determine concentrations of dissolved selenium and suspended selenium;
    b. determine a coordinated flow measurement system;
    c. determine selenium speciation in water and sediment (including effects of treatment technology on selenium species being discharged);
    d. determine assimilation capacities in benthic based (e.g, clam) food chain;

e. determine selenium concentrations in tissues of clam-based food chain and in Sacramento splittail;

f. determine trace elements sequestered in bed sediments and in algal mats.

2. Model and/or monitor effects of Delta hydrodynamics (e.g., including the effects of State and Federal pumps, South Delta Barriers, supplemental flows for anadromous fish and listed species) on the fate of selenium from the San Joaquin River into the Delta and North Bay estuary during differing water year types (e.g., dry-year, normal-year and wet-year hydrology).

   a. identify elevated risk periods for potential adverse environmental effects based on hydrodynamics and water year type.

3. Identify and track the sources of selenium contamination in Grassland wetland supply channels source water responsible for exceedences of the Federal/State 2 ug/L standard. for wetland water supplies in the Grasslands area.

I.B. Reclamation, in coordination with the Service, the U.S. Geological Survey, and other appropriate agencies, will request that the CALFED Science Program staff implement a review, by no later than January 2005, of selenium budget development for the Delta pursuant to studies identified in I.A. above, and review of data related to the regional drainage and selenium problem in the San Joaquin Valley, and effects to listed species.

1. Review data from I. A above to evaluate how implementation of the Grassland Bypass Project is affecting the recovery of giant garter snake, delta smelt, Sacramento splittail, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp, San Joaquin kit fox, or mountain plover.

I.C. Reclamation and/or the Authority will provide a Mud Slough Compliance Plan to the Service's Endangered Species Division by January 1, 2006. The Plan will identify methods by which the Project will meet all applicable water quality objectives (including any revisions of selenium objectives promulgated by EPA and adopted by the Regional Board) for impacted waters including Mud Slough (North) and the San Joaquin River by no later than October 1, 2010.

I.D. Reclamation and/or the Authority will adhere to the appropriate Selenium Load Reduction Values per the terms and exceptions of the Use Agreement (both annual and monthly selenium loads) for 2001-2009 described in Appendix C or Appendix D of the Use Agreement for the Grassland Bypass Project.

I.E. To minimize the risk of take associated with uncertainties about the effects of contaminants on listed species, allow an updated re-evaluation of Project effects based on ongoing research and monitoring, and assist in agency-coordinated adaptive management of Project impacts, Reclamation and the Service shall conduct a comprehensive synthesis and review of the Project and its effects on federally listed and proposed species, to be completed during the year 2006. Within three months of this coordinated review, the Service shall make a written finding, based on this review, regarding whether reinitiation pursuant to 50 CFR 402.16 is needed.

The following terms and conditions implement reasonable and prudent measure number II, to minimize the incidental take from selenium contamination from the Grassland Drainage Area to the Grasslands wetland supply channels on giant garter snake, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

II.A. Reclamation and the Authority shall ensure that discharges from the Grasslands Drainage Area (GDA), subject to the exceptions provided in the Use Agreement, do not cause exceedence of the 2.0 ppb monthly mean objective for wetland water supply channels listed in Appendix 40 of the 1996 Basin Plan Amendment adopted by the State and approved by the EPA.

1. Reclamation and/or the Authority will provide advance notice of sudden changes of flow or quality. Reclamation and/or the Authority will develop procedures to coordinate operations with the downstream wetland managers. Reclamation and/or the Authority will work cooperatively with downstream entities regarding the timing of discharges and establish procedures which will ensure advance notice to, and coordination with, downstream wetland managers of upcoming releases.

2. Reclamation and the Authority will work with the Regional Board and other parties to identify the cause of exceedences of the 2 ppb (monthly mean) Grassland wetland water supply standard and to identify possible corrective actions. If the identified exceedences are attributable to the GDA, then corrective actions will be taken.

II.B. Reclamation and/or the Authority will implement the following conservation measures to avoid and minimize take of Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

1. To assess potential risks from selenium and other drainwater contaminants from Grassland Bypass Project discharges in Mud Slough (North), Reclamation and/or the Authority will conduct a contaminant survey of vernal pools adjacent to Mud Slough (North).

a. Reclamation and/or the Authority will collect baseline contaminant data from vernal pools adjacent to Mud Slough (North) during the winter of 2002 The baseline contaminant survey will include analysis of sediment/soil and detritus from vernal pools adjacent to Mud Slough (North) and subject to overflow or flooding of Mud Slough.

b. In the event of overflow from Mud Slough (North), as may occur during a heavy rainfall event, Reclamation and/or the Authority will collect contaminant data (e.g., water, sediment/soil and detritus) from vernal pools adjacent to Mud Slough (North) within 30 days of that event.

2. Reclamation and/or the Authority will work cooperatively with the Service and other agencies to develop a contingency plan, as necessary, to address drainwater contamination in vernal pools adjacent to Mud Slough if the Service determines via II.B.1. above, that agricultural drainage from the GDA has the potential to adversely impact listed vernal pool invertebrates. Reclamation and/or the Authority will complete and implement a Service-approved contingency plan within one year of the Service's determination of an adverse effect attributable to the GDA.

II.C. As part of a larger effort to support recovery of the giant garter snake, Reclamation and/or the Authority shall work cooperatively with the Service and other appropriate agencies to implement the following conservation measures to avoid and minimize negative effects to giant garter snake.

1. Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop an appropriate study plan, such as a mark and recapture survey or augmentation of ongoing surveys as appropriate, to assess population and distribution of giant garter snake in the Grassland wetlands, Grassland wetlands supply channels, and Mud Slough (North). Reclamation, together with the Service and other appropriate agencies, will seek to obtain funding and initiate the study within 1 year of this consultation.

2. Either in conjunction with Number 1 above or separately, Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop a study plan on the effects of contaminants (specifically selenium and mercury) on giant garter snake surrogates within the Grassland wetlands, Grassland wetlands supply channels, and Mud Slough (North). Reclamation, together with the Service and other appropriate agencies, will initiate the monitoring identified in this study plan within 1 year of this consultation.

3. Reclamation and/or the Authority will eliminate subsurface agricultural drainage (from the GDA) from the Grassland wetlands supply channels as set out in the project description and Use Agreement. In addition, within their ability and

respective authorities, Reclamation and the Authority will work cooperatively with other agencies to maintain Grassland wetlands supply channels in a manner that protects and maintains giant garter snake habitat.

4. Reclamation will determine the amount of existing giant garter snake habitat in the Grassland wetlands, Grassland wetland supply channels, and Mud Slough (North) within 12 months of this biological opinion consistent with the commitment on page 2-62 of the Biological Opinion on Implementation of the CVPIA and Continued Operation and Maintenance of the CVP (Service File No., 1-1-98-F-0124).

5. Reclamation and/or the Authority, together with the Service and other appropriate agencies, will develop a contingency plan should it be determined that selenium discharged from the GDA into Mud Slough (North) is negatively affecting giant garter snakes. Reclamation and, if appropriate, the Authority, will complete and implement a Service-approved contingency plan for giant garter snakes within one year of the determination of an adverse effect attributable to the GDA.

Pilot programs irrigating with subsurface drainwater on the surface of agricultural field sometimes result in highly seleniferous ponding, or could result in elevated concentrations of selenium or boron in food chains, creating hazards to wildlife. The following terms and conditions implement reasonable and prudent measure number III, to minimize the incidental take of listed species associated with implementation of the In-Valley-Treatment element of the Grassland Bypass Project for San Joaquin kit fox and mountain plover.

III. A. Reclamation and/or the Authority will monitor groundwater conditions for all IVT lands. Groundwater conditions will include: depth to groundwater and selenium concentration in groundwater.

III. B. Reclamation and/or the Authority will establish and commence implementation of a tiered contaminant monitoring program within 9 months of this opinion, in collaboration with the Service's Endangered Species and Environmental Contaminants Divisions of the SFWO, that will be sufficient to evaluate the safety of IVT lands for wildlife generally and specifically to identify the potential for dietary exposure to selenium of San Joaquin kit fox and mountain plover. Monitoring data will be compared with the ecological risk guidelines for selenium found in Table 1 on page 31 of the biological assessment (also table E2-1 in appendix E2 of the final Environmental Impact Statement and Environmental Impact Report for the Grasslands Bypass Project). For monitored media and analytes not covered by these ecological risk guidelines (i.e., selenium in fur, mercury in bird eggs etc.) the interpretive criteria for adverse effect shall be drawn from a review of the scientific literature. In addition, boron will be monitored long enough in biota at the IVT site to reasonably establish what the avian exposure to this constituent is.

III. C. Reclamation and/or the Authority will implement any measures identified by the Service, including hazing or other appropriate measures, as necessary for remediation of adverse effects to mountain plover. If ponding or other conditions are found such that wildlife exposure to contaminants is detected, irrigation of the IVT field will cease until an irrigation method that does not produce the adverse condition is identified and implemented.

III. D. Reclamation and/or the Authority will implement the reasonable measures identified by the Service as necessary for remediation of adverse effects to San Joaquin kit fox associated with IVT lands.

III. E. Data from the IVT Monitoring Program shall be provided to the Environmental Contaminants and Endangered Species Divisions of the SFWO at least annually for review.

III. F. Reclamation and/or the Authority shall fully fund the IVT Monitoring Program for a 5-year period. At the end of the 5-year monitoring program the Service will review the existing data and determine if and where monitoring needs to continue. Reclamation will continue to fund subsequent IVT contaminant monitoring until 2010 if the Service determines it is necessary.

III. G. Reclamation and/or the Authority will conduct monitoring on IVT lands by a Service-approved biologist every two weeks during the months of November through February of each year to determine if IVT lands are being used by mountain plover. Reclamation and/or the Authority will notify the Service's Sacramento Fish and Wildlife Office, Endangered Species Division (fax 916-414-6713, referencing this biological opinion), within 2 working days if mountain plover are observed on IVT lands.

III H. If mountain plovers are found at the IVT site(s), Reclamation and/or the Authority should also inform the adjoining water districts, provide a press release to the news media about the presence of this rare bird in the area and provide recommendations from the Service for its protection.

Reporting Requirements

Reclamation must provide the Service's Endangered Species Division and Environmental Contaminants Division with annual reports that include: monitoring and modeling data as required from the terms and conditions of this opinion, water and biota monitoring data from the Grassland Bypass Project, status and progress of implementation of all environmental commitments and conservation measures in the Description of the Proposed Action, and status and progress of all Terms and Conditions of this biological opinion. The first annual report is due October 2002, and annually thereafter through October 2010.

The Sacramento Fish and Wildlife Office is to be notified within three working days of the finding of any dead listed wildlife species or any unanticipated harm to the species addressed in this biological opinion. The Service contact person for this is the Chief, Endangered Species Division at (916) 414-6620.

Reclamation must require the Authority to report to the Service immediately any information about take or suspected take of listed wildlife species not authorized in this opinion. Reclamation must notify the Service within 24 hours of receiving such information. Notification must include the date, time, and location of the incident of the incident or of the finding of a dead or injured animal. The Service contact is the Service's Law Enforcement Division at (916) 414-6660.

Any contractor or employee who during routine operations and maintenance activities inadvertently kills or injures a listed wildlife species must immediately report the incident to their representative. This representative must contact the California Department of Fish and Game immediately in the case of a dead or injured San Joaquin kit fox, mountain plover or giant garter snake. The California Department of Fish and Game contact for immediate assistance is State Dispatch at (916) 445-0045.

The U.S. Fish and Wildlife Service Regional Office in Portland, Oregon, must be notified immediately if any dead or sick listed wildlife species is found in or adjacent to pesticide-treated areas. Cause of death or illness, if known, also should be conveyed to this office. The appropriate contact is Richard Hill at (503) 231-6241.

If Reclamation or the Authority obtain information that was not considered in this opinion, Reclamation and the Authority shall provide the new information to the Service's Sacramento Fish and Wildlife Office, Endangered Species Division. If requested by the Service, Reclamation and the Authority shall convene a meeting with the Service's Endangered Species and Environmental Contaminants Divisions within 30 days of the Service's request.

Conservation Recommendations

Section 7(a)(1) of ESA directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1) Reclamation should proactively encourage and fund retirement of seleniferous agricultural lands, including but not limited to those within or adjacent to the Grassland Drainage Area. This support could take the form of land purchases, incentives for withdrawing such lands from irrigation, disincentives for applying Federal water, reclassifying seleniferous lands, et cetera, and should be pursued by Reclamation whether independently or in cooperation with other appropriate Federal, State, and local agencies.
2) Reclamation should reallocate Central Valley Project water from retired lands to meet listed species water supply needs.
3) Reclamation should assist the Service in the implementation of recovery actions in the Recovery Plan for Upland Species in the San Joaquin Valley (USFWS 1998), Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes (USFWS 1995), and the Draft Recovery Plan for the Giant Garter Snake (USFWS 1999). Priority 1 Recovery Actions from these plans include the following:
    a. Protect habitat on private lands in the North and South Grasslands for giant garter snake;
    b. Protect habitat on private lands in the Mendota area for giant garter snake;
    c. Develop/update and implement management plans for Mendota, China Island, Los Banos, and Volta Wildlife Areas for giant garter snake;
    d. Improve in-Delta habitat conditions for Delta native fishes by increasing freshwater flows.
    e. Expand and connect existing natural land in the Mendota area, Fresno County, with the Ciervo-Panoche Natural Area, through restoration of habitat on retired, drainage-problem land.
4) Reclamation should assist the Service and other relevant parties in implementation of recommended actions to reduce the extent and severity of drainwater contamination identified in the San Joaquin Valley Drainage Program's Final Report: A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley.
5) Reclamation and the Authority should provide education to their staff(s) on identifying and protecting listed species in the project area.
6) Reclamation should provide outreach to the public and to schools on protecting listed species.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Reinitiation–Closing Statement

This concludes formal consultation on the action(s) outlined in the (request or reinitiation request). As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

1) Reclamation should proactively encourage and fund retirement of seleniferous agricultural lands, including but not limited to those within or adjacent to the Grassland Drainage Area. This support could take the form of land purchases, incentives for withdrawing such lands from irrigation, disincentives for applying Federal water, reclassifying seleniferous lands, et cetera, and should be pursued by Reclamation whether independently or in cooperation with other appropriate Federal, State, and local agencies.
2) Reclamation should reallocate Central Valley Project water from retired lands to meet listed species water supply needs.
3) Reclamation should assist the Service in the implementation of recovery actions in the Recovery Plan for Upland Species in the San Joaquin Valley (USFWS 1998), Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes (USFWS 1995), and the Draft Recovery Plan for the Giant Garter Snake (USFWS 1999). Priority 1 Recovery Actions from these plans include the following:
    a. Protect habitat on private lands in the North and South Grasslands for giant garter snake;
    b. Protect habitat on private lands in the Mendota area for giant garter snake;
    c. Develop/update and implement management plans for Mendota, China Island, Los Banos, and Volta Wildlife Areas for giant garter snake;
    d. Improve in-Delta habitat conditions for Delta native fishes by increasing freshwater flows.
    e. Expand and connect existing natural land in the Mendota area, Fresno County, with the Ciervo-Panoche Natural Area, through restoration of habitat on retired, drainage-problem land.
4) Reclamation should assist the Service and other relevant parties in implementation of recommended actions to reduce the extent and severity of drainwater contamination identified in the San Joaquin Valley Drainage Program's Final Report: A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley.
5) Reclamation and the Authority should provide education to their staff(s) on identifying and protecting listed species in the project area.
6) Reclamation should provide outreach to the public and to schools on protecting listed species.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

Reinitiation–Closing Statement

This concludes formal consultation on the action(s) outlined in the (request or reinitiation request). As provided in 50 CFR §402.16, reinitiation of formal consultation is required where

Literature Cited

Ahl, J.S.B. 1991. Factors affecting contributions of the tadpole shrimp, Lepidurus packardi, to its oversummering egg reserves. *Hydrobiologia* 212:137-143.

Albers, P.H., D.E. Green, and C.J. Sanderson. 1996. Diagnostic criteria for selenium toxicosis in aquatic birds: dietary exposure, tissue concentrations, and macroscopic effects. *J. Wildl. Dis.*, 32:468-485.

Alcorn, J.R. 1946. The birds of Lahontan Valley, Nevada. *Condor* 48:129-138

Alpers, C.N. and M.P. Hunerlach. 2000. Mercury Contamination from Historic Gold Mining in California. U.S. Geological Survey Fact Sheet FS-061-00. Sacramento, California. 6 pp.

Andrews, R., and R. Righter. 1992. Colorado birds. Denver Mus. Natur. Hist., Denver, CO. 442 pp.

Arthur, J.F. and M.D. Ball 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Bureau of Reclamation, Sacramento, California.

Arthur, J.F. and M.D. Ball 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 in T.J. Conomos, editor. Pacific Division, Amer. Assoc. Advance. Sci., San Francisco, California.

Arthur, J.F. and M.D. Ball 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Bailey, H.C., S. Clark, J. Davis, and L. Wiborg. Unknown date. The Effects of Toxic Contaminants in Waters of the San Francisco Bay and Delta. Final Report prepared for the Bay/Delta Oversight Council. Dept. of Water Resources, Contract No. B-59645.

Bailey, H.C., D.J. Ostrach, and D.E. Hinton. 1991. Effect of Rice Irrigation Water in Colusa Basin Drain on Fertilization Success and Embryonic Development in Striped Bass. Contract No. 9-169-250-0 Draft Report to California State Water Resources Control Board. 31 p

Baker Matta, M., J. Linse, C. Cairncross, L. Francendese, and R.M. Kocan. 2001. Reproductive and transgenerational effects of methylmercury or Aroclor 1268 on *Fundulus heteroclitus*. *Environ. Toxicol. Chem.*, 20:327-335.

Barclay, W.R. and A.W. Knight. 1984. Physio-chemical processes affecting production in a turbid vernal pool. Pages 126-142. IN S. Jain and P. Moyle, eds. Vernal pools and intermittent streams. Inst. Ecol. Pub. 28. Univ. Calif. Davis, California.

Beam, J., K. Cripe and C. Fien. 1999. San Joaquin Valley Giant Garter Snake Project. Unpublished report, California Department of Fish and Game, Los Banos, CA, 3 pp. and attachments.

Beckon, W.N., and M. Dunne. 2000. Biological Effects, Pages 64-98 in: Grassland Bypass Project Annual Report 1998-99. U. S. Bureau of Reclamation, Sacramento, California.

Beckon, W. N., M. Dunne, J. D. Henderson, J. P. Skorupa, S. E. Schwarzbach, and T. C. Maurer. 1999. Biological effects of the reopening of the San Luis Drain to carry subsurface irrigation drainwater. Pages 91-118 in: Grassland Bypass Project Annual Report October 1, 1997 through September 30, 1998. U. S. Bureau of Reclamation, Sacramento, California.

Beckon, W. N., M. Dunne, and A. Holmes. 2001. Biological Effects, Chapter 7 in [DRAFT] Grassland Bypass Project Annual Report 2000. San Francisco Estuary Institute for U. S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and San Luis & Delta-Mendota Water Authority. Sacramento, California.

Belk, D. 1977. Zoogeography of the Arizona fairy shrimps (Crustacea: Anostraca). *J. Ariz. Acad. Sci.* 12:70-78.

Bell, H.M. 1994. Analysis of habitat characteristics of San Joaquin kit fox in its northern range. Master Thesis. California State University, Hayward, California.

Bennett, J., J. Hofius, C. Johnson, and T. Maurer July 2001. Tissue Residues and Hazards of Water-Borne Pesticides for Federally Listed and Candidate Fishes of the Sacramento-San Joaquin River Delta, California: 1993-1995. U.S. Fish and Wildlife Service Study ID:1130-1F18, Sacramento, California, 24 pp.

Branchiopod Research Group. 1996. Vernal pool faunal survey Naval Air Station Miramar. Department of Biology, University of San Diego, San Diego, California.

Brett, J.R. 1952. Temperature tolerance of young Pacific salmon, genus *Oncorhynchus*. *J. Fish. Res. Bd. Can.* 9:265-323.

Brode, J. M. 1988. Natural history of the giant garter snake *(Thamnophis couchi gigas). In:* Proceedings of the conference on California herpetology, H. F. Delisle, P.R. Brown, B. Kaufman, and B. M. McGurty (eds.). Southwestern Herpetologists Society, Special Publication No. 4:25-28.

Brode, J. and G. Hansen. 1992. Status and future management of the giant garter snake (*Thamnophis gigas*) within the southern American Basin, Sacramento and Sutter counties, California. California Department of Fish and Game, Inland Fisheries Division, January 1992.

Burger, J. 1992. Trace Element Levels in Pine Snake Hatchlings: Tissue and Temporal Differences. *Arch Environ. Contam. Toxicol.* 22:209-213.

(CDFG) California Department of Fish and Game. 1992. Annual report on the status of California state listed threatened and endangered animals and plants. State of California, Department of Fish and Game, Sacramento, California.

(CDFG) California Department of Fish and Game. 1998. Natural Diversity Data Base. RareFind 2. Version 2.0.8 (March 30, 1998). Computer report for U.S. Geological Survey 7.5-minute quadrangles covering the AT&T cable upgrade project area and vicinity. California Department of Fish and Game, Sacramento, California.

Caywood, M.L. 1974. Contributions to the Life History of the Splittail *Pogonichthys macrolepidotus* (Ayres). M.S. Thesis, California State U., Sacramento. 77 pp.

Cech, J.J., Jr., B.W. Wilson, and D.G. Crosby. 1998. Multiple Stresses in Ecosystems. Lewis Publishers, Boca Raton, FL. 202 p.

Chilcott, J. May 2000. Review of Selenium Concentrations in Wetland Water Supply Channels in the Grassland Watershed. Staff Report of the California Regional Water Quality Control Board, Central Valley Region, Sacramento, California, 25 pp.

Coe, T. 1988. The application of section 404 of the Clean Water Act to vernal pools. Pages 356-358 *in* J. A. Kusler, S. Daly, and G. Brooks, eds. Urban wetlands. Proceedings of the National Wetland Symposium, Oakland, California.

Crader, Philip G. 2000. Water Quality Monitoring, Chapter 4 in Grassland Bypass Project Annual Report 1998-1999. San Francisco Estuary Institute for U. S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, San Luis & Delta -Mendota Water Authority. Sacramento, California.

Craft, D., L. Mao, J. Fields, and B. Moore.January 2000. Tracy Fish Collection Facility Studies California. Volume 9, Chemistry and Water Quality at the Tracy Fish Collection Facility, Tracy, California. U.S. Bureau of Reclamation, Mid Pacific Region, Sacramento, California.

(CSWRCB) California State Water Resources Control Board. 1994. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. CSWRCB, Sacramento, CA 95 pp.

Cutter, G.A., L.S. Cutter, M. Doblin, and S. Meseck. 2000. Selenium in the San Francisco Bay and Delta: historical trends and present status. *In* CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

Cutter, G.A., and M.L.C. San Diego-McGlone. 1990. Temporal variability of selenium fluxes in San Francisco Bay. *The Science of the Total Environment* 97/98:235-250.

Daniels, R.A. and P.B. Moyle. 1983. Life history of splittail (Cyprinidae: *Pogonichthys macrolepidotus*) in the Sacramento-San Joaquin estuary. *Fishery Bulletin* 84-3:647-654.

Davis, J. A., M.D. May, G. Ichikawa, and D. Crane. 2000. Contaminant concentrations in fish from the Sacramento-San Joaquin Delta and Lower San Joaquin River, 1998. San Francisco Estuary Institute, Richmond, CA.

Dobkin, D.S. 1994. Conservation and management of neotropical migrant landbirds in the Northern Rockies and Great Plains. University of Idaho Press, Moscow, Idaho. 183 pp.

Donald, D.B. 1983. Erratic occurrence of anostracans in a temporary pond: colonization and extinction or adaptation to variations in annual weather? *Can. J. Zool.* 61:1492-1498.

Driver, E.A. 1981. Caloric value of pond invertebrates eaten by ducks. *Freshwater Biology* 11:579-581.

DWR and USDI (Department of Water Resources and United States Department of Interior, Bureau of Reclamation, Mid-Pacific Region). 1993. Effects of the Central Valley Project and State Water Project on delta smelt. 134 pp.

DWR and USDI (Department of Water Resources and United States Department of Interior, Bureau of Reclamation, Mid-Pacific Region). 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. 230 pp.

Eisler, R. 1985a. Toxaphene Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews Report No.4. Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, MD, 26pp..

Eisler, R. 1985b. Selenium hazards to fish, wildlife, and invertebrates: a synoptic review. Contaminant Hazard Reviews Report No.5. Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, MD, 57pp.

Eng, L. L., D. Belk, and C. H. Erickson. 1990. California anostraca: distribution, habitat, and status. *J. Crus. Biol.* 10:247-277.

Engberg, R.A., D. W. Westcott, M. Delamore, and D.D. Holz. 1998. Federal and state perspectives on regulation and remediation of irrigation-induced selenium problems. In *Environmental Chemistry of Selenium*, W. T. Frankenberger and S. Benson, *eds*. New York: Marcel Dekker.

Eriksen, C. H. and D. Belk. 1999. Fairy shrimps of California's puddles, pools, and playas. Mad River Press, Eureka, California, 196 pp.

Fairbrother, A., and J. Fowles. 1990. Subchronic effects of sodium selenite and selenomethionine on several immune functions in mallards. *Arch. Environ. Contam. Toxicol.*, 19:836-844.

Feyrer, F. and S. Matern. 2000. Changes in fish diets in the San Francisco Estuary following the invasion of the clam *Potamocorbula amurensis. IEP Newsletter* Volume 13, Number 4, Fall 2000.

Fitch, H. S. 1941. Geographic variation in garter snakes of the genus *Thamnophis sirtalis* in the Pacific coast region of North America. *American Midland Naturalist*, 26:570-592.

Foe, C.G. 1995. Evaluation of the potential impact of contaminants on aquatic resources in the central valley and Sacramento-San Joaquin Delta Estuary. White paper for the Department of Water Resources from the California Regional Water Quality Control Board, Central Valley Region, Sacramento, California, 23pp.

Fugate, M. L. 1992. Speciation in the fairy shrimp genus Branchinecta (Crustacea: Anostraca) from North America. Ph.D. dissertation. Department of Biology, University of California, Riverside, California.

(GAF and Authority) Grassland Area Farmers and San Luis and Delta-Mendota Water Authority. 1998. Long-Term Drainage Management plan for the Grassland Drainage Area. September 30.

Gallagher, S. P. 1996. Seasonal occurrence and habitat characteristics of some vernal pool branchiopoda in Northern California, U.S.A. *Journal of Crustacean Biology* 16: 323-329.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pp.64-94 in D.W. Kelley, ed.: Ecological studies of the Sacramento-San Joaquin estuary, Part 1. Calif. Dept. Fish and Game, Fish Bulletin No. 133.

Garrett, K., and J. Dunn. 1981. Birds of southern California status and distribution. Los Angeles Audubon Publishers. 408 pp.

Gill, G.A. 2000. Studies of flux from Delta sediments. Progress Report *in:* C. Foe (Ed.), An assessment of ecological and human health impact of mercury in the Bay-Delta watershed. Central Valley Regional Water Quality Control Board, Sacramento, CA (November 2000).

Gilpin, M. E. and M. E. Soule. 1986. Minimum viable populations: processes of species extinction. Pages 19-34 *in* M. E. Soule, ed. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, Massachusetts.

Goodbred, S.L., R.J. Gilliom, T.S. Gross, N.P. Denslow, W.L. Bryant, and T.R. Schoeb. 1997. Reconnaissance of 17β-Estradiol, 11-Ketotestosterone, vitellogenin, and gonad histopathology in common carp of United States streams: potential for contaminant-induced endocrine disruption. Open File Report 96-627. U.S. Geological Survey, Sacramento, CA. 34 pp. + appendices.

Goodman, D. 1987*a*. The demography of chance extinction. Pages 11-34 *in* M. E. Soule, ed. Viable populations for conservation. Cambridge University Press, Cambridge, Great Britain.

Goodman, D. 1987*b*. How do any species persist? Lessons for conservation biology. Conservation Biology 1:59-62.

Grassland Bypass Project. May 2001. Monthly Data Report, March 2001, Preliminary Results. Compiled by the San Francisco Estuary Institute, 19 pp.

Hall, H. M. 1983. Status of the kit fox at the Bethany wind turbine generating (WTC) project site, Alameda County, California. The Resources Agency, California Department of Fish and Game. Sacramento, California.

Hansen, G. E. 1996. Status of the giant garter snake (*Thamnophis gigas*) in the San Joaquin Valley in 1995. Final report for Calif. Depart. Fish and Game Standard Agreement No. FG4052IF. Unpubl. 31 pp.

Hansen, G.E. 1986. Status of the giant garter snake *Thamnophis couchi gigas* (Fitch. in the Southern Sacramento Valley During 1986. Final report for Calif. Depart. Fish and Game Standard Agreement No. C-1433. Unpubl. 31 pp.

Hansen, G.E. 1982. Status of the giant garter snake (*Thamnophis couchi gigas*. along portions of Laguna and Elk Grove creeks, Sacramento County, California. Report to Sacramento County Planning Dept. 15 p.

Hansen, R. W. 1988. Review of the status of the giant garter snake (*Thamnophis couchi gigas)* and its supporting habitat during 1986-87. Final report to California Department of Fish and Game, Contract C-2060. 31 pp.

Hansen, R. W 1980. Western aquatic garter snakes in central California: an ecological and evolutionary perspective. Fresno, CA. California State University, Fresno. Thesis. 78 pp.

Hansen, G. E. and J. M. Brode. 1980. Status of the giant garter snake *Thamnophis couchi gigas* (Fitch). California Department of Fish and Game, Inland Fisheries Endangered Species Program Special Publication 80-5, 14 pp.

Hansen, R. W. and G. E. Hansen. 1990. *Thamnophis gigas* (giant garter snake) reproduction. *Herp. Rev.* 21(4): 93-94.

Harris, J. H. 2000. Preliminary Assessment of Biological Resources Portions of Mercy Springs Water District. Environmental Consulting, Oakland, California. June, 24, 2000. 11 pp.

Heinz, G. H. 1996. Selenium in birds. In *Interpreting Environmental Contaminants in Animal Tissues*, W. N. Beyer, G. H. Heinz, and A.W. Redmon, eds., pp. 453-464. Boca Raton, Florida: Lewis Publishers.

Heinz, Gary H., D.J. Hoffman. 1998. Methylmercury chloride and selenomethionine interactions on health and reproduction in mallards. *Environ. Toxicol. Chem.*, 17:139-145.

Helm, B.P. 1998. Biogeography of eight large Branchiopods endemic to California. Pp. 124-139 *in* C.W. Witham, E.T. Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff, eds. Ecology, conservation, and management of vernal pool ecosystems--proceedings from a 1996 conference. California Native Plant Society; Sacramento, CA.

Henderson, J.D., T.C. Maurer, and S.E. Schwarzbach. 1995. Assessing Selenium Contamination in Two San Joaquin Valley, California Sloughs: An Update of Monitoring for Interim Re-use of the San Luis Drain. U. S. Fish and Wildlife Service internal report, Division of Environmental Contaminants, Sacramento, CA.

Henny, C.J., and G.B. Herron. 1989. DDE, selenium, mercury, and white-faced ibis reproduction at Carson Lake, Nevada. *J. Wildl. Manage.*, 53:1032-1045

Hinds, N.E.A. 1952. Evolution of the California landscape. Calif. Div. of Mines Bull. No. 158. 240 pp.

Holland, R. F. 1978. The geographic and edaphic distribution of vernal pools in the Great Central Valley, California. California Native Plant Society, Special Publication 4:1-12.

Holland, R. F. 1998. No Net Loss? Changes in great valley vernal pool distribution from 1989 to 1997. California Department of Fish and Game, Natural Heritage Division, Sacramento, California, 16 pp.

Holland, R. F., and S. Jain. 1988. Vernal pools. Pages 515-533 *in* M. E. Barbour and J. Major, eds. Terrestrial vegetation of California, new expanded edition. California Native Plant Society, Special Publication Number 9, Sacramento, California.

Hunting, K.W., and S. Fitton. In Press. Winter distribution and habitat use by the mountain plover (Charadrius montanus) in California.

Imai, I., S. Itakura, Y. Matsuyama, and M. Yamaguchi. 1996. Selenium requirement for growth of a novel red tide flagellate *Chattonella verruculosa* (Raphidophyceae) in culture. *Fisheries Sci.*, 62:834-835.

Jarvinen, A.W., and G.T. Ankley. 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals. Society of Environmental Toxicology and Chemistry (SETAC) Press, Pensacola, FL. 364 pp.

Jones and Stokes Associates. 1989. Draft Environmental Impact Report: Vasco Road and Utility Relocation Project SCH#: 89032123. Prepared for Contra Costa Water District, Concord, California.

Jones and Stokes Assoc., Inc. 1993. Sutter Bypass fisheries technical memorandum II: Potential entrapment of juvenile chinook salmon in the proposed gravel mining pond. May 27, 1993 (JSA 91-272). Sacramento, California. Prepared for Teichert Aggregates, Sacramento, California. 31 pp + Appendix.

Jorgensen, P.D., and H.L. Ferguson. 1984. The birds of San Clemente Island. *Western Birds* 15:111-130.

Jurek, R.M. 1973. California shorebird study: accelerated research program for shore and upland migratory game birds. Project final report. California Department of Fish and Game, Sacramento. 233 pp.

Karkoski, J. 1994. A Total Maximum Monthly Load Model for the San Joaquin River. Staff Report of the California Regional Water Quality Control Board, Central Valley Region.

Kimmerer, W. and C. Peñalva. 2000. All Copepods are not created equal: effects of the clam Potamocorbula amurensis on estuarine foodwebs. *In* CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

King, G. 1992. Geomorphology of Piedmont vernal pool basins, California. Pages 19-36. *The California Geographer.* California Geographical Society.

Knopf, F.L. 1996a. Prairie legacies - birds. Pages 135-148 in F. Samson and F. Knopf, ed. Prairie Conservation. Island Press, Covelo, California. 339 pp.

Knopf, F.L. 1996b. Mountain plover (Charadrius montanus). In The Birds of North America. Editors: A. Poole and F. Gill. Number 211. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C. 16 pp.

Knopf, F.L., and J.R. Rupert. 1995. Habits and habitats of mountain plovers in California. *Condor* 97:743-751.

Knopf, F.L., and J.R. Rupert. 1996. Reproduction and movements of mountain plovers breeding in Colorado. *Wilson Bulletin* 108:28-35.

Krapu, G.L. 1974. Foods of breeding pintails in North Dakota. *J. Wild. Manag.* 38(3):408-417.

Kuivila K.M., and C.G. Foe. 1995. Concentrations, transport and biological effects of dormant spray pesticides in the San Francisco Estuary, California. *Environ. Toxicol. And Chem.*, 14(7):1141-1150.

Larsen, C.T., F.W. Pierson, and W.B. Gross. 1977. Effect of dietary selenium on the response of stressed and unstressed chickens to *Escherichia coli* challenge and antigen. *Biol. Trace Elem. Res.*, 58:169-176.

Lemly, A.D. 1996a. Assessing the toxic threat of selenium to fish and aquatic birds. *Environ. Monit. Assess.*, 43:19-35.

Lemly, A.D. 1996b. Selenium in aquatic organisms. Pp.427-445 in: W.N. Beyer, G.H. Heinz, and A.W. Redmon, (eds.), Interpreting Environmental Contaminants in Animal Tissues. Lewis Publishers, Boca Raton, FL.

Lemly, A.D. 1996c. Winter stress syndrome: an important consideration for hazard assessment of aquatic pollutants. *Ecotoxicol. Environ. Safety*, 34:223-227.

Lemly, A.D. 1997a. A Teratogenic Deformity Index for Evaluating Impacts of Selenium on Fish Populations. *Ecotoxicol. Environ. Safety*, 37:259-266.

Lemly, A.D. 1997b. Ecosystem Recovery Following Selenium Contamination in a Freshwater Reservoir. *Ecotoxicol. Environ. Safety*, 36:275-281.

Lemly, A.D. 1997c. Environmental Hazard of Selenium in the Animas La Plata Water Development Project. *Ecotoxicol. Environ. Safety*, 37:92-96.

Lillebo, H.P., S. Shaner, D. Carlson, N. Richard, and P. DuBowy. 1988. Water quality criteria for selenium and other trace elements for protection of aquatic life and its uses in the San Joaquin Valley. SWRCB Order No. W.Q. 85-1 Technical Committee Report, Appendix D. California State Water Resources Control Board, Sacramento, CA.

Luoma, S.N. and T.S. Presser. 2000. Forecasting Selenium Discharges to the San Francisco Bay-Delta Estuary: Ecological Effects of a Proposed San Luis drain Extension. U.S. Geological Survey Open File Report 00-416, Menlo Park, California.

May, J.T., R.L. Hothem, C.N. Alpers, and M.A. Law. 2000. Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California. U.S. Geological Survey, Open File Report 00-367. Sacramento, California. 35 pp.

McGrew, J.C. 1979. *Vulpes macrotis. Mammal.* Species 123:1-6.

Meng, L. 1993. Status of Sacramento splittail and longfin smelt. Report submitted to U.S. Fish and Wildlife Service, August 1993.

Meng, L., and P.B. Moyle. 1995. Status of splittail in the Sacramento-San Joaquin Estuary. *Trans. Am. Fish. Soc.* 124:538-549.

Messersmith, J.D. 1966. Fishes collected in Carquinez Straight in 1961-1962. Pages 57-62 *in*: D.W. Kelly, editor. Ecological Studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fisheries Bulletin 133.

Monroe, M.W. and J. Kelly 1992. State of the estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moore, S.B., J. Winckel, S.J. Detwiler, S.A. Klasing, P.A. Gaul, N. R. Kanim, B.E. Kesser, A.B. DeBevec, K. Beardsley, and L. K. Puckett. 1990. Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California, Volume I and II, San Joaquin Valley Drainage Program, Sacramento.

Morrell, S.H. 1972. Life hisotry of the San Joaquin kit fox. *California Fish and Game* 58:162-174.

Moyle, P.B. 1976. Inland fishes of California. University of California Press, Berkeley, 405 pp.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. *Trans. Am. Fish. Soc.* 121:67-77.

Moyle, P.B., R.D. Baxter, T. Sommer, T.C. Foin, and R.R. Abbott. 2001. In prep. Sacramento Splittail White Paper. Presented in Draft Form at the January 29, 2001, CALFED Splittail Science Conference. 42 pp.

Moyle, P.B. and R. M. Yoshiyama 1992. Fishes, aquatic diversity management areas, and endangered species: A plan to protect California's native aquatic biota. Draft report prepared for California Policy Seminar, University of California, Berkeley, California. July 1992. 196 pp.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an estuary. *Science* 231:567-573.

(NRCS) Natural Resources Conservation Service 2000. 1997 National Resources Inventory, Summary Report, Revised December 2000. U.S. Department of Agriculture, NRCS and Iowa State University Statistical Laboratory, Ames, IA, 94pp.

(NRC) National Research Council. 1980. Mineral Tolerance of Domestic Animals. Committee on Animal Nutrition, NRC. National Academy of Sciences, Washington, DC.

(NRC) National Research Council. 1984. Nutrient Requirements of Poultry. Eighth Revised Edition. Committee on Animal Nutrition, NRC. National Academy of Sciences, Washington, DC.

(NRC) National Research Council. 1989. Irrigation-Induced Water Quality Problems: What Can Be Learned From the San Joaquin Valley Experience. Committee on Irrigation-Induced Water Quality Problems, Water Science and Technology Board, Commission on Physical Sciences, Mathematics, and Resources, NRC. National Academy Press, Washington, DC.

Ohlendorf, H.M., R.L. Hothem, T.W. Aldrich, and A.J. Krynitsky. 1987. Selenium contamination of the Grasslands, a major California waterfowl area. *Sci Total Environ.* 66:169-183.

Ohlendorf, H.M. 1996. Selenium. Pp. 128-140 in: A. Fairbrother, L.N. Locke, and G.L. Hoff (eds.), Noninfectious Diseases of Wildlife. Second Edition, Iowa State University Press, Ames, IA.

Olson, O. E. 1986. Selenium toxicity in animals with emphasis on man. *J. Am. Col. Toxicol.* 5:45-70.

O'Toole, D., and M.F. Raisbeck. 1998. Magic numbers, elusive lesions: Comparitive pathology and toxicology of selenosis in waterfowl and mammalian species. In: W.T. Frankenberger, Jr., and R.A. Engberg, eds., Environmetal chemistry of selenium. Marcel Dekker Inc., New York. P 355-395.

Panoche Drainage District. 2000. San Joaquin River Water Quality Improvement Project, Phase I. Negative Declaration/Initial Study. August 14, 2000.

Paveglio, F.L., and S.D. Clifton. 1988. Selenium accumulation and ecology of the San Joaquin kit fox in the Kesterson National Wildlife Refuge area. Report prepared for the U.S. Bureau of Reclamation. U.S. Fish and Wildlife Service, San Luis National Wildlife Refuge.

Pease, W., K. Taylor, J. Lacy, and M. Carlin. 1992. Derivation of site-specific water quality criteria for selenium in San Francisco Bay. Staff Report, California Regional Water Quality Control Board - San Francisco Bay Region, Oakland, CA. 37 p.

Pennak, R.W. 1989. Fresh-water invertebrates of the United States: Protozoa and mollusca. 3rd Ed. 628 pp.

Peters, M. 1994. Crustacea and amphibian sampling report, San Luis NWR Complex, 1994. Unpublished. July 1993.

Porter, K.R. 1972. Herpetology. W.B. Saunders Co., Philadelphia. 524 p.

Presser, T.S. February 26, 2001. Comments on Draft Environmental Impact Statement/Environmental Impact Report for the 9-year renewal of the Grassland Bypass Project. Memorandum from U.S. Geological Survey to the Bureau of Reclamation and Summers Engineering.

Presser. T. S. August 2001. Case Study Request from Federal Agencies: Monthly Forecasts for Selenium Concentrations in a Dry Year (1994) using Bay-Delta Selenium Model. U.S. Geological Survey, Menlo Park, California.

Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta. Pp. 115 - 119 in J. L. Turner and D. W. Kelley, eds.: Ecological studies of the Sacramento-San Joaquin estuary, Part 2. California Department of Fish and Game Fish Bulletin No. 136.

(Regional Board) California Regional Water Quality Control Board Central Valley Region. 1998. Compilation of Electrical Conductivity, Boron, and Selenium Water Quality Data for the Grassland Watershed and San Joaquin River: May 1985-September 1995. February 1998.

Rhian, M., and A. L. Moxon. 1943. Chronic selenium poisoning in dogs and its prevention by arsenic. *J. Pharmacol. Exp. Ther.* 78:249-264.

Romer, A.S. 1966. Vertebrate Paleontology, 3rd ed. University of Chicago Press, Chicago. 468 p.

Rossman, D. A. and G. R. Stewart. 1987. Taxonomic reevaluation of *Thamnophis couchi.* Occasional Papers of the Museum of Zoology, Louisiana State University, No. 63, 23 pp.

Rossman, D.A., N. B. Ford, and R. A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman and London.

Russell, S.M., and D.W. Lamm. 1978. Notes on the distribution of birds in Sonora, Mexico. *Wilson Bulletin* 90:123-131.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. *Bulletin of U.S. Bureau of Fisheries* 27(637):103-152.

Saiki, M.K., and D.U. Palawski. 1990. Selenium and other elements in juvenile striped bass from the San Joaquin Valley and San Francisco Estuary, California. *Arch. Environ. Contam. Toxicol.*, 19:717-730.

Schamber, R.A., E.L. Belden, and M.F. Raisbeck. 1995. Immunotoxicity of chronic selenium exposure. Pp. 384-393 *in* G.E. Schuman, and G.F. Vance, (eds.), Decades Later: A Time For Reassessment. Proceedings of the 12th Annual National Meeting, American Society of Surface Mining and Reclamation, Princeton, WV.

Schwartz, M.K., K. Ralls, D.F. Williams, and R.C. Fleischer. 2000. Genetic variation and substructure of San Joaquin kit fox population. Unpublished report.

Sefchick-Edwards, J. 1998. Boron. Pp. 25-40 *in* P.L. Martin and D.E. Larsen (Eds.), Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water, and Sediment. *National Irrigation Water Quality Program Information Report No. 3.* United States Department of Interior; U.S. Bureau of Reclamation, Denver, CO. 198 pp.

Seiler, R.L., J.P. Skorupa, D.L. Naftz, and B.T. Nolan. In Press. Irrigation-induced Contamination of Water, Sediment, and Biota in the Western United States ---- Synthesis of Data from the National Irrigation Water Quality Program. *Professional Paper Series.* U.S. Geological Survey, Reston, VA.

Service 2001. Endangered Species Projects Database (Paradox). Sacramento Fish and Wildlife Field Office, Sacramento, California.

(SJVDP) San JoaquinValley Drainage Program. 1990. A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley. Final Report of the San Joaquin Valley Drainage Program, Sacramento, California, 183pp.

Simovich, M., R. Brusca, and J. King. 1992. Invertebrate survey 1991-1993 PGT-PGE/Bechtel pipeline expansion project. University of San Diego, Alcala Park, San Diego, California.

Skorupa, J.P., S.P. Morman, and J.S. Sefchick-Edwards. 1996. Guidelines for interpreting selenium exposures of biota associated with nonmarine aquatic habitats. Report to U.S. Department of Interior, National Irrigation Water Quality Program. U.S. Fish and Wildlife Service, Division of Environmental Contaminants, Sacramento, CA. 74 p.

Skorupa, J.P. 1998. Selenium poisoning of fish and wildlife in nature: Lessons from twelve real-world examples. Pp. 315-354 *in*: W.T. Frankenberger, Jr., and R.A. Engberg (eds.), *Environmental Chemistry of Selenium.* Marcel Dekker, New York, NY.

Slotton, D. G., T.H. Suchanek, and S.M. Ayers. 2000. CALFED-UC Davis Delta Mercury Study: Year 2 Findings. *In* CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

Sommer, T.R., Baxter, and B. Herbold. 1997. Resilience of Splittail in the Sacramento-San Joaquin Estuary. *Trans. Am. Fish. Soc.* 126:961-976.

Strecker, J.K. 1912. The birds of Texas. Baylor University Bulletin 15:23. Swarth, H.S. 1914. A distributional list of the birds of Arizona. Cooper Ornithological Club. *Pacific Coast Avifauna* 10:21.

Steensen, R.A., J.E. Chilcott, L.F. Grober, L.D. Jensen, J.L. Eppinger, and T. Burns. 1997. Compilation of electrical conductivity, boron, and selenium water quality data for the Grassland Watershed and San Joaquin River, May 1985-September 1995. Staff Report. California Regional Water Quality Control Board, Central Valley Region, Sacramento, CA. 59 p.

Stevens, D. E., S. W. Miller, and B. C. Bolster 1990. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. California Department of Fish and Game Candidate Species Status Rept. 90-2. 149 pages.

Stewart, A.R., S.N. Luoma, M. Doblin, K. Hieb, and K. Miles. 2000. Bioaccumulation of selenium in the food web of San Francisco Bay: importance of feeding relationships. *In* CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

Storer, T.I., R.L. Usinger, R.C. Stebbins, and J.W. Nybakken. 1972. General Zoology, 5th ed. McGraw-Hill Inc., New York. 899 p.

Suchanek, T.H., D.G. Slotton, S. Ayers, and D.C. Nelson. Methyl mercury bioaccumulation in re-flooded wetlands in the San Francisco Bay-Delta ecosystem.. *In* CALFED Bay-Delta Program Science Conference 2000. Data presented at the CALFED Science Conference in October 2000.

Sugnet and Associates. 1993. Preliminary compilation of documented distribution, fairy shrimp and tadpole shrimp proposed for listing. Roseville, California.

Swanson, C. And J. J. Cech, Jr. 1995.Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. 77 pp.

Swanson, G.A., M.I. Meyer and J.R. Serie. 1974. Feeding ecology of breeding blue-winged teals. *J. Wildl. Manage.* 38:396-407.

Swarth, H. 1914. A distributional list of the birds of Arizona. Cooper Ornithological Club. *Pacific Coast Avifauna* 10:21.

Sweetnam, D.A. and D.E. Stevens 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. 98 pages plus appendices.

Tully, W.C., and K.W. Franke. 1935. A new toxicant occurring naturally in certain samples of plant foodstuffs. VI. A study of the effect of affected grains on growing chicks. *Poult. Sci.*, 14:280-284.

Turner, J.L. and D.W. Kelley 1966. Ecological studies of the Sacramento-San Joaquin Delta. Calif. Dept. Fish and Game Bull. 136.

(USDI-BOR) U.S. Bureau of Reclamation. 1999. Kesterson Reservoir 1998 Biological Monitoring. Final Report prepared by CH2M HILL for the U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA (May, 1999).

(USDI-BOR) U.S. Bureau of Reclamation. 2001a. Biological Assessment, Central Valley Project Improvement Act, Long-Term Refuge Water Supply Water Service Agreement for the San Joaquin River Basin Federal Wildlife Refuges, State Wildlife Areas and Grasslands Resource Conservation District, Merced and Fresno Counties, California. February 2001.

(USDI-BOR) U. S. Bureau of Reclamation. 2001b. Grassland Bypass Project Final Environmental Impact Statement /Environmental Impact Report. May 25, 2001.

(USDI-BOR *et al*.) U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and San Luis & Delta-Mendota Water Authority. 1998. Grassland Bypass Project, Annual Report. October 1, 1996 through September 30, 1997. May 1998.

(USDI-BOR *et al*.) U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, San Luis & Delta-Mendota Water Authority, and U.S. Environmental Protection Agency. 1996. Compliance monitoring program for use and operation of the Grasslands Bypass Project. Mid-Pacific Region, Sacramento, California. September 1996.

(USDI-BOR/FWS/GS/BIA) United States Department of the Interior - Bureau of Reclamation/Fish and Wildlife Service/Geological Survey/Bureau of Indian Affairs. 1998. Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water, and Sediment. National Irrigation Water Quality Program Information Report No. 3. Bureau of Reclamation, Denver, CO. 198 p.

(USDI-FWS) U.S. Fish and Wildlife Service. 1992. Wetland losses within northern California from projects authorized under Nationwide Permit No. 26. Sacramento Field Office. Sacramento, California.

(USDI-FWS) U.S. Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; determination of threatened status for the giant garter snake. Federal Register 58:54053-54066.

(USDI-FWS) U.S. Fish and Wildlife Service. 1994. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. 34 pages, plus figures.

(USDI-FWS) U.S. Fish and Wildlife Service. 1996. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.

(USDI-FWS) U.S. Fish and Wildlife Service. 2000. Interim Water Contract Renewal Consultation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, File No. 1-1-00-F-0056, Sacramento, California, 6 chapters and appendix.

(USDI-FWS and NMFS) U.S. Fish and Wildlife Service and National Marine Fisheries Service. 2000. Formal Section 7 Consultation on the Environmental Protection Agency's Final Rule for the Promulgation of Water Quality Standards: Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, File No. 1-1-98-F-21, Sacramento, California.

Wang, J.C.S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 28.

Wang, C., R.T. Lovell, and P.H. Klesius. 1997. Response to *Edwardsiella ictaluri* challenge by channel catfish fed organic and inorganic sources of selenium. *J. Aq. Anim. Health*, 9:172-179.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Tech. Rept. 9.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. *J. Theor. Bio.* 48:215-229.

White, P.J., H.B. William, J.J. Eliason, and M.T. Hanson. 2000. Catastrophic decrease in an isolated population of kit foxes. The Southwestern Naturalist. 45(2):204-211.

Whiteley, P.L., and T.M. Yuill. 1989. Immune function and disease resistance of waterfowl using evaporation pond systems in the southern San Joaquin Valley, California, 1986-89. Final Report to the U.S. Fish and Wildlife Service, National Wildlife Health Research Center, Madison, WI. 202 p.

Wiener J.G., 1995. Bioaccumulation of Mercury in Fish. National Forum on Mercury in Fish. USEPA, Office of Water. June 1995. EPA 823-R-95-002.

Wylie, G.D. 1998. Results of the 1998 Survey for Giant Garter Snakes in and around the Grasslands Area of the San Joaquin Valley. Unpublished Report, U.S. Geological Survey-Biological Research Division, Western Ecological Research Center, Dixon Field Station, 2pp. and attachments.

Wylie, G. D., M. Cassaza, and J. K. Daugherty. 1997. 1996 Progress report for the giant garter snake study. Preliminary report, USGS, Biological Resources Division.

Young, Bob. 1999. Summary, Chapter 1 in Grassland Bypass Project Annual Report 1997-1998. U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and San Luis & Delta-Mendota Water Authority, Sacramento, California. June 1999.

Young, Bob. 2000. Summary, Chapter 1 in Grassland Bypass Project Annual Report 1998-1999. San Francisco Estuary Institute for U. S. Bureau of Reclamation, U.S. Bureau of Reclamation and U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and San Luis & Delta-Mendota Water Authority. Sacramento, California.

Final Biological Opinion, September 27, 2001
Regional Director, Mid-Pacific Region, U.S. Bureau of Reclamation

Young, Bob. 2001. Summary, Chapter 1 in [DRAFT] Grassland Bypass Project Annual Report 1998-1999. San Francisco Estuary Institute for U. S. Bureau of Reclamation, U.S. Bureau of Reclamation and U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Geological Survey, Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and San Luis & Delta-Mendota Water Authority. Sacramento, California.

Zedler, P.H. 1987. The ecology of southern California vernal pools: a community profile. Biological Report 85 7.11. U.S. Fish and Wildlife Service, Washington, D.C.

Personal/Written Communications

Allen, L. August 13, 2001. Revised Biological Assessment for the Grassland Bypass Project. Memo from Deputy Regional Environmental Officer, U.S. Bureau of Reclamation to Deputy Assistant Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Fish and Widlife Office, Sacramento CA, 4pp.

Allen, L. August 16, 2001. Comments on August 3, 2001, Administrative Draft Biological Opinion on the Continuation of the Grassland Bypass Project, Madera, Merced and Fresno Counties, California, October 1, 2001 - December 31, 2010. Memo from Deputy Regional Environmental Officer, U.S. Bureau of Reclamation to Deputy Assistant Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Fish and Widlife Office, Sacramento CA, 16 pp.

Browning, G. July 17, 2001. Mendota Pool Group Contribution to Elevated Selenium Levels in the San Joaquin River and the Grasslands Area, March and April 2001. Letter from Luhdorff and Scalmanini, Consulting Engineers, Woodland, California, to Judi Tapia, U.S. Bureau of Reclamation, South Central California Area Office, Fresno, California, 3pp.

California Department of Fish and Game, unpublished data, 1999, Stockton, California.

California Department of Fish and Game, unpublished data, 2000, Stockton, California.

Final Biological Opinion, September 27, 2001
Regional Director, Mid-Pacific Region, U.S. Bureau of Reclamation

McGahan, J.C. Revised June 21, 2001. High Selenium Concentrations in the Grasslands Channels above the 2 ppb Water Quality Objective. Memorandum to Central Valley Regional Water Quality Control Board from Summers Engineering, Hanford, California, 2pp.

Skorupa, J.P. Personal Communication. U.S. Fish and Wildlife Service, Sacramento Fish and Widlife Office, Environmental Contaminants Division.